SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) ..... $3.00 a year
Scientific American Supplement (Established 1876) ..... 5.00 "
Scientific American Building Monthly (Established 1885) ..... 2.50 "
Scientific American Export Edition (Established 1878) ..... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, SEPTEMBER 6, 1902.

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.

VENTILATION OF UNDERGROUND ROADS.

The New York Subway, which gives every indication of being in regular service by the close of next year, will have a distinct advantage over the majority of the London tunnel roads in the fact that the greater part of it lies very near the street surface. This advantage will be felt both in respect of the ease of access (elevators being necessary only at a few stations) and in respect of that most important point, ventilation. The official investigations which have been recently carried out to test the quality of the air in the London tunnels possess considerable interest for the residents of this city, although we have every reason to expect that the air in our Subway will be purer and sweeter. The tests referred to show that in the London "tubes" there is normally 100 per cent more carbonic acid gas than the law recognizes as healthy and allowable in English factories and workshops, where the maximum amount permitted is seven parts in 10,000. At street level the average is four in 10,000. As compared with this, the tests on air taken from the Charing Cross station of the Central London Railway showed that there were 13.8 volumes of carbonic acid gas in every 10,000, while in the crowded cars it rose as high as 27.5. While there is no special danger in these conditions, it is considered that in granting franchises for future underground roads it will be advisable to call for better provisions for ventilation than exist in those which have been already built. When these roads were constructed it was supposed that the air would be kept in constant circulation by the piston-like effect of the trains as they moved through the tunnels. It was found that while the trains do keep the air in circulation they have no tendency to draw in fresh air, or expel that which is vitiated. With a view to meeting this defect the engineers who have made the investigation suggest the provision of special outlets, placed where they will best serve their purpose. Special air inlets are also to be provided at each station; and in order to produce the necessary suction to draw the pure air into the tunnel behind a train it is proposed to provide trap-doors at each station, which can be closed immediately after the last car of a train has left it. By this arrangement each length of tunnel, with its moving train, will form a sort of mammoth air pump, and the air throughout the whole system will be in a condition of constant renewal and purification. The plan proposed appears to be thoroughly practicable and simple, and no doubt it will command the attention of our Subway engineers. Of course it would be impossible to adopt this system on the main four-track road, where the tracks are only separated by lines of supporting columns; but on those portions of the road where the track lies in single tube this method could be applied, no doubt, with good results.

WEST POINT METHODS FOR SANDHURST.

It will be remembered that one of the most undisputed facts brought out by the recent South African war was that while the British officers were conspicuous for courage, many of them were woefully lacking in professional ability. The reforms which have been brought about by the war in the British army have included the appointment to the command of the Staff College at Sandhurst of Colonel Kitson, an officer well known in this country, who has always been a great admirer of West Point methods, and who, indeed, since his appointment has openly announced his determination to remodel that institution on the lines of our own military academy. Americans have always been proud, and justly so, of this famous and historic institution, and it is distinctly gratifying to know that the methods which have made this institution known the world over are to be adopted by the leading nation of the Old World. Hitherto, Sandhurst has been more a social and aristocratic institution than a military one; certainly it has never been noted for the hard work and severe curriculum for which West Point is renowned. Should Col. Kitson succeed in infusing into the pupils at Sandhurst the principles and *esprit de corps* that characterize West Point graduates he will have earned the lasting gratitude of the British nation, and will be found to have done more to promote the efficiency of the British army than any military man in England since the days of Cromwell.

A POINT IN BOILER CONSTRUCTION.

In an article in which it was shown that flaring the tubes after they have been expanded in place increases the holding power about 300 per cent, a strong plea is put in for the flaring, as against the mere expanding, of boiler tubes by our contemporary, The Locomotive. Among the many valuable full-sized tests which have been carried out from time to time by that journal, was a series to determine the holding power of tubes that were set in various ways. It was found that when tubes 3 inches in external diameter were merely expanded into the tube-sheet it required a pull of about 6,300 pounds to withdraw them, whereas it took about 19,700 pounds to withdraw those which were expanded and flared. From these data it is shown that a 4-inch tube, running under a pressure of 200 pounds per square inch, and merely expanded into place, has a factor of safety of 2.5, which our contemporary considers to be entirely too small. With the tubes properly flared, the factor of safety under like conditions would be 7.8, which is considered to be quite large enough. While it is admitted that there are many water-tube boilers that are running satisfactorily to-day with tubes that are merely expanded into place, it must be remembered that there has been a great rise in pressures of late years, and that constructions which may have been thoroughly up to the standard fifteen or twenty years ago are considerably below it in this day of pressures of 200 pounds to the square inch and upward. These conditions, we think, should render the practice of flaring the tube ends an indispensable feature of first-class modern boiler construction.

OUR FASTEST BATTLESHIP.

For the first time in its history the American navy possesses a battleship with a speed of 18 knots and over. The distinction belongs to the new "Maine," which, on August 23, was sent over the Cape Ann course for her official speed trials. The contract calls for a speed of 18 knots an hour on a run of four continuous hours. The lowest speed on any stretch of the trial was on a 6-mile leg on which she averaged only 17.35 knots an hour, while the fastest stretch was made at a speed of 18.9 knots. The result was that the mean speed developed, disregarding tidal allowances, was announced as 18.3 knots an hour. These figures, however, were made by the builders of the boat, and are subject to correction when the official results are made known. Although the "Maine" has slightly exceeded her contract speed, the result for an American warship was rather disappointing, for the reason that our battleships have been accustomed to exceed their contract trial speeds by a knot or more an hour when steaming over the Cape Ann trial course. Thus, the "Oregon" made 16.8 knots an hour, or 1.8 knots more than the contract speed; the "Iowa" showed an advance of 1.1 knot, and the vessels of the "Alabama" class are 1.1½ knots faster than their trial requirements. On the other hand, we understand that the trial of the "Maine," unlike those of some of her predecessors, was carried out under normal conditions as regards coal and stokers, and, therefore, the speed achieved is more likely to be maintained when this vessel is in regular service than that of vessels whose trials were run under abnormal conditions.

ELECTRIC GLASS SMELTING.

A large electric installation for the smelting of glass by the electric current, which is being erected at Deutsch Matrei in Tyrol, will be in working order in the course of a few months. These are the first works constructed for the manufacture of glassware by electricity; though several experimental plants have been laid down, and the electrical process of glass-making has been practised for some time past at Plattenberg in Westphalia, where there is an installation of 2,000 horse power, water and steam combined, for supplying the necessary current. The first successful attempts at glass manufacture by the aid of the electric current were made some four years ago at Cologne by F. Becker, a glass-maker. Glass-making by electricity is rather a difficult process, since there is a great danger of devitrification through the heat generated by the arc being too intense. To surmount this difficulty Becker devised an ingenious arrangement of a series of arcs, and the glass in a molten state followed into crucibles which were heated by coal or some other means. But Becker found this process of combining electrical and ordinary heat unsatisfactory. Volker, his collaborator in these experiments, suggested another process by which he to a certain extent availed himself of the conductivity of the glass. On each side of the receptacles he ranged electrodes, and by this means kept the glass in a molten condition for some time. But in this system there was the danger of the glass being deteriorated by the crumbling carbon, by which its purity was ruined, and it was rendered unsaleable. To obviate this difficulty the electrodes were placed behind perforated diaphragms. Völker also devised a system by which he could melt the glass, not with the arc, but by a direct current of high resistance, by making briquettes of the smelting materials and the carbon, and thus fusing the components. The Industrie Verriere et des Dérivés of Brussels, in conjunction with the glass works at Plattenberg, took up the invention and reduced it to practice at Plattenberg and Brussels; but at first it was not found to be a very satisfactory process. The consumption of the current was too heavy. For example, a kilogramme of glass required 4 horse-power-hours to produce it. This consumption of current, however, has now been reduced to 1½ and 1¼ horse-power-hours. The cost of production will be still further cheapened at the works of the Matrei Compagne, the electric furnaces for which are to be simpler and more durable. A potential of 3,000 electric horse power will be utilized. Whether this electric process of manufacturing glass will become of any commercial utility it is yet too early to say; but the material at present produced by the electric current has no special advantages over that made by the conventional smelting process to recommend it.

THE EMERALD INDUSTRY OF COLOMBIA.

The British Foreign Office has published an interesting report concerning the emerald mining industry of the Republic of Colombia. According to this report the finest emeralds are discovered at the mines of Muzo and Coscuez, the property of the Colombian government. They are at present rented to a British company. Up to the year 1875 all the emerald mines in the country were the property of the nation. After that date the government granted the right of exploration and working to private enterprises, reserving only the right to the two foregoing mines. Since then several companies have been formed and considerable capital expended, with very poor results. The most promising of the latter appears to be the Somondoco mines, worked by a British company. The department of Boyaca, from a mining point of view, is of a totally different geological formation to the mining departments of the republic, no gold or silver being found except in the few rivers emptying into the Magdalena.

The one great mine of production is that of Muzo, famous since the year 1555 for the production of the finest emeralds of the world, a stone, in the rough, weighing 2,330 carats having been taken from one of the many veins of this mine. These mines are the property of the Colombian government, which leases them for periods of five years to the highest bidder at public auction, which takes place in the capital of the republic one year previous to the expiration of the term in force. The value of the production of these mines has always been kept a secret by the lessors.

The mode of working is similar to that generally adopted in large quarry mines. The top soil is removed by a hydraulic monitor washing until the slate rock is left bare, this being cut away by means of stout long bars handled by native labor, which is cheap, abundant and very good, and with the aid of blasting with black powder manufactured at the mines and employed where no danger can be done to existing veins. The precious stones are then extracted from the veins, which run in no given direction or angle in this slate rock formation. The stones are found chiefly in pockets, but occasionally some are found isolated from the veins, necessitating constant care and vigilance. The immense amount of debris which necessarily falls from the quarry, is carried away by means of discharges of water from reservoirs at an elevation above the workings. The flow of water is regulated automatically, great care being taken conveniently to direct this great discharge of water so that no damage may be done to existing productive veins. The short term of the lease does not admit of any very extensive system being adopted, (as for example, at the Kimberley diamond mines in South Africa,) to prevent stealing of the stones, but special care is taken in the selection of the workpeople, who, in turn, watch most carefully all operations on the banks. The stones, after extraction, are arranged in their respective classes, ranging from first to sixth quality, by the superintendent in charge, who forwards them insured to the markets.

The major portion of the stones are sent to British India to be cut, and afterward the better qualities to the markets of Europe for sale.

The theory of the genesis of the emerald is that the silicate of glucina and alumina ran in the fissures of the veins and their cooling off formed this particular hexagonal crystal, and according to its abundance pro-

duced greater or less quantity, as also the quality, according to the favorable or unfavorable conditions existing. The Coscuez group is said by tradition to be very rich and the quality of the stones said to be of the particular "canutillo" form and of superb quality. Many attempts have been made to find the actual "locus in quo" of the productive formation, but up to the present without success.

Recently, however, an emerald producing formation of great importance has been discovered by the aid of old Spanish parchments in the Somondoco district, locally known by the name of Chivor, but as yet has not been worked by the discoverers; at present only the old Spanish tunnels and workings, indicating that in past centuries great mining operations had been carried on there, have been overhauled, giving proof of the existence of emeralds of considerable crystallization. It is intended to open up these extensive workings, so long lost to the world since the suspension of the works by order of the King of Spain in the year 1792, owing to the fact that all the emerald properties, Muzo and Coscuez included, produced a loss and not a profit to the kingdom of Spain. This was due to the dishonesty of the captains of the mines, who, by law, were obliged to deliver the fifth part of the production to the King of Spain in return for the assistance afforded to them by the Royal House in the form of troops and ammunition to protect them from hostile tribes. It was during this suspension that so many mines were lost sight of and completely overgrown with tropical vegetation, as were also the bridle-paths which led to them through the forests and mountains. Even towns with 2,000 inhabitants dependent on the mines were abandoned; some have been rediscovered by accident, a hunter coming upon a paved street, or some stone foundations of a house. The Spaniards always built their houses with stone foundations. Among these lost towns Muzo may also be counted. At one time it boasted of seventeen churches and a large population. To-day there is one church and only about 300 people. It is interesting to note that, with one or two exceptions only, all the mines of any worth now being worked were known to the Spaniards, and in the majority of cases considerable workings are evident.

THE HEAVENS IN SEPTEMBER, 1902.

BY HENRY NORRIS RUSSELL, PH.D.

As the sun moves southward, and the shortening days bring the coolness of autumn, it seems appropriate to inquire: What is the nature of this immense supply of heat? By actual measurement (allowing for the heat absorbed by our atmosphere) it is found that the heat received by the earth under a vertical sun is enough, if all of it could be utilized, to run a one horse power engine for every four square feet of exposed surface. On account, however, of the absorption of heat by the air and the great mechanical losses in any form of heat engine, not 10 per cent of this power can be put to practical use. Nevertheless the energy is there, though we cannot harness it.

Now the cross-section of the earth, as seen from the sun, is about 1,200 million million square feet. So the rate at which the sun expends energy in warming the earth amounts to about 300 million million horse power.

But this is not all. If there were a number more planets each as large as the earth and at the same distance from the sun, they would form a close-packed spherical shell inclosing the sun completely, and intercepting all its radiation. This sphere would be 186,000,000 miles in diameter and would contain over 2,000,000,000 planets. The total radiation of the sun must then be 2,000,000,000 times what the earth receives. The corresponding number of horse power is about 600,000,000,000,000,000,000,000—a number quite beyond our power to grasp. It amounts to over 10,000 horse power for every square foot of the sun's whole surface.

What can supply the sun with this enormous amount of energy?

If the sun's heat was not kept up in some way, calculation shows that it would cool off entirely in a very few thousand years. Even if it were all composed of the best of fuel, its combustion would only keep it radiant for five or six thousand years more.

A satisfactory explanation has been given by Helmholtz, who assumes that the whole mass of the sun is slowly contracting. The mass of the descending layers and the force of solar gravity that acts on them are so great that a very large amount of heat is evolved by the process. His calculations show that the whole amount of the sun's radiation in a year would be accounted for by a decrease of 250 feet in the sun's diameter. The whole shrinkage of the sun in the 300 years since the invention of the telescope would be about fifteen miles. Twenty times as great a change could hardly be detected by the best modern observations. So we shall have to wait a few thousand years before any evidence of this shrinkage can be obtained by observation.

THE HEAVENS.

At 9 P. M. on the 15th Cygnus is overhead. Lyra lies to the west of it, then Hercules, Corona and Boötes, the last near setting. Ophiuchus and Serpeus are in the southwest, and Scorpio is setting there. Sagittarius is west of south. Jupiter is just due south, and Saturn is an hour west of him. Between them, and a little distance above, are the two double stars of Capricornus—both worth looking at with a fieldglass.

Aquila is above them, marked by the brilliant Altair, east of which is the little group of Delphinus. The southeastern sky is very dull, the only bright star being the lonely Fomalhaut, in the constellation of the Southern Fish, low down near the horizon.

Pegasus and Andromeda lie east of the zenith, with Aries and Perseus below and to the left. Capella is just rising in the northeast. Cepheus is above the Pole, Cassiopeia to the right, and Ursa Minor and Draco to the left of it, while Ursa Major is well down toward the northern horizon.

THE PLANETS.

Mercury is evening star throughout the month. On the 24th he is at his greatest elongation, but being south of the sun, sets less than an hour after sunset, and is, therefore, hard to see. On the 20th he passes close to the bright star Spica, their apparent distance being less than ¼ of a degree. This will be an interesting sight, though one must look sharp to see it in the twilight.

Venus is morning star, rising rather less than two hours before the sun. Although 150,000,000 miles distant, she is still the brightest of the planets. Mars is morning star in Cancer, rising about 2 A. M. in the middle of the month and gradually increasing in brightness.

Jupiter is in Capricornus, and is by far the brightest object in the evening skies. Saturn, which is in Sagittarius, comes next to him in this respect.

Uranus is in Ophiuchus. On the 10th he is in quadrature with the sun, and comes to the meridian at 6 P. M.

Neptune is in Gemini, and is also in quadrature with the sun on the 27th, being due south at 6 A. M.

THE MOON.

New moon occurs at noon on the 1st, first quarter at noon on the 9th, full moon at 1 A. M. on the 17th, and last quarter at 6 P. M. on the 23d. The moon is nearest us on the 19th and farthest away on the 7th. She is in conjunction with Mercury on the 3d, Uranus on the 9th, Saturn on the 12th, Jupiter on the 14th, Neptune on the 24th, Mars on the 27th and Venus on the 30th.

At 7 P. M. on the 23d the sun crosses the celestial equator, entering upon the sign of Libra, and, according to the almanacs, autumn commences.

THE SUPPLANTING OF AGRICULTURE BY CHEMISTRY.

Senator Berthelot, the well-known French chemist, has published an interesting paper anent the chemical synthesis of aliments, in which he foresees in the difficulties it still presents the economical emancipation of the human race, and the transformation of this planet into a vast pleasure ground. The more the conquest of electrical energy advances the nearer it appears to M. Berthelot that mankind approaches toward the substitution of chemistry for agriculture.

Just as agriculture was evolved from the hunting, fishing and pastoral stages of primitive mankind, so chemistry now sets up to displace with its products agricultural industries based on the production of living organisms, animal and vegetable, by the creation of nutritive matters. The farm is already being edged out by the factory, and engineers and mechanics will soon take the place of peasants and field laborers. It is not long since the possibility of creating by synthesis all the organic matters was held to be chimerical; now the possibility has been demonstrated so often as to render it undeniable. Alimentary stuffs may be broadly divided into three fundamental classes —fats, sugars and albumenoids. As early as 1854 M. Berthelot by chemical synthesis created bodies exactly similar to natural fats by means of substances related to them, namely, glycerine and acid. He also generated these two substances with hydrocarbons. Sugar can now be produced in the chemist's laboratory by similar combinations. Chemical synthesis has not yet created the albumenoids, which are more complex and more liable to spoil. There is no doubt, however, but this feat will shortly be accomplished. Chemical discoveries have already given rise to changes in agriculture. Madder has gone out of cultivation in the south of France, indigo in the West Indies and vanilla in other tropical places, owing to the chemical substitutes, and chemical foodstuffs are no more an impossibility than chemical dyestuffs. M. Berthelot, however, utters a note of warning against the illusion of thinking that food can be condensed into lozenges and pills, and that one's meals can be carried in a small chocolate box in one's waistcoat pocket. The human organism has its habits which are tantamount to necessities, and among its habits is that of burning from 250 to 300 grammes of carbon daily, and of eliminating from 15 to 20 grammes of nitrogen. Allowance must also be made for the waste in the body of about one-seventh of the food it consumes. A certain bulk or weight of food will, therefore, continue to be indispensable, and though this may be chemical food it is not likely ever to become so condensed that a man can carry a week's rations on the march without inconvenience as is sometimes suggested.

ANOTHER GREAT HYDRAULIC ELECTRIC POWER PLANT.

A company has organized in Los Angeles to build a large power plant on the banks of Feather River. This plant will be the largest electrical power development scheme yet undertaken or proposed in western America, and will rival that of the Niagara power plant. It will be located in Plumas county, Cal., from which point current will be transmitted to San Francisco, a distance of 180 miles. The water supply is to be obtained from the North Fork of Feather River, and impounded in two reservoirs of unusual size, one of which will cover 8,000 acres, and the other, in Butte Valley, a few miles distant and some 250 feet lower, will cover about 2,000 acres. The watershed area tributary to these reservoirs is about 600 square miles, on which the most prominent elevation is Lawson's Peak, a region of perpetual snow. The average rainfall of that region for the last twenty years has been about 67 inches, and for the twenty years previous to that about 70 inches, with a range of from 33 inches as a minimum to 103 inches as a maximum.

It is well known that Feather River is the largest tributary of the Sacramento, and only second to the Sacramento in discharge of any of the streams of the State, while the greater portion of the flow of the Feather comes from the watersheds tributary to the reservoir sites purchased by the new company. These reservoirs, when constructed, will be without parallel in the western half of the United States, and will be so designed as to equalize the flow of the stream available for power to about 1,500 cubic feet per second. From the main reservoir in Big Meadows it is proposed to construct a canal about 10 miles in length to the Butte Valley reservoir, the water being delivered into this reservoir, whence it will be carried along the edge of the canyon of Feather River by a series of tunnels for a distance of 5 miles to Mosquito Creek, where it will be given a vertical fall of 1,600 feet, producing a total of about 270,000 horse power.

The favorable character of the dam sites for these reservoirs and the absence of serious engineering obstacles on the conduits will render this enormous undertaking comparatively inexpensive and vastly cheaper per unit of power than any other power plant yet constructed in the West. It will enable the company to deliver the power even at the long distance of transmission contemplated, in successful competition with other plants. When it is remembered that the total development of power at Niagara thus far has not exceeded 100,000 horse power, a better conception of the magnitude of this new enterprise and its possibilities may be had. A corporation has been organized, to be known as the Western Power Company, with an authorized capital of $5,000,000, whose headquarters will be Los Angeles.

The feasibility of transmitting electricity over 180 miles has been fully demonstrated. Only a short time ago the Bay Counties Power Company completed connections with San Francisco over lines of the Standard Electric Company, and is now transmitting power to that city via Oakland around the head of San Francisco Bay with a pressure of 40,000 volts over a distance of 223 miles.

WHERE WOOD ENGRAVING ORIGINATED.

Much controversy was at one time excited about the country that could claim to have originated wood engraving. A very simple process was known to the Egyptians for the production of stamps, and it has been asserted that the Chinese printed from blocks of pear tree as early as the tenth century. The independent origination of the art has been generally credited to Germany among modern nations. In the Cologne district a St. Christopher, which has often been reproduced, was cut in 1423, a St. Sebastian in 1437, and a Madonna has been dated 1418. Playing cards were, however, in use in France in the middle of the fourteenth century, and the figures were impressions from wood blocks. It is allowable for France to dispute the priority of Germany, and many attempts have been made to claim the art as due to French enterprise. M. Henri Bouchot, of the Bibliothèque-Nationale, now declares that a part of a block with a representation of a Crucifixion has been discovered in a country town of France. The costumes are evidently those worn in the middle of the fourteenth century, and it is assumed that the wood block belongs to some time between 1340 and 1350.