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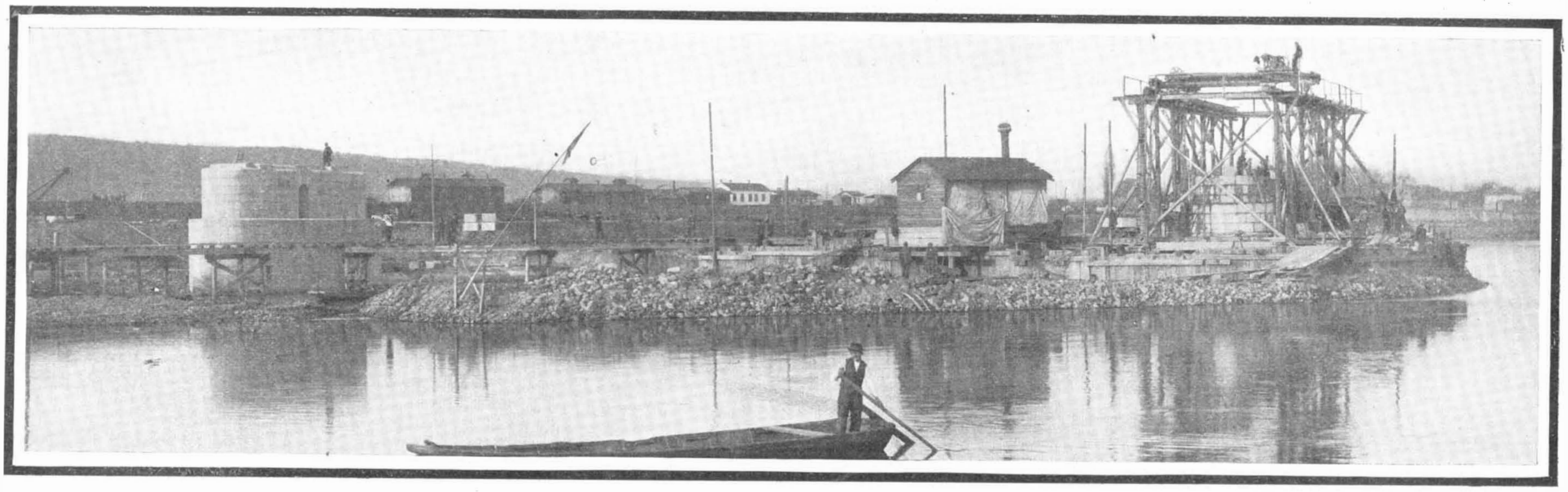
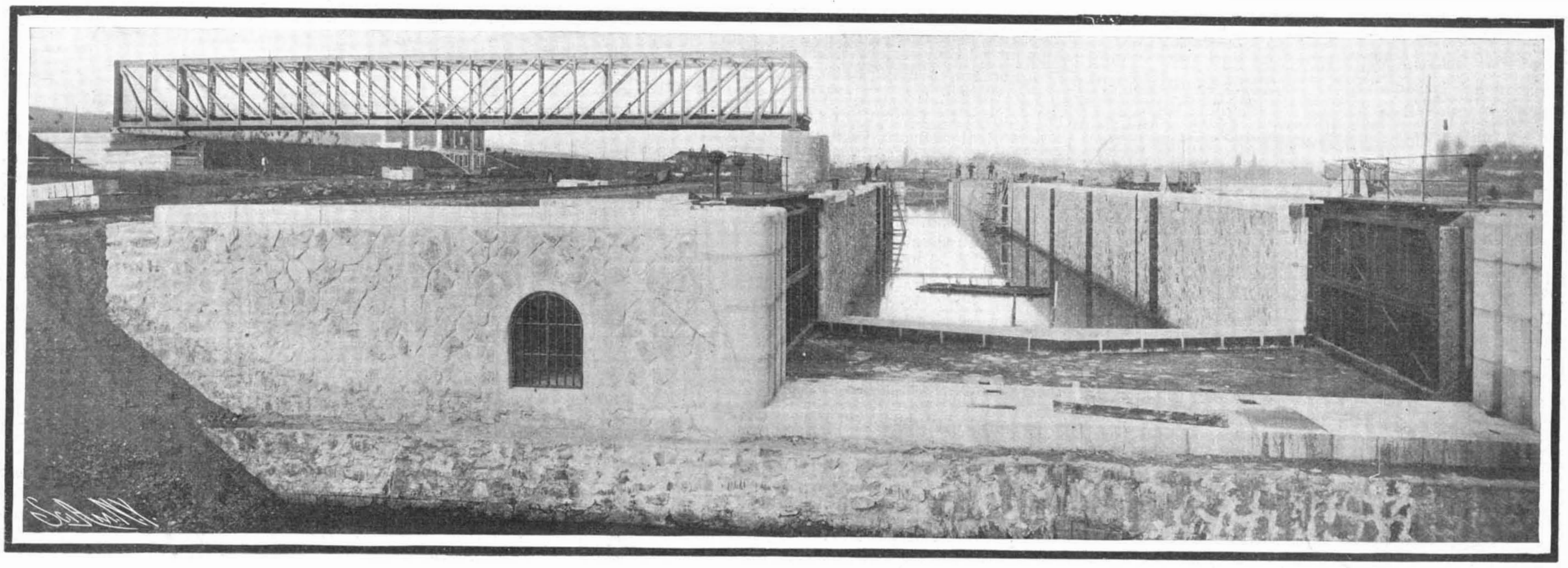
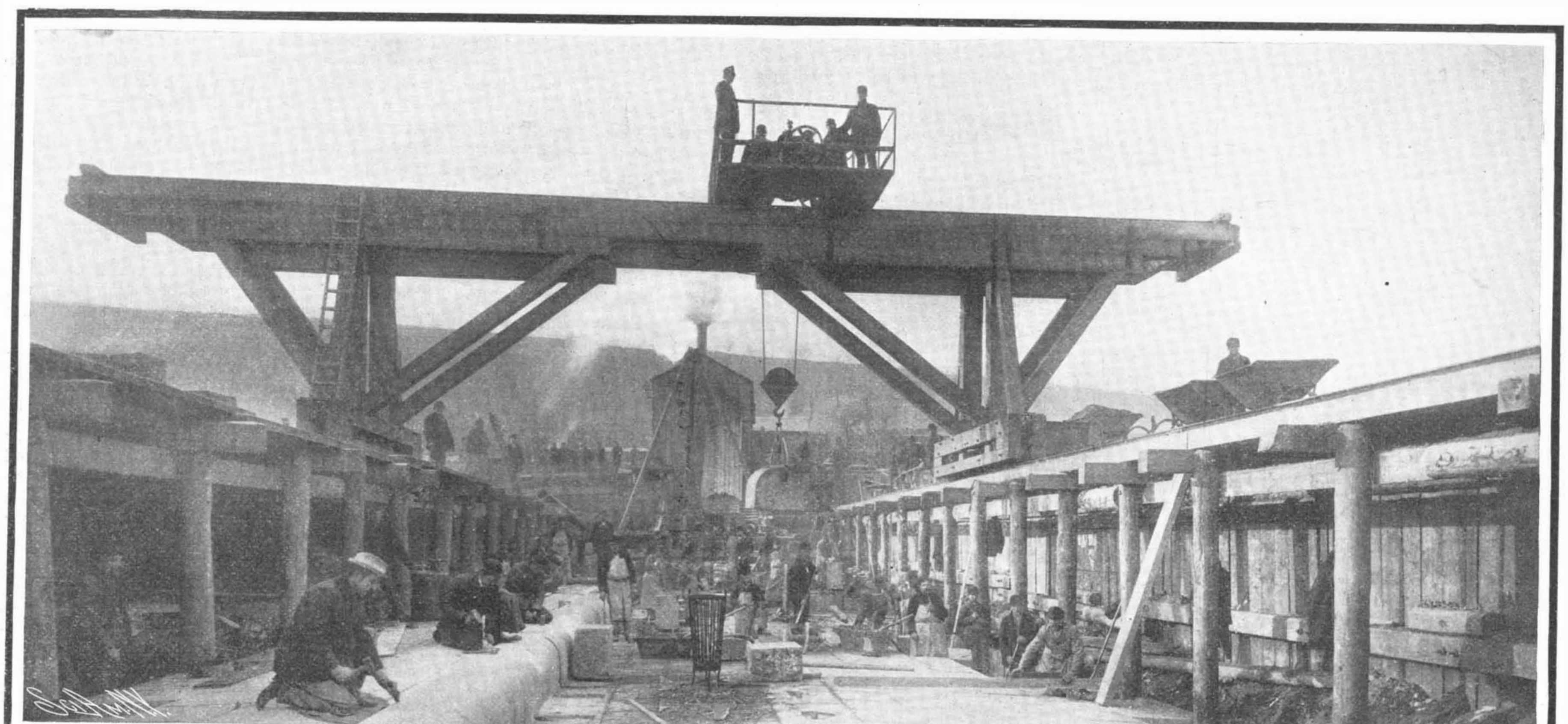


BUILDING THE WEIR AND BRIDGE NEAR MIROWITZ.



THE LOCKS AT MIROWITZ.



THE NEEDLE WEIR NEAR KLECAN.

THE CANALIZATION OF THE ELBE AND THE MOLDAU.

THE CANALIZATION OF THE ELBE AND THE MOLDAU.*

IN the opening up of new sections or districts, the problem of transportation demands immediate solution. It is for this reason that we find the homes of the early settlers scattered along the watercourses of the country. As the comers increase, intercommunication is maintained along the trails or paths of least resistance originally laid out by the denizens of the neighborhood in their progress to and from their feeding grounds.

Occupied with providing shelter and protection for himself and family, and in clearing and breaking up the land for his harvests, little thought is given to roads by the pioneer, and, consequently, the waterways of the vicinity are the only arteries which connect him with the outside world.

Increase in population and many helping hands, make it possible to widen the trails; and thus rude roads are constructed, which, as time advances and occasion requires, are developed into scientifically built highways, to be followed by bands of steel rails which cover the land, and, for the present, at least, seem to give the acme of transportation. The movement of heavy burdens by water, through natural or artificial channels, is far cheaper than by any other means of transportation, simply because the cost of maintenance is light. Before the advent of the locomotive, natural and artificial waterways received much consideration at the hands of the legislators and authorities. Of this, the numerous canals all over the world, connecting great lakes with tide waters or uniting the heads of navigable streams flowing in opposite directions, bear significant witness. Where canals were not actually dug, torrents or rivers whose shallow flow was not sufficient to float boats of mercantile size, were converted into slack-water canals as a quicker and cheaper method of meeting the demand.

Of these we had in our own country not a few, and to-day an observant traveler through the upper Lehigh Valley may still see the remains of the old locks and weirs which, at one time, dammed back the waters of the Lehigh and made of it a navigable stream bearing upon its sluggish bosom the precious coal from that carboniferous section toward the coast for further distribution.

Private interests controlling the railroads frowned upon and discouraged these primitive methods, while the ever-increasing demand for quicker transit caused them to be eventually abandoned in favor of the more rapid-moving car.

Despite the fact that all, or nearly all, the railroads of Europe are owned and run by the government, both freight and passenger rates are high there, and canals once established are never abandoned; rather is the agitation for new and more extended connections on the increase. The canalization of the upper reaches of the Elbe and the Moldau rivers, which we describe and illustrate, is but one of many such cases in point.

The great inland empire of Austria is traversed by many rivers. The lordly Danube, from its sources in the Tyrolese Alps, passes through the very heart of the dual empire, laving the edges of its most important cities, and flowing, a mighty stream, southerly and easterly, form the only outlet to the Black Sea. But from the north the Moldau, rising in upper Bohemia, and passing Prague on its way, empties into the Elbe, which, continuing its course through Saxony and Prussia to the German Ocean, supplies Austria with an outlet nearer to the center of commerce. To make the most of these conditions, it was decided (and for six years the work has already been carried forward) to form a back-water canal system in the upper reaches of these rivers, so that the great coal beds of Bohemia may have an opportunity to deliver their products at the sea without breaking bulk. It is not our purpose to give here an exhaustive treatise upon the subject, but to content ourselves with some interesting data, a general view of the regulation of the Moldau and the situation and method of construction of one of the locks, accompanied by a detailed view of one of the weirs.

These two main streams of Bohemia have from the earliest times been used for freighting purposes. Logs and timber from the Bohemian forests were floated northward, while the salt from the north, so necessary to the well-being of the sturdy Cechs, stemmed their courses in the opposite direction. Rising in the Riesengebirge (Giant Range) the Elbe develops as it runs southward to Pardubitz; thence passing to the westward, it reaches Kolin, whence, with a northwesterly trend, it hurries along to the Bohemian frontier without touching Prague, the capital city, receiving the waters of the Moldau opposite the city of Melnik. The fact that Prague is situated upon the Moldau and thus was left out of the improvement of the Elbe, made it necessary to include the river Moldau in the scheme. From Melnik the Moldau reaches back into Bohemia in almost a straight line to the border of Upper Austria, and the canalization of its unnavigable portion becomes the more important since the traffic upon its waters from its mouth to Budweis is capable of great development. The Moldau from Melnik *via* Prague to Budweis, and the Elbe from Melnik to the Bohemian frontier, are under the control of the Austrian government and comprise a strip of navigable water 345 kilometers (about 202 miles) long, of which about 7-10 is between Melnik and Budweis and 3-10 between Melnik and the frontier on the Elbe. Since 1870, when the tolls were removed, traffic on the Elbe from Shandau to Aussig and further down has increased beyond conception. In the year 1901 the amount of freight carried upon the Elbe in boats and timber rafts amounted to 3,521,495 tons, and upon the Moldau from Prague to Melnik, its junction with the Elbe, 294,921 tons. From which will be seen that the traffic upon the Moldau reaches scarcely one-tenth of that upon the Elbe, the greater part of which is carried over the short distance of 38 kilometers (about 23½ miles) between Aussig and the Bohemian frontier.

Since, with a simple regulation of the Moldau, no specially profitable results were in sight, the government determined upon a system of canalization of the river, which should provide a minimum depth of water of 2.1 meters (very nearly 7 feet), extending from Prague to Aussig. This is depth enough to float the largest 900-ton barges (100 tons smaller than those proposed for the new Erie Canal) now navigating the lower Elbe.

Between Prague and Melnik the Moldau falls 82.54 feet, and the Elbe, between Melnik and Aussig, drops 70.34 feet. As a consequence, there would be a lift of 152.89 feet to be overcome. For this purpose it would be necessary to build five dams or weirs across the Moldau, of which we show the needle dam at Klecan in detail while under construction, together with the finished weir and locks at Libschitz, while six dams across the Elbe will be needed.

The plan of the system is to construct sluices or side canals of greater or less length, extending from the weir, so that, if possible, the points of greatest fall in the river may be passed by.

Near the return of these canals to the natural river level are situated the locks, of which the combined drops are thus more than the fall of the river from the head of the dam to the re-entrance of the canal into the stream. In this way the number of weirs, and consequently the obstacles to the free passage of the boats, will be greatly reduced. The longest side sluice a canal of 10 kilometers (about 6¼ miles) in length, lies adjacent to the confluence of the Moldau with the Elbe. Here the terrain is flat and very low, being annually flooded by the freshets.

Accordingly, the side canal, which enters the Elbe just above Melnik, is shut off by a powerful flood gate. A few words concerning the conception and management of the work will be of interest here.

For the carrying out of the entire scheme a commission under the chairmanship of the governor of Bohemia was formed and endowed with all necessary technical and administrative powers.

This commission was inaugurated on November 23, 1896, and as early as July, 1897, had begun the building of the weir at Klecan. By the close of 1898 this was finished. During this year the dam at Libschitz was begun; and in two years it too was finished. The first dam at Troja, just below Prague, was begun in 1899, and something over a year ago it was turned into the system for traffic. As early as 1900 the dam at Mirowitz was begun, and the lateral canal from Wranan to Horin was commenced in 1902. Rapidly, as we see, this great work progresses. Twenty-six million Austrian crowns (about $5,500,000), of which the empire pays two-thirds and the department of Bohemia one-third, will be expended upon the improvement.

The following specifications confer upon the work its stamp of usefulness. In the passages around the dam a width of 30 meters (98.43 feet) must be maintained, and a molded depth of half a meter more than on the rest of the line.

For the navigation of the canalized river, locks are to be provided, with an upper chamber serving as a simple lock. The working length of each lock is to be 225 meters (738 feet), and that of its upper part, which is adapted to close separately and form a smaller lock, is to be 78 meters (255.91 feet). The clearance at the thresholds is to be 11 meters (36 feet); the width of the bottom of the main locks and the side canals, 20 meters (66 feet); and the depth of the sills 2½ meters (9.2 feet). The minimum depth of the canal is 2.1 meters (6.89 feet). The angle of slope below water is as 1:2, and above water, as 1:1½. The under side of all bridges over the canal must be at least 4.5 meters (14¾ feet) above the normal surface level of the water. For the preservation of the fisheries interest, a portion of the dam is to be constructed after a manner already approved, so as to allow the fish free passage both ways. The whole undertaking has been carried out with painstaking conformity to these rules.

The locks are thus capable of passing five large Elbe barges at one time, and as a consequence a gross tonnage of 3,800,000 tons can be yearly carried with ease. In considering the cuts singly we see in No. 2 the erection of the needle dam and the difficulties of its construction. This picture was taken standing upon the dam foundation on the left shore and at a point below the dam; it affords a peculiarly interesting view of the dam head and its supports.

There was much dry dredging done, for the machines lifted out 17,500 cubic meters (nearly 20,000 cubic yards) of material per month. After the first section of the dam was completed, in order to make a connection with the second section, a provisional dam had to be built across the entire width of the river, which required the removal of 25,125 cubic meters (about 28,000 cubic yards) of material per month. In cut No. 1 we have a perspective view of the country round about, with the dam at Libschitz at work, and an excellent view of the lock with its double chambers in the foreground. On the extreme right of the dam we see the fish-pass and the locks or spillways for the rafts. These locks were put to use on June 20, 1901, and at the close of navigation for that year 922 rafts had passed down. On the same day the ship locks were opened, and kept in service for 156 days, or till November 15 of the same year, and records show that 998 boats of all kinds passed up and down, of which 46 were steamers and 78 large Elbe barges. During the following year the traffic increased to 2,008 boats, of which 310 were steamers, 1,550 boats in tow and stone flats, and this despite the late opening of navigation. Upon the whole stretch thus far opened to public service the traffic has been regular and without obstruction.

To-day it extends from Prague to Libschitz, about 25 kilometers (say 17 miles). The work is being constantly pressed toward completion and there is no doubt but great benefit will be derived from the improvement, not only by the immediate vicinity, but its effects will be felt in more distant regions of the empire.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

AERIAL NAVIGATION.*

By O. CHANUTE, Chicago, Ill.

THERE are now dawnings of two possible solutions of the problem of aerial navigation—a problem which has impassioned men for perhaps 4,000 or 5,000 years. Navigable balloons have recently been developed to what is believed to be nearly the limit of their efficiency, and after three intelligent but unfortunate attempts by others, a successful dynamic flying machine seems to have been produced by the Messrs. Wright.

It is therefore interesting to review the present status of the question, the prospects of its solution, and the probable uses of the hoped-for airships.

BALLOONS.

As to balloons, we may pass over the early gropings and failures to make them navigable. It was recognized very soon that the spherical balloon was the sport of the wind, that it was necessary to elongate it in order to evade the resistance of the air, and that, inasmuch as aerial currents are much more rapid than aqueous currents, it was necessary of obtain considerable speeds in order to have a useful airship. This means that there must be great driving power, and that this power shall weigh as little as possible; for in any case the balloon itself with its adjuncts and passengers will absorb the greater part of its lifting power.

Giffard was the first to apply in 1852 an artificial motor to an elongated balloon. This motor consisted in a steam engine of 3 horse-power, which weighed with its appurtenances 462 pounds, and Giffard obtained only 6.71 miles per hour, although his balloon was 144 feet long and 39 feet in diameter, or about the size of a tramp steamer.

Dupuy de Lome in 1872 went up with a balloon 118 feet long and 49 feet in diameter, but, having a wholesome dread of the contiguity of fire and inflammable gas, he employed man power (weighing about 2,000 pounds to the horse-power) to drive his screws, and he obtained less speed than Giffard. The accidents to Wölfert and to DeBradsky have since shown the soundness of his fears.

Next came Tissandier in 1884, who employed an electric motor of 1½ horse-power, weighing some 616 pounds, with which he attained 7.82 miles per hour.

Meanwhile the French war department took up the problem. It availed itself of the labors of the previous experimenters and made careful and costly investigations of the best modes of construction, of the best shapes to cleave the air, and of the weight and efficiency of motors. This culminated in 1885 when Messrs. Renard and Krebs, of the aeronautical section, brought out the war balloon "La France" which attained about 14 miles an hour (or half the speed of a trotting horse) and returned to its shed five times out of the seven occasions on which it was publicly taken out.

This airship was 165 feet long, 27½ feet in diameter, and was provided with an electric motor of 9 horse-power, weighing with its appurtenances some 1,174 pounds. The longitudinal section was parabolic, somewhat like a cigar rolled to a sharp point at both ends, the largest cross-section being one-fourth of the distance from the front, and it was driven, blunt end foremost, by a screw attached at the front of the car. No better shape and arrangement have yet been devised and subsequent experimenters who have wandered away therefrom have achieved inferior results, so far as the coefficient of resistance is concerned.

In 1893 the French war department built the "General Meusnier," named after an aeronautical officer of extraordinary merit of the first French Republic. This war balloon is said to be 230 feet long, 30 feet in diameter, 120,000 cubic feet in capacity and to have been originally provided with a gasoline motor of 45 horse-power. It is said by all the writers on the subject that it was *never taken out*. Possibly the French were waiting for a war which fortunately never came; but, be this as it may, it is probable that with the reduction which has since taken place in gasoline motors this balloon could carry an engine of some 70 horse-power, and attain a speed of about 30 miles an hour, which is greater than that of transatlantic steamers.

Some unsuccessful experiments were carried on in Germany in 1897. First by Dr. Wölfert, whose balloon was set on fire by his gasoline motor and exploded in the air, killing both himself and his engineer, and later by Schwarz, whose aluminium balloon proved

* Paper read before Section D, American Association for the Advancement of Science, December 30, 1903.

unmanageable and was smashed in landing. The most ambitious attempt, however, was that of Count Zeppelin, who built in 1900 a monster airship 420 feet long and 39 feet in diameter. It was a cylinder with paraboloid ends, but the shape was inferior and almost all the lifting power was frittered away on an internal frame of aluminium, so that the gasoline motor could be of only 32 horse-power, and the speed attained has variously been stated at 8 to 18 miles per hour. Nevertheless the design of Count Zeppelin contained many excellent features, and a movement is now on foot in Germany to enable him to try again, through means of a popular subscription. The mere size, if he builds again as large, is a great element of success, for as the cubic contents and lift increase as the cube of the dimensions, while the weights increase in a far smaller ratio, a balloon of this great size ought to be able to lift a very powerful motor, and to attain a speed of 30 or more miles per hour. He has shown that the size is not beyond the possibility of control.

Meanwhile gasoline motors had been increasing in efficiency and diminishing in weight. The French war department gave no sign and it was reserved for a Brazilian, Mr. Santos Dumont, to show to the Parisians what could be accomplished by equipping an airship with a gasoline motor. The history of his triumphs is so present to all minds that it need only be alluded to, but it may be interesting to give some details of the sizes and arrangements of his various balloons. His first idea seems to have been that, in order to make it manageable, a balloon should be made as small as possible, and that it was practicable to disencumber it of many adjuncts hitherto considered indispensable. Neglecting to study carefully what had been found out by his predecessors, he had to learn by experience, and he built five balloons, all navigables, before he produced in 1901 his No. 6, with which he won the Deutsch prize, by sailing 3½ miles and return in half an hour. This balloon was 108 feet long, 20 feet in diameter, and was provided with a gasoline motor of 16 horse-power which might be driven up to 18 or 20 horse-power. While the speed over the ground was 14 miles an hour, retarded as it was by a light wind, the speed through the air was about 19 miles an hour, a small but marked advance over any previous performance; but the result would have been still better if the shape had been that of Col. Renard's balloon.

Since then Mr. Santos Dumont has built four new navigable balloons. His No. 7, with which he expects to compete at St. Louis in 1904, is 160 feet long and 23 feet in diameter, and is to be provided with a motor of 60 horse-power. His No. 8 was sold to parties in New York last year. His No. 9, which is his visiting balloon, is only 50 feet long and 18 feet in diameter, and provided with a 3 horse-power motor. Its speed is only 10 miles an hour, but it is handy to ride around to breakfast or afternoon teas. He is now finishing his No. 10, the omnibus, which is 157 feet long and 28 feet in diameter, with a motor of 46 horse-power. Fares are to be charged for by the pound of passenger when it comes out next spring.

Emulators of Santos Dumont there have been that have come to grief. Mr. Roze built in 1901 a catamaran consisting of two twin balloons, which, although 148 feet long, failed to raise their own weight serviceably. Mr. Severo built in 1902 a navigable balloon which was so injudiciously constructed that the car broke away in the air, and the inventor was killed as well as his engineer. Later in the same year De-Bradsky built a navigable balloon equipped with a gasoline motor located so near the vent for the gas that the latter took fire, exploded the balloon, and the inventor and his engineer were killed, thus for the second time verifying the fears of the experts who discountenanced this combination.

Some meritorious projects have been published but not yet carried out. Among these may be mentioned that of Mr. Yon, now deceased, and that of Mr. Louis Godard. The latter project was for a balloon 180 feet long and 36 feet in diameter, with two steam motors of 50 horse-power each. It was expected to attain a speed of 30 miles per hour.

One navigable balloon which was built this year, that of the Lebaudy brothers, has achieved a great success. It is 185 feet long, 32 feet in diameter, and is equipped with a gasoline motor of 40 horse-power. It has beaten the speed of Santos Dumont, having on many occasions, it is said, attained 24 miles an hour.

There is also a navigable balloon being built in Paris by Mr. Tatin for Mr. Deutsch, the donor of the famous prize. This is 183 feet long, 27 feet in diameter, and is equipped with a gasoline motor of 60 horse-power.

Besides these there are said to be a number of navigable balloons either being built or proposed in France. They are those of the Marquis de Dion, of Pillet & Robert, of Girardot, of Boisset, and of Bourgoin, but there is no telling how many of them will materialize.

These are all French balloons, while there are in England the balloon of Mr. Spencer, 93 feet by 24 feet, with nominally 24 horse-power; of Mr. Beedle, 93 feet by 24 feet, with 12 horse-power, and that of Dr. Barton, now in construction, with dimensions of 170 feet in length, 40 feet in diameter, and equipped with a number of aeroplanes and three gasoline motors of 50 horse-power each. It is a question whether the weight of the aeroplanes will leave sufficient margin to lift the 150 horse-power.

The ultimate practicable size for balloons is not yet known, but the mathematics of the subject are now tolerably well understood. The larger the balloon the more speed it can attain, and it is possible to design it so that the results shall not be disappointing. Those inventors who expect to attain 70 to 100 miles an hour by some happy combination do not know what they are talking about.

It is interesting to speculate which of the above-mentioned navigable balloons would, if competing, stand a chance of winning the $100,000 prize which has been offered by the St. Louis Exposition of 1904. So far as can now be discerned, the only vessels which are likely to develop the required minimum speed of 20 miles an hour over the ground, which speed really requires about 25 miles an hour through the air, as there will almost invariably be some wind, will be the Santos Dumont No. 7, the Lebaudy, and the Deutsch airships, all of them French. The English vessels of Spencer and of Beedle are too small to lift sufficient power to drive them at 25 miles an hour. The balloon of Dr. Barton might gain this speed if it were not 40 feet in diameter, besides being loaded down with aeroplanes, and it remains to be seen what will be the effect of this combination. The American airships all seem to be too small to lift enough power to give them the required speed save the Stanley airship, 228 feet by 56 feet in diameter, begun in San Francisco. Should this be completed in time, and should the weights be kept approximately near those stated in the circulars, it might have a chance to obtain 25 miles an hour, but it would need more than three times the 50 horse power contemplated in order to do so, and the weight of the aluminium shell and framing would probably absorb much of the lifting power.

FLYING MACHINES.

If the aeronautical contest at St. Louis were scheduled to take place a few years later, thus giving time to consummate recent success, it is not improbable that the main prize would be carried off by a flying machine. This yet lacks the safe flotation in the air which appertains to balloons, but it promises to be eventually very much faster.

The writer found, somewhat to his surprise, when on a visit to Paris last April, that a decided reaction has set in among the French against balloons. It seemed to be realized that the limit of speed had been nearly reached for the present, and that but small utility was to be expected from navigable balloons. They must be large, costly, and require expensive housing, while they are slow and frail and carry very small loads. As commercial carriers they are not to be thought of, but they may be useful in war and in exploration.

Hence the French are turning their thoughts toward aviation and propose to repeat some of the experiments with gliding machines which have taken place in America. Even Col. Renard, the celebrated pioneer of the modern navigable balloon, is now said to have become a convert to aviation and to say that the time has come to try the system of combined aeroplanes and lifting screws for flying apparatus.

A good deal of experimenting has been done with power-driven flying models. The more recent types have been actuated by twisted rubber threads, by compressed air and by steam, and the most notable experiments in order of date are those of Penaud, Tatin, Hargrave, Phillips, Langley, and Tatin and Richet. The data for these (except the first) will be found by searchers in such matters in the London Times edition of the "Encyclopædia Britannica," in the article on aeronautics. The most successful experiment was that of Prof. Langley, who obtained in 1896 three flights of about three-fourths of a mile each with steam-driven models, the apparatus alighting safely each time and being in condition to be flown again.

The one great fact which appears from all these various model experiments is that it requires a relatively enormous power to obtain support on the air. Omitting the cases in which the power was probably overestimated, the weights sustained were but 30 to 55 pounds to the horse-power expended, thus comparing most unfavorably with the weights transported by land or by water; for a locomotive can haul about 4,000 pounds to the horse-power upon a level track, and a steamer can propel a displacement of 4,000 pounds per horse-power on the water at a speed of 14 miles an hour.

But models are, to a certain extent, misleading. They seldom fly twice alike, and they do not unfold the vicissitudes of their flight. Moreover, the design for a small model is sometimes quite unsuited for a large machine, just as the design for a bridge of ten feet opening is unsuited for a span of one hundred feet.

After experimenting with models three celebrated inventors have passed on to full-sized machines, to carry a man. They are Maxim, Ader, and Langley, and all three have been unsuccessful, simply because their apparatus did not possess the required stability. They might have flown had the required equilibrium and strength been duly provided.

At a cost of about $100,000, Sir Hiram Maxim built and tested in 1894 an enormous flying machine, to carry three men. It consisted in a combination of superposed aeroplanes, portions of which bagged under air pressure, and it was driven by two screws 17 feet 10 inches in diameter, actuated by a steam engine of 363 horse power with steam at 275 pounds pressure. The supporting surface was about 4,000 square feet, and the weight 8,000 pounds. The machine ran on a track of 8 feet gage, and was prevented from unduly rising by a track above it of 30 feet gage. At a speed of 36 miles per hour all the weight was sustained by the air, and on the last test the lifting effect became so great that the rear axle trees were doubled up and finally one of the front wheels tore up about 100 feet of the upper track, when steam was shut off and the machine dropped to the ground and was broken. Its short flight disclosed that its stability was imperfect, and Sir Hiram Maxim has not yet undertaken the construction of the improved machine which he is understood to have had under contemplation.

Having already built in 1872 and 1891 two full-sized flying machines with doubtful results, Mr. Ader, a French electrical inventor, built in 1897 a third machine at a cost of about $100,000 furnished by the French war department. It was like a great bird, with 270 feet supporting surface and 1,100 pounds weight, being driven by a pair of screws actuated by a steam engine of 40 horse-power which weighed about 7 pounds per horse-power. Upon being tested under the supervision of the French army officers, the equilibrium was found so defective that further advance of funds was refused. The amount lifted per horse-power was 27 pounds.

The data for the full-sized flying machine of Prof. Langley, tested October 7 and December 8, 1903, have not yet been published. From newspaper photographs it appears to be an amplification of the models which flew successfully in 1896, and this, necessarily, would make it very frail. The failures, however, seem to have been caused by the launching gear, and do not prove that this machine is worthless. Like the failures of Maxim and Ader, it does indicate that a better design must be sought for, and that the first requisites are that the machine shall be stable in the air, shall be quite under the control of its operator, and that he, paradoxical as it may appear, shall have acquired thorough experience in managing it before he attempts to fly with it.

This was the kind of practical efficiency acquired by the Wright Brothers, whose flying machine was successfully tested on the seventeenth of December. For three years they experimented with gliding machines, as will be described farther on, and it was only after they had obtained thorough command of their movements in the air that they ventured to add a motor. How they accomplished this must be reserved for them to explain, as they are not yet ready to make known the construction of their machine nor its mode of operation. Too much praise cannot be awarded to these gentlemen. Being accomplished mechanics, they designed and built the apparatus, applying thereto a new and effective mode of control of their own. They learned its use at considerable personal risk of accident. They planned and built the motor, having found none in the market deemed suitable. They evolved a novel and superior form of propeller; and all this was done with their own hands, without financial help from anybody.

Meantime it is interesting to trace the evolution which has led to this result and the successive steps which have been taken by others.

It is not enough to design and build an adequate flying machine; one must know how to use it. There is a bit of tuition which most of us have seen, that of the parent birds teaching their young to fly, which demonstrates this proposition. Even with thousands of years' evolution and heredity, with adequate flying organs, the birdlings need instruction and experience.

Safety is the all-important requisite. It is indispensable to have a flying machine which shall be stable in the air, and to learn to master its management. Nothing but practice, practice, practice, will gain the latter, and upon this the school of Lilienthal and his followers is founded.

Otto Lilienthal was a German engineer of great originality and talent, who after making very valuable researches, assisted by his brother, published a book in 1889, "Der Vogelflug als Grundlage der Fliegekunst," which it is very desirable to have translated and published for the benefit of English investigators. Then, putting his theories to the test of practice, he built from 1891 to 1896 a number of aeroplane machines with which he diligently trained himself in gliding flight, using gravity for a motive power, by starting from hillsides. He grew exceedingly expert, and made, it is said, more than 2,000 flights, until one rueful day (August 9, 1896) he was upset and killed by a wind gust, probably in consequence of having allowed his apparatus to get out of order.

He was followed by Mr. Pilcher, an English marine engineer, who slightly improved the apparatus, but who, after making many hundred glides, was also upset and killed in October, 1899, through structural weakness of his machine.

The basis for the equilibrium of an apparatus gliding upon the air being that the center of gravity shall be on the same vertical line as the center of air pressure, both Lilienthal and Pilcher re-established this condition by moving their bodily weight to the same extent that the center of pressure varied through the turmoils of the wind. The writer ventured to think this method erroneous, and proposed to reverse it by causing the surfaces themselves to alter their position, so as to bring the center of pressure back vertically over the center of gravity. He began experimentally with man-carrying gliding machines in June, 1896, and has since built six machines of five different types, with three of which several thousand glides have been effected without any accidents. The first was a Lilienthal machine, in order to test the known before passing to the unknown, and this was discarded some six weeks before Lilienthal's sad accident.

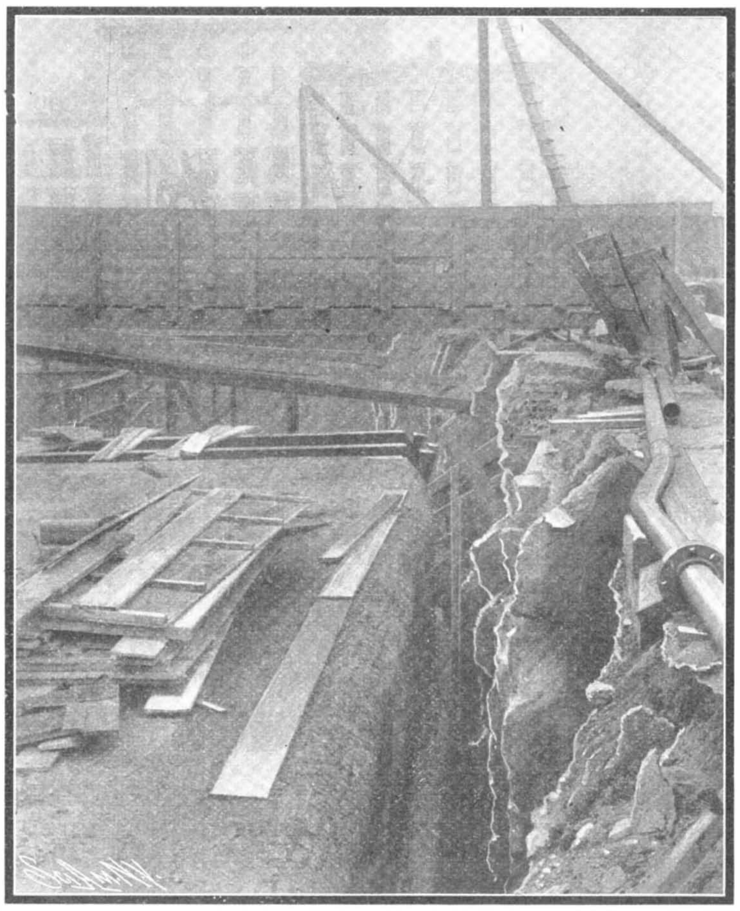
With three of the other machines favorable results were obtained. The best were with the "two-surface"

machine, equipped with an elastic rudder attachment designed by Mr. Herring, and this was described and figured in the "Aeronautical Annual" for 1897.

Three years later Messrs. Wilbur and Orville Wright took up the problem afresh and have worked independently. These gentlemen have placed the rudder in front, where it proves more effective than in the rear, and have placed the operator horizontally on the machine, thus diminishing by four-fifths the resistance of the man's body from that which obtained with their predecessors. In 1900, 1901, 1902, and 1903 they made thousands of glides without accidents and even succeeded in hovering in the air for a minute and more at a time. They had obtained almost complete mastery over their apparatus before they ventured to add the motor and propeller. This, in the judgment of the present writer, is the only course of training by which others may hope to accomplish success. It is a mistake to undertake too much at once and to design and build a full-sized flying machine *ab initio*, for the motor and propeller introduce complications which had best be avoided until in the vicissitudes of the winds bird-craft has been learned with gravity as a motive power.

Now that an initial success has been achieved with a flying machine, we can discern some of the uses of such apparatus, and also some of its limitations. It doubtless will require some time and a good deal of experimenting, not devoid of danger, to develop the machine to practical utility. Its first application will probably be military. We can conceive how useful it might be in surveying a field of battle, or in patroling mountains and jungles over which ordinary means of conveyance are difficult. In reaching otherwise inaccessible places such as cliffs, in conveying messages, perhaps in carrying life lines to wrecked vessels, the flying machine may prove preferable to existing methods, and it may even carry mails in special cases, but the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few, because the weight will, for the same design, increase as the cube of the dimensions, while the supporting surfaces will only increase as the square. It is true that when higher speeds become safe it will require fewer square feet of surface to carry a man, and that dimensions will actually decrease, but this will not be enough to carry much greater extraneous loads, such as a store of explosives or big guns to shoot them. The power required will always be great, say something like one horse-power to every hundred pounds of weight, and hence fuel cannot be carried for long single journeys. The north pole and the interior of Sahara may preserve their secrets a while longer.

Upon the whole, navigable balloons and flying machines will constitute a great mechanical triumph for man, but they will not materially upset existing conditions as has sometimes been predicted. Their design and performance will doubtless be improved from time to time, and they will probably develop new uses of their own which have not yet been thought of.



CONSTRUCTION OF THE SUBWAY AT UNION SQUARE, NEW YORK CITY.

THE NEW YORK RAPID TRANSIT SUBWAY.

EXAMPLES OF ENGINEERING IN ITS CONSTRUCTION.

Unexpected engineering problems confronted the contractors in charge of the actual construction of the great New York Rapid Transit Subway now approaching completion.

We present herewith two illustrations of work done on the 42d Street section, where the subway extends westerly across town from Fourth Avenue to Broadway, passing under Madison, Fifth, and Sixth Avenues.

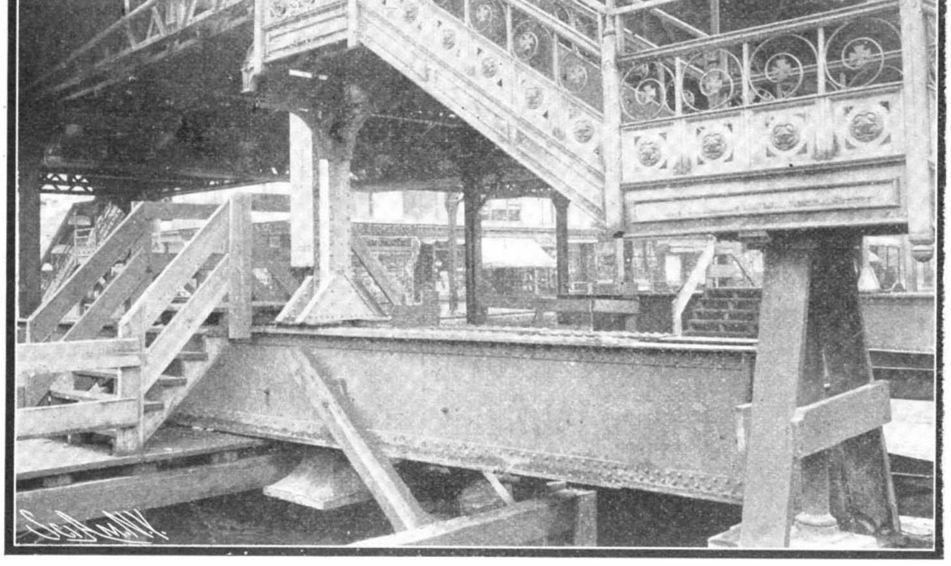
The manner of suspending a large Croton main running north and south through Madison Avenue across 42d Street, at the southeast corner of 42d Street and Madison Avenue, is shown in one of the illustrations, which stood intact and in perfect working during the blasting operations below, as the rock was taken out from 42d Street. The subway in 42d Street is quite deep, and was excavated through solid rock. It will be noticed a bridge truss was built over the gap, well braced, from which iron rods depend, having chains at their ends passing around underneath the pipe. Nuts at the top end of the rods permit of adjustment to take up any sagging that might occur. Forty-second Street at this point easterly and in front of the Grand Central Depot was excavated its full width up to the building line, to provide for the large underground passenger station. Beyond the truss is a glimpse of the 42d Street front of the Manhattan Hotel.

In passing under Sixth Avenue, to provide space for the Sixth Avenue subway passenger station, it became necessary to temporarily supply supports for the pillars of the elevated railway station. The other illustration shows how the east station pillars were held up during the construction going on below. Two very heavy iron girders separated enough to allow the elevated railway post to pass between them, were bridged over the space running in an easterly and westerly direction, parallel with 42d Street. Triangular-shaped steel brackets were riveted to the post, and rested upon the top of the beams, actually suspending or supporting the post during the time excavating was going on below. The flaring foot of the post will be seen below the girders. The ornamental stairway leading to the station is above.

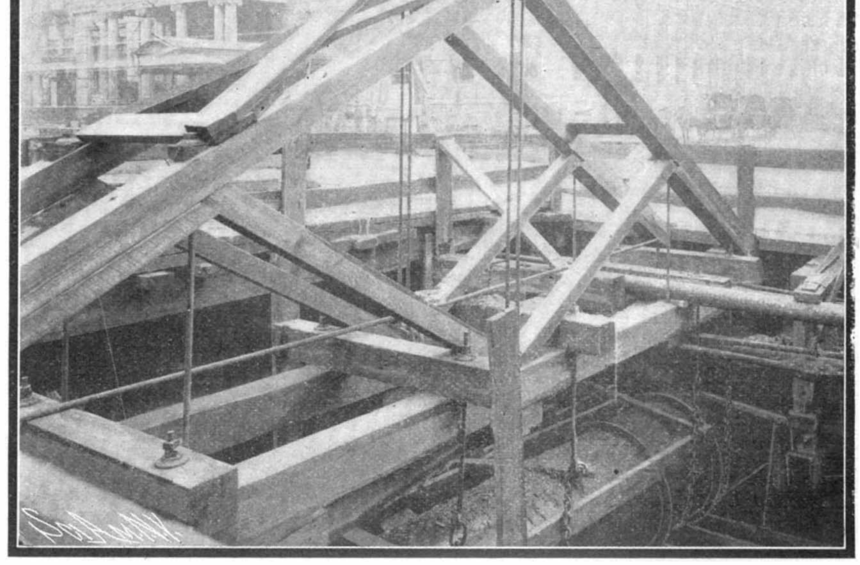
The wooden steps over the girders continued the east sidewalk line of Sixth Avenue. On the north side of 42d Street beyond will be noticed another pair of steps and a similar set of girders to support the stairway upon that side of the street.

Another noticeable locality where the Subway passes is the east side of Union Square on Fourth Avenue. Here an immense excavation through solid rock was blasted out. The illustration shows the jagged appearance of the rock on the right, and the clearance space between the rock and the exterior wall of the Subway, which is about 12 inches and is filled in with soil. Below will be noticed a lateral enlargement of the wall; this is where the conduits are located for carrying the heavy electric cables to supply the power. The view is taken opposite 15th Street, looking south, showing the Morton House on 14th Street in the background and a glimpse of the Washington equestrian statue, close to which the west wall of the Subway passes. At this point Fourth Avenue curves to the southeast in crossing 14th Street, the beginning of which can be seen by the cross girders just beyond the finished brickwork at the top. The compressed-air pipe is at the right on the surface, to supply power to the drills, and the ends of the old Subway electric conduits will be observed. Union Square Park is at the right of the picture.

Opening for Machinery in Australia.—The Canadian commercial agent at Sydney, New South Wales, reports the extraordinary success of artificial irrigation on comparatively small areas of land, and predicts for it a great future. The prospects for selling pumping machinery, motors, and other power generators—as, for instance, windmills and steam, oil, and hot-air machinery—are very good. It would be advisable to sell such machinery through agents who understand how to put it up. Some firms that sell that class of machinery for certain manufacturers could be induced to take hold of new ones, if good and cheap. It would be necessary to send a competent expert and put up some sample machines, in order to prove their efficiency.—Richard Guenther, Consul-General, Frankfort, Germany.



SUPPORT OF ELEVATED RAILWAY SIXTH AVENUE STATION, CORNER OF SIXTH AVENUE AND FORTY-SECOND STREET.



TEMPORARY SUPPORT OF LARGE WATER MAIN AT CORNER OF MADISON AVENUE AND FORTY-SECOND STREET.

THE DICK SYSTEM OF LIGHTING TRAINS BY ELECTRICITY.*

By EMILE GUARINI.

THE Schuckert establishment of Vienna has just begun the exploitation of the Dick system of the electric lighting of railway cars. This system, in which each car is provided with a current generator, remedies the inconveniences of other systems, which may be referred to two types. The first of these, which employs a central car, has the disadvantage of necessitating a train of always uniform make-up; while the second, which consists in providing each car with a battery of accumulators, has the inconvenience of requiring numerous recharging stations and batteries of wide surface, which increase the dead weight and the cost of exploitation.

In the Dick system each car is provided with a small dynamo driven by one of the axles for furnishing the current during the running, and with a small battery for actuating the lamps during stoppages or during slow running. To this is added an arrangement for preventing the overcharging of the accumulators and another for regulating the tension of the current furnished to the lamps. Moreover, the operation is rendered independent of the direction of running.

An installation comprises a dynamo, a battery of accumulators, a closet for the apparatus, a current conductor, and a number of lamps.

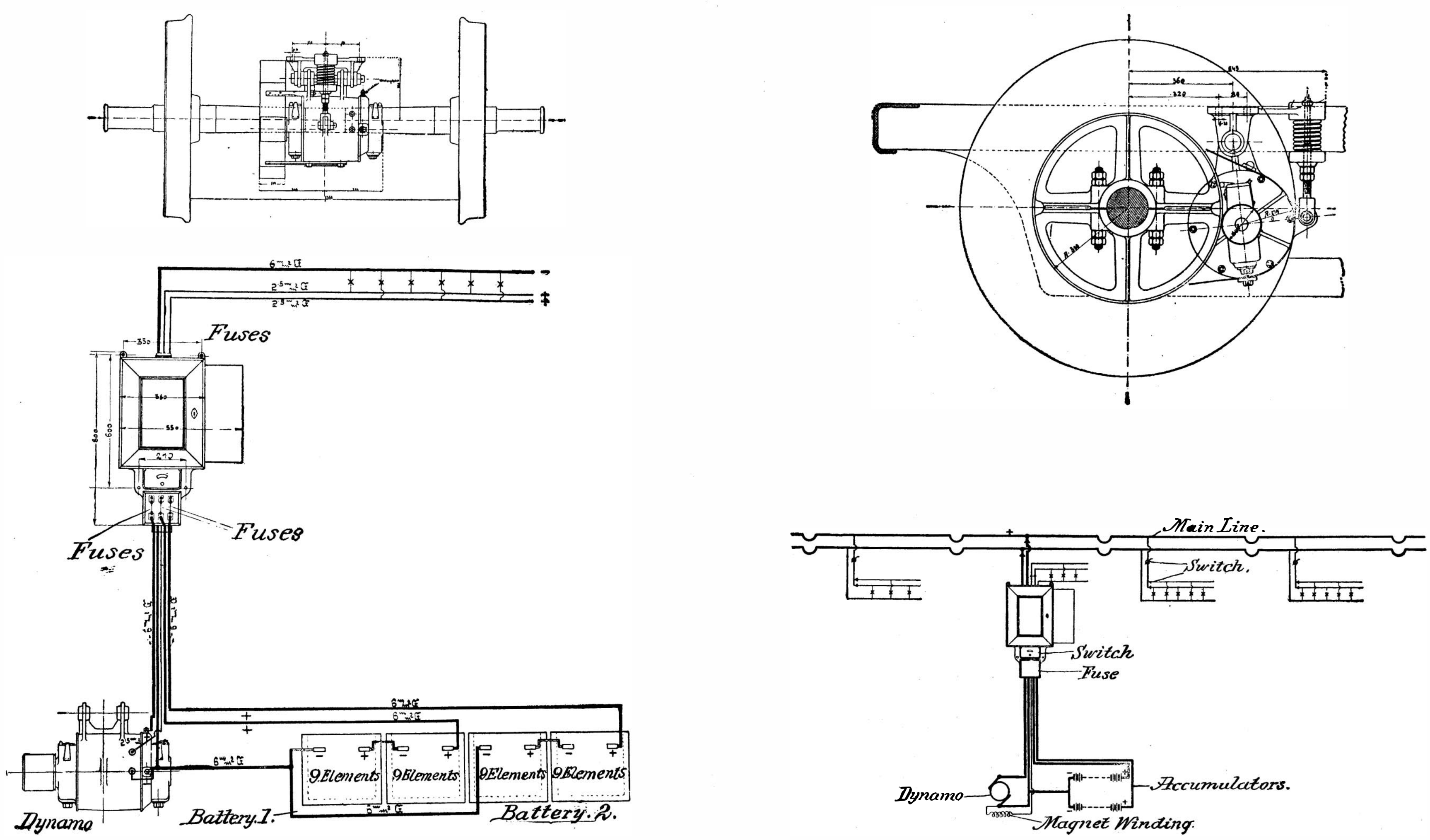
The dynamo is completely inclosed. The magnetic arrangement is a four-pole one, and the armature is a grooved inductor wound in series. The current is collected through four carbon brushes of 90 deg. angular spacing. The brush carriers may be arranged according to the direction of the running. The lubrication is effected, through a wick lubricator, with very fluid mineral oil. If, for any reason, the lubrication becomes insufficient, the solid grease of another lubricator melts under the action of the heat developed and makes up for the inadequacy of the wick lubricator.

The normal type is constructed for a maximum efficiency of 29 amperes under 49 volts, with a number of revolutions that may vary from 700 to 2,400 per minute. The total weight, inclusive of the suspension, and the starting gear, is about 440 pounds. The actuating of the dynamo is done by one of the axles through the intermedium of friction disks, belts, or bevel-wheels. The bevel-wheels or other transmission arrangements are inclosed in a protecting case impervious to dust and water.

The batteries of accumulators, which are two in number, are capable of furnishing a current to 22 eight-candle lamps for five hours. The batteries, which are of wide surface, offer a great resistance, a remarkable sureness of operation, and a great lack of sensitiveness to strong discharges. They are ordinarily arranged in four troughs of nine elements housed in one case in common suspended beneath the car. This case is 41 inches in length by 22 in width, and 12½ in height. Two troughs, comprising eight elements, constitute a battery.

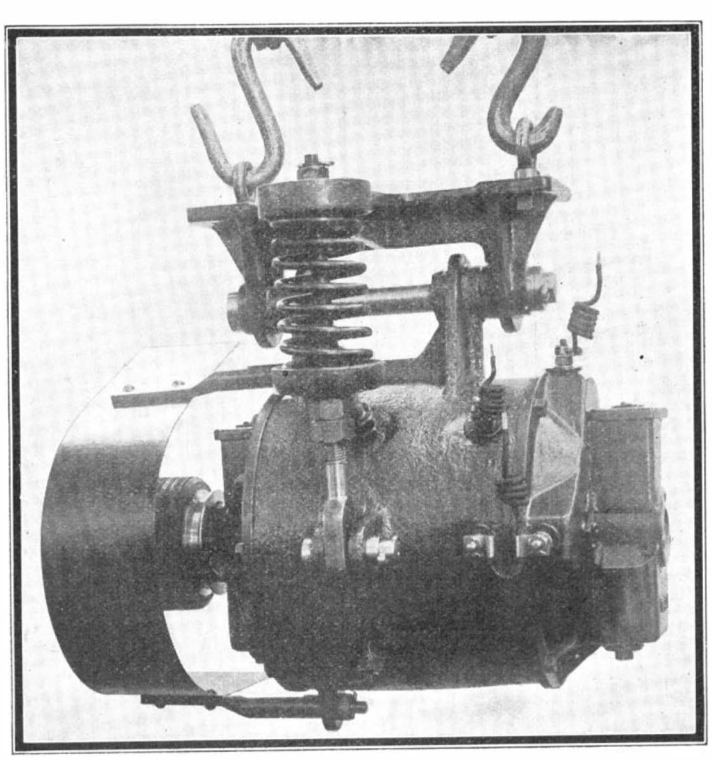
The commutating apparatus, as a whole, for the dynamos, the batteries, and the lamps, is inclosed in the closet already mentioned, and which is opened only for inspection. In this there is an automatic commutator, upon the electro-magnetic principle, for connecting the dynamos with the batteries or the lamps, and also a tension regulator for modifying the excitation current. At the moment of throwing the lamps out of circuit, this regulator keeps the charging current constant during the running until the tension of the elements reaches at least 2.6 volts. The charge of the battery is then complete. When the lamps are put in circuit the regulator so operates that the tension of the lamps and the intensity of the current remain constant, and that, on another hand, one of the two batteries, owing to the interposition of a slight resistance, becomes discharged. At the same time, the second semi-battery, in parallel with the dynamo, takes part in the supplying of the lamps. In this way a perfectly steady light is obtained. When the lamps are thrown out of circuit the batteries are again coupled in parallel and put under charge. The apparatus closet contains also a relay, of which the object is to diminish the tension of the machine indirectly when the charge of the batteries is complete. This relay acts upon the regulator in such a way that, when the battery is completely charged, the regulator no longer receives the current intensity desired for the charge, but performs the rôle of a tension regulator, and thereby prevents an overcharge from occurring.

The service of the installation is of the most simple character. The throwing of the lamps into and out of circuit is effected by the employes by means of a special key. The lamps of a car are all lighted or extinguished at once. The arc commutator in common for the lamps and batteries is analogous to a street car controller. The cylinder rheostat has four positions, viz.: "Light—Darkness," "Darkness—Light." The position is maintained by a ratchet-wheel.

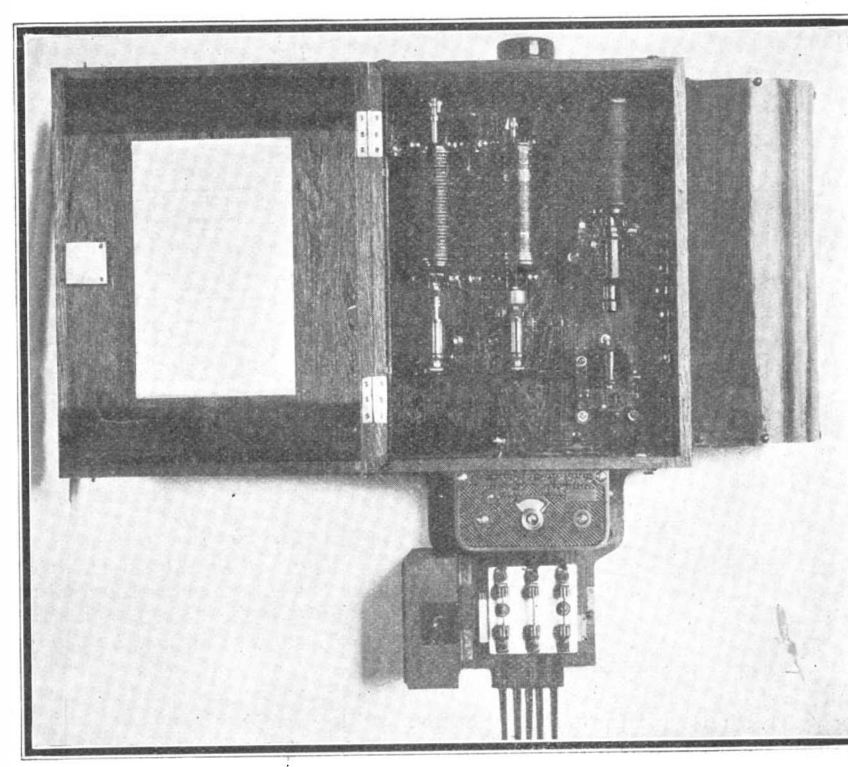


THE DICK SYSTEM OF TRAIN LIGHTING.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



DYNAMO FOR ELECTRIC TRAIN LIGHTING.



SWITCH BOX OF THE DICK SYSTEM OF ELECTRIC TRAIN LIGHTING.

Upon the whole, the Dick system has the advantage of permitting of proportioning the intensity of the lighting to the necessities of the exploitation, of being provided with an arrangement for preventing the overcharging of the battery, of permitting at once of the direct supplying of the lamps and charging of the battery, and, finally, of not being exclusively restricted in its application to high-speed railway cars. In fact, there is nothing to prevent giving it an arrangement that shall permit of its use upon suburban trains. In this case, two or more cars may alone be provided with it and furnish the current for the others. The net cost is then 1.5 heller per car-hour.

The Dick system seems, therefore, to well solve the problem of the cheap and certain electric lighting of railway cars. We may hence expect to see it soon adopted upon the principal railway systems of Europe.

PROPOSED AUXILIARY FIRE PROTECTION WATER SUPPLY FOR MANHATTAN AND BROOKLYN.

COMMISSIONER OAKLEY, of the New York Department of Water Supply, Gas, and Electricity, has transmitted to Mayor McClellan the reports of the chief engineers of his department in Manhattan and Brooklyn on a proposed high-pressure fire service. In his letter he says:

"In the Borough of Manhattan the chief engineer has selected as the district in which this system should be installed the area bounded by Twenty-third Street on the north; Broadway to Fourteenth Street, to Fourth Avenue, and the Bowery on the east; Chambers Street on the south, and the North River on the west; comprising about 1,350 acres.

"A map (drawing No. 1) is appended, showing the boundaries of this district, together with a preliminary plan of the trunk line and distribution systems of high-pressure mains and provisional locations for the pumping stations.

"You will observe in the report that it is proposed to erect three pumping stations, definite locations of which cannot be fixed until the relative cost of land and other questions have been considered.

"The subdivision of the pumping plans was deemed advisable on the ground that should any one station be disabled, or be rendered ineffective, during the course of a conflagration, two-thirds of the output of the plant, or double the present capacity of the Fire Department, would be available.

"Provision has been made for the use of fireboats in case of emergency, which emergency, however, is not anticipated.

"The plan submitted contemplates a capacity of 1,000,000 gallons per hour at each of the three stations, or a combined capacity of 3,000,000 gallons per hour. The pressure at the station will be 300 pounds. The minimum pressure at the hydrants is estimated at 200 pounds. It may be noted that the new service will furnish more than three times the water now supplied at one fire by the entire present fire equipment on a fourth alarm. The pressure will be more than double that now maintained. Each station will furnish thirty-two streams through three-inch hose with one and three-quarter-inch nozzle. Each hydrant will deliver approximately 2,600 gallons per minute, or five such streams.

"It is proposed to place 1,010 hydrants in addition to those that are at present in the district outlined, or in other words, two hydrants are proposed for each street intersection, giving ten such streams as described. From the four corners of a block forty such streams may be played on a fire within the block. Forty streams are equivalent to about 20,000 gallons per minute, or 1,200,000 gallons per hour, which is thirty-three and one-third per cent more water than the present fire apparatus can deliver at one time on any one building.

"It is intended by concentrating the fire-fighting forces, much time, and the loss of hose due to friction will be saved, and the operation of the officers and men facilitated.

"You will observe that Mr. Hill reports that it is ill-advised and impracticable to combine the system of fire protection with that of street cleaning.

"The source of energy, and the character of engines, or motors, namely, gas or electricity, used at the pumping stations are fully discussed in the report solely for the purpose of showing the difference in cost of construction and maintenance, all of which can be determined upon at a later date.

"In the original proposition the question of the use of salt water in fire fighting was considered. We have found, however, on investigation, that the distributing mains of the Croton system are sufficient to supply the several pumping stations proposed with fresh water. As the use of fresh water will remove one of the chief objections to the proposed high-pressure fire service, we include in our plans the use of fresh water, augmented by the salt water when necessary. This proposition does not in any way affect the original plans, but makes them more feasible and possible.

"The amount of water used for fire purposes has been estimated to be about one-tenth of 1 per cent of the amount consumed in both boroughs of Manhattan and the Bronx for one year.

"The estimated cost for the construction of the pumping stations, the laying of the mains for the distribution system complete, telephone system, and contingencies, with the use of electrical motors, will amount to $3,950,400, and with the use of gas engines, $5,293,200.

"The allowance for contingencies may seem large, but in view of the fact that the sub-surface condition of the street in the district outlined is congested, it is practically impossible to estimate in advance the actual cost of construction; and in view of this fact, we have allowed a sum of money which we think will probably be sufficient to meet obstructions which cannot be determined until actual construction is commenced.

BROOKLYN SUPPLY.

"In the Borough of Brooklyn, it is proposed to install a high-pressure fire service in the following territories:

"No. 1. The Coney Island district, covering about 147 acres.

"No. 2. The dry goods and high office building district, with an area of about 575 acres.

"No. 3. The lower water front district, with an area of 845 acres; making a total of 1,567 acres. Full descriptions of these districts are given in the report on pages Nos. 2 and 5, and in plates Nos. 1, 2, and 3.

"For the Coney Island district provision has been made for fourteen streams, discharging 250 gallons per minute each, under a pressure at the engines of 150 pounds and at the hydrants from 135 to 140 pounds. This pressure would be sufficient to throw a stream of about 380 gallons per minute to an effective vertical height of about ninety feet, which would be ample fire protection for that district, especially taking into consideration the character of the buildings existing therein.

"In the river front and dry goods and high office building district provision has been made for from twenty-five to thirty streams, discharging 500 gallons per minute each, with a pressure at the engines of about 300 pounds, corresponding to about 225 pounds at the most distant hydrant in the system.

"At Coney Island pumping station, for considerations of safety which are fully discussed in the report, gas engines will be adopted.

"For the river front and dry goods and high office building districts, the pumping stations will be equipped with electrical plants, for reasons which are also detailed in the report.

"The hydrants will be so located in this district that the whole number of streams, representing the full capacity of the main plant, namely, from twenty-five to thirty streams, can be concentrated on any block within the district.

"At Coney Island the hydrants will also be located so as to bring the full number of streams that can be supplied from the plant to bear on any block within the district.

"It is proposed in Brooklyn, as well as in the Manhattan system, that fresh water will be normally used, it being shown in the report that even assuming that a fire took place during the morning period of maximum daily consumption, water could be drawn during that period at the rate of about 20,000,000 gallons per day at any station in Brooklyn, except Coney Island, without reducing the pressure in the trunk mains below the existing pressure, and that as the consumption decreased through the day, the available draft for fire purposes would, of course, correspondingly increase. In other words, the mains would readily furnish in twenty-four hours an amount of fresh water practically equal to that consumed for fire purposes in Brooklyn in the whole year in 1901 and 1902.

"The contingency of being compelled to pump river water in either of the Boroughs of Manhattan or Brooklyn is very remote.

"In the Coney Island district it may be occasionally necessary to use salt water, as is explained in the report.

"The estimated cost for the construction of the three stations, the laying of the mains, and the maintenance of the plant in Brooklyn is $1,475,000.

"The plants recommended in both the Boroughs of Manhattan and Brooklyn may be completed in about one year from the beginning of the work."

CONTEMPORARY ELECTRICAL SCIENCE.*

THE STRING GALVANOMETER.—W. Einthoven gives a full description of his string galvanometer, which appears likely to displace the capillary electrometer as an instrument of physiological research, at all events. The instrument consists essentially of a silvered quartz thread which is stretched like a string in a strong magnetic field. When an electric current is passed through the thread, the latter is deflected perpendicularly to the direction of the magnetic lines of force, and the amount of the deflection can be measured by means of a microscope with an eye-piece micrometer. The thread now used is 2.4 μ thick, with a resistance of 10,000 ohms. If the tension is very feeble, and the deflection requires 10 or 15 seconds to establish itself, the instrument can be made extremely sensitive, sufficient to measure a current of 10^{-12} ampere. But, as a rule, the tension used is such that the final position is reached in about one second or less. The motion is absolutely dead beat, and there is no perceptible disturbance from tremors, nor any creeping of the zero as in the capillary electrometer. The author has applied the instrument to obtaining photographic "electro-cardiograms," showing the currents traversing the human body with every heart beat. These are very characteristic of the person.—W. Einthoven, Proc. Roy. Acad. Sc., Amsterdam, August 27, 1903.

MEDICAL ELECTRICITY.—The Angers meeting of the French Association for the Advancement of Science was held from August 4th to 12th. The section of Medical Electricity met on four days, and dealt with a number of interesting papers, including one by Albert Weil on infantile paralysis and its treatment by continuous currents, and papers on the treatment of cancer by MM. Mondain, Bloch, and Leduc. In the discussion several practitioners specified cases of beneficial treatment by means of X-rays, the successful cases being confined to surface cancers. As regards deep-seated cancers, M. Bordier preferred the treatment by bipolar electrolysis, by which good results had been obtained in cancer of the stomach and the breast. M. Leduc mentioned the healing of a cancroid in the eye and nose after a single electrolytic introduction of zinc as an ion. M. Bordier described the treatment of paralysis of the tongue by static electricity, which was unsuccessful, though continued for five months. Rhythmic galvanization was then substituted, one pole being in the mouth and the other at the root of the tongue. The faculty of pronouncing consonants was gradually recovered, in the succession of labials, sibilants, gutturals, and dentals.—Report in Arch. d'Electr. Med., August 15, 1903.

X-RAY TREATMENT OF CANCER.—Dr. Mondain gives full particulars of a case of cancer of the breast cured by X-rays. The patient came from a family affected with arthritic gout, and her mother had died of uterine cancer at 55. The first signs of cancer appeared in 1900, the patient being then 53. In August, 1902, Prof. Troisier declared the case to be incurable, and likely to lead to death in a few months. In October the pains set in, and the author was consulted in January of the present year. Ulceration had at that time made considerable progress, the ulcer covering an area 12 cm. by 8 cm., and suppurating freely. Two months later the X-rays were applied, the apparatus being a coil of 35 cm., worked with an alternating current, and provided with a Nodon valve and Ducretet interrupter. The X-ray tube was soft, and provided with a potassium regenerator. The treatment commenced on March 11 and continued for 10 minutes every day, the distance of the tube varying from 20 cm. to 30 cm. After the first six days the pains ceased, and there were traces of scarring. By April 1, 8 mm. from the border had been healed. On April 28 the treatment was interrupted owing to the surrounding skin becoming affected through the absence of lead screens. But it was resumed during May until the ulcer had completely scarred over. At present the place is covered with a natural skin, and the patient has completely recovered. The author believes that X-rays, though not necessarily efficient in every case, offer the most promising method hitherto known.—Mondain, Arch. d'Electr. Med., September 15, 1903.

THE EARTH IN WIRELESS TELEGRAPHY.—A. Voller has continued his studies with regard to the part played by the earth in conveying wireless messages, and has found that that part is not as important as he had been led to suppose by his former results. There is a distinct propagation of waves through the earth's crust, which may be utilized for wireless telegraphy. But the waves thus propagated are subject to strong damping owing to the conductivity of the earth. And since the crust is by no means homogeneous, the waves lose their spherical shape and become distorted, thus leading to the mutual interference of portions of the same wave traveling by different routes. The author used a Braun-Siemens experimental apparatus which could be connected to mast-wires or earth-plates at will. At a distance of 30 meters, with mast-wires, but without earth-plates, the telephone interpreted the signals distinctly. With earth-plates, but without mast-wires, the signals only carried as far as 15 meters. Without either mast-wires or earth-plates, the distance carried was only 2 or 3 meters, and the earth, therefore, offers a certain advantage in conveying signals, but the lengths of the wires leading to the earth-plates influence the result considerably. The author has not made any experiments with a long stretch of water, but he supposes that the uniformity of its conductivity would insure favorable results as compared with earth conductors.—A. Voller, Phys. Zeitschr., October 1, 1903.

INTERMITTENT CURRENTS IN ELECTROTHERAPEUTICS.—S. Leduc points out that intermittent currents of low tension are at present the most accurate means of diagnosis at the disposal of the medical electrician. It is very important that the electric quantities involved in the production of a definite excitation should be capable of precise specification. The author therefore describes the various requisites for the purpose. The source should be a battery of primary or secondary cells or a continuous-current central station. There must be an arrangement for varying the potential in the circuit very gradually, and there must be an interrupter working at a speed capable of accurate regulation and of interrupting the current for any given fraction of a period. For this purpose he employs a rotary interrupter with two brushes, one of which is fixed while the other is movable. The adjustment is made by shifting the movable brush, and the period of interruption is ascertained by means of an aperiodic milliammeter. The circuit is closed on a non-polarizable resistance. Then the potential is raised until the ammeter marks, say, 10 milliamperes. The movable brush is then displaced until the intermittent current has a strength of 1 milliampere. The current then passes for a tenth of a period. The author found by this method that the E.M.F. necessary to produce a given excitation is a minimum when the current passes for one-thousandth of a second. This minimum is a valuable criterion for the pathological state of a nerve or muscle.—S. Leduc, Arch. d'Electr. Med., September 15, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

COLORING OF METALS.

From the French of M. PAUL MALHERBE in the Chronique Industrielle.

DIRECT COLORATION OF IRON AND STEEL BY CUPRIC SELENITE.

IRON precipitates copper and selenium from their salts. Immersed in a solution of cupric selenite, acidulated with a few drops of nitric acid, it precipitates these two metals on its surface in the form of a dull black deposit, but slightly adherent. Yet, if the object is washed with water, then with alcohol, and rapidly dried over a gas burner, the deposit becomes adherent. If rubbed with a cloth, this deposit turns a blue black or a brilliant black, according to the composition of the bath.

The selenite of copper is a greenish salt insoluble in water, and but little soluble in water acidulated with nitric or sulphuric acid. It is preferable to mix a solution of cupric sulphate with a solution of selenious acid, and to acidulate with nitric acid, in order to prevent the precipitation of the selenite of copper.

This process, originated by the writer, is quite convenient for blackening or bluing small objects of iron or steel, such as metallic pens or other small pieces. It does not succeed so well for objects of cast iron; and the selenious acid costs 0.20 franc per gramme, which is an obstacle to its employment on large metallic surfaces.

The baths are quickly impoverished, for insoluble yellow selenite of iron is deposited.

Brilliant Black Coloration.—Selenious acid, 6 parts; cupric sulphate, 10; water, 1,000; nitric acid, 4 to 6.

Blue Black Coloration.—Selenious acid, 10 parts; cupric sulphate, 10 parts; water, 1,000; nitric acid, 4 to 6.

By immersing the object for a short time the surface of the metal can be colored in succession yellow, rose, purple, violet, blue.

COLORATION OF COPPER AND BRASS WITH CUPRIC SELENITE.

When an object of copper or brass is immersed in a solution of selenite of copper acidulated with nitric acid, the following colors are obtained, according to the time of the immersion: Yellow, orange, rose, purple, violet, and blue, which is the last color which can be obtained. In general, the solution should be slightly acid; otherwise the color is fugacious and punctate.

	I.	II.
Selenious acid	6.5	2.9
Sulphate of copper	12.5	20.
Nitric acid	2.0	2.5
Water	1,000.	1,000.

PRODUCTION OF RAINBOW COLORS ON METALS.

Iron, Copper, Brass, Zinc, Etc.

1.—The following process of irisation is due to Puscher. It allows of covering the metals with a thick layer of metallic sulphide, similar to that met with in nature—in galena, for example.

These compounds are quite solid and are not attacked by concentrated acids and alkalies, while dilute reagents are without action. In five minutes thousands of objects of brass can be colored with the brightest hues. If they have been previously cleaned chemically, the colors deposited on the surface adhere with such strength that they can be worked with the burnisher.

Forty-five grammes of sodium hyposulphite are dissolved in 500 grammes of water; a solution of 15 grammes of neutral acetate of lead in 500 grammes of water is poured in. The clear mixture, which is composed of a double salt f hyposulphite of lead and of sodium, possesses, when heated to 90 to 100 deg. C., the property of decomposing slowly and allowing the deposit of brown flakes of lead sulphide. If an article of gold, silver, copper, brass, tombac, iron, or zinc is put into this bath while the precipitation is taking place, the object will be covered with a pellicle of lead sulphide, which will give varied and brilliant colors, according to its thickness. For a uniform coloration, it is necessary that the pieces should be heated quite uniformly. However, iron assumes under this treatment only a blue color, and zinc a bronze color. On articles of copper the first gold color which appears is defective. Lead and tin are not colored.

By replacing the neutral acetate of lead with an equal quantity of cupric sulphate and proceeding in a similar way, brass or imitation gold is covered with a very beautiful red, succeeded by an imperfect green, and finally a magnificent brown, with iridescent points of greenish red. The latter coating is quite solid and may be of service in industry.

Zinc is not colored in this solution, and precipitates in it a quantity of flakes of greenish brown (cupric sulphide), but if about one-third of the preceding solution of lead acetate is added, a solid black color is developed, which, when covered with a light coating of wax, gains much in intensity and solidity. It is also useful to apply a slight coating of wax to the other colors.

2.—Very beautiful designs may be obtained, imitating marble, with sheets of copper plunged into a solution of lead, thickened by the addition of gum tragacanth, and heated to 101 deg. C. Afterward they are treated with the ordinary lead solution. The compounds of antimony, for example the tartrate of antimony and potash, afford similar colorations, but require a longer time for their development. The solutions mentioned do not change, even after a long period, and may be employed several times.

3.—By mixing a solution of cupric sulphate with a solution of sodium hyposulphite, a double hyposulphite of sodium and of copper is obtained.

If in the solution of this double salt an article of nickel or of copper, cleaned with nitric acid, then with soda, is immersed, the following colors will appear in a few seconds: Brilliant red, green, violet, blue, rose. To isolate a color, it is sufficient to take out the object and wash it with water. The colors obtained on nickel present a moire appearance, similar to that of silk fabrics.

With three parts of sodium hyposulphite and one part of lead acetate, a bath is produced, whose products of decomposition include sulphur and lead sulphide, which afford deeper colors than the preceding bath, and in which the red and violet seem to predominate. Prolonged continuance would produce a gray patina from the sulphide of lead.

The best solutions are secured by a mixture containing about four parts of sodium hyposulphite, one part of lead acetate, and one part of cupric sulphate. If the metallic plate is immersed in this solution, there will appear in a short time on one of the faces a uniform bright color, generally red, depending upon the duration of the immersion. On the other face, bright rainbow hues and colored curves will appear.

Iron also is affected by these baths. The colors obtained are less beautiful, for the gray surface of the iron reflects the light a little. Still, certain light-colored irons are colored blue with much facility.

4.—Tin sulphate affords with sodium hyposulphite a double salt, which is reduced by heat, with production of tin sulphide. The action of this double salt on metallic surfaces is the same as that of the double salts of copper and lead. Mixed with a solution of cupric sulphate, all the colors of the spectrum will be readily obtained.

5.—Coloration of Silver.—The objects of copper or brass are first covered with a layer of silver, then they are dipped in the following solution at the temperature of 90 to 100 deg. C.: Water 3,000 parts; sodium hyposulphite, 300 parts; lead acetate, 100 parts.

6.—Iron precipitates bismuth from its chlorhydric solution. On heating this deposit, the colors of the rainbow are obtained.

COLORATION BY ELECTROLYSIS.

1.—Colored Rings by Electrolysis (Nobili, Becquerel).—In order to obtain the Nobili rings it is necessary to concentrate the current coming from one of the poles of the battery through a platinum wire, whose point alone is immersed in the liquid to be decomposed, while the other pole is connected with a plate of metal in the same liquid. This plate is placed perpendicularly to the direction of the wire, and at about one millimeter from the point.

Solutions of sulphate of copper, sulphate of zinc, sulphate of manganese, acetate of lead, acetate of copper, acetate of potassium, tartrate of antimony and potash, phosphoric acid, oxalic acid, carbonate of soda, chloride of manganese, and manganous acetate, may be employed.

2.—A process, due to M. O. Mathey, allows of coloring metals by precipitating on their surface a transparent metallic peroxide. The phenomenon of electrochemical coloration on metals is the same as that which takes place when an object of polished steel is exposed to heat. It first assumes a yellow color, from a very thin coating of ferric oxide formed on its surface. By continuing the heating, this coating of oxide increases in thickness, and appears red, then violet, then blue. Here, the coloration is due to the increase in the thickness of a thin coating of a metallic oxide precipitated by an alkaline solution.

The oxides of lead, of tin, zinc, chromium, aluminium, molybdenum, tungsten, etc., dissolved in potash, may be employed; also protoxide of iron, of zinc, of cadmium, of cobalt, dissolved in ammonia.

Lead Solution.—Potash, 400 grammes; litharge or massicot, 125 grammes. Boil ten minutes, filter, dilute until the solution marks 25 deg. Bé.

Iron Solution.—Dissolve in boiling water ferrous sulphate, and preserve sheltered from air. When desired for use, pour a quantity into a vessel and add ammonia until the precipitate is re-dissolved. This solution, oxidizing rapidly in the air, cannot be made use of for more than an hour.

3.—Electro-chemical coloration succeeds very well on metals which are not oxidizable, such as gold and platinum, but not well on silver. This process is employed for coloring watch-hands and screws. The object is placed at the positive pole, under a thickness of 3 centimeters of the liquid, and the negative electrode is brought to the surface of the bath. In a few seconds all the colors possible are obtained. Generally, a ruby-red tint is sought for.

4.—Coloration of Nickel.—The nickel piece is placed at the positive pole in a solution of lead acetate. A netting of copper wires is arranged at the negative pole according to the contours of the design, and at a short distance from the object. The coloration obtained is uniform if the distance of the copper wires from the object is equal at all points.

COLORING OF BRASS.

1.—(a) Brown bronze: Acid solution of nitrate of silver and bismuth. (b) Brown bronze: Nitric acid. (c) Light bronze: Acid solution of nitrate of silver and of copper. (d) Black: Solution of nitrate of copper. In all cases, however, the brass is colored black, if after having been treated with the acid solution, it is placed for a very short time in a solution of potassium sulphide, of ammonium sulphydrate, or of hydrogen sulphide.

2.—The brass is immersed in a dilute solution of mercurous nitrate; the layer of mercury formed on the brass is converted into black sulphide, if washed several times in potassium sulphide. By substituting for the potassium sulphide the sulphide of antimony or that of arsenic, beautiful bronze colors are obtained, varying from light brown to dark brown.

3.—Clean the brass perfectly. Afterward rub with sal ammoniac dissolved in vinegar. Strong vinegar, 1,000 parts; sal ammoniac, 30 parts; alum, 15 parts; arsenious anhydride, 8 parts.

4.—A solution of chloride of platinum is employed, which leaves a very light coating of platinum on the metal, and the surface is bronzed. A steel tint or gray color is obtained, of which the shade depends on the metal. If this is burnished, it takes a blue or steel gray shade, which varies with the duration of the chemical action, the concentration, and the temperature of the bath. A dilute solution of platinum is prepared thus: Chloride of platinum, 1 gramme; water, 5,000.

Another solution, more concentrated at the temperature of 40 deg. C., is kept ready. The objects to be bronzed are attached to a copper wire and immersed for a few seconds in a hot solution of tartar, 30 grammes to 5 liters of water. On coming from this bath, they are washed two or three times with ordinary water, and a last time with distilled water, and then put in the solution of platinum chloride, stirring them from time to time. When a suitable change of color has been secured, the objects are passed to the concentrated solution of platinum chloride (40 deg.). They are stirred, and taken out when the wished-for color has been reached. They are then washed two or three times, and dried in wood-sawdust.

5.—To give to brass a dull black color, as that used for optical instruments, the metal is cleaned carefully at first, and covered with a very dilute mixture of neutral nitrate of tin, 1 part; chloride of gold, 2 parts. At the end of ten minutes this covering is removed with a moist brush. If an excess of acid has not been employed, the surface of the metal will be found to be of a fine dull black.

The nitrate of tin is prepared by decomposing the chloride of this metal with ammonia and afterward dissolving in nitric acid the oxide of tin formed.

6.—For obtaining a deposit of bismuth on brass, the latter is immersed in a boiling bath, prepared by adding 50 to 60 grammes of bismuth to nitric acid diluted with 1 liter of water, and containing 32 grammes of tartaric acid.

7.—The electrolysis of a cold solution of 25 to 30 grammes per liter of the double chloride of bismuth and ammonium determines on brass or on copper a brilliant adherent deposit of bismuth, whose appearance resembles that of old silver.

Production of Rainbow Hues.—Various Colors.—1. Dissolve tartrate of antimony and of potash, 30 grammes; tartaric acid, 30; water, 1,000; add chlorhydric acid 90 to 120 grammes, pulverized antimony 90 to 120 grammes. Immerse the object of brass in this boiling liquid, and it will be covered with a pellicle, which, as it thickens, reflects quite a series of beautiful tints, first appearing iridescent, then the color of gold, copper, or violet, and finally of a grayish blue. These colors are adherent, and do not change in the air.

2.—The sulphide of tin may be deposited on metallic surfaces, especially on brass, communicating shades varying with the thickness of the deposit. For this purpose, Puscher prepares the following solutions: Dissolve tartaric acid, 20 grammes, in water 1,000 grammes; add a salt of tin 20 grammes, water, 125 grammes. Boil the mixture, allow it to repose, and filter. Afterward pour the clear portion, a little at a time, shaking continually, into a solution of hyposulphite of soda 80 grammes, water 250 grammes. On boiling, sulphide of tin is formed, with precipitation of sulphur. On plunging the pieces of brass in the liquid, they are covered, according to the period of immersion, with varied shades, passing from gold-yellow to red, to crimson, to blue, and finally to light brown.

3.—The metal is treated with the following composition: Solution A.—Cotton, well washed, 50 parts; salicylic acid, 2 parts, dissolved in sulphuric acid 1,000 parts, and bichromate of potash, 100 parts. Solution B.—Brass, 20 parts; nitric acid, density 1.51, 350 parts; nitrate of soda, 10 parts. Mix the two solutions, and dilute with 1,500 parts of water. These proportions may be modified according to the nature of the brass to be treated. This preparation is spread on the metal, which immediately changes color. When the desired tint is obtained, the piece is quickly plunged in an alkaline solution; a soda salt, 50 parts; water, 1,000 parts. The article is afterward washed, and dried with a piece of cloth. Beautiful red tints are obtained by placing the objects between two plates, or better yet, two pieces of iron wire-cloth.

4.—Put in a flask 100 grammes of cupric carbonate and 750 grammes of ammonia and shake. This liquid should be kept in well-stoppered bottles. When it has lost its strength, this may be renewed by pouring in a little ammonia. The objects to be colored should be well cleaned. They are suspended in the liquid and moved back and forth. After a few minutes of immersion, they are washed with water and dried in wood-sawdust. Generally, a deep blue color is obtained.

5.—Plunge a sheet of perfectly clean brass in a dilute solution of neutral acetate of copper, and at the ordinary temperature, and in a short time it will be found covered with a fine gold yellow.

6.—Immerse the brass several times in a very dilute solution of cupric chloride, and the color will be deadened and bronzed a greenish gray.

A plate of brass heated to 150 deg. C. is colored

violet by rubbing its surface gently with cotton soaked with cupric chloride.

7.—On heating brass, perfectly polished, until it can be no longer held in the hand, and then covering it rapidly and uniformly with a solution of antimony chloride by means of a wad of cotton, a fine violet tint is communicated.

8.—For greenish shades, a bath may be made use of, composed of water, 100 parts; cupric sulphate, 8 parts; sal ammoniac, 2 parts.

9.—For orange brown and cinnamon brown shades: Water, 1,000 parts; potassium chlorate, 10 parts; cupric sulphate, 10 parts.

10.—For obtaining rose-colored hues, then violet, then blue: Water, 400 parts; cupric sulphate, 30 parts; sodium hyposulphite, 20 parts; cream of tartar, 10 parts.

11.—For yellow, orange, or rose-colored shades, then blue, immerse the objects for a longer or shorter time in the following bath: Water, 400 parts; ammoniacal ferrous sulphate, 20 parts; sodium hyposulphite, 40 parts; cupric sulphite, 30 parts; cream of tartar, 10 parts. By prolonging the boiling, the blue tint gives place to yellow, and finally to a fine gray.

12.—A yellowish brown may be obtained with water, 50 parts; potassium chlorate, 5 parts; nickel carbonate, 2 parts; sal nickel, 5 parts.

13.—A dark brown is obtained with water, 50 parts; sal nickel, 10 parts; potassium chlorate, 5 parts.

14.—A yellowish brown is obtained with water, 350 parts; a crystallized sodium salt, 10 parts; orpiment, 5 parts.

15.—Metallic moire is obtained by mixing two liquids: (a) Cream of tartar, 5 parts; cupric sulphate, 5 parts; water, 250 parts. (b) Water, 125 parts; sodium hyposulphite, 15 parts.

16.—Finally, a beautiful color is formed with one of the following baths: (a) Water, 140 parts; ammonia, 5 parts; potassium sulphide, 1 part. (b) Water, 100 parts; ammonium sulphydrate, 2 parts.

Bronzing of Brass.—The object is boiled with zinc grains and water saturated with ammoniacal chlorhydrate. A little zinc chloride may be added to facilitate the operation, which is completed as above

It may also be terminated by plunging the object in the following solution: Water, 2,000 parts; vinegar, 100 parts; sal ammoniac, 475 parts; pulverized verdigris, 500 parts.

TYPES OF FRENCH ARMY AUTOMOBILES.*

By the Paris Correspondent of the SCIENTIFIC AMERICAN.

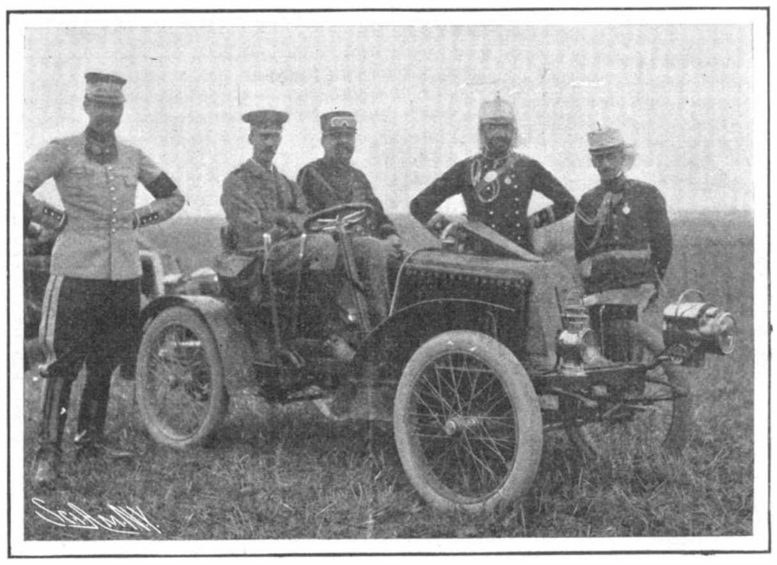
THE value of the automobile as an adjunct to the army has been so well recognized in France that every year sees an increased number of cars which are used by the different corps. During the military maneuvers, the good performances of the lighter cars as well as of the heavy tractors is best brought out, and every year the progress which is noted in this direction is considerable, both in adapting the cars to the needs of the army as well as the number of trained chauffeurs which the army has. In France the overseeing of automobile matters is intrusted to a special commission of officers; this commission forms part of the technical staff belonging to the artillery. The automobile staff, composed of four officers, who are at the same time skilled engineers, headed by General Lambert, has already done a great deal toward promoting the automobile question, owing to the advanced views and practical experience of its members. Both heavy tractors for the artillery and light cars for the officers' use have been tried in many ways, so as to secure the best system.

One of the favorite types of car is the Turcat-Mèry, illustrated below. It carries the officers forming the Automobile Commission, headed by Gen. Lambert, with Capt. Genty at the wheel. The Turcat-Mèry automobile, it may be remarked, has become one of the most successful of the Paris types ever since the form of car invented by the two young engineers of Marseilles was taken up by the De Dietrich firm, who discarded their old type in its favor on account of the great advantages it possessed. The valuable features of the Turcat-Mèry car lie in the perfection of the different mechanical parts rather than in any innovation in the principles.

M. Paul Meyan made a 1,450-mile trip with one of these cars, and it held up admirably. He started from Paris and made a run through the South of France, and then into Spain, crossing the Pyrenees, where he went as high as 6,200 feet altitude in the mountain passes. On the next page is seen a view taken at Carcassonne, France. The car in the background is one of the same type and is steered by Capt. Genty, who is piloting three other officers. In the foreground is a De Dietrich hauling wagon, which has proved very successful in army use for transporting artillery material. It was put through a severe test when it ran from Paris to Monte Carlo and back, covering about 1,200 miles in all. After this performance the commission decided to adopt it.

A lighter automobile for two people is shown below, carrying some of the foreign visiting officers who came to view the military maneuvers. This car is of the Decauville make, and has proved a favorite in the army after a number of trials. A Renault light car is also shown above. This car made a very good record for itself last fall when it was used during the maneuvers for the rapid transmission of orders.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



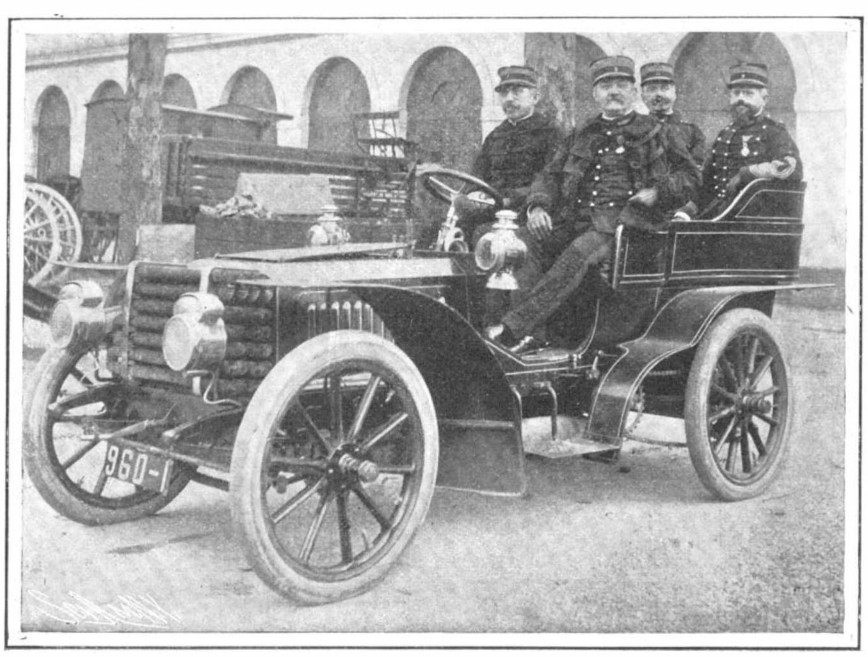
LIGHT AUTOMOBILE USED FOR TRANSMISSION OF ORDERS.

MINING IN STAFFORDSHIRE IN THE OLDEN TIMES.

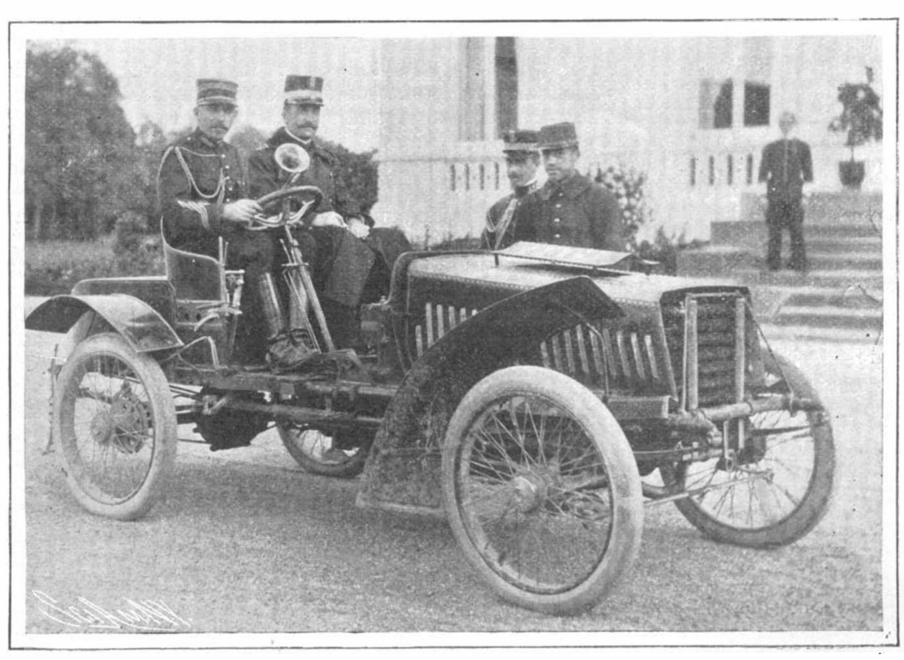
A GENERAL meeting of the Institution of Mining Engineers was held in Birmingham on February 1, under the presidency of Mr. Isaac Meachem, Jr.

An interesting paper, "A Few Notes on Early Mining in Staffordshire and Worcestershire," was read by Mr. J. H. Jackson, in which he said that although the art of mining is an ancient one in England, the scarcity of records dealing with our greatest industry renders it a difficult subject to follow. It had become a source of extraordinary revenue to the capitalist, long before it was deemed necessary to keep records of underground workings, and not until an act of Parliament was passed to enforce it, did the keeping of such records become general. The coal fields of North and South Staffordshire, especially the latter, when in their infancy were particularly adapted to the inadequate means the old-time miner had at his disposal for the working of coal. Over many areas the thick coal lies near the surface, and to a great extent the different strata lie in a plane identical with that of the horizon. There the old-time miner found his working ground. Wherever the out-crops or wash-outs have favored him, there he has left evidence of his labor. In addition to the abundance of fuel possessed by the Britons in their vast forests, they appear to have been acquainted with the use of coal, quantities of which has been found in British deposits. Whittaker and Pennant have both cited instances to prove that coal was known to the aborigines of Great Britain, the former depending in a great measure on the derivation of the word "coal," and the latter on the flint ax found embedded in a seam of coal in Monmouthshire. In Lancashire, workings in the Arley mine have been ascribed to the Romans.

A deed relating to the Heronville family of the year 1315, describes a piece of land at Wednesbury as "lying near Bradeswalle against the coal pits," and Leland, the antiquary, in 1538 writes: "There are secoles at Weddesbyrie, a village near Walsall." Camden, who wrote his "Britannia" about the year 1575, says: "The south part of Staffordshire hath coles, digged out of the earth, and mines of iron, but whether more to their commodity or hindrance I leave to the inhabitants, who do, or shall, better understand it." By an old deed of the 46th year of the reign of Edward III. it appears that both coal and ironstones were raised at Amblecote. In Plot's time workings in the thick coal and Stourbridge fireclay were in existence, the latter mineral being used for the manufacture of glasshouse pots. The historian of 1686, says: "But the clay that surpasses all others in this country is that at Amblecot, on the banks of the Stour, in the parish of old Swinford yet in Staffordshire." The following is an account of the method of working the thick coal in Dud Dudley's day: "In these pits, after you have made or hit the uppermost measures of cole, and sunk or digged thorow them, the colliers getting the nethermost part of the coles first, about two yards in height or more, and when they have wrought the crutes or staules (as some collieries call them) as broad and as far in under the ground as they think fit, they throw the small coles (fit to make iron) out of their way on heaps to raise them up so high, to stand upon, that they may, with the working of their picks or manndrills over their heads, and at one end of the coles so far in as their tool will permit, and so high as their working cometh into a parting in the measure of cole, the which coles, to the parting by hisself clogging and ponderous weight, fall often many tons of coles, many yards down at once." One traces by this evidence of a system of undergoing, cutting and falling as practised later in the square work system, once so vigorously applied in getting the thick coal when the latter was more plentiful in the district.



A TURCAT-MERY CAR.



DECAUVILLE CAR USED IN THE MANEUVERS.

In some of the old workings around Amblecote, however, another system seems to have been in practice where the old-time miner has in some cases merely removed the spires and white coal, the slipper and sawyer leaving the intermediate measures behind, probably, the writer surmised, on account of their unfitness for the purpose for which the fuel was then required. It is interesting to note that the divisions of the thick coal of South Staffordshire still bear the same nomenclature which they did in Dud Dudley's day, their names holding good after the lapse of two and a half centuries. But the record of mining left by the old makers of iron with pit coal, does not account for all the rather extensive area which the old-time miner worked over along the Netherton anticline.

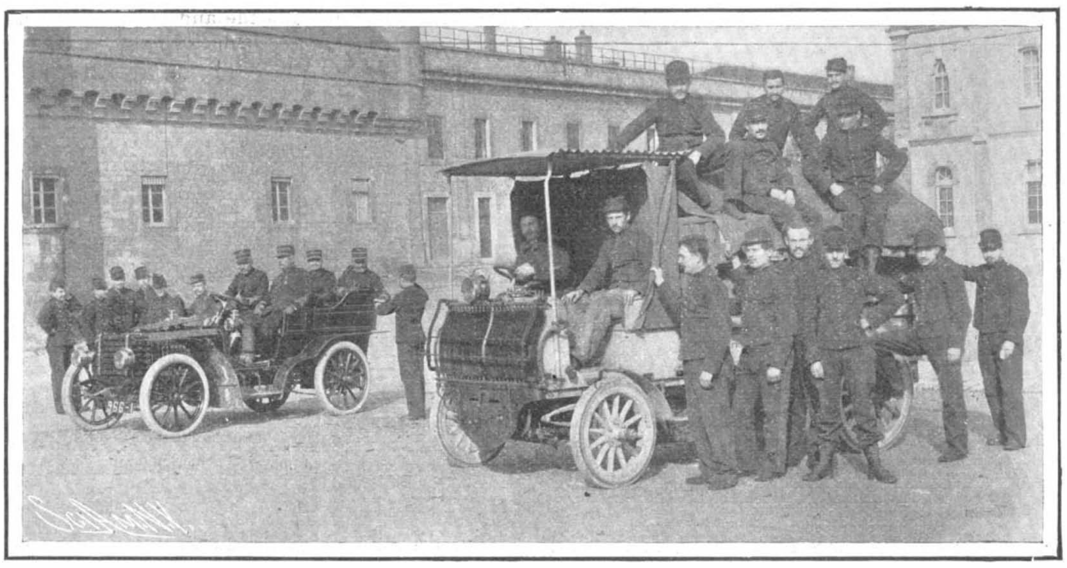
For six miles the thick coal lies in close proximity to the surface along the flanks of the ridge, and for three parts of that distance the miner working to-day finds bracings of work of another period. A broken pick, a smoking pipe, an earthen drinking mug or bottle rudely glazed, bear testimony of those who delved underground in the dark days when England was plunged in internecine warfare and religious strife.

In the time of Dud Dudley some of the shafts up which the coal was drawn were constructed square and timbered, while others were circular in shape and bricked. At Wednesbury a few were lined with special bricks made to fit the radius of the shafts, which were about 6 feet in diameter. On the eastern flank of the Netherton anticline, near Lodge Farm, where, and as long as, the Grains and Gubbin ironstone measures lie near the surface, they have been worked by a number of old bell shafts. These shafts are about 6 feet in diameter at the surface and gradually increase to 8 feet where they reached the Gubbin ironstone, when they bell out until the Upper Heathen coal is met, at which point each is about 13 feet in diameter. The Heathen coal is never pierced by them. At various angles boreholes 2½ inches diameter are met with in the present open work, some of which have been traced for a number of yards in length. Bell shafts are not altogether a proof of antiquity, for the late Sir Warrington W. Smyth, referring to the methods of working the ironstone at Tankersley, Yorkshire, in 1853, says: "Wherever the courses of ironstone nodules come up to within a short distance of the surface they are vigorously attacked by small shafts, termed bell pits." In the case of Lodge Farm workings, however, beech trees over 7 feet in girth have grown on the land about the shafts, which have been filled up with rubbish. The writer submitted that the pig-iron made here (there are refuse heaps from smelting operations near) was afterward conveyed to Cradley Forge to be worked into bars, etc., and believed that the work belongs to the seventeenth century.

Gunpowder was first used in Staffordshire about the year 1680. That some system of ventilation was in practice at this period is shown by an account of a mine at Hardingswood in North Staffordshire, given by the historian, Dr. Plot, as he speaks of passages called thurlings through the ribs which "gave convenience of air," and from what follows the necessity of sinking two shafts had already become apparent. In Cornwall 150 years ago, to save the cost of driving in hard ground, they carried a staging one part above the floor of the level being driven, upon which boards were laid, their joints carefully stopped with clay, pitch, and oakum, with turfs placed over all. This acted as an intake for the air current, called a sailes. Traces of a kindred system have been found in some of the old workings in South Staffordshire.

Looking backward to the middle of the seventeenth century, one finds the mining industry of South Staffordshire more extensive than at first might be supposed. Clays were worked at many places, and coal had been traced around Amblecote, Netherton, Wednesbury, Gornal, Sedgley, Dudley, Coseley, Ettingshall, on Pensnett Chase, and at Hasco Bridge, now Askew Bridge, near Himley. In the north of the county, Apedale, Hanley, Burslem, and Cheadle had their coal mines. Limestone was being worked at Dudley, Sedgley, and Walsall.

A short discussion followed, and the meeting was closed with a vote of thanks to the author for his paper.



A TURCAT-MERY MACHINE AND A DE DIETRICH AUTO TRACTOR.

THE UNITED STATES ARMY GENERAL UTILITY AND REPAIR AUTOMOBILE.

THE United States Long Distance Automobile Company has recently completed and tested the vehicle herewith illustrated, which is intended for the United States army. This machine is designated as a battery wagon, and is to be used as a general utility wagon by the machinist, blacksmith, carpenter, and farrier. It is driven by a 24-horse-power gasoline engine, and has an auxiliary 5-horse-power Holley high-speed gasoline motor, which drives by a Reynold silent chain a ½-kilowatt dynamo, a lathe, emery wheel, and grindstone. The dynamo supplies eight 16-candle-power, 50-volt, portable lamps for general illumination when working at night. The lathe is arranged in slides, so that it can remain in the body when not in use, and be pulled out and operated from the ground. The side of the body at this point is hinged at the top, so that it can be raised, and protect the workman from the sun or rain. The body of the vehicle is divided into fourteen compartments, each of which serves a special purpose. One contains the carpenter's and saddler's chests, another the lathe, and still others harness, a roll of leather, an anvil and forge, instruments, pikes, etc. Two wheels for the artillery, besides a supply of wagon poles, are carried on the roof, while picks and shovels are strapped to the sides. The main engine, which is conservatively rated at 24 horse-power, it is claimed, will develop about 30 horse-power at a moderate piston speed. It has four cylinders cast in pairs with the heads integral with the cylinders. The bore and stroke are 4⅝ by 6 inches respectively, and the normal speed is from 300 to 800 R. P. M., the latter giving about ten miles per hour on the high-speed gear. The engine, however, can be run much faster if necessary. All the valves are mechanically operated, and, for this purpose, two cam shafts are used, the exhaust valves being on one side and the inlet valves on the other, similar to current practice on many of the best European cars. The two cam shafts can be readily taken out or examined without opening the crank case.

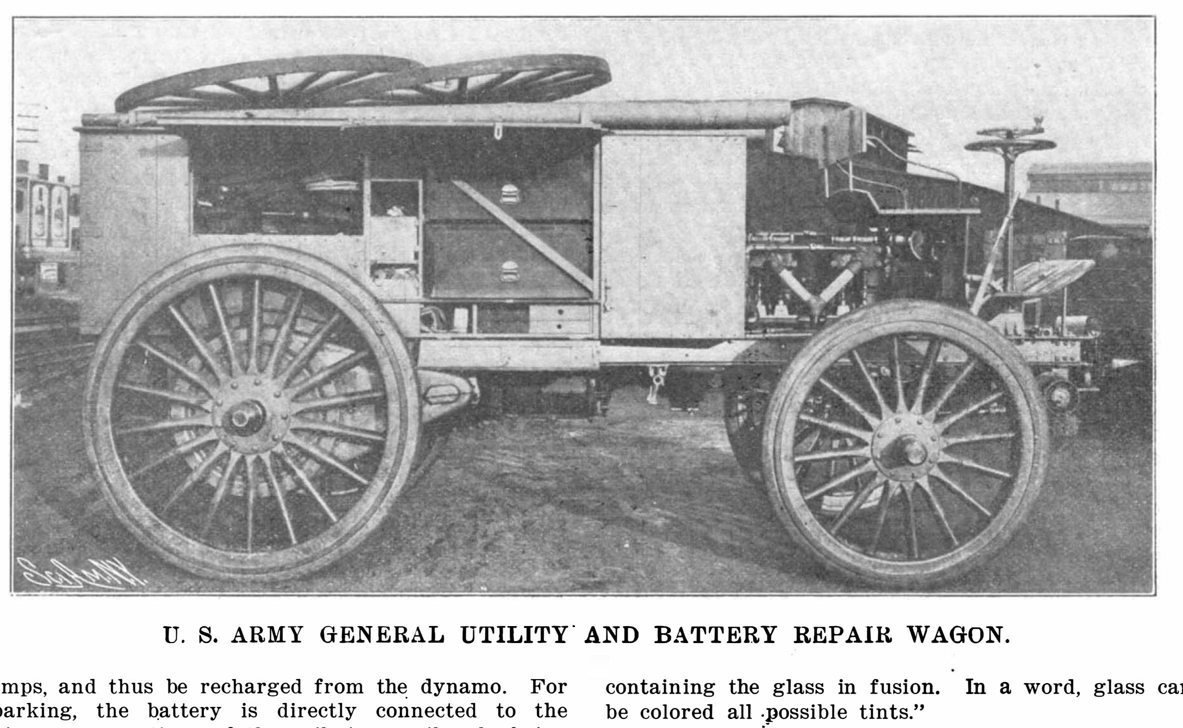
The ignition is by jump spark, and is automatically timed. Two cells of storage battery are used for this purpose. These can be connected in series with the lamps, and thus be recharged from the dynamo. For sparking, the battery is directly connected to the primary connections of the coil (one coil only being used) and the secondary is commutated to the four cylinders. This method uses slightly more current than when the primary is interrupted, but it is more reliable, and with a dynamo for recharging, the difference in current is of no consequence.

The change gear is of the sliding type, giving four speeds ahead and one reverse. The forward speeds are all operated with one lever, moving in an H-shaped slot, while the reverse is operated with a separate lever. The clutch is of the external band type, the band being of steel faced with copper blocks. An individual chain drive is used, the chains being of the ¾ by 1½-inch pitch Whitney roller type, incased in bronze oil-tight casings. The wheels are exceptionally strong. The front ones are 48 inches in diameter, and the rear ones, 56 inches. All four are shod with 5-inch Firestone solid tires. The wheel base is 9 feet, 2 inches, and the tread 5 feet.

A winch geared down 24 to 1 is provided in front, to be used in extreme cases of mud or grade. The extreme height of the machine is 7 feet 7½ inches, and its total length is 15 feet. The weight loaded is estimated at 10,000 pounds.

The frame is made of 5 x 1⅞-inch channel steel, while the body has an angle-iron skeleton. The gasoline tank has a capacity of 80 gallons. This amount of fuel runs the machine 300 miles, which is equivalent to 3¾ miles per gallon. The radiator is of the round-tube type and is placed back of the engine, with a fan blowing the air through instead of drawing it by suction. The body is painted a plain khaki, to correspond with the government regulations.

This machine was run from Jersey City to Washington, where, after tests by army officers, it was duly accepted by the government. It is the only war automobile that the United States army possesses, and it is to be hoped that it will serve as a nucleus for the accumulating of other automobiles of such types as the experience of army officers abroad has shown are most valuable.



U. S. ARMY GENERAL UTILITY AND BATTERY REPAIR WAGON.

PRODUCTION OF ARTIFICIAL PRECIOUS STONES, PAST AND PRESENT.*

From the French of M. ALFRED DE VAULLABELLE in Cosmos.

THE brilliancy and beauty of precious stones, as well as their elevated price, and the insufficiency of production, early excited the idea of reproducing artificially these marvels of mineralogy. The Egyptians, it is said, are entitled to the honor of giving birth to this imitative art, which has continued among modern peoples, and has made great progress since the year 1819. The naturalist Pliny, in his history, speaking of artificial corundums, says: "It is difficult to distinguish genuine stones from the spurious. The genuine weigh more than the others, and produce a greater sense of cold when put in the mouth." At Thebes, ornaments enriched with colored glass were manufactured, which the Phœnicians and Carthaginians exported to distant points, and sold at fabulous prices. In a work entitled "Mappæ Clavicula" which dates from the Middle Ages, and whose author is unknown, colored glasses are described, which were used in ornamenting frames and making jewels.

The means employed by our ancestors in the imitation of gems is unknown. We know only that these imitations were held in high regard, and that artificial stones were the object of a lucrative trade; but if it is impossible to discover the processes employed in the time of Pliny, some of those in use by the alchemists of the twelfth and thirteenth centuries are known. Thus, in his treatise "L'Essence des Mineraux," Thomas Aquinas informs us that certain manufacturers produced hyacinths that could not be distinguished from natural hyacinths, and sapphires closely resembling genuine sapphires. "They obtain emeralds," he says, "by employing brass powder of good quality. The ruby is procured by means of crocus of iron (ferric oxide) of good quality. To obtain the topaz, it is necessary to take aloe wood and place it on the vessel containing the glass in fusion. In a word, glass can be colored all possible tints."

At the period of the Renaissance, Cardan produced emeralds by submitting to a very high temperature a mixture of rock crystal reduced to powder, *matricuite*, verdigris, and vermiculaire. The *matricuite* is a glass

* This article is designed to give the consecutive researches of various scientists, which have gradually led to the recent successes in the production of precious stones of practical value, especially the production of the ruby by M. Verneuil, of which he has presented samples to the French Academy of Sciences, and of which the method is now in the hands of Parisian jewelers.—Note by Translator.

composed of potash, silica, alumina, and lead oxide; vermiculaire is ammoniacal acetate of copper.

At the end of the sixteenth century, the production of artificial corundums was quite common in England, but it was only in the reign of Louis XIV. that this industry was introduced into France; from that time it has not ceased to occupy the first rank.

Kircher, who lived about the middle of the seventeenth century, gives in his works a method of imitating the diamond. This was by melting at a very elevated temperature a mixture of *smalta* (a kind of glass produced with a metallic oxide), minium, and goat bone. Thus was obtained, it appears, after exposure to the fire for ten days, a crystal of very great purity, but which was still further purified by remelting with oxide of lead. This crystal is nearly the same as our strass, of which the formula, as given by M. Dumas, is the following: Silica, 38.2 parts; oxide of lead, 53 parts; potash, 7.8 parts; alumina, borax, arsenious acid, traces.

Both from its very high price and its incomparable brilliancy, the diamond was from the beginning the object of imitation. The first attempts were those of Cagnaird, Latour, and Gannal in 1828. The crystals presented by Cagnaird to the Academy of Sciences were very brilliant and very hard, but slightly brownish. They were recognized by MM. Thénard and Dumas as silicates of alumina, with no pure carbon. Those of Gannal, much harder, and of great purity and admirable brilliancy, were considered by Mr. Champigny, director of the Petitot jewelry establishments, as true diamonds, but they were in reality only a compound of carbon sulphide and phosphorus, whose composition has not been explained.

Two of our ablest chemists, Despretz and Henri Sainte-Claire Deville, made several attempts to produce the diamond, either by the decomposition of charcoal by means of a battery, or by the crystallization of pure carbon. In a first experiment M. Despretz submitted a piece of charcoal to the energetic action of a battery of 1,600 elements, with the hope of forming diamond crystals. He obtained only a simple piece of graphite without crystalline form. At another time, after having applied force uselessly, he had recourse to patience. During a full month he caused a slight electric current to pass through a stick of charcoal in a vacuum. The results, although still negative, were better; for, with the aid of a microscope, he was able to detect octahedral crystals, with which he could polish a ruby, a stone whose polishing is effected in practice only with diamond powder. Sainte-Claire Deville, with the same object in view, operated in a different way, but he was no more fortunate than his predecessor, and was so discouraged that he regarded the solution of the problem as impossible.

Recourse was then again had to imitation. The best result was that obtained with strass, a sort of crystal bearing the name of its inventor, and which, suitably cut, is of great transparency and purity, producing, under the action of light, fires resembling those of the diamond.

In 1862, M. Lamy discovered a new metal, thallium, whose salts furnish a crystal of great purity, and which, cut like the diamond, resembles that stone more closely than strass. In 1868, when scientific *soirées* were held at the Sorbonne, I saw a necklace made of thallium crystals, which commanded the admiration of all present. This metal is similar to lead, but its color is whiter and resembles that of silver. It is soft, quite malleable, and gives, when burned, a beautiful characteristic green flame.

In 1866, M. de Chamcourtois, a learned engineer, remembering the phenomena presented by the solfataras, in which hydrogen sulphide, under the influence of moist oxidation, is slowly converted into water and sulphurous acid, and deposits crystallized sulphur, advised passing a very slow current of hydrogen sulphide through a mass of sand containing traces of putrid matter. The idea was original, and perhaps might have afforded some result if it had been acted upon, which I believe has never been done.

Next to the thallium crystals, the most beautiful imitation of the diamond thus far produced was due to MM. Sainte-Claire Deville and Woehler. It is a substance resembling carbon, which the chemists have called crystallized boron, or boron diamond.

This remarkable product is prepared by causing the reaction of aluminium on boracic acid at a very high temperature. It occurs in the form of octahedral crystals, incased in the deposit of aluminium, boracic acid, and alumina, from which it is freed by a series of operations too long to be enumerated here. The adamantine boron is infusible, and is oxidized only at the temperature at which the diamond is burned. It is not attacked by the most energetic acids or by the alkalies, but is ignited at a red heat in an atmosphere of gaseous chlorine. The hardness of this crystal is so great that it can be utilized for cutting the most resistive stones.

In his memoir on aluminium, Sainte-Claire Deville says: "I have the honor of presenting to the Academy a diamond having natural facets, of excessive hardness, and which diamond powder only attacks very slowly. This diamond has been worn away on the edges of the octahedron with boron. It had at the outset a groove and two salient edges. It can be seen that the edges have disappeared, and that in several spots the groove itself has been completely effaced, indicating intense action."

Boron is a transparent crystal, which, from its brilliancy and refrangibility, is to be compared with the diamond, and with the diamond alone. In the course of his researches, Sainte-Claire Deville obtained boron crystals of a garnet red and of a honey yellow. These, like the preceding, could be made use of in jewelry. And if they are not so used currently, the cause must be attributed to the smallness of the crystals obtained, as well as the difficulties met with in producing adamantine boron.

In 1880, an accomplished English chemist, M. J. Hanney, succeeded in obtaining the crystallization of pure carbon. Instead of seeking, like many of his predecessors, to isolate carbon by means of liquid solvents, Hanney isolated hydrogen carbide by making the gas react, at a red heat and under the pressure of several thousand atmospheres, on a stable compound containing nitrogen. The carbon thus obtained has the hardness of the diamond, and, like it, cuts all crystals. Its facets are curved and of octahedral form. It exerts no action on polarized light, and burns without residue. Hydrofluoric acid has no influence on it; and, when heated in the voltaic arc, it becomes black, like the natural diamond. The process is dangerous, and the quantity of crystals obtained is not only quite small, but produced at so high a cost that the dealers in diamonds have not had, and doubtless will not have, occasion to be alarmed.

The same year another Englishman, M. J. MacTear, of the Factory of Chemical Products at Saint-Rollox, announced that he had succeeded in obtaining carbon in the form of pure crystals, which could only be diamonds; this, by modifying a general process based on a physical law. This chemist submitted the result of his experiments to Profs. Tyndall and Smith, as well as to other competent persons, who, it is said, were satisfied as to the accuracy of the statement. These crystals possess all the properties of the diamond with reference to the dispersion and refrangibility of light. They resist the action of alkalies, acids, and the intense heat of the oxyhydrogen blowpipe. Several samples, analyzed by Mr. Crookes, were recognized by him as diamonds of the kind known under the name *bort* or Brazil diamond.

It is especially since the efforts of M. Donaud Wieland, one of the most celebrated jewelers of Paris, that the production of artificial corundums has been attended with considerable development.

Still, the colored glass and strass were for a long time the only means made use of. This crystal, when pure, replaces the diamond; colored yellow with ferric oxide and Cassius purple, it has served and still serves for imitating the topaz; with manganese oxide, the ruby; with cupric oxide or chromium oxide, the emerald; with cobalt oxide, the sapphire.

All these imitations, though satisfactory with respect to color, are deficient in hardness, and consequently are subject to change.

Through the successive investigations of MM. Becquerel, Berthier, Ebelman, De Sénarmont, Guadin, Dembrée, Durocher, C. Cros, Deville, Caron, Hautefeuille, Frémy, Feil and Nonnier, remarkable success has attended the efforts for reproducing fine stones, ending, as we shall see later, in the achievement of Verneuil.

M. Becquerel, employing the galvanic current to determine, not only decompositions, but combinations, succeeded, by means of weak currents, in producing artificial crystals presenting all the characteristics of natural crystals. Of these the Museum possesses a very curious collection.

M. Ebelman, director of the Sèvres manufactory, who interested himself much in the reproduction of precious stones, had recourse for procuring artificial corundums to boracic acid as a solvent of the infusible combinations. He put into a platinum crucible mixtures in proportions corresponding to the composition of the stones to be reproduced, and carried the whole to the temperature of the white red. Thus, he obtained at first artificial spinel, which M. Dufrénoy could not distinguish from the genuine spinel, and succeeded in reproducing several other stones, having nearly the characteristics peculiar to the minerals which he wished to imitate.

By employing water as a solvent of the elements of the substances he wished to reproduce, M. De Sénarmont succeeded in crystallizing a large number of minerals, especially quartz.

M. Gaudin, a distinguished chemist and indefatigable investigator, in his experiments, commencing in 1837, heated by means of the blow-pipe a mixture of ammonia alum and of potash alum, to which he added traces of chemical compounds entering into the composition of precious stones. MM. Dufrénoy and Malagutti, on examination, found that the rubies of M. Gaudin had the rhomboidal form and the triple cleavage peculiar to corundum. They found, also, on analysis, that they contained 97 per cent of alumina and 2 per cent of silicate of lime, a composition similar to that of the ruby. It was by a similar process that M. Berthier had already reproduced peridot and several other stones. I have in hand a sample of sapphire, which was presented to me by M. Gaudin, and which the lapidary who cut it considered, in view of its brilliancy and hardness, as a veritable sapphire.

Later, in 1849, M. Daubrée, putting in practice the process he had suggested previously, consisting in causing the reaction, at a sufficient temperature, of steam on the metallic fluorides and chlorides in the state of vapor, succeeded in producing various crystalline species.

By bringing together soluble compounds of the elements of the minerals to be fixed, M. Durocher, and later, M. Charles Cros, obtained a number of crystallized stones. By the same method, but with more energetic means, MM. Deville and Caron succeeded in producing white corundums, rubies, sapphires, and cymophanes, possessing all the optical and crystallographic properties of natural stones. They obtained corundums by combining, at a very high temperature, the vapors of aluminium fluoride and boracic acid. By adding to the aluminium fluoride a small quantity of chromium fluoride, they produced the ruby or the sapphire, according to the proportions of the chromium employed. By a mixture of aluminium chloride and glucinium chloride in equal equivalents, heated in the presence of the vapor of boracic acid, they were able to form cymophane crystals.

In 1860, M. Hautefeuille, following the previous researches of a Venetian artist, Bibaglia, discovered a process for producing aventurine, a sort of crystal colored yellow with ferric oxide, and containing spangles of cupric oxide. This process consists in mixing with the crystal during its fusion fine iron turnings covered with paper. Some years later, M. Pelouze obtained an aventurine of magnificent brilliancy, and harder than the preceding, by melting together 250 parts of sand, 100 parts of sodium carbonate, 50 parts of lime, and 40 parts of potassium bichromate.

About the end of 1877, M. Monnier, by pouring very dilute oxalic acid on a syrupy solution of sodium silicate, obtained on the sides of the vessel in which he was operating, a concretion having all the properties of the natural opal. By replacing the oxalic acid with a solution of nickel sulphate, he produced a magnificent green opal.

M. Frémy, then director of the Museum, and his collaborator, M. Fiel, grandson of the celebrated optician Henri Guinaud, more fortunate than M. Gaudin, whose secret it appears had been discovered, produced in 1877 small crystals of ruby by combining in a special way alumina, silica, and lime with certain chrome salts. The ingenious methods of these experimenters consisted in heating to the red, and for a long time, a mixture of aluminate of lead and silica. In adding to the corundum thus obtained two or three hundredths of bichromate of potash, the product acquired the shade of the ruby. With a little cobalt oxide the sapphire was obtained. The reproduction was exact in density, hardness, brilliancy, color, and, according to M. Janetaz, in crystallographic and optical properties. The corundums of Frémy and Fiel can be cut by lapidaries and utilized in horology. These chemists presented to the Academy a very interesting memoir relative to synthetic mineralogy, in which they treated of the artificial production of corundums, rubies, and different crystalline silicates. It was by continuing the remarkable work conducted in this direction by MM. Becquerel, Sainte-Claire Deville, Caron, Gaudin, Debray, and Hautefeuille, that MM. Frémy and Fiel discovered the processes which they employ for producing alumina variously colored and crystallized—that is to say, the ruby and the sapphire.

Seconded in their researches by an eminent chemist, M. Henri Vaux, MM. Fiel and Frémy, aiming to approach as near as possible to the natural conditions which probably determine the formation of corundum, the ruby, and the sapphire, had recourse to the most energetic calorific apparatus employed in industry, especially that of the Saint Gobain Company, which enabled them to operate upon considerable masses.

Keeping in mind the researches of Sainte-Claire Deville and those of Prof. Daubrée, who was the first to discover the important rôle played by fluorine as a mineralizer in the formation of mineral deposits and of silicates, these scientists sought and discovered the method of producing disthene (aluminium silicate) by means of the fluoride of aluminium and of silica. They obtained also magnificent rubies by calcining a mixture of equal weights of alumina and barium fluoride, with the addition of two or three hundredths of potassium bichromate. Following the same methods, that is, by utilizing the action of barium fluoride on alumina in presence of silica, they produced crystallized double silicates analogous to the double silicate of alumina and baryta of which I have spoken.

"It is probable," say MM. Fiel and Frémy, in terminating their memoir, "that our experiments, which produce in considerable quantities bodies whose hardness is comparable with that of natural rubies, will at some time be utilized in jewelry and goldsmith work. The purpose we have pursued is exclusively scientific, and we place within the public domain the facts discovered, and shall be very happy to learn that they have received a useful application in industry."

Ten years later, in 1887, M. Frémy, with the aid of his *preparateur*, M. Verneuil, undertook new experiments on the crystallization of alumina, and had the satisfaction of obtaining very beautiful artificial rubies. The method employed consisted in causing the reaction at a red heat of barium fluoride on alumina containing traces of potassium bichromate. The new crystals, instead of being formed in a hard, vitreous, lamellar gangue, like that obtained in 1877, now appeared in a porous and friable gangue, regularly crystallized and of absolute purity. The samples presented to the Academy of Sciences were recognized, after examination, as formed of pure alumina, only colored with traces of chrome, and in all points to be compared with natural rubies. Their crystallization is rhomboidal, their brilliancy really adamantine, their shade exact, and their transparency perfect. They have the hardness of the natural ruby; and, like it, become black when heated, resuming their beautiful rose tint on cooling.

Now M. Verneuil, to-day professor at the Museum,

has discovered the method of producing the ruby artificially by melting a mixture of alumina and oxide of chrome at a constant temperature of several thousands of degrees, and in layers superposed from the outside to the inside, in order to prevent the production of cracks in the crystalline mass. This eminent chemist has succeeded in creating a magnificent ruby, weighing about 2,500 grammes, and having a commercial value of about 3,000 francs.

For securing the extreme temperature indispensable for the success of this operation, M. Verneuil had recourse to a vertical oxyhydrogen blowpipe, the flame of which was directed from above downward. The hardness of the stone was secured by an energetic tempering, suddenly suspending the action of the blowpipe.

The ruby of M. Verneuil has admirable fluorescence, on account of its great purity. It possesses all the physical properties of the natural ruby, and like the natural ruby, can be cut and receive a very beautiful polish.

We hope that now the desire expressed by MM. Frémy and Fiel in 1877 will be realized, that industry will draw advantage from this splendid discovery, and that the jewelers and the general public will share the advantages. A manufactured ruby is not to be considered as a spurious ruby when it possesses all the crystallographic, physical, and chemical properties of the natural ruby. We see no reason why any difference between them should be established. Further, and from the very fact that such a stone is the marvelous result of the incessant efforts of experimental science, it should have for us as much value, if not more, than the natural ruby.

THE N-RAYS.

NATURAL science and technology have given us in late years so many marvelous discoveries and inventions, that the appearance of a new wonder scarcely attracts attention, unless it entirely leaves the frame within which we have confined our mental picture of Nature.

For this reason, perhaps, the discovery by Prof. Blondlot of a new kind of rays has not made much stir either in the professional or in the non-professional world. It offers nothing really new to scientists or to the public; for the physicist it has only cleared away the veil of mist from a heretofore indistinctly and obscurely discernible region, while the unlearned have simply seen something similar to what has been often shown them of late. This does not belittle the work of Blondlot; and the case is not as if the scientists had had more accurate knowledge of the new rays; still, to continue our metaphor, they had determined the outlines of the mist and labored to penetrate it. A given task has rarely such a swift and fine accomplishment as in the discovery of the planet Neptune, the classic example of a discovery dependent upon pure speculation. It is much more frequently the case that natural phenomena, not actually observed, have been long inferred from others before a suitable opportunity, or often an accident, brings a real knowledge of them.

An important example of this is the old theory of chemistry. The chemical elements can be classified according to their atomic weights and certain agreements with each other, and arranged in a table, which shows in the relations of the elements a very strict adherence to law; but in some places there are conspicuous intervals or gaps, which makes the conclusion sufficiently probable that into these places must enter hitherto unknown elements whose chemical properties in general can be approximately foretold.

In perfect correspondence to the case of these elements, the new rays were long ago predicted, for physics can make a similar table of rays. We distinguish two principal kinds—those which are explained as the emission of infinitesimal particles, as the cathode rays, the canal rays, etc., and those which are explained by the theory of undulation, as vibrations. A synopsis of the latter is here given, following an arrangement made by Prof. Braun. In the otherwise fixed variation of the rates of vibration and length of waves, of which only a few characteristic examples are given, there is plainly evident between the shortest producible electrical waves and the longest heat-waves, the residuary rays of Rubens, an inconstancy of variation, an interval, which is probably filled by the newly discovered waves of Blondlot; for both Blondlot and Sognac estimate their wave length as about 0.2 millimeter.

Nomenclature.		No. of vibrations per second.	Wave-length in air.	Method of Generation.
Electrical vibrations.		50	6,000 km.	Usual alternating current.
		25,000	12 "	Discharge of 2 to 16 Leyden jars into 5 to 1,300 m. copper wire. (Feddersen, 1858.)
		500,000	0.6 "	
		10 million.	30 m.	Hertz plate oscillator, 8 m. in length. (Lodge, 1889.)
		50 "	6 "	Hertz' first experiments, 1887.
		500 "	0.6 "	Hertz' mirror experiments, 1888. (2 metallic rods, 20 cm. in length, 3 cm. diam.)
		1,500 "	21 cm.	Metallic globes of 8 to 0.8 cm. diameter. (Righi, 1893.)
		10,000 "	3 "	
		50,000 "	0.6 "	Platinum wire 1.3 mm. long, 0.5 mm. thick. (Lebedow, 1895.)
Heat.		12 billion.	0.024 mm.	Longest known heat rays, the so-called residuary rays of fluorite. (Rubens, 1894.)
Heat.	Light.	450 "	0.00069	Red light, about Line B.
Heat.	Light.	800 "	0.00039	Violet light, about Line H.
				The chemically active ultra-violet rays, and finally the Roentgen rays, have still shorter wave-length and higher rate of vibration.

Having now reached the position taken by natural science in regard to the unknown rays, and having thereby learned their place in universal nature, we will proceed to speak of their discovery and their properties.

The discovery of the N-rays, so called by Blondlot from their "native city," Nancy, makes a new link in the chain of discoveries which we owe, directly or indirectly, to Ruhmkorff's spark-inductor. And it is the more remarkable that these also were obtained by aid of this already incomparably fertile apparatus, since they are sent forth from almost all ordinary sources of light, from the sun, from the Auer mantles, and from glowing metals. Prof. Blondlot, a scientist of high repute, was occupied with experiments to detect polarization phenomena in the Roentgen rays, experiments which had so far reached only negative results, and, if our opinion as to the nature of these rays is correct, are unlikely ever to succeed. Blondlot, however, contrary to other investigators, believed that he had reached something positive, to the effect that the X-rays are already polarized by the dissymmetrical conditions of their origin. He employed for demonstration of the phenomenon a very small, weak, but regular spark, such as is generated by a small induction apparatus; and from fixed variations in the strength of the light he was led to infer the polarization of the rays from a Roentgen tube with aluminium opening. He pursued his experiments, and succeeded in deflecting the invisible rays—which he must previously have taken for Roentgen rays, in accordance with their origin—through a quartz prism, and also in concentrating them by means of a quartz convex lens. The brightening of the spark showed when it was at the burning point; and Blondlot could detect a clear image of the anti-cathode by means of it. Having succeeded with the refraction of the rays, it was to be expected that he should also succeed in reflecting them. A polished glass plate placed at an angle to the direction of the rays gave a clear reflection, exactly as with ordinary light; a plate of dull surface, a diffused reflection.

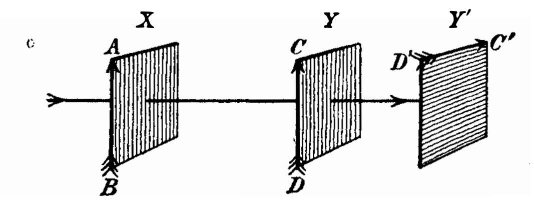


FIG. 1.—N-RAYS REFRACTED.

At the end of these experiments it became clear to Blondlot that he had not to do with Roentgen rays, for these, as has been sufficiently shown by other experiments, can be neither reflected nor refracted; the little spark must be reacting upon a new kind of rays. And these rays must be a pronounced transverse vibration, since only with such can there be any question of polarization.

Simply to refresh the memory, I will indicate in a few words the nature of polarization, and take for simplicity's sake the illustration of an ordinary ray of light.

If a ray of light on its path passes through a tourmaline plate, *X* (Fig. 1), whose edge *A B* is cut parallel with the principal axis of the crystal, it remains outwardly unchanged, except a little colored by the tourmaline; and no visible change takes place if *X* is turned to a plane vertical to the direction of the ray. Now let the ray pass through a second tourmaline plate, *Y*, whose edge *C D* is likewise parallel with the principal axis. As long as *C D* is parallel with *A B*, the ray passes through unobstructed, but if *Y* is turned so that *C D* and *A B* are on an inclined plane to each other, the ray becomes dim, and disappears entirely when *C D* is vertical to *A B*, as in *Y′*.

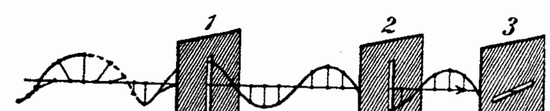


FIG. 2.—N-RAYS REFLECTED.

The ray, then, observed with a tourmaline plate, conducts itself in an entirely different manner, according as it has or has not previously passed through another tourmaline plate.

The explanation can only be such as is illustrated in Fig. 2. Of the vibrations which take place vertically to the direction of the ray, but not upon a fixed plane—this can be only imperfectly illustrated in the drawing—only those pass through the first plate which can enter the cleft. The vibrations on the other side of the cleft are on a plane fixed by the position of the cleft and the direction of the ray. The second plate, in the indicated position, cannot affect them, but the third must perforce entirely exclude the vibrations.

A ray of the nature of our ray of light, after it has entered the first tourmaline plate, is said to be polarized on a linear plane. With two such plates the polarization of every ray of light can be tested. The first plate is called the polarizer, the second, through whose rotation the plane of polarization is learned, the analyzer.

The N-rays which leave the Roentgen tube are, from the dissymmetry of the conditions of their origin, polarized on a linear plane; and since with the means by which they are recognized—a spark springing across between two points—a direction is plainly marked, it is not difficult to see that the spark must act as an analyzer. That is, as the spark-expanse is turned in different directions, the vibrations occurring on a fixed plane will be shown differently in it. It is therefore not necessary, as Blondlot soon found, to use an electric spark to detect the vibrations. Any little weak flame will perform the same service, with the self-evident limitation that it cannot act as an analyzer. And there is a still more convenient method of demonstrating the new rays; although they do not affect naturally phosphorescent substances, they intensify the light from those to which slight phosphorescence has been given from some outside source.

By these means the further characteristic of the N-rays can be found out, first of all their power of penetrating opaque substances. Exactly like the Roentgen rays, they pass easily through wood, dark paper, thin plates of metal, etc., but with difficulty through rock-salt, fluorite, sulphur, and glass. It is therefore necessary, in refraction experiments, to use quartz prisms and lenses instead of glass. A property which distinguishes them from the Roentgen rays is that they have no chemical activity, and thus do not affect photographic plates.

Whether this is all which can be said of the new rays, who knows? We human beings are accustomed to judge the occurrences of nature only according to their practical relations to us. The electric waves first attracted general interest through telegraphy; the heat waves are the chief transmitters of energy from sun to earth; the light waves show us the wonders of the universe. Have not the new waves also some part to play in the spectacle of nature?—Translated from Prometheus for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE PLANNING OF A NEW ROME.

PROJECTED EXCAVATION OF THE FORA OF THE EMPERORS.

MUCH akin to carrying coals to Newcastle would it be to attempt to prove in detail the numerous errors the Roman authorities made at the time the *piano regolatore*—plans for the rebuilding of the city and regulating of its streets—was conceived, plans whereby the narrow catercornered and cramped city of the Popes should be developed into a spacious and airy city of modern time, with flights of broad avenues and wide, comfortable streets.

In the quarter of a century which has elapsed since the conception of these plans for the correction of the city's ancient ways and its beautification by the erection of new and ornamental buildings in place of the ungainly seven-storied yellow-washed palaces, so called, more clever heads have long ago acknowledged to what an extent thoughtlessness and arrant impetuosity worked together to produce them; recognizing it at the same time as a dispensation of a kind Providence that, for want of the necessary means to carry them out, the changes have been thus delayed.

For if on the one hand complaints are continually forthcoming that the extension of the confines and the renewal of the dilapidated portions of united Italy's capital city have been inordinately drawn out, so much so, in fact, that the improvements for the most part still exist only on paper, and many quarters of the Eternal City present the very unsatisfactory picture of incompleteness at the present day, there remains one consolation for this painful condition—that this very slowness has afforded the opportunity for revising, changing, improving, and making good, before it is too late, the errors with which the approved and legalized *piano regolatore* fairly bristles.

To this cause a recently published leaflet by the architect Antonio Tolomei, concerning the Via Cavour and the Fora of the Emperors, should be considered as an important contribution. The question discussed here is not of interest to the Roman people alone, but affects the whole scientific and intellectual world. What stranger, wandering afoot among the venerable ruins of ancient Rome, from the Roman Forum through the narrow quarter of the city extending from the foot of the Capitol to the Forum of Trajan, does not experience the heartfelt desire to see this mass of mostly worthless buildings razed to the ground, in order that the underlying Fora of the Emperors may be exhumed, and even in their lordly ruins restored to the light of day for the benefit of present and future generations? What a vast single field of magnificent ruins would be spread out before the human gaze, an uninterrupted vista of a succession of open ruin-covered spaces running from the Palatine over the Forum Romanum and the consecutive Fora of Vespasian, Nerva, Augustus, and Julian to the Forum of Trajan with its gigantic column, which overtops everything from the Capitoline Hill with its antique and Middle Age renaissance building side by side with the huge memorial of Victor Emanuel, the first king of the newly united Italy. The completion of such a huge task, the destruction and excavation of a tract covering more than a dozen blocks of houses, would indeed require immense sums of money, and could scarcely be accomplished within the period of several generations. And yet even the magnitude of the work should not cause the powers that be to abandon the idea altogether, nor,

as Tolomei rightly says, should it be hampered by new difficulties, if its accomplishment be postponed to a more fortunate future.

The ultimate carrying out of the *piano regolatore* as it stands to-day would provide almost insurmountable difficulties to the opening to view of the Emperors' Fora. The new and spacious Via Cavour, which begins at the Central Depot and passing by the Esquiline Hill is almost completed as far as the Roman Forum, is expected, according to the new plans, to lead to the center of the city, the Piazza Venezia, passing the edge of the Roman Forum, and bending to the right in an obtuse angle, traverse that part of the city under which the Emperors' Fora lie, to the foot of the Capitol. Against this direction of the new street, which corresponds almost exactly with the axes of the present Via Salara Vecchia and Via Cremona, Tolomei cites the objection that a new means of access to the new buildings above the Fora of the Emperors would make the excavations more difficult, and perhaps cause them to be abandoned altogether. He cites further objections, which, however, when compared with this latter, are scarcely worth considering. On the contrary he proposes that the continuation of the Via Cavour be carried to the Piazza Venezia in such a manner that the section covering the Emperors' Fora be not cut through, but skirted, the new street occupying the positions of the present Via Tor dei Conti and Via di Campo Carleo. The length of the new street would not be increased materially thereby, though it would receive a much sharper bend, which would hardly have any disadvantageously æsthetic effect, especially since some important remains of the Emperors' Fora would lie in its flight. The most conclusive argument advanced by Tolomei in support of this arrangement is that, should it be found advisable in the future to raze the blocks of houses lying between this new street and the Capitol, and subsequently to excavate and expose to view the remains of the Fora of the above-named Emperors, the new street skirting the excavations and running in a plane several meters above the floor of the Fora would form a terrace from which could be obtained a view of the field of ancient ruins extending from the Palatine to Trajan's lofty column, not equaled elsewhere.

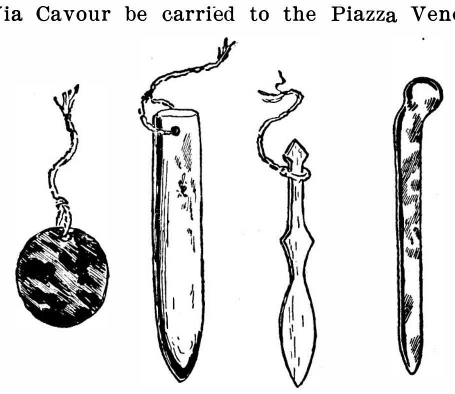


Fig. 2.—HATPINS FOR TOPKNOT.
Two-thirds natural size.

KOREAN HEADDRESSES IN THE NATIONAL MUSEUM.*

By Foster H. Jenings.†

Among the many customs peculiar to quaint Korea, the style and manner of wearing the hat is probably the most noticeable. Fashions there seem never to change, for many styles of hats of to-day are of the same material and shape as those of the days of the Ming dynasty, or of the days of Confucius. The people have hats for all ranks and for all occasions—there are hats for the nobility, for the gentry, for petty officers, for chair bearers, and for almost every ceremony—and perhaps no nation has more ceremonies than the Koreans. There are also hats worn when a person reaches manhood, others for use during ancestral worship, or passing the civil service examination, during betrothal, at marriage, while mourning, and for making official visits to high dignitaries. The hat is in fact a badge of honor and its absence a sign of disgrace.

Fig. 1.—HEADBAND AND TOPKNOT.

For many years butchers were not allowed to wear hats, the Buddhist religion making it a sin to take the life of any living creature. In 1895, however, a petition was presented to the home department of the Korean government asking that public notice be given throughout the eight provinces that butchers be allowed to wear hats the same as other citizens and that they be free from molestation. The preamble of the petition stated the grievances of the butchers; how for five hundred years, although guilty of no crime against their country, they had been grievously oppressed. The government promptly granted the petition. Upon being notified that their request had been allowed, a butcher named Pak, who had prepared the petition, wrote to the country butchers informing them of their approaching deliveranc and warning them against becoming puffed up by their sudden elevation in rank. A month later placards announcing that the petition was granted were posted throughout the country. The butchers in Seoul had for some months been allowed to wear hats; but if a country butcher wore one, he was greeted by some such remark as "You dog of a butcher, what are you doing wearing a hat like one of us?" Butchers are considered lower than beggars, as it is said "something might be made out of a beggar, but it is impossible for a butcher ever to rise."

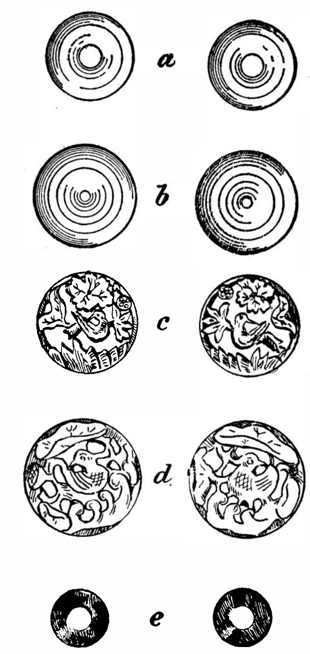


Fig. 3.—BUTTONS FOR HEADBAND DENOTING RANK OF NOBILITY.
About two-thirds natural size.

Fig. 6.—CIVIL SERVICE EXAMINATION HAT.

* From Smithsonian Miscellaneous Collections.

† The author of this paper was a young man of great talent and promise. He was a skillful artist, and when a mere boy often visited the National Museum for the purpose of sketching and study. Through his deep interest in Oriental, and especially in Korean, subjects, he became acquainted with the attachés of the Korean legation, who, impressed by his usefulness, caused him to be made an official of the fifth grade, in which capacity he was employed at the time of his death, January 15, 1900.—W. H.

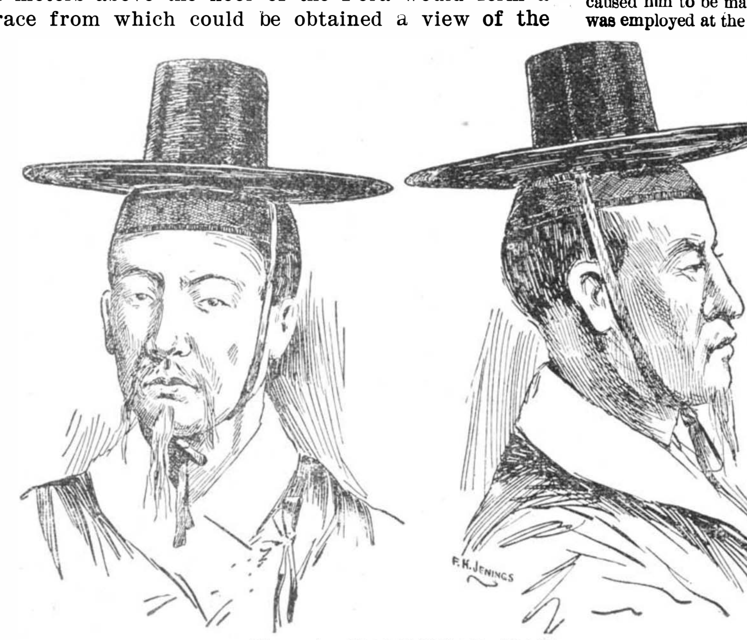


Fig. 4.—NATIONAL HAT.

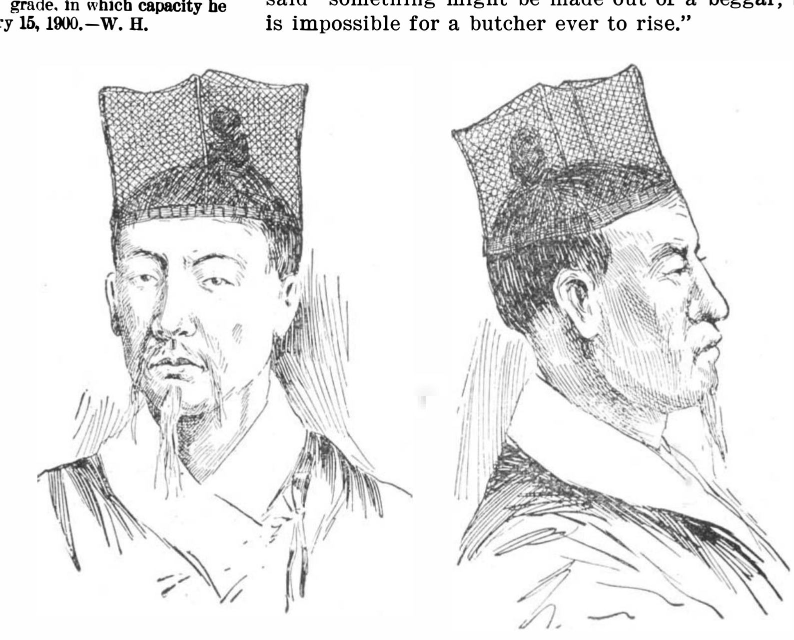


Fig. 5.—HOUSE HAT.

When a boy attains the age of seven years he starts a topknot, which when grown is never changed in form as long as he lives. The topknot was the cause of an amusing episode in Seoul in 1895. Like many other nations when first adopting European customs, the Koreans went to extremes. An edict was issued that all topknots should be cut off, and, as the people naturally objected, soldiers were sent out in the city to forcibly cut off all topknots that had not been removed in compliance with the edict. This created such consternation that farmers would not bring their produce to the city markets, and such suffering resulted from want of food that the edict was abrogated and topknots were once more in full favor.

FIG. 7.—OFFICIAL HAT.

FIG. 9.—WEDDING HAT.

Every Korean, at all times, day and night, wears a band around the head (Fig. 1). The hats are perched on top, never low on the head, and are secured by pins (Fig. 2) to the topknots and by strings tied under the chin. Among the nobility, circular or ring-shaped insignia of rank, about half an inch in diameter, are worn back of each ear and fastened to the head by a string (Fig. 3). Five grades of nobility are thus represented: (*a*) *Ta-kum*, first rank, smooth white jade; (*b*) second rank, smooth gold; (*c*) *Young-kum*, third rank, carved gold; (*d*) fourth rank, car ed white jade; (*e*) *Na-ri*, fifth rank, tortoise shell (anciently of silver). The button of the royal family is of smooth green jade.

The national hat of Korea (*kat*) is made of fine silk over a bamboo framework, stiffened with size (Fig. 4). It has a small, cylindrical, truncated crown and a broad brim with long tying strings. The diameter of the brim is 18 inches and the height of crown 4½ inches. In ancient times the brim was, by royal edict, very much wider to prevent conspirators from whispering to each other, the stiff brims keeping them some distance apart. This illustrates a national characteristic of Koreans, their suspicion of every one, and it will be many years before this universal peculiarity is eradicated in this otherwise kind, genial people. The *kon* is a wide, circular band of black horsehair, 7½ inches high, worn by those of the literary class who have not yet passed a civil service examination or held office (Fig. 5). It may also be worn by one who passes the second grade of merit at the literary or military examinations before holding office, but the lower class of merchants and laborers, unless after such examinations, cannot wear it.

In the Korean civil service examination, one of the requisites is the examination cap, or *yu kon*, composed of a piece of coarse black cotton stuff, shaped like a grocer's paper bag, 9 inches high and 7 inches in diameter. It is worn by students only at the literary examinations, held yearly for the preliminary grade (Fig. 6). This hat is reputed to be made in the shape of the mountain near which Confucius was born, and was introduced from China several centuries ago, probably during the Ming dynasty.

The court or official hat, *samo*, is 7 inches high with a high terraced crown of stiff lacquered paper and woven bamboo, covered with black sateen (Fig. 7). It fits tightly over the forehead, and at the back on either side there are curved, ear-shaped wings of gauze that project horizontally forward. This is practically the coronet of Korea and can be worn only by the nobility on official occasions, but officers of the government wear such hats during an audience with the king. The wings are said to have been made to resemble ears bent forward in the act of listening to catch every word of command the king may utter. The royal hat or crown of the King of Korea is of the same shape as the *samo*, except that the wings are vertical instead of horizontal, indicating that the king receives his commands only from Heaven. The Koreans are great lovers of Chinese classics, and like all peoples of the Far East, attach poetical names to everything. The gauze wings on the official hat are called the "wings of the locust." The Chinese poet says, "like the locust singing in the tree with love and peace toward all men," and as the locust is the emblem of peace, the royalty and men of noble rank, who are supposed to spend their time seeking peace and the welfare of their country, wear the locust-wing emblems on their headdress.

FIG. 10.—*a*. MOURNER'S HAT. *b*. FARMER'S HAT.

Perhaps the most elaborate of Korean hats is the one worn by the king's assistants when he offers sacrifices. This is helmet-shaped and is skillfully woven of thin strips of bamboo incrusted with gilt papier mâché dragons, scrolls, and other emblems. It is fastened to the head by a large hatpin, with cords and tassel, thrust through the sides and back of the hat (Fig. 8).

A hat that seems to be prescribed for the bridegroom at the time of the wedding ceremony is shown in Fig. 9. It is made of lacquered paper, covered with silk and folded into a wedge shape, and depending from the back are three double tassels of red silk.

The largest hat worn in Korea is that of the farmer (Fig. 10, *b*). It is conical, with hexagonal base, and is woven of split stalks of millet. The exterior and interior of the straw are of different color and form a pleasing variety in the weave. It is stoutly braced inside with hoops of bamboo and gives effective protection against wind and storm.

Confucianism prevails among the higher classes in Korea and its influence permeates all classes of citizens. Confucius gave the order that mourning for three years should be worn for the loss of either parent, a custom strictly followed by Koreans. White is a mark of mourning, and all articles of mourning costume are covered with sack-cloth. The mourning hat, or *pang gat*, is largely in evidence in Korea (Fig. 10, *a*); it is made of bamboo splints, the edges scalloped and finished with braiding, and is crowned with a rosette of bamboo. A frame to fit the head is fastened inside, and from it hang tying strings of twisted paper. It is 14 inches high and of 25 inches diameter, and is designed to hide the face, it being considered a grievous breach of etiquette to look into the face of a mourner. Taking advantage of this custom before Korea was opened to foreigners, Jesuit priests disguised themselves as mourners and lived among and taught the people for a long time without detection. When the king dies, the nobility wear the *samo* in white (Fig. 7). In the house and at a certain period the mourner wears a cap and head-band like that shown in Fig. 11).

(To be continued.)

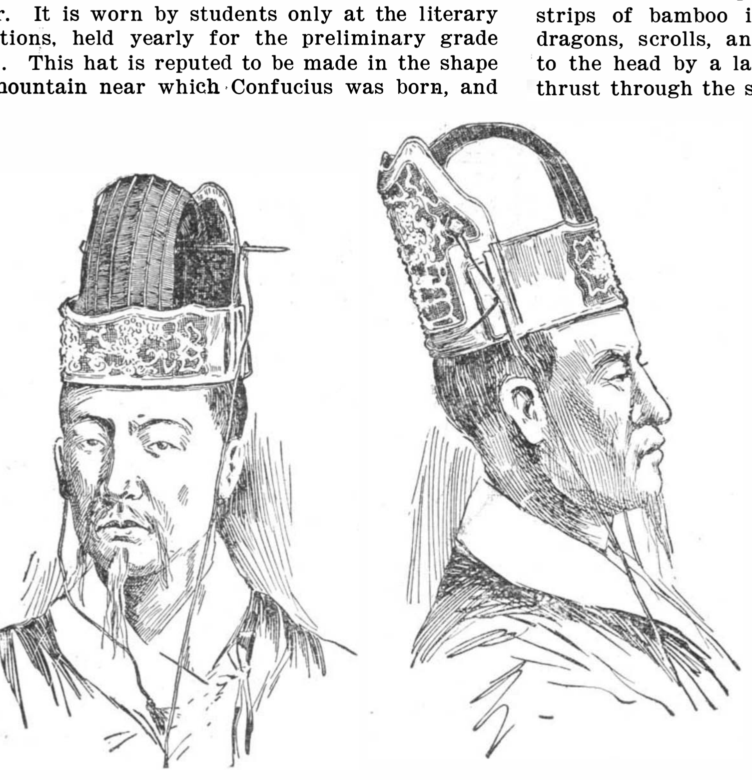


FIG. 8.—CEREMONIAL HAT.

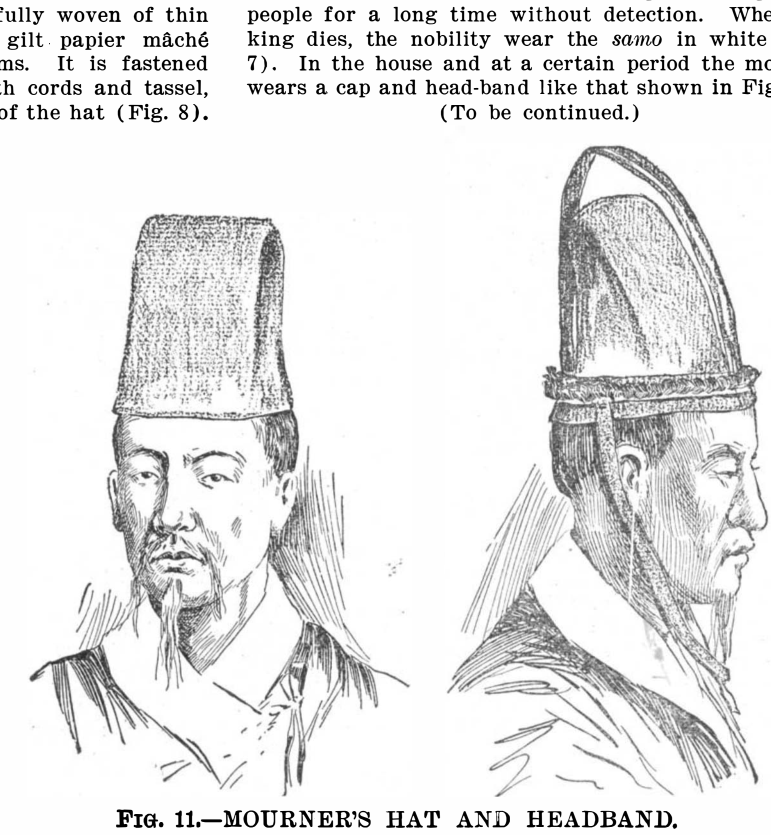


FIG. 11.—MOURNER'S HAT AND HEADBAND.

ENGINEERING NOTES.

The merits of multiple-unit automobile trains, operated by gasoline and electric machinery combined, are at present being exploited on both sides of the Atlantic, French reports giving somewhat meager accounts of what is called the Renard railless train, while in the United States an equipment of apparently similar make-up was recently exhibited. The French wagon train has been described as consisting of a 40-horse-power gasoline or petrol motor car, hitched on to several wagons; but instead of hauling these after the manner of a locomotive, it supplies power electrically to each of the vehicles, which are thus self-propelling. Trials between Paris and Versailles are understood to have been made, with encouraging results. The American outfit consists, similarly, of a gasoline motor car and two trailing wagons, the motor car propelling itself and using its surplus power for driving a dynamo for electric current supply to electric motors on the trailing cars. Though it may be presumed that the preponderating merits of thus carrying along with the train a small central power station have been definitely ascertained, it is not very clear what they are. Self-contained units, driven directly by gasoline engines, without the intermediate electric conversions, would seem to come nearer the mark of perfection in several ways, not the least of which would be that of greater simplicity of equipment and management, and that is an important consideration. —Cassier's Magazine.

The tendency to spontaneous combustion of coal when stored in bulk—in masses of, say, a thousand tons or thereabouts—may appear to be a somewhat unusual point to make in favor of the gas engine as a large-size power unit for central station work. It was, however, made as such recently by a central station engineer, whose contention was that the nearly always present danger of spontaneous ignition in the large reserve stock of coal expedient for a power station of any considerable size to carry, to tide over possible temporary interruptions in the supply, from strikes or other causes, was entirely eliminated by the use of gas engines which took their gas from central gas plants. Curiously, however, the fact appears here to have been overlooked that with the large gas engine plant will come, as an almost inseparable adjunct, the gas producer, taking the place of the steam boiler now accessory to the steam engine installation, so that the large coal pile will remain in evidence as before, and the spontaneous ignition troubles as well, even with certain precautions against them, in the way of selecting and storing the coal. Experience in some cases has dictated the safe height to which coal of certain sulphur percentage may be banked, but this height will vary with some other governing conditions easily enough imagined. The gas engine, therefore, will, after all, have to depend for favorable consideration upon its several other well-known good points rather than upon the one mentioned in the opening lines of this paragraph.—Cassier's Magazine.

In the current number of the Proceedings of the Royal Society of Edinburgh there is printed a lengthy paper by Mr. A. Cameron Smith, B.Sc., in which he describes a direct electrical method of determining latent heat of evaporation at the boiling point. In this method the liquid of which the latent heat is to be determined is contained in a glass vessel which is suspended by a fine wire from the hook of a balance, and the amount of electrical energy is measured which is required for the evaporation of an observed mass. The electrical energy is supplied by a large current passing through a small resistance in the liquid itself. In order to reduce heat losses as much as possible, the vessel carrying the liquid and the resistance is completely surrounded by a double-walled shield, which is filled by the saturated vapor of the liquid itself. The estimation of the electrical energy supplied necessitates the measurement of the current, C (amperes), the resistance, R (ohms), of the heating coil, and the time in seconds, T, during which the current flows. It is expressed by $C^2 R T$ joules, and if M be the mass evaporated in grammes, the latent heat expressed in joules per gramme becomes $C^2 R T/M$. Enumerating the advantages of this method, the author states that in nearly all methods the total heat is measured and the latent heat deduced from an assumption of the mean specific heat. In this method the latent heat is determined directly. Again, the latent heat is obtained by an electrical measurement, which may be made more accurately than is possible when the results depend on the reading of an ordinary mercury thermometer. As a result of several very trustworthy determinations within the last decade, the value of J in electrical units for various calories is known to at least 1 in 2,000. The experiments made by the author have so far had the end in view of testing the reliability of the method, and for this purpose water has always been used, in order to enable a comparison to be made with Regnault's result. Taking this as 536.3 (calories at 15 deg.), and Joule's equivalent J = 4.187 (calorie at 15 deg.), this gives the latent heat in joules per gramme = 536.3 × 4.187 = 2,245.5. Compared with this, the numbers 2,249, 2,264, 2,266 have been obtained in the order given. These numbers seem to indicate a value somewhat higher than Regnault's, but they were obtained with forms of apparatus which subsequent experience showed to be unsatisfactory in several respects. It is hoped that with the present form more concordant results may be obtained. Experiments for this purpose are being continued.

ELECTRICAL NOTES.

According to the latest returns the number of subscribers to the Berlin telephone system has reached the enormous figure of 73,000. This would mean an increase by about 10,000 in the course of last year. Of the above total, about 11,000 would be in the suburbs, Berlin itself being represented by about 62,000, i. e., 6,000 subscribers more than last year. The relative increase in the number of subscribers in the Berlin suburbs, being about 4,000, is thus much higher. The largest Berlin telephone exchange is the main telephone office, comprising 12,340 connections.

L. Lombardi, in a recent issue (No. 3) of the Elektrot. Zeitschr., endeavors to determine, as accurately as possible, the temperature of osmium lamp filaments (using a process designed by Prof. H. F. Weber at the 1891 Frankfurt Congress) from the relation given between the absorbed energy and temperature. The author derives, as an average value of the radiation constant, the figure $C = 0.0000164$. As an average of all the measurements made on osmium lamps, 1,435 deg. is found to represent the temperature of normal luminous intensity, being 135 deg. below the corresponding temperature for ordinary glow-lamp carbon filaments. This striking result, viz., that the normal temperature of the incandescent filament is so materially below the one of carbon filaments, though the economy of osmium lamps be much better than that of ordinary carbon filament lamps, is illustrative of the high luminous power of the osmium filament. In virtue of this behavior, the life of osmium lamps may evidently be much higher than the life of ordinary carbon lamps.

The development of the mechanical equipment of mines has made rapid advance in the last fifteen or twenty years, and in no one feature, possibly, is this more true than in electrical traction haulage. When viewed in the light of an up-to-date locomotive, this progress is remarkable when it is considered that the first electric mining locomotive used in America was installed by the Lykens Valley Coal Company, one of the coal operations of the Pennsylvania Railroad at their Short Mountain Colliery, in 1887. This locomotive was designed by Mr. W. M. Schlessinger, and was built by the Union Electric Company, of Philadelphia. Although a very crude affair, according to our present standards, this and a similar locomotive are still in service. The locomotive weighs about 5 tons, and is equipped with a 32-horse-power electric motor. Motion was imparted to the driving wheels from the motor by a chain-and-cog connection. The pig iron with which the locomotive was loaded was added for tractive effect. The conductor for supplying current to the motor consisted of a T rail carried on supports parallel to the track at a vertical height of about 5 feet and at a distance horizontally from the track rail of 20 inches. The current was conducted from the rail by means of a trolley arm carried along the current rail by three wheels. It was insulated by having a small piece of ordinary sheet gum placed between the rail and its support; the rails were made continuous by being bolted together with fishplates, between which and the rail were placed small pieces of sheet brass. The return current is carried back to the generator by the track rails.—Mines and Minerals.

Before Section G at the meeting of the British Association at Southport, Mr. J. W. Thomas made a highly interesting communication, in which he dealt with the all-important subject of the ventilation of tube railways. After considering the physical conditions essential to good ventilation in tube railways, the calculation is made that the forces brought into play by the moving trains and the natural heat of the tubes will be ample if properly directed. The author thus explained his meaning: In tube railways, if B is the center of three stations, the down train moving from A to B will draw air from the A station into the tube and expel it in the B station, and the up train moving from C to B will draw air from the C station into the tube and expel it in the B station. Three stations are thus directly involved, and a triple-station arrangement will best fulfill the physical conditions. Owing to the elasticity of air, the outlets for expelling the vitiated atmosphere must not be situated far from the points of greatest compression, and should begin in the center of each station underground and end in the open air above the station at the surface. For the same reason the intakes for fresh air should be close to the points where the sudden expansion of the air begins. These points are at the ends of the tubes which the moving trains enter. Doors can be fixed at the ends of the two tubes which the train enters in each station, and closed behind the last train at night, so that the fresh air brought into the end of the tube immediately beyond the doors will drive out the foul air into the next station by natural ventilating pressure. His conclusion is that the providing of fresh-air inlets inside the ends of the tubes which the trains enter, with an outlet shaft in the center of each station, will enable the moving trains to draw in and expel enough air to keep the atmosphere in good condition even in hot summer weather. In addition to this, however, there are two auxiliary aids to ventilation which enable the station masters to make certain that the state of the atmosphere in the tubes is satisfactory: first, having inlets and outlets as above, the timing of the departure of the up and down trains as they move toward the same station will enable enormous volumes of air to be driven to the surface, and a corresponding volume will be drawn in; second, by closing the doors after some of the trains as they leave the stations fresh air must be drawn into the tubes.—London Electrical Engineer.

TRADE NOTES AND RECIPES.

Preparation for Destroying Roaches and Other Insects.—Take glass bottles, 15 or 20 centimeters in height, with quite a large opening. Put oil in each for about 5 centimeters of the height, and place them obliquely in the passageways of the insects. These do not mind the quality of the oil, and entering the bottle, are quickly asphyxiated, the oil obstructing their organs of respiration. Empty the bottles from time to time and renew the oil. Do not employ too thick an oil.—Moniteur Scientifique.

Hygiene of the Poultry Yard.—Fowls are subject to various affections, which often attack their claws. We think it may be useful to reproduce a receipt which accomplishes excellent results. Place under an open shelter, but where water cannot penetrate, the following mixture: Lime, 2 liters; wood ashes, 7 liters; flowers of sulphur, 1 liter. The poultry will come and roll in it to dry their claws. The mixture being alkaline and pulverulent, the vermin will also disappear very quickly from the poultry-yard, which certainly is favorable to the fattening of the fowls.—Le Cosmos.

Petroleum Emulsion.—An emulsion due to M. Gagnière for employment against fumagine (malady of orange trees caused by the cochineal insect) and other diseases caused by insects. It can be applied in all cases where petroleum is indicated.

Dissolve, hot, 4 kilogrammes of black soap in 15 liters of hot water. Let cool to 40 deg. C., and pour in 10 liters of ordinary petroleum, shaking vigorously. Thus, an emulsion of *café au lait* color is obtained, which may be preserved indefinitely. For employment, each liter of the emulsion is diluted, according to circumstances, with from 10 to 20 liters of water.—Les Corps Gras Industriels.

Preparation of Paper Pulp with Broom.—We have already stated that formerly the broom was cultivated for its long resistive fibers. N. S. Persichetti mentions in the Moniteur de la Papeterie Francaise a treatment of the broom for obtaining a paper pulp. The branches, twigs, and roots are cut up and allowed to remain three or four days in cold soda lye of 10 deg. Bé. strength. They are washed, and afterward left for two days in a 2 per cent bath of chloride of lime, when the pieces become friable. Then they are washed in a weak solution of hyposulphite of soda. This material is ground up until the desired fineness is obtained. Besides the soda, the first bath contains after treatment gums and resins. By adding a fat, soap is obtained of good quality.

Process for Obtaining White Wax. —The wax is bleached by exposing to moist air and to the sun, but it must first be prepared in thin sheets or ribbons or in grains. For this purpose it is first washed, to free it from the honey which may adhere, melted, and poured into a tin vessel, whose bottom is perforated with narrow slits. The melted wax falls in a thin stream on a wooden cylinder arranged below and half immersed in cold water. This cylinder is turned, and the wax, rolling round in thin leaves, afterward falls into the water. To melt it in grains, a vessel is made use of, perforated with small openings, which can be rotated. The wax is projected in grains into the cold water. It is spread on frames of muslin, moistened with water several times a day, and exposed to the sun until the wax assumes a fine white. This whiteness, however, is not perfect. The operation of melting and separating into ribbons or grains must be renewed. Finally, it is melted and flowed into molds. The duration of the bleaching may be abridged by adding to the wax, treated as above, from 1.25 to 1.75 per cent of rectified oil of turpentine, free from resin. In six or eight days a result will be secured which would otherwise require five or six weeks.—Les Corps Gras Industriels.

Briquettes of Petroleum.—M. Maestrecci, an officer of the navy, has proposed a simple process for obtaining briquettes of petroleum similar to those of charcoal. Mix with a liter of petroleum oil 150 grammes of ground soap, 150 grammes of resin, and 300 grammes of caustic soda lye. Heat this mixture while stirring. When the solidification commences, which will be in about forty minutes, the progress of the operation requires to be watched. If the mixture tends to overflow, pour into the receiver a few drops of soda, and continue to stir until the solidification is complete. When the operation is ended, flow the matter into molds for making the briquettes, and place them for ten or fifteen minutes in a stove; then they may be allowed to cool. The briquettes can be employed a few hours after they are made.

To the three elements constituting the mixture it is useful to add per kilogramme of the briquettes to be obtained, 120 grammes of sawdust and 120 grammes of clay or sand, to render the briquettes more solid.

Experiments in the heating of these briquettes have demonstrated that they will furnish three times as much heat as briquettes of ordinary charcoal, without leaving any waste.

It will be possible, it seems, by making some modification in the fire-boxes, to suppress the smoke and increase the production of heat in such a proportion that one kilogramme of solidified petroleum will be equivalent to four kilogrammes of coal.—Moniteur Scientifique.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Commercial Museum in the Philippines.—The following letter seeking the co-operation of the Department of Commerce and Labor was received recently, and is published herewith for the information of our manufacturers and exporters. The museum aims to encourage the intelligent and profitable development of the resources of the Philippine Archipelago and to aid in the extension of its domestic and foreign trade relations:

Mr. Shiley to the Secretary of Commerce and Labor.

Manila, P. I., August 10, 1903.

Sir: Some time since the commercial museum invited exhibits from the manufacturers of the United States, Europe, and Japan. The matter was taken up in Japan not only by individual manufacturers, but by the Imperial government. There is now on the way from Japan to the museum a governmental exhibit, accompanied by a number of individual exhibits, aggregating in original value over 5,600 yen ($2,787).

I am aware that the trade of the Philippine Islands cuts a very small figure with the exporters of the United States at the present time. I am convinced that the trade of the Philippines will prove an effective harbinger to a much larger trade in the Orient in the near future.

Great Britain has a firm grip on the commerce of the Orient, but Germany has been making substantial gains in the recent past; in not a few lines Japan intends to have something to say about the commerce of this part of the world. The French in Cochin China hold no mean position, and they are taking advantage of every available means to secure their full share of the growing trade of the East. Russia's position in Manchuria places her where she can successfully outbid all comers in several lines of commodities of which the Orient is a large purchaser.

Notwithstanding the seeming advantages of these countries, the United States, in possession of the Philippines, with the excellent harbor facilities soon to be completed, will occupy a strategic position, and may command her full share of the trade, if only the manufacturers of the States will make a legitimate and determined bid for it.

The United States is on the best of terms with China and Japan. She is nearer this great market than either England, Germany, or France. Manila is an excellent point of departure for tne collection and distribution of merchandise.

This museum is concerned with the development of the commerce and industries of the Philippine Islands. It will be perfectly impartial in dealing with its patrons. Nevertheless, it seems only reasonable that the United States should have a very important part in the development of these islands and of the Orient.

In this laudable work I desire to enlist your cooperation in securing governmental and individual exhibits for the museum. These exhibits should consist of articles which are useful in the various forms of agriculture as practised here, in lumbering, mining, and road making; builders' hardware, mechanics' tools, shelf hardware, blacksmithing tools, cutlery, and gasoline and oil stoves; machinery for manufacturing and refining sugar; rice, cocoanut oil, cocoa, chocolate, and tobacco; dry goods, notions, ladies' and men's furnishing goods, and rubber goods; groceries, provisions, and canned and dried goods; electrical appliances and supplies; engineers' and plumbers' stores and tools; ship chandlers' stores; safes, scales, and balances; optical goods; glass and silverware; jewelry, watches, and clocks; perfumery; paints and oils; stationery; hand cameras and photo supplies; sporting goods; harness and saddlery; office and household furniture; bicycles and carriages.

Such an exhibit placed at the present time before the importers and dealers of the Philippines would, I believe, be an excellent investment for the manufacturers of the United States, for it is noticeable here that our people are looking more and more to the United States as a purchasing market. With proper encouragement this market will continue for years to increase in extent and importance.

Will you be kind enough to inform me what you will be able to do for the museum in this matter?

Very respectfully,

SAMUEL B. SHILEY,

In Charge of the Commercial Museum.

Scope of the Museum.—The museum is divided into various sections which deal (1) with native products, (2) imports, (3) Philippine exhibits in foreign countries, and (4) a department which gives information concerning (*a*) the Philippines, (*b*) foreign countries, (*c*) sources of information, and (*d*) patrons.

Foreign manufacturers and exporters and local producers, manufacturers, exporters, and importers may place exhibits in the museum free of charge. However, in some instances where the exhibits require special care and protection it may be desirable that the exhibitor furnish a suitable case therefor.

In the case of heavy articles or intricate machinery the exhibitor will be required to place them in the museum. Articles for exhibition sent by rail or water transportation to Manila will be looked after by the museum. However, all freight to Manila must be prepaid, unless otherwise arranged for with the museum. There are no customs dues on articles addressed to the commercial museum.

Every article on exhibition will be marked with its name, name of manufacturer and exhibitor, use, price, etc.

In case of valuable or perishable articles the exhibitor may retain the right of property in the articles exhibited, and may change or discontinue his exhibit whenever he feels so disposed, except that he may not demand an article while it is on any special exhibit or when it is wanted for such an exhibit.

The commercial museum is maintained by the civil government, and its services are rendered without charge to its patrons.

All communications and articles for exhibition should be addressed to Samuel B. Shiley, Commercial Museum, Manila, P. I.

British Department of Commerce Suggested.—In its issue of September 24, 1903, the Commercial Intelligence contained an article of considerable interest not only to English readers, but to all countries interested in extending trade. It says:

"The changes which are taking place in the constitution of the cabinet make the time opportune for suggesting that the Prime Minister should seize the occasion to create a Minister of Commerce. It is surely an anomaly that a great trading nation like the United Kingdom should divide the administration of trade and commerce between the Board of Trade, the Foreign Office, and the Home Office. 'This cumbrous system,' writes a leading parliamentary authority, 'ought to be done away with and the great interests of commerce intrusted to the care and responsibility of one department, with a staff solely for that purpose and acting, where necessary, with the Foreign Office.' At the head of this department should be a minister endowed with the highest cabinet rank, who should have the assistance of a permanent board of advisory officials, each an expert in the various subdepartments which should constitute the ministry. Most of the present departments of the Board of Trade should hold their place in this reorganized office. The commercial department and the Foreign Office should merge in it, and the consular service should be administered by the minister of commerce. There can be little doubt that such an arrangement as this would serve the best interests of the country and insure our trade and commerce that attention from the government which it is now denied. It is sufficient to glance at some of the anomalies and disabilities which press most hardly on our business men to see how strong a case there is for immediate reform. Much of the merchant shipping legislation is obsolete. In spite of recent amendments our patent laws are in a most unsatisfactory condition and afford a striking contrast to similar legislation in the United States. Our consuls, despite the fact that some of them at least are earnest and thorough, do not command the confidence of business men. Moreover, our consuls do not have a fair chance to do themselves justice. Their reports, often belated enough before they reach this country, have then to filter through the Foreign Office and the Board of Trade before they reach the British merchant, whose interest in the matters with which they deal has often entirely vanished long before these documents reach him. We ought to have a thoroughly efficient system under which British consuls and commercial attachés throughout the world could send their "news"—while it is news—straight to the British trader at home, something after the fashion that is adopted in the United States. No one who has studied the question can doubt that our railway and canal systems, charges, etc., are in need of thorough reform. The Board of Trade as at present constituted has altogether insufficient powers to safeguard the interests of traders. It is little short of a scandal and a disgrace that a commercial nation should be content to have at the head of its Board of Trade a gentleman who, however estimable in his private capacity, has absolutely no business training or other qualifications fitting him to occupy that very important position. We need a minister of commerce, and if the Prime Minister should seize the present opportunity to create this office and appoint to it a thoroughly efficient statesman he would do much to restore confidence among business men in an administration that has so far been marked chiefly by its capacity for muddling and mismanagement."

American Industrial Capital in Hamilton, Canada.—The cheap electric power furnished by the Cataract Power Company is a determining inducement for manufactories to locate here. This power is generated at Decew Falls, a point 34 miles southeast of Hamilton, and about 10 miles from Niagara Falls. The water has a descent of 280 feet, and is equal to furnishing all the power that may be needed even in the distant future. The utilization of this waterfall should suggest to capitalists in the United States the advantages offered in so many places in our own country where such power is going to waste.

The protective duties in force in Canada make it an object for American capital to invest in manufacturing here. The International Harvester Company, the Deering branch of which is now completing a plant in this city for the manufacture of all kinds of farming machinery and implements, is not only the largest manufactory in any line in Canada, but also the largest of its kind under the British flag. Its buildings already cover a space of 35 acres.

The Westinghouse Company, of Pittsburg, Pa., has for several years had a branch manufactory in this city for the making and applying of the Westinghouse air brake. This company has had plants in several Canadian cities, and, in order to consolidate its industries in a single locality, has organized the Canadian Westinghouse Company, with a capital stock of $2,500,000, the incorporators meeting in this city October 8, 1903. The principal officers elected were: George Westinghouse, president; H. H. Westinghouse and Frank Taylor, vice-presidents; and Paul J. Myler, general manager and treasurer—all of Pittsburg. The company will do a general business in the manufacture of electrical appliances, and as soon as new buildings can be erected here and machinery installed it will give employment to not less than 1,000 hands.

The Pittsburg Steel Company is completing arrangements to establish a branch of its business in this city, and to make a beginning the managers have leased from the Hamilton Nickel-Copper Company its large refinery buildings. This lease is only for one year, in order to give the company time to erect buildings of their own, for which a large tract of land has already been secured.

Edward Elsworth & Co., of Buffalo, manufacturers of cereal foods, have established a branch here this year and are employing 80 hands with a daily output of 800 cases (28,800 packages) of "Force." They have a large export trade, mainly to Great Britain, and are arranging to double their capacity this winter and add the production of "H. O. oatmeal."

The International Harvester Company, the Westinghouse Company, the Pittsburg Steel Company, and the Elsworth Company are new enterprises here, and, when in full operation, will give work to from 6,000 to 8,000 hands. The Hamilton Iron and Steel Company, of which the blast furnace is an important factor, has been adding to its facilities. It owns its steam lake vessels to carry ore from the mines to the furnace. The Canadian government pays a high bounty on all iron made from Canadian ore and a smaller bounty on a mixture of United States and Canadian ore. The furnace and steel and iron mills are built on the bay front, and the company owns its wharves.—James M. Shepard, Consul at Hamilton, Canada.

American Trade in Canton.—In Canton there is a good demand for many kinds of machinery. Rice-hulling machines, knitting machinery (especially for hose), and small power engines (kerosene) will find a market here; in fact any modern invention attracts the Chinese.

If there were more representatives of American manufacturers here with samples, undoubtedly agencies cou'd be established and profitable business result in many branches.

Trans-Pacific freight rates are most reasonable at present, while New York and eastern American shipments *via* the Suez Canal are lower now than ever before. The entering of the great ships of the Hill Line (Great Northern Railway) from Seattle will create a still cheaper through rate as far as Chicago and St. Louis. This, coupled with the construction of the new railroad from Canton to Peking, brings the products of central and southern China to the world's markets, whereas formerly, owing to crude and expensive methods of transportation, this was impossible.—Robert M. McWade, Consul-General at Canton, China.

Prospective Quinine Trust.—Dutch Indies papers comment upon rumors that the Peruvian-bark raisers of Java are to form a trust. As Java supplies fully 75 per cent of the total amount of Peruvian bark used in the world, and only eig ty planters are engaged in cu'tivating the trees, it is proposed to erect more quinine factories in Java and to use at least one-half of the yearly crop for this purpose, as well as to interest the Peruvian-bark growers in other countries in the trust and so dictate the price for quinine in the markets of the world independent of the European industry.—Richard Guenther, Consul-General, Frankfort, Germany.

South African Exhibition.—Under date of November 21, 1903, United States Consul-General W. R. Bigham, writing from Cape Town, urges the appointment, in the interests of the manufacturers and merchants of the United States, of a commissioner to the South African exhibition to be held in Cape Town during the months of November and December, 1904, and January, 1905. He calls attention to the fact that this exhibition will offer an excellent opportunity to exhibit goods, and he believes that our merchants and manufacturers would receive great benefit by exhibiting. He says, further, that some commissioner should be appointed from among the American citizens resident in South Africa at the present time. He thinks some one could be found to act.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SELECTED FORMULÆ.

Indelible Ink, for Writing on Metal or Glass.—

Sodium silicate	5 parts.
Liquid India ink	5 parts.
Boiling water, q. s.	

Dissolve the silicate in sufficient boiling water, and add the ink. Only sufficient water should be used to make the product thin enough to flow easily. The ink may be used on rubber stamps also. Chinese white (Winsor & Newton's) may be used instead of India ink. A steel pen may be used. The container should be shaken up before using the ink.—Nat. Druggist.

Protective for Horses and Fine Cattle Against Insects.—The following is highly extolled for this purpose by a German agricultural authority:

Oil of clove	3 parts.
Oil of bay	5 parts.
Tincture of eucalyptus	5 parts.
Alcohol	150 parts.
Water	200 parts.

Mix. Use as a spray. The above will answer for finely bred cattle, but would be too expensive for use on large herds.—Nat. Druggist.

Liquid Shoe Polish.—A formula for a liquid shoe polish containing wood alcohol, lampblack, and castor oil, follows:

Sandarac	¼ ounce
Shellac	1 ounce
Glycerin	1½ drams
Castor oil	2 drams
Oil of mirbane	½ dram
Lampblack	2 drams
Wood alcohol	2 ounces

A similar formula containing no castor oil is:

Resin	2 drams
Gum thus	2 drams
Turpentine	2 drams
Sandarac	4 drams
Shellac	1 ounce
Wood alcohol	8 ounces
Lampblack	1 dram

Dissolve all but the pigment in the alcohol, filter, and add the lampblack. Instead of lampblack, zinc white, ultramarine blue, or other similar coloring may be used. This formula is said to produce an elastic and unbreakable varnish-polish.—Pharm. Era.

To Renovate Straw Hats.—Hats made of natural (uncolored) straw, which have become soiled by wear, may be cleaned by thoroughly sponging with a weak solution of tartaric acid in water, followed by water alone. The hat after being so treated should be fastened by the rim to a board by means of pins, so that it will keep its shape in drying.

Another method is as follows: Sponge the straw with a solution of

Sodium hyposulphite	10 grammes
Glycerin	5 grammes
Alcohol	10 grammes
Water	75 grammes

Lay aside in a damp place for twenty-four hours and then apply:

Citric acid	2 grammes
Alcohol	10 grammes
Water	90 grammes

If the hat has become much darkened in tint by wear it will probably be necessary to expose it to the action of a more pronounced bleaching agent. The fumes of burning sulphur may be employed for the purpose. The material should be first cleaned by thoroughly sponging with an aqueous solution of potassium carbonate, followed by a similar application of water, and it is then suspended over the sulphur fumes. These are generated by placing in a metal or earthen dish so mounted as to keep the heat from setting fire to anything beneath, some brimstone (roll sulphur), and sprinkling over it some live coals to start combustion. The operation is conducted in a deep box or barrel, the dish of burning sulphur being placed at the bottom, and the article to be bleached being suspended from a string stretched across the top. A cover not fitting so tightly as to exclude all air is placed over it, and the apparatus allowed to stand for a few hours.

Hats so treated will require to be stiffened by the application of a little gum water, and pressed on a block with a hot iron to bring them back into shape.

If a waterproof stiffening is required, use one of the varnishes for which formulas follow:

I.

Copal	450 parts
Sandarac	75 parts
Venice turpentine	40 parts
Castor oil	5 parts
Alcohol	800 parts

II.

Shellac	500 parts
Sandarac	175 parts
Venice turpentine	50 parts
Castor oil	15 parts
Alcohol	2,000 parts

III.

Shellac	750 parts
Rosin	150 parts
Venice turpentine	150 parts
Castor oil	20 parts
Alcohol	2,500 parts

—Drug. Circ.

THE

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