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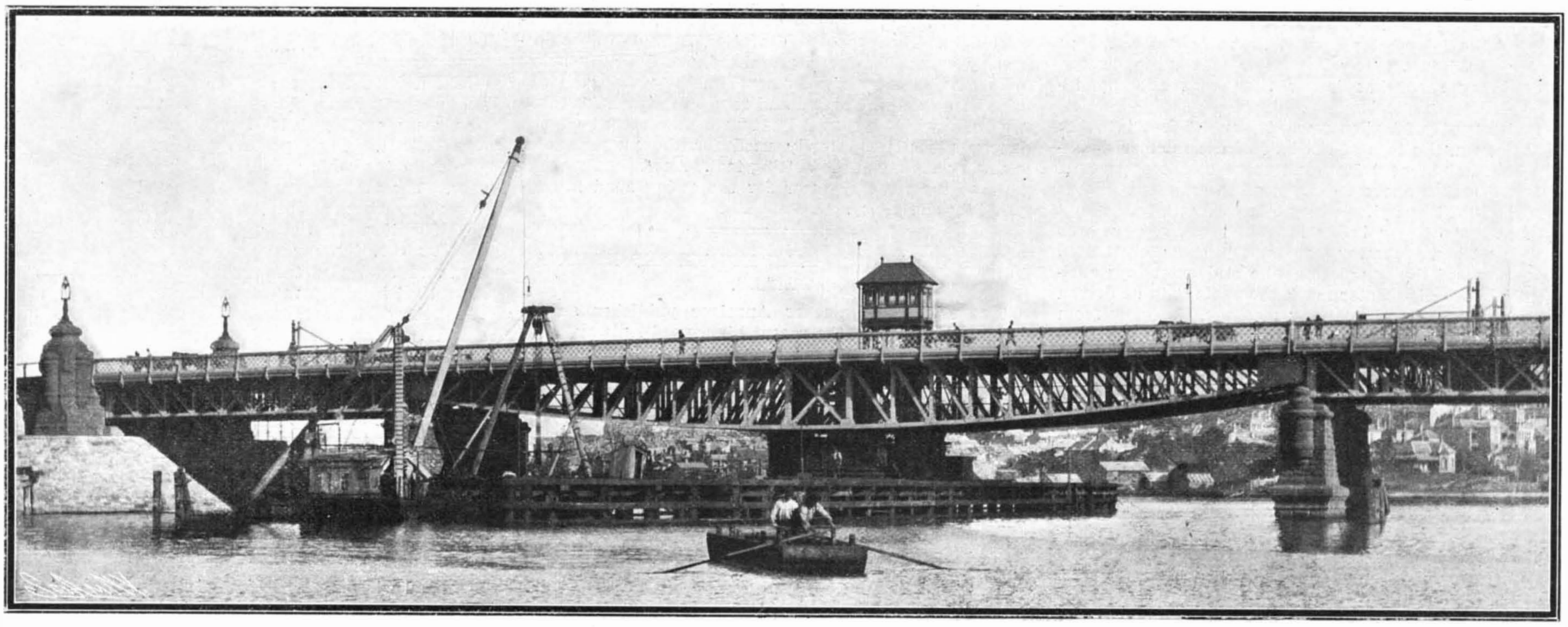
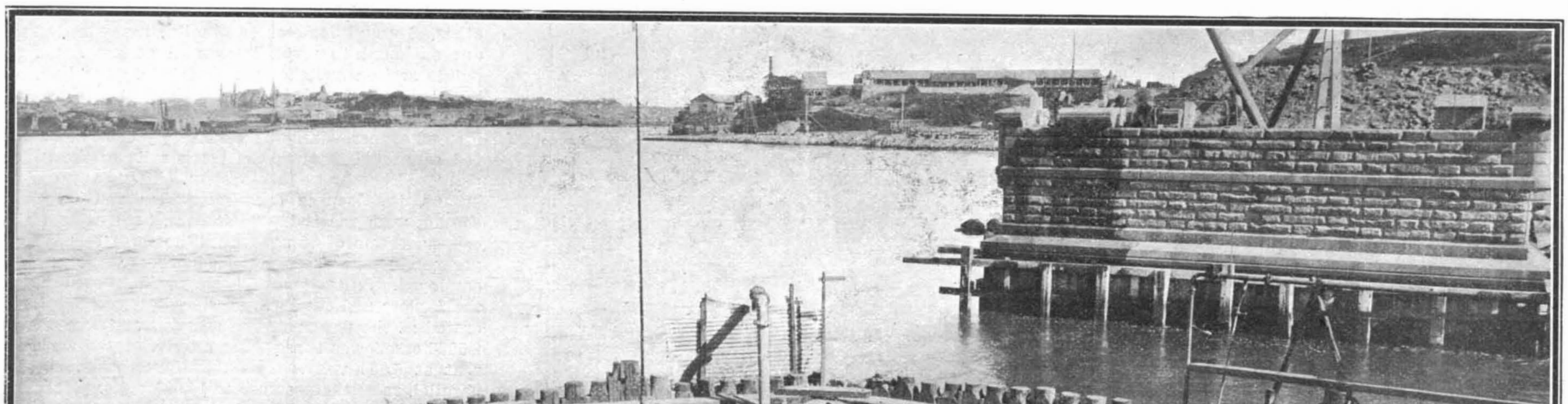


THE GLOBE ISLAND BRIDGE AT SYDNEY.



THE POLYGONAL DRAW PIER FOUNDATION, SHOWING THE UPPER HORIZONTAL FRAMEWORK.

THE GLOBE ISLAND BRIDGE AT SYDNEY.

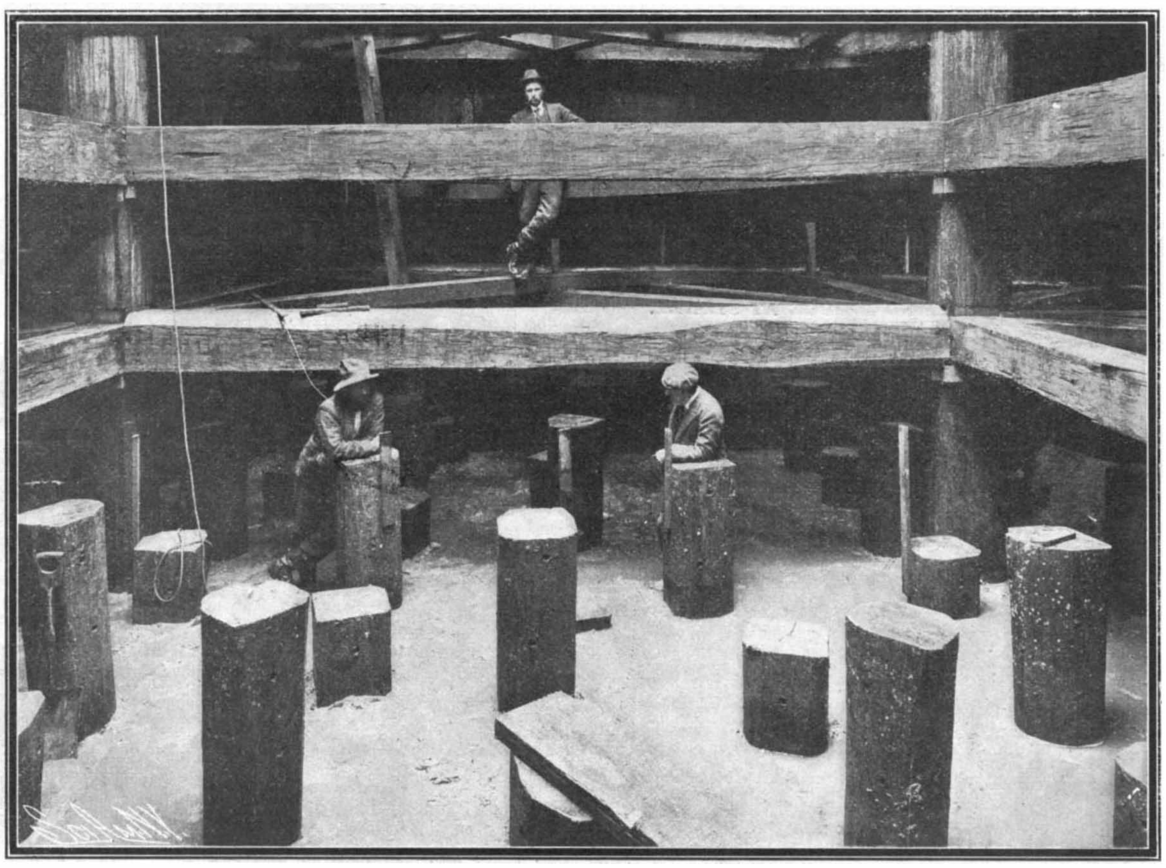
CONSTRUCTION OF THE GLOBE ISLAND BRIDGE, SYDNEY, NEW SOUTH WALES.

By JOHN PLUMMER.

THE completion of the fine Pyrmont Bridge at Sydney, New South Wales, has been followed by the opening of a second, of equal importance, across another portion of the harbor in the immediate vicinity, the object being to connect Globe Island with the mainland, the old bridge, constructed of wood, having become unsafe for traffic.

Preliminary borings having shown that the rock forming the bed of the river at the proposed site of the bridge was 99 feet below high-water mark, and covered with a thick layer of clay, it was decided that, instead of sinking a caisson tc assist in forming the foundation of the pivot pier for the swing bridge, as in the case of the Pyrmont structure, a coffer dam should be built, so that the work of concreting could be carried on in the "dry." The bed of the harbor forming the site of the intended pier was first dredged out to a depth of 35 feet below low-water mark, the cleared area being somewhat larger than that actually required.

Subsequently 97 piles were driven 26 feet into the clay bottom, the tops of one-half of the number finishing at a height of 2 feet, and those of the other half 3 feet 6 inches above the level of the foundation. As the heads of these piles were to be 31 feet 6 inches and 33 feet respectively below low-water mark, each was driven with a "follower," or false pile, loosely bolted to the top of the foundation pile and extending sufficiently above high-water mark to enable it to be driven with an ordinary pile-driving machine, the blow from the "monkey" being taken on the head of the "follower," and transmitted to the foundation pile beneath.



INSIDE THE COFFER DAM, SHOWING THE FOUNDATION PILES AND HORIZONTAL BRACES.

THE GLOBE ISLAND BRIDGE AT SYDNEY.

When the foundation pile was driven to the required depth, the "follower" was unbolted by a diver, and attached to the next pile.

The driving of the foundation piles being completed, a commencement was made with the coffer dam to surround them. An octagonal frame, 48 feet across the flats, and constructed of ironbark, one of the toughest and most durable of Australian timbers, was lowered onto the dredged area, and firmly wedged in true position with struts from the foundation piles, the struts being fixed by divers. This framework represented the outline of the intended coffer dam. Eight main corner piles were then driven, and an inner and outer walling bolted around, reaching above high-water mark. Between the two walls thus formed the intermediate sheet piles forming the actual wall of the dam were driven.

Upon the completion of the wall, the top framework, or horizontal braces, corresponding with that on the floor of the dam, was placed in position, others being placed at regular intervals all the way down, thus imparting stability to the dam, enabling the water to be pumped out, and the sludge removed from off the clay bottom, so that the concrete foundation could be placed upon it. As the concrete was put in, the horizontal braces were removed, the strain borne by them being transferred, by means of temporary struts, to the concrete, which was finally carried up to within a foot of low-water mark, when the masonry was commenced.

This coffer dam is asserted to be the deepest single-wall dam ever constructed, having a head of water 41 feet deep. It was designed and constructed under the supervision of Mr. Percy Allan, M. I. C. E., M. Am. S. C. E. (New York), of the New South Wales State Department of Public Works, assisted by Mr. W. Y. Hanna, State Commissioner of Roads and Principal State Engineer for Roads and Bridges. The total length of the bridge, including the swing span, is 353 feet, and it is provided with a steel floor, carrying a 40-foot wood-blocked roadway and a couple of 5-foot footpaths. The banks forming a causeway at either end of the bridge rise 70 feet from the base, and contain 660,000 cubic feet of stone, quarried from the island, which abounds with excellent building materials.

The swing span resembles in general appearance that at Pyrmont Bridge, and is 191 feet long, affording two clear waterways of 60 feet each for shipping. The span revolves on a cast-iron roller path, 37 feet in diameter, carrying steel coned treads. These latter had to be machined, but were so large that it was found, almost at the last moment, that there were no lathes in Great Britain or Continental Europe capable of doing the work. In this dilemma it was suggested that chipping and filing, in place of machining, should be resorted to. The proposed deviation from the specifications was not, however, permitted, the difficulty being overcome in a somewhat novel manner with the aid of a horse walking round and round the track for three weeks, revolving a stiff built-up arm centered on the bridge pivot, temporarily used for the purpose, and carrying at its end the cutting tool. As at the Pyrmont Bridge, the motive power for the swing span is supplie by electricity.

NOTES ON THE GERMAN HIGH-SPEED RAILWAY TRIALS.

THE Elektrotechnischer Anzeiger publishes an interesting article on the recent high-speed railway trials between Marienfelde and Zossen. As is known, these trials have been carried out by the "Studiengesellschaft für Elektrische Schnellbahnen." Preliminary trials and laboratory tests with regard to air pressures at high velocities showed that a parabolic form offered the least resistance, this being about 90 kilogrammes per square meter at a speed of 200 kilometers per hour. To reduce this item further, Siemens & Halske gave the top of the car a tapered form, so as to appear like a hood. Very little alteration appears to have been made in general design of either of the cars since two years ago. The Siemens & Halske car affords seating capacity for 48 passengers, and is 22 meters (72 feet) long and 2.56 meters (8 feet 4 inches) wide. On the other hand, the car of the Allgemeine Elektricitäts Gesellschaft has a length of 21 meters (69 feet) and a width of 2.8 meters (9 feet 2 inches), and provides room for 40 passengers. Both are built as corridor cars. The bogies are mounted on springs, both spiral and flat springs being used. At the beginning of the tests a wheel base of 1.9 meters (6 feet 3 inches) was employed, the wheels being 1.2 meters (4 feet) in diameter; afterward these dimensions were increased. Brakes—operated on the Westinghouse system and also by hand—act on every wheel, and an electric brake, actuated by current from a storage battery, is also provided. It is stated that if the brakes are applied when the car is traveling at 200 kilometers (124 miles) an hour, it travels a distance of 1.5 kilometer (nearly a mile) before stopping. The cables were placed underneath the floor and on the roof of the car. In the Siemens & Halske car all control operations are done by pneumatic means, the driver having, consequently, only light work to do. Mechanical means were employed by the Allgemeine Elektricitäts Gesellschaft for transmitting these operations to the various apparatus distributed at different parts of the car. For this purpose a main shaft runs along the ceiling of the car. Owing to the construction of the bogies, and also to the high speed of the cars, gearing between the motors and axles was neither possible nor desirable, and the 250-horsepower motors—two for each bogie—are mounted direct on the axle, and, in the case of the Siemens & Halske car, without the intervention of springs. The Siemens & Halske motor weighs 4 tons, and its rotor is fed with three-phase current at a potential of from 1,150 to 1,850 volts, the voltage of the stator varying between 500 and 1,000. Arrangements are provided to connect the transformer at will, either in star or delta fashion. The Allgemeine Elektricitäts Gesellschaft motor is lighter, weighing only 3.2 tons. Its conductors consist of copper bars, the voltage of the rotor and stator being 325 and 435 volts, respectively. A play of 300 mm. (1.18 inches) between the hollow axle of the motor and the car axle has been allowed by this firm, and a mechanical connection between the two is provided by means of a spring coupling. Siemens & Halske adopted metallic resistances—built up of metal strips —which were well cooled by being placed on the outside of the car. Liquid resistances with forced circulation were employed by the Allgemeine Elektricitäts Gesellschaft. They possess the great advantage of gradually increasing and decreasing the working current. The transformers are mounted horizontally beneath the floor, and efficient cooling by air presents no difficulties. In the Allgemeine Elektricitäts Gesellschaft's car, the air cooling was collected from the roof and conducted through pipes to the transformers. A vertical iron pipe is mounted in the car and through it all the cables are conveyed from the roof to underneath the floor. Instead of mounting the three collector bows on one vertical hollow steel post as Siemens & Halske do, the Allgemeine Elektricitäts Gesellschaft employs for each bow a separate pole. Of the total weight of about 93 tons, 16.3 tons are in motors, 12.3 tons in transformers, and 5.1 tons in resistances. In the course of the trials, however, it became evident that the total weight might be reduced by several tons. Siemens & Halske constructed the overhead equipment. At a distance of 7.4 feet from the center of the track is the line of wooden posts. These are spaced 38 yards apart and carry horizontal iron brackets to which the overhead wires are attached by means of double insulators. A small horizontal play is thus secured to the wires, and this is said to insure a good contact between bow and wire. A distance of 39 inches separates the wires, which are vertically mounted one above the other. Every kilometer (0.62 mile) the overhead wires are anchored to resist horizontal stresses. At these points section switches are inserted in the line. If a high-tension wire should break, the line conductors are automatically short-circuited. This is performed by a loop of copper wire, which normally encircles a metal rod connected through the track rails to the common point of the three-phase system. When any one wire breaks, the loop is drawn together and comes into contact with the rod. As feeders, both cable (with a copper section of 70 square millimeters) and bare copper conductors (section 50 square millimeters) were employed. Suitable switches are interposed between the feeders and the line wires. Electric energy is generated at the power station situated at Oberspree by a 2,500-horsepower three-phase alternator, delivering current at 6,000 volts. Two transformers, connected in parallel, raise the pressure to 14,000 volts. After many preliminary tests and calculations, the actual speed trials were commenced on the Marienfelde-Zossen line, 23 kilometers (14 miles) in length, in 1901. Since the maximum gradients are but 1:200, and the smallest curves have a radius of not less than 2,000 meters (6,550 feet), this line is particularly suited for high-speed tests. The results of these trials and other particulars have been reported from time to time in our columns.

LIGHT ALUMINIUM ALLOYS.

THOUGH the metal aluminium has been known for many years, it is only comparatively recently that its manufacture on a commercial scale has been carried on. After its first separation by Wöhler in 1828, it was for many years only a laboratory product, and was regarded more as a curiosity than anything else. When, however, cheaper methods of producing it were discovered, and its manufacture on a commercial scale thus rendered possible, great things were expected of it. Its exceeding lightness as compared with other metals, its beautiful color, and its freedom from oxidation under ordinary circumstances, gave hopes for a bright future. That these hopes have not been altogether fulfilled there can, we think, be little doubt; for, possessing though it does the above-mentioned valuable characteristics, the metal lacks in the pure state one or two qualities necessary for its use in many directions where it might have been expected to find a place. The drawbacks to which we allude are its low tensile and compressive strength, its liability to form blowholes when cast in molds, and the difficulty there has always been in soldering it. That the pure metal, in spite of these drawbacks, has been put to a great variety of purposes, we are well aware, but its field of usefulness has certainly been restricted by them. That the metal has a great future before it, we feel no doubt, but this future will depend far more on its alloys with other metals than on its inherent qualities in the pure state. In its power of alloying satisfactorily with many other metals, lies its chief strength. Engineers and scientists have been busy in this direction for some time

and their efforts have in many cases been attended with no little success, and many of the alloys formed, apart from any commercial value they may have, are interesting in themselves. It is, however, their utilitarian side that is of chief value to engineers, who are always on the look-out for fresh materials to meet the ever-changing demands of constructive science.

In a paper read before the American Society for Testing Materials, at Delaware Gap, on July 3 last year, by Dr. Joseph W. Richards, on the subject of "Light Aluminium Alloys," some interesting facts were brought forward.

With regard to commercial aluminium of a purity of from 99 per cent to 99.5 per cent, the following table gives the usual limits of physical properties of Number 1 quality:

	Elastic Limit.	Ultimate Tensile Strength.	Percentage Reduction of Area.
	lbs. per sq. in.	lbs. per sq. in.	
Castings	8,500	14,000 to 18,000	15
Sheet...........	12,500 to 25,000	24,000 " 40,000	20 to 30
Wire...........	16,000 " 33,000	25,000 " 55,000	40 to 60
Bars...........	14,000 " 23,000	28,000 " 40,000	30 to 40

In all cases where it is required to use aluminium without the admixture of any other metal it is advisable to use it pure, as it then resists alteration caused by atmospheric and other corroding agencies better than any of its alloys. The principal metals which have been used for alloys of aluminium are zinc, copper, nickel, magnesium, titanium, tungsten, chromium, manganese, and silver. In making the alloys no lower quality of aluminium should be used than that having a percentage of pure metal of 99.5, and for the very best results the percentage should be 99.75. As a general rule, it is advisable to melt the aluminium first, and then to stir or dissolve the other metal in it. To facilitate the solution of a metal of very high melting-point, such as nickel, it is desirable to prepare first an alloy of the metal with aluminium in something like equal proportions. This alloy cast into bars is then added to the melted aluminium, and dissolves much faster than the pure metal.

The rate at which aluminium alloys are melted is important. Their specific heats are large, and it takes a great amount of heat, though not a high temperature, to melt them. The furnace, therefore, should be kept at a moderate temperature, and patience should be exercised until the metal melts, which will take from 30 to 50 minutes, starting from a cold crucible. It is important that the alloy should never be above a cherry-red heat and it should never adhere to or wet the crucible. When the alloying metal has been all dissolved, the whole is to be vigorously stirred and cast at once. The use of a flux is in no case recommended, for it attacks the walls of the crucible, facilitates the reducing action of the aluminium upon them, and injures the alloy. With careful regulation of temperature, and the use of no flux, a good crucible will last almost indefinitely.

Almost all the light strong alloys melt easier than aluminium. They are all hardened and stiffened by working, but frequent annealing is necessary in order to avoid cracks. With regard to the effect that the addition of different metals has on aluminium, various tests show that chromium hardens aluminium strongly, the alloys having somewhat the qualities of self-hardening steel. Alloys of 7 per cent of titanium have been made, but the best is that with 2 per cent. It has an elasticity comparable to spring brass, and a tensile strength of from 30,000 pounds to 35,000 pounds when rolled hard, and 21,000 pounds when annealed. Susini makes a series of alloys with different percentages of manganese, copper, and zinc. The three alloys he recommends most are given below:

Manganese.	Copper.	Zinc.
1 to 3	1.5	0.5
1 to 5	2.5	1.0
2 to 8	4.5	1.5

Used with copper and nickel, manganese makes the hardest light alloy of aluminium yet produced.

Mannesmann, in making aluminium tubes, found that a fraction of 1 per cent of tungsten made the metal stronger, and increased its resistance to corrosion. It appears to have been used considerably in military experiments. It draws and spins well, without tearing and without smearing the tools.

Wolframinium, although it contains only a very small proportion of tungsten, is one of the alloys on which it appears to have a beneficial effect. This alloy also contains antimony, which imparts to it good casting qualities. Analysis shows that the following are the proportions of the different metals which enter into its composition: Aluminium, 98.04 per cent; copper, 0.375 per cent; tin, 0.105 per cent; antimony, 1.422 per cent; and tungsten, only 0.038 per cent. The copper gives strength, and the tin fusibility. This alloy resembles silver in color, and it casts well in chilled or sand molds, and polishes finely. Its mechanical properties are as follows:

	Tensile Strength per Square Inch. Pounds.	Elongation. Per cent.
Hard rolled	52,000	2.14
Annealed	38,000	15.24

Perhaps some of the most wonderful alloys of aluminium at present known are made with aluminium and magnesium, but the cost of the latter metal makes them expensive. They are now known under the name of magnalium.

Wöhler was the first man to experiment with mixtures of aluminium and magnesium, but success did not attend his efforts to any great extent, owing, perhaps, to the use of impure materials. Success, however, attended the trials undertaken by Dr. Ludwig Mach, who worked with pure metals, and who varied his proportions from 70 to 98 parts of aluminium and 2 to 30 parts of magnesium. The results were most striking, as the following table will show:

	Tensile Strength per Square Inch. Pounds.	Elongation. Per cent.
Two Per Cent Magnesium in Alloy.		
Cast in sand	17,900	3.00
Cast in chills	28,600	2.00
Castings water-chilled..	40,000	1.00
Annealed sheet	25,600	18.00
Hard sheet	41,300	2.70
Four Per Cent Magnesium in Alloy.		
Cast in chills	28,600	2.00
Annealed sheet	28,200	8.00
Hard sheet	44,900	2.10
Six Per Cent Magnesium in Alloy.		
Castings water-chilled..	57,600	1.00
Annealed sheet	28,100	17.00
Hard sheet	44,100	1.00
Eight Per Cent Magnesium in Alloy.		
Castings water-chilled..	54,900	1.60
Ten Per Cent Magnesium in Alloy.		
Cast in sand	21,400	2.40
Cast in chills	33,600	3.40
Castings water-chilled..	61,100	4.20

By the above table it will be seen that this alloy can be made having a range of tensile strength from 25,600 pounds per square inch, with an elongation of 18 per cent, to a tensile strength of 61,100 pounds per square inch, with an elongation of 4.2 per cent.

The above figures are striking, and point to an extended use for these alloys, and if the price of magnesium could be reduced, they would no doubt be much more used than they are at present. The mixture most suitable for castings appears to be one having from 10 to 15 per cent of magnesium. It melts at about 700 deg. Cent., remains hot a long time, and fills out the most delicate molds, and the castings are so bright that pickling is unnecessary. Beautiful screw-threads can also be formed in this alloy; its melting-point can be raised by adding chromium and nickel, but it is thereby made more brittle. All these alloys of magnesium and aluminium are patented by Dr. Mach, and are made by the Magnalium Gesellschaft of Berlin.

An alloy of aluminium with 10 per cent of tin is recommended. It is whiter than aluminium, and it is more easily soldered than the pure metal. The best material for soldering aluminium is said to be an alloy of 20 parts tin, 11 parts zinc, 1 part aluminium, and part of 10 per cent phosphor tin; but the soldering of aluminium does not yet appear to be a very satisfactory operation. Alloys of aluminium and nickel alone have not been found advantageous, but with certain percentages of copper they are satisfactory.

Zinc is the cheapest, and at the same time one of the most efficient, of the metals which improve the mechanical properties of aluminium. The alloys are made by first melting all the aluminium to be used in a clean graphite crucible, bringing it a little above the melting point, the zinc being added in small pieces, so that it does not chill the aluminium, but is absorbed directly it is added. The conclusions arrived at by the author of the paper are that magnesium alloys are the best all round of the light aluminium alloys, but they are expensive. The zinc alloys are the cheapest to make, and are equal in mechanical properties to very nearly the best alloys made with more expensive metals, and therefore promise to have, of all light aluminium alloys, the largest sphere of usefulness.—Engineering.

CONSTITUTION AND PROPERTIES OF SILICON STEEL.

In a paper recently presented to the Académie des Sciences, M. Leon Guillet shows the results of his experiments upon the constitution of ferro-silicons and the influence which silicon has upon the properties of iron. He studied two series of silicon steel from a micrographic and also a mechanical standpoint. 1. Micrographic tests.—Whatever may be the percentage of carbon in the steels the micrographic views are similar for the same proportion of silicon. They differ only by the greater or less quantity of perlite or graphite. From 0 to 5 per cent of silicon, the steels have the same structure as carbon steels. The silicon is found to be in a state of solution in the iron; from 5 to 7 per cent silicon, perlite and graphite are seen; the graphite is surrounded by white patches of greater or less size, whose nature has not yet been defined. From 7 to 18 per cent, only the white parts are to be seen, and these are often bordered by graphite. Sometimes brilliant particles are seen around the graphite. In the case of 11 to 30 per cent silicon, crystals are found which increase as the percentage of silicon is higher. As a result of these experiments the author distinguishes three main groups in the silicon steels. The first group comprises steels of which all the carbon is combined and having from 0 to 5 per cent of silicon. Second, steels whose carbon is only partly combined and partly in the state of graphite, with 5 to 7 per cent of silicon. Third group, steels in which all the carbon is in the state of graphite. They contain more than 7 per cent of silicon.

A series of mechanical tests were made upon the steels. Only those which contain 0.200 carbon and less than 7 per cent silicon are capable of being rolled. The same is true for steels of 0.900 carbon, containing less than 5 per cent silicon. It is only these samples which were given the mechanical tests. The results may be summed up as follows: The breaking load and the elastic limit are higher in the silicon steels than in ordinary steels of the same carbon value, but it does not increase much with the percentage of silicon. Their resistance to shocks (as tested by the Fremont method) is not high; their hardness is greater than for ordinary carbon steels.

As to the influence of different treatments of the steel, annealing and tempering were noted. An annealing at 900 deg. C. for a not too long period, is found to soften the silicon steels. When the time is sufficiently long, carbon is precipitated in the state of graphite; the steel becomes very brittle and has no elongation. Tempering is found to harden the silicon steels to a great degree. The steel of 0.208 carbon and 0.409 silicon, after tempering at 850 deg. C. in water at 15 deg., showed a great hardness. In general, the resistance to shock is higher after tempering than before, and in the steels of high carbon value it is quite exceptional. This explains why the silicon steels are found especially valuable for making springs. As a *resumé* of his researches, the author reaches the following conclusions. 1. Only the steels containing less than 5 per cent silicon are available. 2. These steels show a greater resistance to shocks after tempering than before, and this resistance is relatively high for steels having a large proportion of carbon. 3. Certain anomalies exist in the composition of industrial ferro-silicons and silicon steels, especially as concerns the existence of the compound Fe_2 Si. These researches, like those of M. Osmond, seem to prove the existence of two solutions of silicon in iron. One of these is probably the solution Fe, Si, and the second the solution Fe, Fe_2 Si.

FERROMOLYBDENUM IN STEEL MAKING.

This alloy is prepared preferably by fusing pure metallic molybdenum, to which is added the required percentage of metallic iron, also in the state of fusion. By this means the alloy is obtained in remarkable purity, and both metals are thoroughly and uniformly mixed.

Since the Krupp Works have been and are still buying large amounts of molybdenum ore in this country, it is assumed that molybdenum is used extensively in these works for the preparation of superior steels, while it is an assured fact that English manufacturers of alloys deal largely in ferromolybdenum.

This ferromolybdenum alloy was further improved by the introduction of various percentages of nickel, and a material was obtained which more than answered expectations, for it was found to be readily fusible, the nickel acting as a vehicle. The great value of this alloy was readily acknowledged in this country as well as abroad, so that it is employed at present to a large extent in the United States, in England, and on the Continent. It serves principally for the manufacture of forgings, guns, rifle barrels, wire, boiler plates, and shells, and is found in the market as a compound, carrying about 75 per cent molybdenum and 25 per cent nickel, or nearly 50 per cent molybdenum and 50 per cent nickel, besides

	Per cent.
Iron	2.0 to 2.5
Carbon	1.0 to 1.5
Silicon	0.25 to 0.5

Since molybdenum increases the elongation of carbon steel considerably and very much more so than nickel alone, the importance of this alloy will be easily recognized. It is added by leading firms in such proportion that the finished molybdenum-nickel steel contains 0.25 per cent of molybdenum, whereby the elongation of the carbon steel is increased from 4 to 45 per cent. It will be readily seen, then, that this effect of the alloy is of the greatest value for all classes of forgings and particularly for large crank and propeller shafts. Since the addition of this small percentage of the alloy causes but little expense, it is evident also that an increase of elongation, obtained at such small cost, is of the greatest import for wire drawing; while experience shows that a molybdenum-nickel steel of that composition is a very desirable material for the manufacture of plates for high-pressure boilers or boilers of torpedo boats.

Furthermore, it has been found that by the addition of about 1 per cent of molybdenum, the hardest chrome-nickel steels are rendered readily machinable—a fact which is of great interest and importance to manufacturers of armor plates, shells, and similar products. In order to show, however, the unusual activity displayed at present in this field of metallurgy, we will mention that a patent has been obtained lately, numbered 22,504, for a high-grade steel, containing less than 1.20 per cent of carbon, from 6 to 15 per cent of molybdenum, from 2.50 to 6 per cent of chromium, and less than 2 per cent of silicon.—Dr. J. Ohly in Mines and Minerals.

Danish Fresh Meat for Berlin.—Under date of October 9, 1903, United States Deputy Consul-General S. W. Hanauer, of Frankfort, Germany, reports that a joint stock company has been formed in Copenhagen to export fresh meat, by means of cold storage cars, to the city markets of Berlin.

[Concluded from SUPPLEMENT No. 1465, page 23470.]

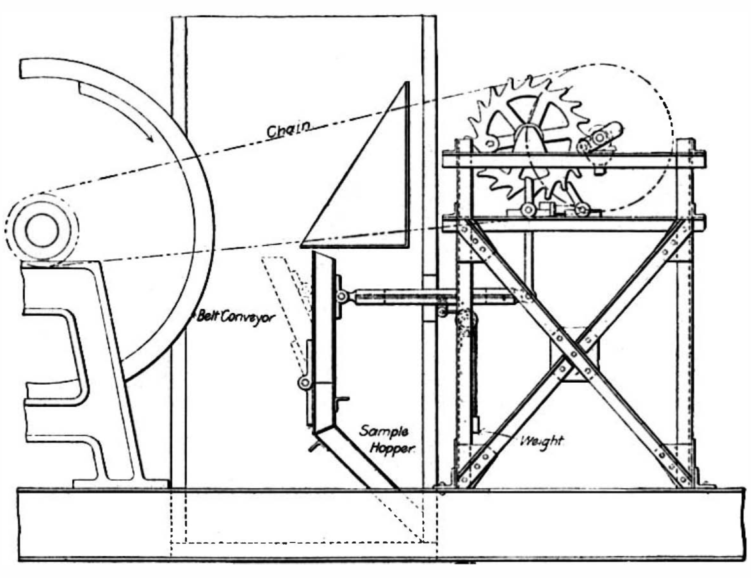
THE EDISON PORTLAND CEMENT WORKS.

As we have already indicated in the classification contained in the introduction to this article, the weighing and mixing house and small rock stock house constitute the second general division or group of buildings. The crushed rock from the main stock house emerges on the tunnel conveyer and is lifted by another belt conveyer on to the first dump at the upper part of the weighing house. Here there are two bins, one for the limestone and the other for the cement rock, each of 60 tons capacity. A 10-ton weighing bin is located beneath each of these bins. In the 10-ton bins, the proper proportions of each of the raw materials are secured. The frequent sampling, together with the thorough mixing of the raw materials in the stock house, and also the subsequent weighing and mixing, enable a much more uniform product to be obtained in the finished cement than with the usual methods.

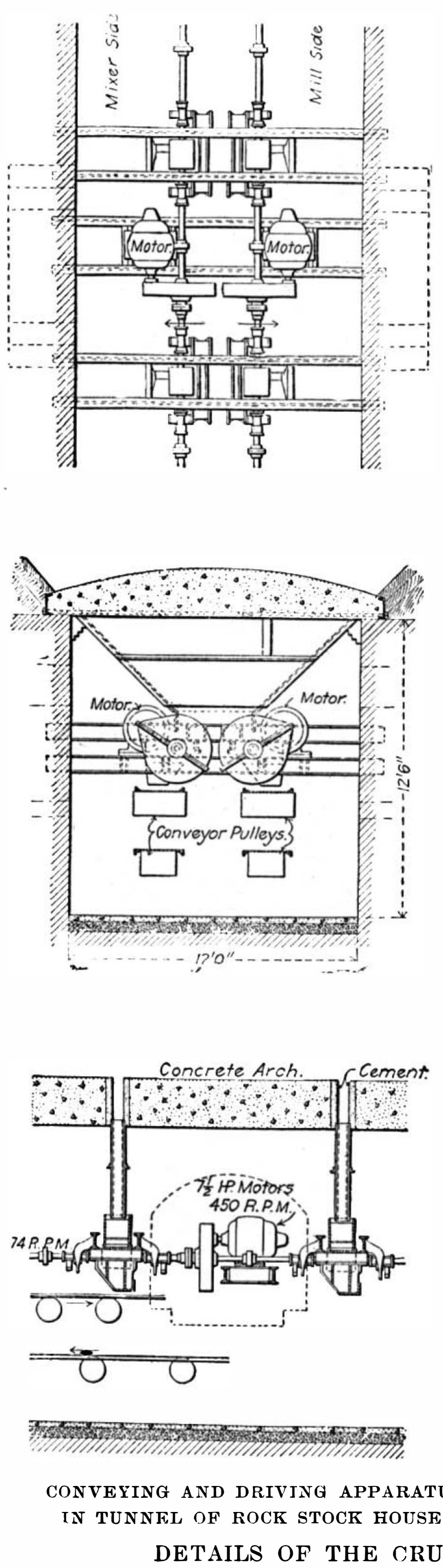
At the small rock stock house starts a long tunnel in which travels a 36-inch belt conveyer, passing another raw-material or chalk grinding house, receiving the load delivered by the rolls there and then rising to the top of the blower house. Here it discharges upon a conveyer traversing the length of the building and passing two stationary trippers, the first taking off a proper proportion of the load and replacing the remainder, if any, upon the belt, to be carried on to the second. Each tripper supplies eight bins, from which the material is supplied to the discharge pipes of as many fan blowers. The material falls by a system of baffle plates transversely through the current of air maintained by the blower. The fine material is carried on by the current of air to settling chambers, whence it finds its way to suitable bins below. The coarse material falling through the currents of air is transferred by conveyers back to the chalk grinding house for further reduction. Air for the blowers is taken directly from the tops of the settling chambers already mentioned, and is thus kept in circulation and used over and over again. The dust is removed from the bins below the settling chambers by conveyers and carried directly to the chalk stock house. The finely ground material is designated as chalk for want of a better distinguishing name.

The fine grinding rolls in the chalk grinding house were designed by Mr. Edison, and are practically the same as those used by him in his ore separating works. The rolls are 28 inches in diameter and have an 8-inch crushing face. One roll is driven from the main shaft and two others are driven from it by friction, pressure being created between the rolls by the tension of a ⅝-inch steel wire cable carried continuously around the sheaves mounted loosely upon the extended shafts of the direct-driving working roll and the idler roll. This cable is continuous around all four sheaves, passing from one pair of shafts to the other by way of suitable winder sheaves and a tension sheave attached to the piston rod from an 8-inch air cylinder. The repeated winding of this cable so multiplies the effect of the air pressure in the cylinder that the working pressure between the grinding rolls is normally maintained at from 14,000 to 18,000 pounds per square inch. So severe is the service that the life of the wire cable is not more than two weeks. It is evident that this device of creating a pressure between the grinding rolls relieves the roll bearings of all pressure except that due to the weight of the parts supported by them. The set of rolls handles about 200 barrels per hour, but has a record of 280. Eighty-five per cent of this ground material passes through a sieve of 200 meshes per linear inch. The grinding rolls are arranged to receive an extra roll and additional sets are to be added to bring them up to a producing capacity of 5,000 barrels of cement per day. When the house is increased and the rolls are installed, the producing capacity will be 10,000 barrels per day. The engine is of the same type as that in the crushing plant, but it is larger, having a reading of 750 horse power. It also drives a 100-kilowatt generator for the motors of this department.

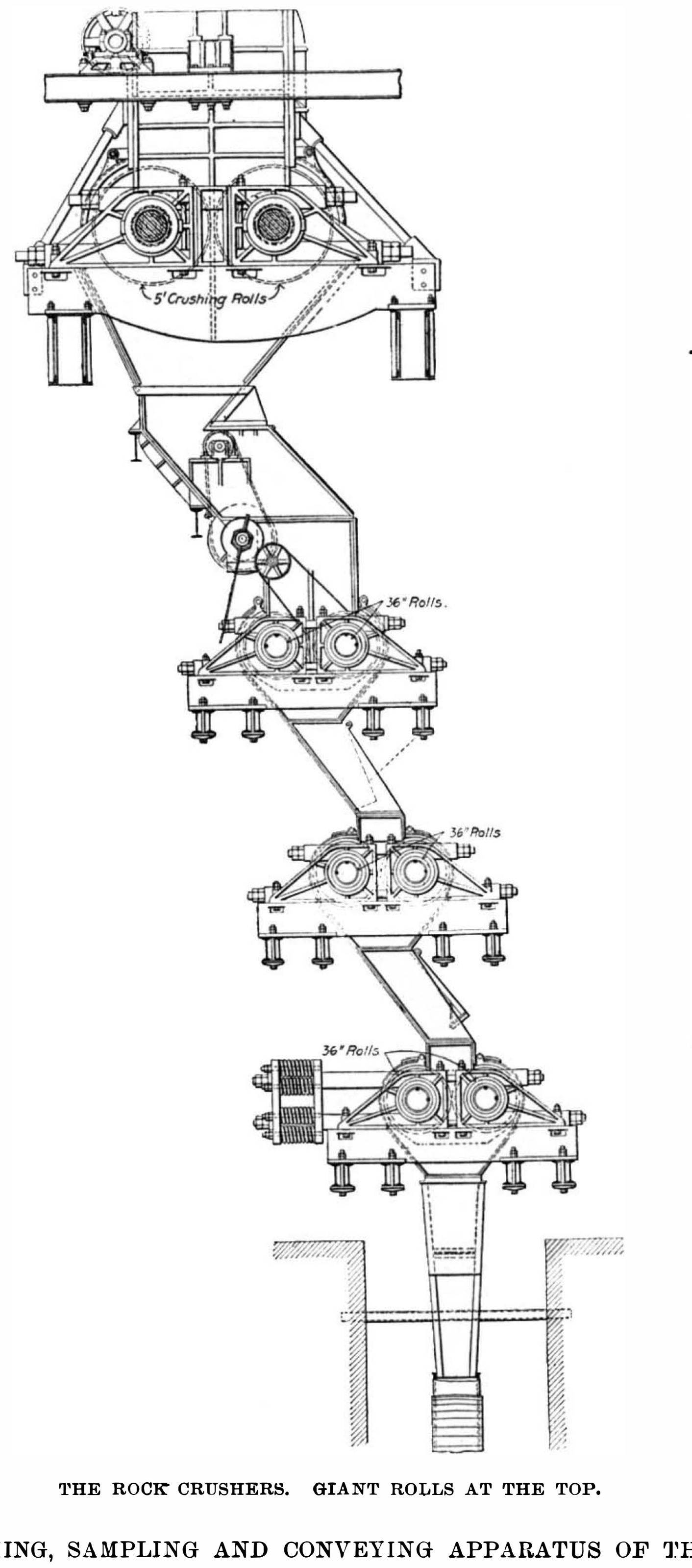
The separating apparatus, constituting one of the most striking features of the works, is located in the blower house, which is a comparatively large building for the distribution of finely ground rock to the outlets of some sixteen blowers. The fine material is separated from the coarser by the action of the air blast in conjunction with baffle plates. Ten per cent of the material which fails to pass the 200-mesh screen is ground by the baffles and returned by conveyers to



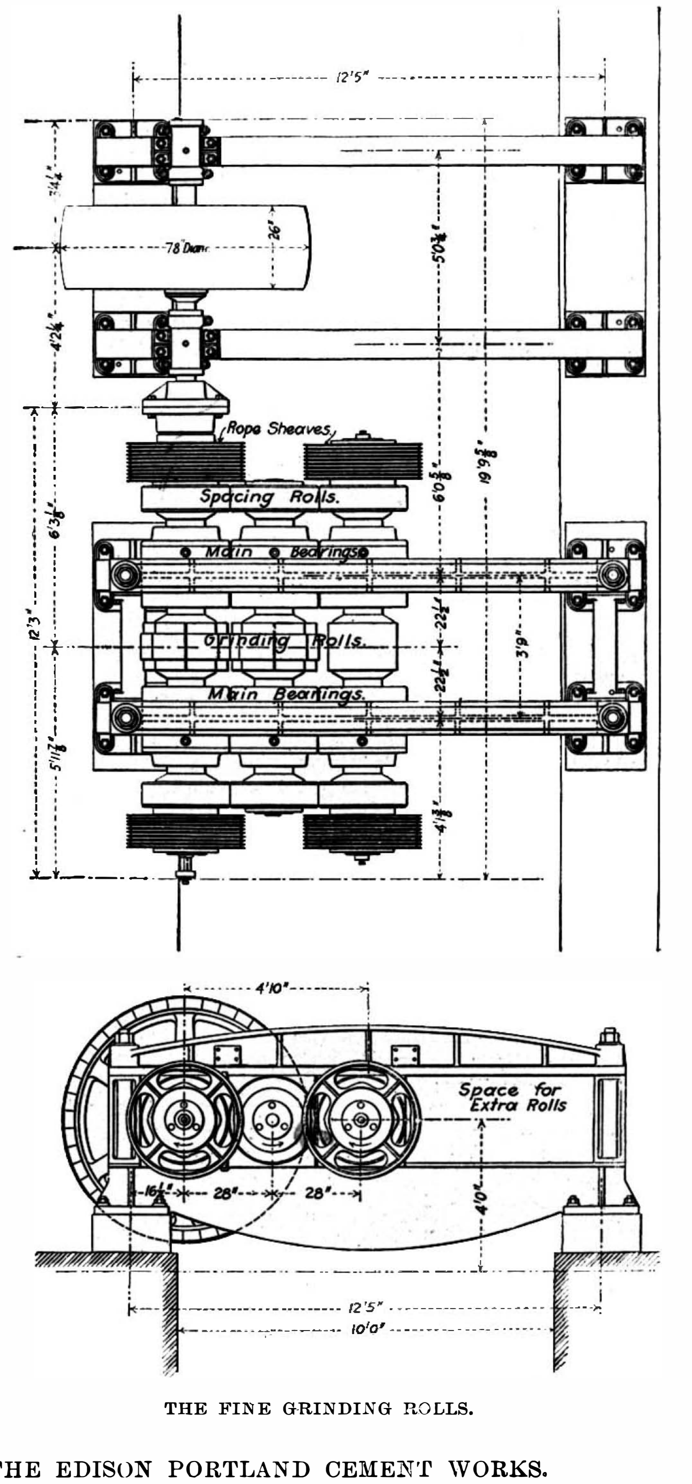
THE AUTOMATIC SAMPLER.



CONVEYING AND DRIVING APPARATUS IN TUNNEL OF ROCK STOCK HOUSE.



THE ROCK CRUSHERS. GIANT ROLLS AT THE TOP.



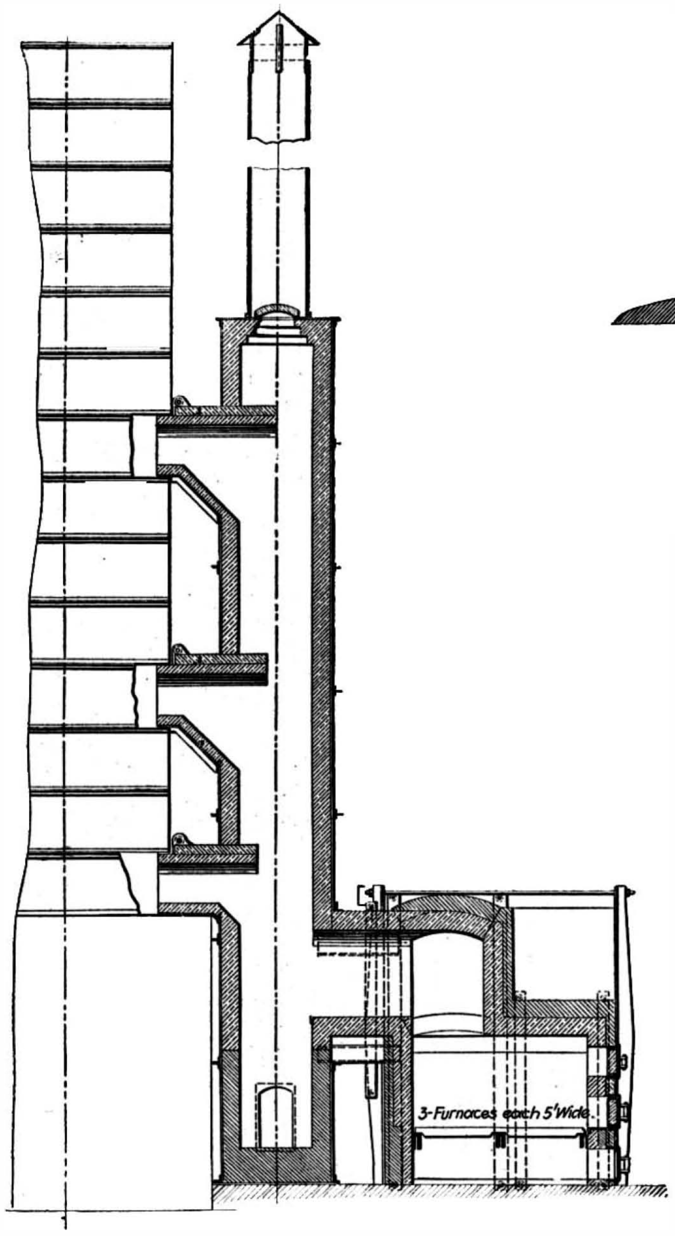
THE FINE GRINDING ROLLS.

DETAILS OF THE CRUSHING, SAMPLING AND CONVEYING APPARATUS OF THE EDISON PORTLAND CEMENT WORKS.

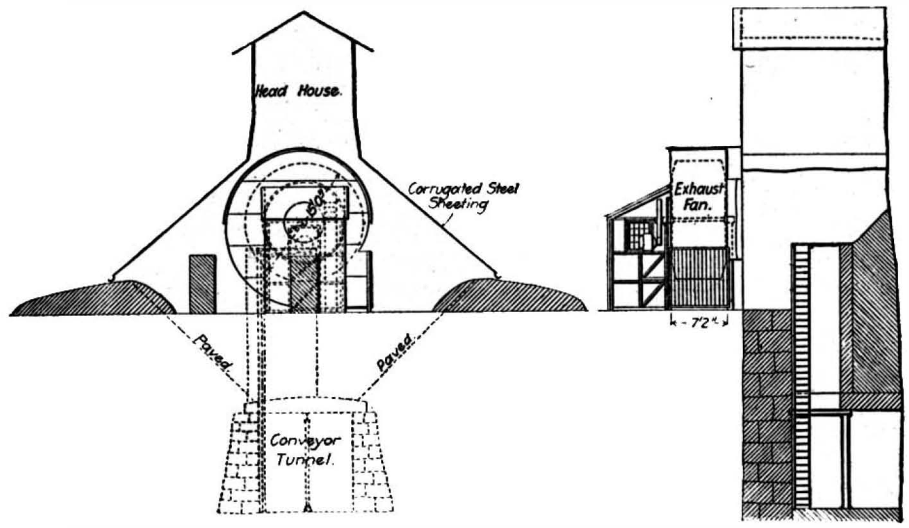
the fine grinding rolls. Space enough has been left for eight more blowers. By increasing the size of the building the capacity of the blower house may be increased to 10,000 barrels.

A 36-inch belt conveyer carries the discharges from the grinding rolls to an electrical belt conveyer in the topmost part of the blower house. In conjunction with two S-dumps this latter conveyer feeds a number of chutes, one to the outlet of each blower. In this outlet, the material drops through a set of baffle plates, while the current of air is streaming through it. The air carries the dust into a large settling chamber beyond where the dust settles to the bottom on account of the reduced velocity of the air. In each case the coarse gunny walls of this chamber prevent any inequalities of air pressure. It should be noted, however, that air for the suction side of the fan is taken leading from the blower house. His sense of touch tells him when the screw is taking hold of the material. The screw delivers to a belt which leads to the kiln house.

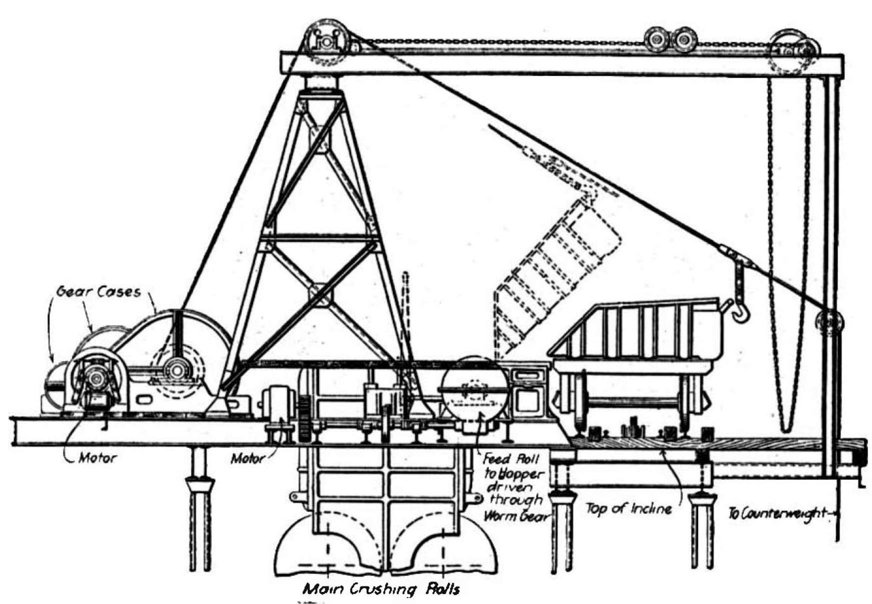
The burning plant consists essentially of the roaster house, the clinker crushers, and clinker stock house. At the present time there are installed only two kilns, but provisions are made for multiplying this equipment by eight, thus providing sixteen kilns, so as to give an average capacity of 18,000 barrels per day, with suitable extra capacity to allow for laying off two or more kilns at a time for repairs or for relining. Those who are at all familiar with the ordinary kiln used in cement works will be more than astonished at the extraordinary size of those to be found at the Edison Works. While the usual form of kiln is constructed of steel plate with a diameter of 6 feet and a length product. The feed is regulated by friction-driven screw conveyers of small size. The clinker formed by the vitrification of the chalk, as it works its way through the kiln under the intense heat of the powdered coal flame, drops out at the lower end into a revolving, cylindrical cooler. One of our figures shows the manner of the cooler's delivery into a bucket conveyer, by which the clinker is removed from the roaster house. The air admitted to the roaster or kiln is drawn through the cooler, and is, therefore, warmed by the heat drawn from the clinker. The cooler rotates much in the same way as the rotary kiln itself; but as the inclination (0.75 inch per foot) is considerably greater than that of the rotary kiln, the passage of the clinker is much more rapid. Ordinarily the clinker from the cooler is spouted directly from the bucket conveyer shown in the illustration of the cooler. This



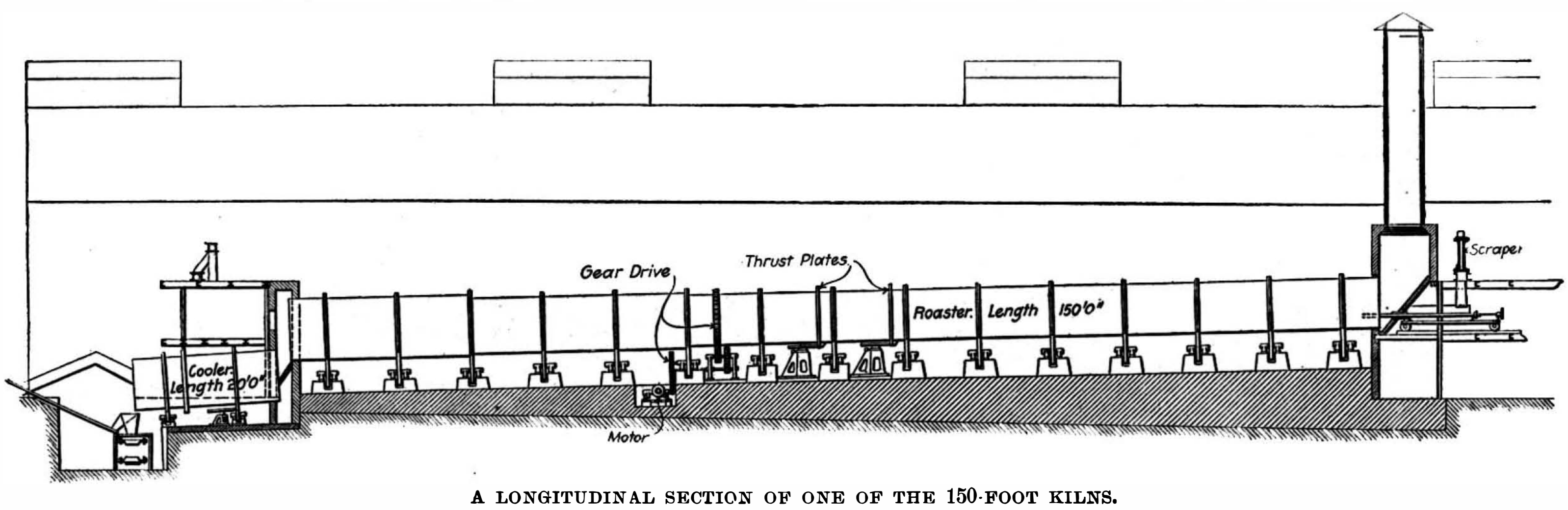
ROCK DRIER FURNACES AND STACK.



THE ROCK STOCK HOUSE AND ITS FAN.



THE SKIP-UNLOADING APPARATUS AT THE GIANT ROLLS.



A LONGITUDINAL SECTION OF ONE OF THE 150-FOOT KILNS.

THE EDISON PORTLAND CEMENT WORKS.

from the top of the chamber. The blower thereby sets up an internal circulation.

In the stock house, which has a capacity of 1,000 tons of chalk, the finely-ground material is conveyed from the blower house by belt conveyers, and from it the same material is delivered by means of a long screw conveyer, dubbed "Cæsar's Wife" for the reason that it is above reproach. "Cæsar's Wife" consists of a truss bridge a few feet above the floor, upon which the 18-inch screw conveyer is carried. The bridge is pivoted to the discharge end of the conveyer, and the outer end is swung in the arc of a circle by means of a stationary rack on which it is moved by means of a pinion. At the pivoted end, the bridge carries its own motor and operator, inclosed like the exposed motors throughout the plant in a housing of gunny sacking. The operator rotates the screw against the ground material, which is dumped in a pile by the belt conveyer of 60 feet, the Edison kilns are built of cast iron 150 feet long and from 8 to 9 feet in exterior diameter. The lining of firebrick brings the interior diameter to about 6 feet. Each rotary kiln is supported on thirty wheels at fifteen points of its length, and is revolved at a speed varying from one revolution in 35 seconds to one revolution in 40 seconds, according to the requirements of the material fed through. Power for rotation is derived from geared motors located about midway the length of the kilns. The rotaries are inclined downward from the feeding end, the pitch being 0.32 inch per foot. They are held in place by two thrust wheels bearing against turned rings encircling the shell. The output of each kiln is normally about 750 barrels per day of twenty-four hours. The fuel used is a pulverized coal fed into the lower end of each kiln by compressed air. The amount of fuel which is used is less than 80 pounds per barrel of spout, in the figure in question, is mounted upon a truck carrying also a second spout, which may be brought into position to receive the clinker from the cooler. The second spout carries the clinker away from the bucket conveyer, and delivers it to the bad clinker elevator, the conveyer discharging upon the pavement outside the roaster house. By this provision any defective product may be isolated until the difficulties, whatever they may be, are removed. The conveyer in passing upward and outward from the roaster house travels beneath perforated pipes, from which streams of water are sprayed upon the hot clinker, further cooling it on its way to the crushing house.

The clinker crusher house contains two sets of 36-inch rolls and has a capacity of 200 tons per day. The rolls are duplicates of those in the rock crusher plant. The crushed material can be stored in an adjacent stock house, which has a capacity equal to the

daily output of the crusher. The crushed clinker is transferred to the stock house by chutes leading to a belt conveyer in a tunnel underneath it, and in its transit the proper amount of sulphate of lime is added. It is then taken by a belt conveyer to an elevator and thus fed into the feed rolls above the clinker grinders. The grinding rolls here are counterparts of those in the raw material grinding plant, and a 750-horsepower engine is used to drive them, the engine being located in an adjacent building and also connected with an electric generator for the local motors. From the grinding rolls, the material is handled in a second blower house where the fines are separated from the coarse in the same manner that the separation is effected in the case of the ground raw material. Overflow chutes take care of the excess of supply over capacity. The ground cement is lifted by an inclined belt conveyer to a belt conveyer extending lengthwise in the upper part of the cement stock house, where it is dumped in two piles, one toward each end. The cement stock house has a capacity of 100,000 barrels. Additional stock houses are to be constructed whenever their need may arise. A transverse conveyer extends between each pile in the cement house, the conveyer having two 16-inch screws. This conveyer, which has been christened "Big Cæsar," discharges upon an electric 12-inch screw conveyer at one side of the stock house.

The plant for pulverizing the coal fed to the rotary kilns is extensive and complete. From cars in which the coal is received the fuel passes through a "grizzly," where the larger pieces are crushed and the whole delivered by conveyer to the stock house. Since soft coal is used the grizzly has very little work to do. From the stock house a conveyer delivers it to a transfer tower, whence the crushed coal is conveyed to the drier house. Here a drier stock is installed, constructed upon the same principle as the rock drier, but not quite so elaborately. Its dimensions are 6 x 7 feet in plan and 18 feet in height. Steam coils heat the air for drying the coal. The air is driven through the coils at the rate of 30,000 cubic feet per minute. The coal falling through the drier into a storage or hopper below is taken by a special screw conveyer and deposited upon a conveyer belt for delivery to the coal grinding house. Here is installed an overhead or ball mill, passing which the coal enters a tube mill below. The screw conveyer transfers the material from the ball mill to the tube mill. The 12-inch conveyer transports the powdered coal from the tube mill to the fine coal storehouse located conveniently adjacent to the roaster house. For the storehouse, the capacity of which is 100 tons, a 12-inch screw conveyer transfers the fuel to the rotaries. The power plant consists of three 500-horsepower Climax boilers installed in a building adjacent to the roaster house. In the intervening space between the buildings an air compressing plant is to be found. A large and well-equipped machine shop has been installed both for construction and repair.

The greatest difficulty to be contended with in a cement plant is the general prevalence of dust. Elaborate precautions have been taken by Mr. Edison to protect his machinery from this destroying agent. Many of the 125 motors of the plant are protected by gunny sacks, as we have already pointed out. A dust fan set in one wall exhausts air from the motor room. The action of the fan induces the flow of air through the walls of the gunny inclosure, but does not allow dust to pass through. A dust-proof entrance vestibule affords means of ingress and egress to a gunny-sacking motor room. The effectiveness of the gunny chamber may be understood when it is stated that the interior air is entirely clear when the outer air is completely dust-laden. The outside of the chamber is rapidly coated with dust, which is swept off at intervals. Of the output of this plant, it is said that a minimum of 85 per cent will pass through a sieve of 200 meshes per linear inch. The plant has now a capacity of 1,500 barrels per day of twenty-four hours and employs 300 men. For four rotary kilns, doubling the present output without exceeding the present capacity of any other department except that of raw material fine grinding, it is estimated that the labor and cost of operation will be increased by only about 10 to 20 per cent.

[Concluded from Supplement No. 1465, page 23480.]

GRANTS MADE BY THE CARNEGIE INSTITUTION.

ENGINEERING.

W. F. Durand, Cornell University, Ithaca, N. Y. For experiments on ship resistance and propulsion. $4,120.

Abstract of Report.—Prof. Durand reports that certain equipment necessary for the conduct of the experiments was completed early in the spring. Experiments in connection with the work on propellers were begun, and all of the work of observation required for the complete determination of the performance of thirty-five model propellers was finished. To complete the investigation immediately in view, fourteen propellers remain to be experimented with. He feels that the complete experimental determination for thirty-five propellers constitutes a most satisfactory summer's work. This is five-sevenths of the entire field to be covered by this particular investigation. The work of making the detailed reductions and analyses of these observations will presumably occupy most of the winter. But very gratifying progress has been made in the preliminary measurements, speed having been determined from distance and time records in 444 cases and thrust-turning momentum determined by integration from autographic records in 655 cases.

Leonard Waldo, New York City. For study of aluminium bronzes. $4,500.

Abstract of Report.—Mr. Waldo reports that through the death of his associate, George S. Morison, and the breakdown in health of his chief assistant, progress has been slow; he is unable to do more than report progress. He (a) prepared a bibliography on alloys of aluminium and copper and of other aluminium compounds; (b) has had in operation six kinds of specially built furnaces, and is building a seventh, to determine the best methods for making large castings and sound wire bars or billets of aluminium bronze; (c) his rolling mill experiments for producing tubes, sheet, wire, and forged bars. from billets cast during the year, are practically complete and are satisfactory.

Notes taken during the process of rolling and cold drawing, relative to temperature, speeds and cost are awaiting collation and reduction. A complete report will be prepared during the coming year.

EXPLORATION.

Raphael Pumpelly, Newport, R. I. For preliminary examination of the trans-Caspian region. $6,500.

Abstract of Report.—The reconnaissance covered a region of 1,750 miles in length, with trips from 10 to 300 miles away from the railroad base. Throughout the great part of this area the remains of ancient occupation abound, in the form of large tumuli, village sites, fortresses, and cities.

The structure of the tumuli examined and their contents indicate a very remote beginning and occupation during long periods. The builders had apparently archaic pottery, no metals, slight knowledge of stone implements, and probably wooden weapons. The people were settled and had the domestic horse, cow, pig, sheep, and goat. Many of these seats of early dwelling seem to have become in time eminences upon which arose fortresses, or to have become the citadels of towns growing up around them. Thus they probably contain the continuous record of the development of the civilizations of the region from a very remote antiquity down to historic times.

The reconnaissance work of Prof. Davis, Mr. Huntington, and R. W. Pumpelly has shown the former existence of several glacial epochs, and has made much progress in correlating these with the progress of prehistoric physical events in the building of the plains and the expansions of the former Aralo-Caspian seas. Their observations give reason to hope that further study will correlate these physical events with important phases of human development in connection with Asiatic and European history.

GEOPHYSICS.

Frank D. Adams, McGill University, Montreal, Can. For investigating the flow of rocks. $2,500.

Prof. Adams has been engaged for some years past in an experimental investigation into the nature of the movements set up during the folding and deformation of the rocks of the earth's crust.

Abstract of Report.—Dr. Adams reports that McGill University has provided for his use in carrying on the investigation on the flow of rocks a large room in the basement of the new chemical building of the university. In this room he has installed the apparatus he formerly had and ordered a third and much more powerful hydraulic press, by which pressure up to 120 tons may be secured and maintained, if necessary, for weeks at a time. Ample provision has been made in the installation of the new hydraulic press, looking to the possibility of the extension of the plant in its adaptation to the most varied experimental uses.

On the completion of the installation Dr. Adams commenced the investigation of high differential pressures on dolomites from Maryland, Massachusetts, and the province of Quebec. It was found that at ordinary temperatures these dolomites could be made to flow in the same manner as in the case of the pure Carrara marble. He is now carrying on experiments to ascertain the effect of heat upon the flow of dolomite. In order to compare the effects produced at high pressures with those produced by lower pressures, the higher representing the condition at lower depths in the earth's crust, experiments have been begun on the flow of marble with the 120-ton press.

Dr. Adams is also carrying on a series of investigations into the force required to drive water Portland oolite, which is the rock he has selected for further experiments on the deformation of limestones when heated, with water passing through them. He has also assembled material to commence the study of granite essexite and diabase, as typical igneous rocks under very high pressures at ordinary temperatures.

C. R. Van Hise, University of Wisconsin, Madison, Wis. For investigating the subject of geophysical research, etc. $2,500.

In the "Year Book" for 1902, page 26, an extended report was presented on the subject of geophysics. As the trustees were not prepared to act upon the project, a further study of the problem was made, at the request of the executive committee, by Prof. Van Hise, who investigated the subject of geophysical research in European institutions and made a report, which is printed in the "Year Book."

GEOLOGY.

T. C. Chamberlin, University of Chicago, Chicago, Ill. For study of the fundamental principles of geology. $6,000.

Abstract of Report.—Plans for the consideration of the different phases of the complex subjects of this investigation were arranged with numerous collaborators, and details of this collaboration and the results obtained are given in Prof. Chamberlin's report printed in the "Year Book."

Bailey Willis, U. S. Geological Survey, Washington, D. C. For geological exploration in eastern China. $12,000.

This grant was for the purpose of carrying on a comparative study of the geology of eastern Asia and western North America by observations in stratigraphy, structure, and physiography in eastern China and Siberia, and by the collection of fossils, particularly with reference to the development of the Cambrian faunas.

He proposed to begin his inquiries in the mountain district in Shantung—the Taishan—a geological unit of about 4,000 square miles, where a study could be made of the geology from pre-Cambrian gneisses to the Coal Measures.

Mr. Eliot Blackwelder, an instructor in elementary geology and paleontology in the University of Chicago, accompanied Mr. Willis.

Abstract of Report.—Under date of September 30, 1903, from Tientsin, China, Mr. Willis reports that all preparations are completed, that authority has been received from the Chinese and German governments, and that with his associate, Mr. Blackwelder, he is about to leave for the province of Shantung. From Shantung it is proposed to go to Liautung. Mr. Willis expects to return to Pekin January 1, 1904, and as soon as may be thereafter to enter upon a trip that will probably continue until the end of June, 1904.

HISTORY.

Worthington C. Ford, Library of Congress, Washington, D. C. For an examination of the historical archives of Washington. $2,000.

For the purpose of studying the historical archives of Washington and ascertaining their extent and their characteristics, Mr. Ford prepared a scheme of inquiry which was arranged in two divisions. The first division included a general statement of the contents of each repository of archives, a statement of the place in which it is contained, and the history of the collection; also a statement of the funds available for the maintenance of the collection and of the conditions under which documents are accessible. The second division referred to the preservation of the collections and the arrangements for enlarging them.

Abstract of Report.—The purpose of this grant was to defray the expense of making a general survey of the archives of the government and the preparation of a report which would be helpful to historical investigators. Dr. Claude H. Van Tyne and Mr. Waldo G. Leland began the work in January, 1903, following general suggestions offered by Mr. Ford. They have examined the manuscript material in every branch of the government, and have prepared a statement as to the nature and extent of the administration records, as well as of the more important collections of historical material. This description is now nearly ready for printing. It will make a book of 250 or 300 pages of the size of the "Year Book." While it does not attempt to describe individual documents, but only classes and collections of documents, it is sure to be helpful to historical scholars seeking material.

PALEONTOLOGY.

E. C. Case, State Normal School, Milwaukee, Wis. For continuation of work on the morphology of Permian reptiles. $500.

Abstract of Report.—In connection with the preparation of a monograph on the Pelycosauria of the American Permian deposits, Prof. Case spent most of the summer in the British Museum and several weeks in the museums of Paris and Berlin in the study of reptiles of Permian age contained therein. The main line of work resolved itself into a careful comparison of the faunas of the deposits of America, Russia, and South Africa. The most important result was the demonstration that American forms are practically completely different from those of Russia and South Africa, the sole connecting faunas being of the most primitive type, and none, so far as known, being common. This emphasizes the peculiarity of the presence of a typical American Pelycosaurian in the deposits of Bohemia. Prof. Case also obtained many isolated facts of morphology that will be of material assistance to him in the study of the fauna.

O. P. Hay, American Museum of Natural History. For monographing the fossil Chelonia of North America. $2,200.

Abstract of Report.—Dr. Hay reports that he has prepared 200 pages of typewritten manuscript, and has had made, under his personal supervision, 210 drawings and 80 photographs of fossil turtles. He finds that there are about 180 species, and that there yet remains much to be done before the monograph will be ready for publication. During the summer he spent two months in the Bridger deposits of Wyoming, collecting fossils, and secured 135 specimens of turtles that will add greatly to our knowledge of Eocene forms.

G. R. Wieland, Yale University, New Haven, Conn. For continuation of his researches on living and fossil cycads. $1,500.

Abstract of Report.—Dr. Wieland expects to have a memoir ready by the close of the calendar year, dealing with the fossil cycads from a biological standpoint. He has developed a new method for the study of fossil cycads by perfecting or inventing inverted drills, by means of which he has secured leaves, branches, fruits, flowers, and terminal buds in the form of cylindrical cores cut from the cycad trunks. He has also adopted

the novel plan of cementing together again, in their original position, the parts of such cores resulting from the cutting of a series of thin sections, and in this way securing a second series, also complete. By these methods he has cut a dozen fruits, in various stages of growth, from a silicified cycad trunk. He has also cut thin longitudinal and transverse sections of flowers surrounded by leaf bases. It is now possible to make, in the case of cycads, intensive studies of single trunks, such as have never before been made in the case of any fossil plants.

S. W. WILLISTON, University of Chicago, Chicago, Ill. For preparing a monograph on the Plesiosaurian group. $800.

Abstract of Report.—Prof. Williston reports that he investigated the type material of Plesiosaurs at Colorado College, University of Kansas Museum, the American Museum of Natural History in New York, the Museum of the Academy of Natural Sciences, Philadelphia, and the National Museum, Washington. Important material has been sent him from these and other sources, upon which he is at present engaged. He hopes to complete his study during the year 1904.

PHYSICS.

HENRY CREW, Evanston, Ill. For study of certain arc spectra. $1,000.

Abstract of Report.—Prof. Crew reports that after the building of certain apparatus, which required several months, he began the experimental part of his work. He found unexpected difficulties in working with magnesium and zinc, the two metals in which he hoped to find the order of appearance of the lines of the spark spectra.

His second problem was to complete the maps of the spectra of cadmium and aluminium. The map of the cadmium arc has been completed; that of aluminium nearly so.

The difficulty of obtaining an oscillograph has delayed the beginning of work on the third problem, the determination of the E. M. F. curves with the "rotating metallic arc."

A. A. MICHELSON, University of Chicago, Ill. For aid in ruling diffraction gratings. $1,500.

Abstract of Report.—Prof. Michelson encountered many serious difficulties in the ruling engines for diffraction gratings, most of which he now believes are overcome. The work is now being pushed vigorously, and he hopes before another year to make a favorable report on the results obtained.

HAROLD PENDER, Johns Hopkins University, Baltimore, Md. For experiments on the magnetic effect of electrical convection. $750.

Abstract of Report.—The object of Dr. Pender's grant was to perform in Paris, in conjunction with Mons. B. Cremieu, experiments on the magnetic effect of electrical convection and to confer with M. Poincaré concerning the same. Dr. Pender met with great success in clearing up a controverted question as to the presence of a magnetic field about a bare metallic surface when charged and set in motion, which field is in all probability due to what is usually termed a convection current of electricity.

R. W. WOOD, Johns Hopkins University, Baltimore, Md. For research, chiefly on the theory of light. $1,000.

Abstract of Report.—Prof. Wood reports that one-half of the grant has been expended for the salary of an assistant, and that the balance he plans to expend for apparatus. Through the aid given he was able to accomplish much more experimental work than he otherwise could have done. During the year he obtained results which were published in seven papers, all of which pertain to researches connected with the theory of light.

A considerable amount of work was also done on an investigation on the dispersion of sodium vapor; this has not yet been published.

PHYSIOLOGY.

W. O. ATWATER, Wesleyan University, Middletown, Conn. For experiments in nutrition. $5,000.

Abstract of Report.—The purpose of this grant was to promote researches involving the direct determination of the amount of oxygen consumed by man for sustaining the bodily functions. The grant has been expended chiefly for the services of experts and assistants, for devising and constructing or purchasing apparatus, for developing methods for the determination of oxygen and for efficiency tests and experiments with men in the apparatus.

Several tests of the efficiency of the apparatus and method of manipulation were made. The feasibility of the use of the apparatus for the experiments with men has also been tested by three experiments with different subjects, with satisfactory results. Attention is now being devoted to alterations and improvements in the apparatus and to modifications of methods; efficiency tests and experiments with men are also in progress.

ARTHUR GAMGEE, Montreux, Switzerland. For preparing report on the physiology of nutrition. $6,500.

Abstract of Report.—Dr. Gamgee began and has carried on a study of the extensive literature on this subject, which had to be mastered for the purpose of the inquiry on which he was engaged. He began by inspecting European laboratories and by visiting scientific men in Europe. He also visited Prof. Atwater, at Middletown, Conn., and acquainted himself with the work now in progress there. He also visited other Americans. It is probable that his complete report will be transmitted in May, 1904.

PSYCHOLOGY.

G. STANLEY HALL, Clark University, Worcester, Mass. For certain investigations on the anthropology of childhood. $2,000.

Abstract of Report.—The result of Dr. Hall's work in connection with this grant is best indicated by the titles of the papers he has published, giving the results obtained during the year. These are (1) Reaction to light and darkness; (2) children's ideas of fire, heat, frost, and cold; (3) curiosity and interest; (4) showing off and bashfulness as phases of self-consciousness, and (5) marriage and fecundity of college men and women.

E. W. SCRIPTURE, Yale University, New Haven, Conn. For researches in experimental phonetics. $1,600.

Report.—Prof. Scripture's report is printed in the "Year Book."

ZOOLOGY.

H. E. CRAMPTON, Columbia University, New York. For determining the laws of variation and inheritance of certain lepidoptera. $250.

Abstract of Report.—In order to obtain data for the problems of variation, their relation to selection, and for the study of correlation, Dr. Crampton investigated the following material: (a) 848 cocoons of Philosamia cynthia; (b) 1,410 cocoons of Samia cecropia; (c) 400 cocoons of Callosamia angulifera, etc.; (d) 75 cocoons (preliminary) of Attacus orizaba, and (e) one family, Hypercheiria io.

The data secured furnished material for examination into variation and selection by comparing: (a) Metamorphosing and non-metamorphosing, (b) the perfect and imperfect survivors, and (c) the mating and non-mating moths.

Dr. Crampton thinks that certain general conclusions are justified from the facts already determined. Surviving individuals are less variable than those which succumb; mating individuals are less variable than those which fail to mate, and the index of correlation of the pupal characters is higher for the selected individuals in both cases. In a word, selection proceeds upon a basis of deviations from type and upon a correlative basis.

J. E. DUERDEN, Chapel Hill, N. C. For investigation of recent and fossil corals. $1,000.

Abstract of Report.—With a view to obtaining suitable material for continuing his researches on fossil corals. Dr. Duerden has lately visited the principal museums and geological surveys in Great Britain, where Paleozoic corals are most abundant. These museums, and also the Smithsonian Institution, have placed at his disposal numerous specimens. Other material has been purchased. These collections will be studied during the present winter, with the hope of showing the relationship of fossil to recent corals.

Dr. Duerden has deposited with the Carnegie Institution, with a view to its publication, the manuscript and drawings of a memoir entitled "The coral Siderastræa radians and its post-larval development." This work is illustrated by fifteen plates and numerous text figures, and gives an account of the morphology of a coral and its growth for a period of four months. It carries the development of the coral much farther than any previous work and contains many fundamental results in madreporarian morphology.

C. H. EIGENMANN, Indiana University, Bloomington, Ind. For investigating the blind fishes of Cuba. $1,000.

Abstract of Report.—Dr. Eigenmann did not begin his work under the Carnegie grant until October. He expects to spend from four to six months in Cuba, during the entire breeding season, and to make general collections in the caves and streams. He will also make an effort to secure the blind fishes from the Island of Jamaica. He has made arrangements with the Cuban government to co-operate with him, as far as practicable, in giving him facilities for carrying forward his investigation.

L. O. HOWARD, Department of Agriculture, Washington, D. C. For preparing manuscript and illustrations for a monograph on American mosquitoes. $2,000.

Abstract of Report.—Dr. Howard began his work by making arrangements to secure observers at points in the United States, Central America, and the West Indies sufficiently different in their faunistic characteristics to promise comparatively little duplication. He also published an announcement of the proposed monograph for the purpose of attracting volunteer observers and contributors; and, through correspondence, a great deal has been done in that direction, both in the West Indies and the United States. He also utilized the services of a number of the members of his force in the Department of Agriculture in making collections and observations.

He reports that the results as a whole have been surprising to him. A number of new species of mosquitoes have been discovered and one new genus, and much important specific information regarding the geographic distribution of the different species has been gained. This information has been of special interest and value regarding the yellow fever mosquito (Stegomyia fasciata) and the different species of the malaria-bearing mosquitoes of the genus Anopheles. A new species of this genus was found in the immediate vicinity of Washington. Great advance has been made in following out the life histories of the different species and genera; this has been done for nearly one hundred species.

All the collections and specimens have not yet been received by Dr. Howard, but every observer will send a series of specimens of adults, eggs, larvæ, and pupæ together with cast larval skins of all species observed. These have been and will be accompanied by full notes of habits, etc., together with drawings of structural peculiarities.

H. S. JENNINGS, University of Michigan, Ann Arbor, Mich. For experiments on the behavior of lower animals. $250.

Abstract of Report.—Dr. Jennings, who is a research assistant of the Carnegie Institution, is now at the Marine Biological Laboratory at Naples, carrying forward investigations on the reactions and behavior of very low organisms, such as amœba and other rhizopoda. He expects to have a general work in regard to the behavior of the lowest organisms ready for publication during the year. He has submitted to the institution for publication a paper entitled "Reactions to Heat, Light, and other Stimuli in the Ciliate Infusoria and in Rotifera, with Considerations on the Theories of Animal Behavior."

C. E. MCCLUNG, Kansas University, Lawrence, Kans. To making a comparative study of the spermatogenesis of insects and other classes of arthropods, and if possible to determine the specific functions of the different chromosomes. $500.

Abstract of Report.—Prof. McClung reports that owing to the fact that his own work and that of others show the main features of insect spermatogenesis, he determined to make use of the grant for the prosecution of other more difficult and expensive studies. He commenced by purchasing some literature to which he did not have access, and began the search for an object upon which he might prosecute his investigations. There appeared to be two ways to get at the problem—to study the germ cells of hybrids or to experiment upon fertilized eggs in the early cleavage stages. He decided to adopt the first mentioned plan for the beginning of the work. With this object in view, he spent the summer at the Woods Hole marine biological laboratory, but did not succeed in obtaining satisfactory forms of hybrids. He feels certain, however, that if the proper animals are secured the true function of the chromosomes may be settled as definitely as any other fact relating to cell structure.

E. B. WILSON, Columbia University, New York. For investigations in experimental embryology, etc., in Naples. $1,000.

Abstract of Report.—Dr. Wilson utilized this grant to defray the expenses of a visit to the Naples Zoological Station, extending from February to July, during which time he was actively engaged on studies in experimental embryology. His first purpose was to search for available material for the experimental analysis of the early developmental stages in mollusks and annelids, which possess high theoretical interest in their bearings on the general problems of differentiation. He reports a large measure of success in this direction. He found two excellent objects for his research, and made as exhaustive an analysis of them as the time would permit. He demonstrated conclusively the mosaic character of the development in the molluscan egg, and obtained striking evidence of the self-differentiation and specification of embryonic cells. This result is interesting from its bearing on the problem of differentiation and also, perhaps, in even a greater degree, through the firm basis which it gives for the general method and point of view in studies of cellular embryology.

A second general division of his work included the experimental study of prelocalization in the unsegmented egg, which yielded results of no less interest than the cleavage stages. Of these the most important relate to the embryonic basis of correlation and to the relation between quantitative and qualitative prelocalization in the germ.

Dr. Wilson adds a general comment on the nature of this work to the effect that its principal significance lies in its connection with recent studies of the cellular basis of inheritance and development, taken in connection with experimental studies of heredity such as those that have grown out of the rediscovery of the Mendelian law. He is fully persuaded that there is now a very good prospect of making an essential advance toward an understanding of the actual mechanism of hereditary transmission, and expresses the hope that the studies in this direction may receive their due share of support.

H. V. WILSON, University of North Carolina, Chapel Hill. For morphology and classification of deep sea sponges. $1,000.

Abstract of Report.—In order to complete his investigation of the deep sea sponges of the Pacific Ocean, Prof. Wilson visited the museums of London, Paris, Leiden, and Berlin to make a direct examination of the types stored therein. He returned to America in August, and is at present engaged upon the text of his report.

MARINE BIOLOGICAL LABORATORY, Woods Hole, Mass.; J. Blakely Hoar, treasurer. For maintenance of twenty tables. $10,000.

Abstract of Report.—This appropriation was made for the purpose of aiding the laboratory by paying for the maintenance of twenty research tables. The persons assigned to the tables were selected by the Carnegie Institution.

The following investigators occupied the Carnegie tables during the season of 1903: (1) Prof. M. A. Bigelow, Columbia University, New York; (2) Dr. R. M. Strong, University of Chicago, Ill.; (3) Prof. C. E. McClung, University of Kansas, Lawrence; (4) Prof. George Lefevre, University of Missouri, Columbia; (5) Prof. William E. Kellicott, Barnard College, N. Y.; (6) Prof. Arthur W. Greeley, Washington University, St. Louis; (7) Mr. C. J. Brues, Columbia University, N. Y.; (8) Mr. Fred. E. Pomeroy, Bates

College, Lewiston, Me.; (9) Mr. J. W. Scott, University of Chicago, Ill.; (10) Dr. H. G. Spaulding, College of the City of New York; (11) Dr. Leo Loeb, McGill University, Montreal, Canada; (12) Dr. Henry Kraemer, Philadelphia, Pa.; (13) Mr. Grant Smith, Harvard University, Cambridge, Mass.; (14) Prof. Joseph Guthrie, Iowa State College, Ames, Iowa; (15) Miss A. B. Townsend, Cornell University, Ithaca, N. Y.; (16) Mr. M. A. Chrysler, University of Chicago, Ill.; (17) Mr. Gustav Ruediger, Chicago, Ill.; (18) Miss Helen Dean King, Bryn Mawr University, Pa.; (19) Mr. James A. Nelson, University of Pennsylvania; (20) Prof. Christian P. Lommen, University of South Dakota.

The director of the laboratory, Dr. C. O. Whitman, reports that the entire number of investigators at the laboratory during the season was 130, of whom 54 were students and 76 original investigators. He further states that every worker at the laboratory shares the general advantage secured by the Carnegie Institution grant; that most of the occupants of the Carnegie tables were investigators of established reputation, a few of them fellows from different universities engaged in their first original work; that it is not expected that the work undertaken will come to publication immediately, as in most cases it will necessarily extend over two or three years; that it is anticipated that the Carnegie support will not encourage hasty and fragmentary production, but will secure thorough work and permanent results.

MARINE BIOLOGICAL STATION, Naples, Italy. For maintenance of two tables. $1,000.

Abstract of Report.—One of the tables at this station was occupied for three months during the spring by Dr. E. B. Wilson, of Columbia University, and the other by Prof. H. S. Jennings, of the University of Michigan. The remainder of the year the tables were open to whomever the director of the laboratory might wish to assign to them. The arrangement with the laboratory was that the tables were intended for the use of persons engaged in original biological researches, and carried with them the right to be furnished with the ordinary material and supplies of the laboratory.

[Continued from SUPPLEMENT No. 1465, page 23483.]

THE PARIS AUTOMOBILE SHOW.

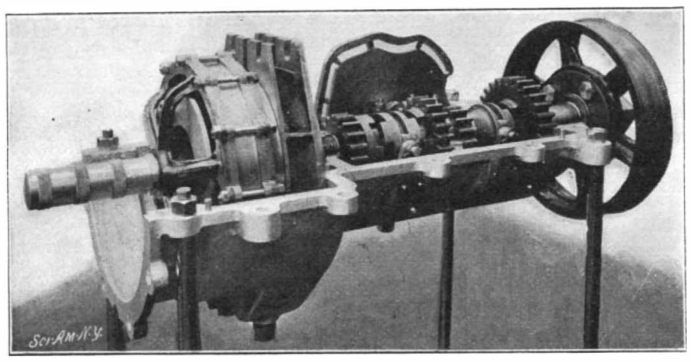
By the Paris Correspondent of the SCIENTIFIC AMERICAN.

SOME more of the novel features in construction that were seen at the last Automobile Show in Paris will be found in the following descriptions:

A NEW METHOD OF MOTOR GOVERNING.

A motor of quite an original type has been brought out by a Swedish firm, the Vagnfabriks Aktiebolaget, of Södertelge. The idea is to control the speed of the car entirely from the motor and to do away with other methods of speed regulation. In the usual motor its speed is changed by throttling the admission, varying the time of ignition, cutting off the exhaust, changing the composition of the explosive mixture, etc. Then, to further vary the speed, the car needs a set of sliding gears. In the present system the speed of the car is varied almost entirely by varying the work done in the motor cylinder by a simple method, without lowering the efficiency to any extent. After a number of experiments, the inventors have now succeeded in governing an explosive motor almost as well as a steam engine, and the efficiency remains about the same for all loads. It is recognized that the best method for governing and operating a gas engine is by admitting and burning a variable quantity of fuel in a certain quantity of air, compressed at a constant pressure. This method is used successfully on some stationary motors. To apply it to a four-cycle motor, the proportion of combustible gas in the explosive mixture should be varied, keeping the total quantity of mixture the same. It is not possible to do this, however, seeing that when the mixture is too diluted it will not ignite.

A method has been found for igniting even a poor explosive mixture, and this consists in admitting the gas and the air separately into the cylinder, so that they mix but slightly in the cylinder head. When the motor compresses, the strong explosive mixture lies next to the make-and-break igniter, while the mixture next to the piston is more diluted and weaker. The manner in which this condition is realized in practice will be understood from the following description of the motor. The combustion space is made exceptionally long. The inlet tube has a throttle valve, *I* (see the illustration) placed in it. Directly below it is the inlet valve of the usual construction, and below this, in the combustion chamber, is the exhaust valve. On the near side of the motor will be seen the special air valve, *A*, which is far removed from the inlet valve. A pipe leads to it for carrying air into the cylinder. This air-valve, *A*, is kept closed by a spring, which has a tension such that when the normal quantity of explosive mixture is admitted into the cylinder, the valve does not open. Should the supply of gas be cut off by the throttle, *I*, an increased suction will occur in the motor and the valve, *A*, will open, admitting a certain quantity of air. The latter has but little tendency to mix with the gas in the cylinder owing to the position of the air valve and a curved pipe in the cylinder head, which directs the air downward on its side of the cylinder. As the quantity of air which is admitted is such that the cylinder becomes practically filled, the compression remains constant.



THE HAUTIER INTERNAL-GEAR CLUTCH AND TRANSMISSION GEAR.

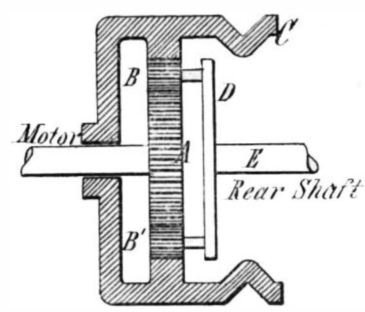
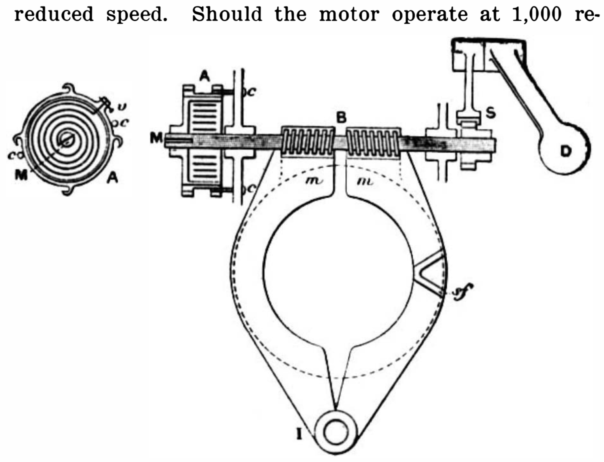


DIAGRAM OF HAUTIER CLUTCH.

The method of governing the speed is simple. When the admission of gas is cut off by throttling, more air is let in at *A*. This causes the force of the explosion to diminish and the motor gives less power. With the throttle left in a given position, should the motor speed lessen owing to additional load, there is more time given to the stroke and the suction decreases more. Explosive mixture and less air is then drawn in, and the motor gives greater power to meet the demand of the load. This action is a valuable feature, as the motor is self-governing for variable loads. As the motor uses a constant and high compression and brings the high quality explosive mixture nearest the spark, it is seen that a good and rapid combustion can be secured with even a small quantity of gas. This makes it possible, owing to the quick combustion, to dispense with the usual shifting of the spark, up to 1,200 revolutions, and the igniter is set once for all. Among the advantages of the new motor, which has been already applied with success to various forms of automobiles and hauling wagons, are the following: At light loads on the motor (as is the usual case) the quantity of cold air admitted is large, and the motor becomes less heated than usual. This makes it possible to overload the motor considerably for a short time, owing to the lessened risk of overheating. The apparatus for shifting the time of the spark is dispensed with. As the motor is self-governing as above seen, no centrifugal governor is needed to prevent racing, as the speed is cut down by admitting air. No gear-changing device is needed where the motor has sufficient power. But in order not to make the motor too large, a low-speed gear is used for going up very steep grades. In the usual cases the motor is governed entirely by one lever, which works the throttle on the inlet. Another point is that the consumption of fuel at light loads is less than usual, owing to the uniform efficiency of the motor.

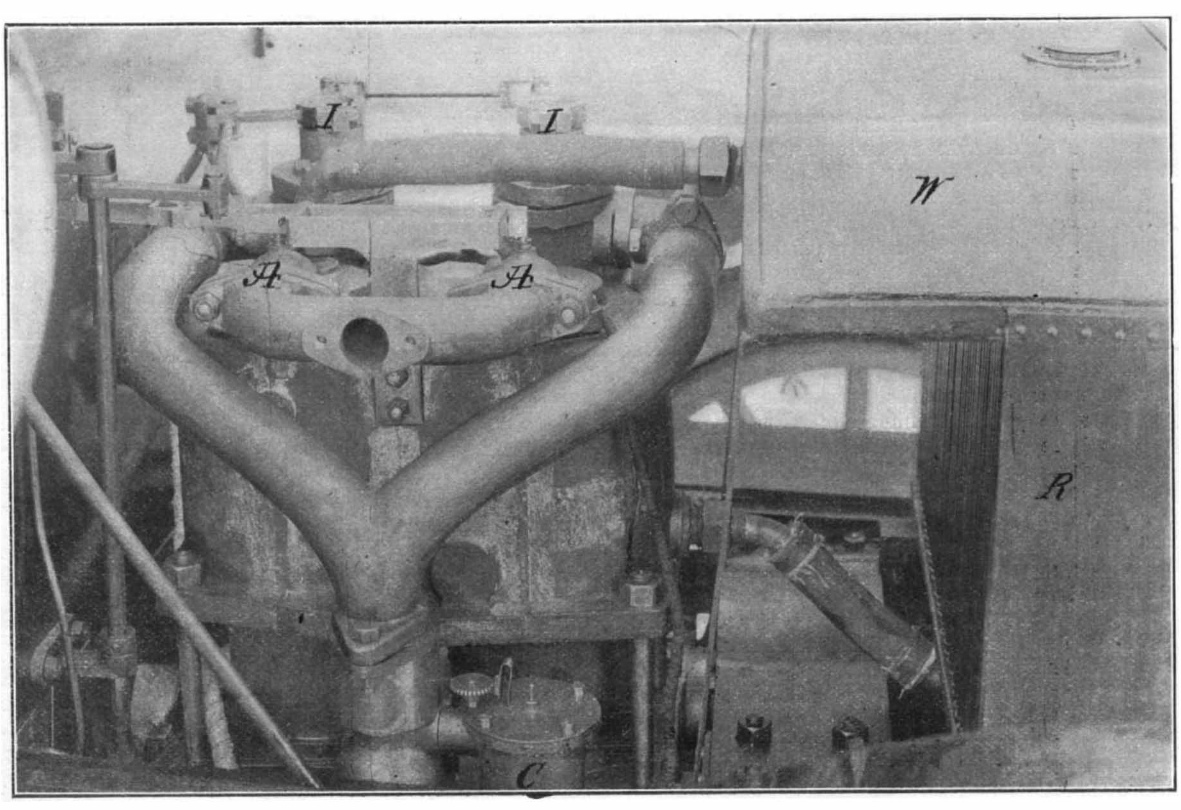
THE HAUTIER SPEED-REDUCING CLUTCH.

The original feature of the Hautier automobile lies in the new method of coupling the motor to the transmission shaft, and also in the new form of gear-changing box which has been adopted. The new clutch is designed to replace the usual friction cones. It is entirely metallic and runs in oil, doing away with the usual leather surfaces. This device not only acts as a clutch, but it at the same time reduces the speed of the motor, so that the transmission shaft runs at a reduced speed. Should the motor operate at 1,000 revolutions, the transmission will turn at only 200. This action, which is a valuable one, is carried out by the following method: The motor shaft carries a gear, *A*, on the end. *B B′* are two small pinions which engage with *A*. They are mounted on shafts which are placed on the arm, *D*, which is fixed to the end of the rear shaft, *E*. These pinions turn loose on their shafts. On the outside is an internal gear, *C*, attached to an exterior case or cylinder. Its internal teeth engage with the pinions, *B B′*. The cylinder is mounted loose on the motor shaft by a set of arms. This disposition will be observed in the engraving, where the motor shaft projects in front.



CLAMPING JAWS OF THE HAUTIER CLUTCH.

When the motor revolves, the pinions, *B B′*, turn loose on their shafts, while the arm, *D*, remains stationary, and the rear shaft, *E*, does not turn. The pinions cause the crown, *C*, to revolve loose on the shaft, *M*. In this case the motor runs free and is out of gear. To cause the motor to drive the shaft, *E*, the crown, *C*, is stopped by a brake seen in the lower cut, consisting of a pair of jaws which encircle it. The action of the brake stops the crown from turning. The gear, *A*, forces the pinions, *B B′*, to travel around it and carry along the arm, *D*. The shaft, *E*, is thus revolved by the motor, but at a reduced speed, which depends upon the ratio of the gearing. In the usual case the shaft turns at one-fifth the motor speed. The lower diagram shows the method of applying the jaws, *M M*, against the outer part of the crown. The action is brought about gradually by varying the pressure up to the point where the drum is completely blocked. The outer rim has a V section, *s f*, into which the jaws fit, so as to increase the effect. The screws *B*, bring the jaws together by turning the shaft, *M*, against the action of a spiral spring. The advantages of this method are that the gears for the speed changing (which come after the shaft, *E*) are now operated at a slow speed and the friction is lessened. The engraving shows the speed-changing gears to the right, contained in a second portion of the case. Here the different gears are always in play and the speed-changing is effected by coupling any one of them with the main shaft, as usually they turn loose upon it. Back of the main shaft is a parallel shaft which carries the auxiliary gears. This shaft is always in gear with the rear shaft, which turns independently. When one of the front pinions is locked upon the main shaft, it transmits the movement to the corresponding auxiliary gear and thence from the parallel shaft is the rear shaft carrying the differential. The movement



MOTOR ARRANGED FOR GOVERNING BY MEANS OF AUXILIARY AIR.

A A, Auxiliary air valves. *C*, Carbureter. *I I*, Throttle valves above the inlet valves. *W*, Water tank. *R*, Radiator.

of the different clutches is carried out by a set of levers which are worked by the large cam plate seen in the rear.

A NEW MAGNETIC CLUTCH.

Among the new devices which have been brought out for transmitting the movement of the motor to the rear is the magnetic friction clutch which the Pipe Company are now employing in their new cars. A portion of the chassis will be observed in the engraving. The operation of the clutch is illustrated in the diagram, which shows the motor shaft, *M*, carrying upon it an iron disk, *A*. The latter can be magnetized by coils 1, 2, 3, 4, which are sunk below the surface. At *D* is the rear transmission shaft. It carries the disk, *B*, which is keyed to it and can slide back and forth.

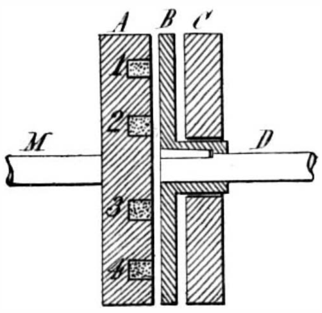


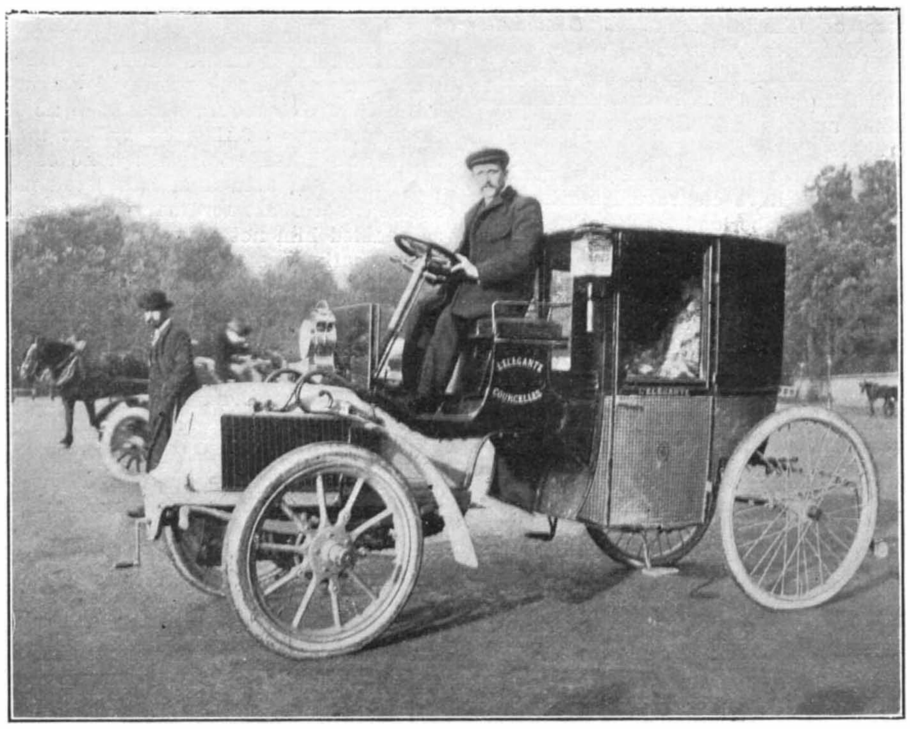
DIAGRAM OF MAGNETIC CLUTCH.

C is a heavier disk which turns loose upon *B*. The middle disk is made lighter than the others. When the motor is to be coupled to the car, current is sent through the magnets of disk, *A*, causing it to attract *B* and *C*. The latter is attracted more strongly than *B*, and thus serves to clamp *B* and *A* together.

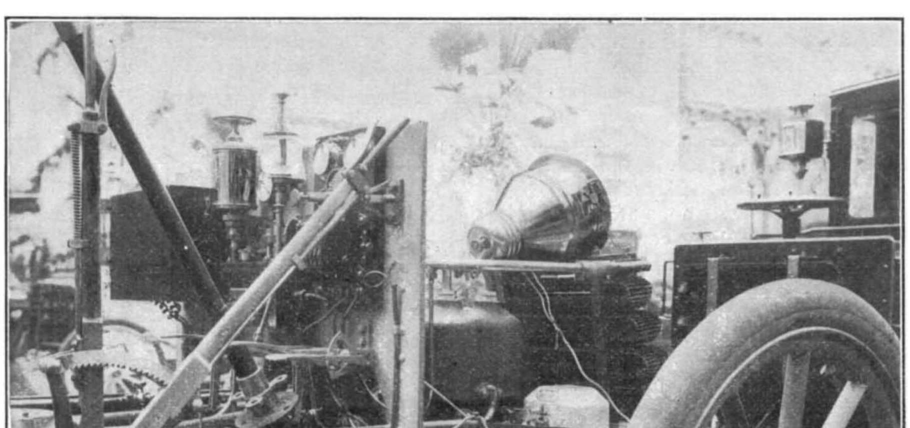
The action is as follows: When the car is running on the road and the motor is to be thrown out of gear, the current is cut off by a lever. This causes the surfaces to be separated. As the middle disk has but little inertia, this part will come to a stop quickly, allowing the heavy disk, *C*, to revolve loosely. The rear gears connected with *D* can therefore be interlocked by the shifting mechanism very easily, owing to the slow speed they now have. To carry out the operation of the magnetic clutch gradually and without shocks, the current is thrown on by degrees. A pedal on the foot-board is made to revolve a small cylinder, which is placed above it upon a contact board shown in the engraving. The cylinder has six contact brushes, and, as it turns, it cuts out the resistance interposed in the circuit. The current is supplied from a small magneto-dynamo of special form, seen alongside of the motor. The dynamo (which also gives ignition current) can be made to work in parallel with a storage battery of a few cells and thus give current for the headlight. The magnetic clutch, owing to its progressive action, is superior to the ordinary form in many ways. It can be given a certain play or slip, by operating the pedal, and this is of value in many cases, such as in starting and stopping the car, and also in hard places on the road.

THE COLIN GASOLINE FORE-CARRIAGE.

The cab shown in one of our illustrations is fitted with a new fore-carriage recently invented by M. Colin, the novel feature of which is that it drives by its pair of wheels, which also turn on steering knuckles in the usual manner, instead of the whole machine being moved, as has been done with previous fore-carriages. An 8-horsepower de Dion motor furnishes the power. It is mounted on the frame of the fore-carriage, with its shaft running longitudinally of the vehicle; and it drives the three-speed sliding-gear transmission placed back of it, through an ordinary cone clutch. A universally-jointed shaft alongside of the transmission takes the power from the latter through bevel gears and re-transmits it through another set of bevel gears to the inner live axle, which drives the wheels direct. The tractor can be readily attached to or detached from an ordinary horse-drawn cab and is said to offer great advantages in the way of quiet, vibrationless running and freedom from side slip, even when the car is running fast on slippery asphalt and has its wheels suddenly blocked.



THE COLIN FORE-CARRIAGE APPLIED TO A COUPÉ.

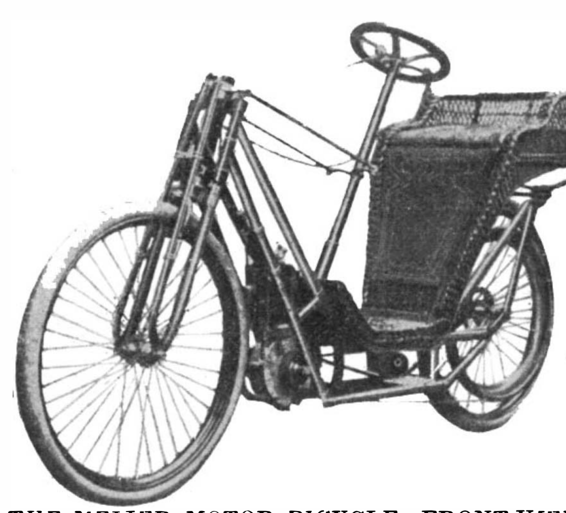


PIPE CAR WITH MAGNETIC CLUTCH

The dynamo that generates current for the clutch is seen beside the motor, and an electric headlight is placed on top of the radiating coils.

A NOVEL MOTOR BICYCLE.

The accompanying illustrations show a motor bicycle of extremely novel construction, which was exhibited by M. Meijer, of Velp, near Arnheim, Holland.



THE MEIJER MOTOR BICYCLE—FRONT VIEW.

The frame is of double tubing, forming two trusses between which the motor is placed. The seat is mounted on springs above the rear wheel. The carbureter, muffler, and driving belt are placed between the two frames; the batteries and spark coil are placed under the seat; while the 1¼-gallon gasoline tank follows the line of the seat and the platform.

The transmission of power to the rear wheel is by a belt running over a jockey pulley, which is moved so as to tighten or loosen the belt, by means of a hand lever beside the seat. The motor is started by a crank. The rider then places one foot on the foot-board and gives a push with the other, at the same time throwing on the power and quickly stepping upon the machine. The latter thus starts quickly. The rider stands upon the foot-board till the machine is under way, after which he can seat himself and ride in comfort. The machine is particularly adapted for ladies' use, and, with its steering wheel, has much the appearance of an up-to-date touring car.

MOTOR BICYCLE FOR LADIES—SIDE VIEW.

CONTEMPORARY ELECTRICAL SCIENCE.*

Cold Spectrum of Radium.—Sir William and Lady Huggins have succeeded in observing and photographing the spectrum shown by radium as it glows when cold. They used a small quartz spectroscope constructed for the observation of very faint celestial objects. With an exposure of 24 hours, faint traces of two lines were seen on the plate. The final exposure employed was 72 hours. The spectrum consists of eight bright lines and at least eight faint lines, together with a faint trace of a continuous spectrum in the blue region. The two very strong characteristic rays of the spark spectrum of radium at 3814.5 and 3649.6 are not present. In fact, the spectrum is not the radium spectrum at all. On closer examination, the authors found that it was practically identical with the nitrogen spectrum, except that all the lines were slightly shifted. Without attempting an explanation, the authors point out that in radium we have a body which sets up at ordinary temperatures a radiation that has hitherto only been obtained in connection with an electric discharge. The nitrogen whose spectrum appears may be either occluded or atmospheric nitrogen. A spark spectrum of radium bromide, taken with the same apparatus, shows all the usual lines as recorded by Demarçay.—Sir William and Lady Huggins, Proc. Roy. Soc., August 15, 1903.

Production of Helium from Radium.—Some further important evidence with regard to the suspected gradual conversion of radium or radium emanation into helium is furnished by Sir William Ramsay and F. Soddy. The gas evolved from 20 milligrammes of pure radium bromide by its solution in water, and which consisted mainly of hydrogen and oxygen, was examined for helium, and after the other two gases had been removed the D_3 line of helium was found in the spark spectrum. In another experiment, practically all the helium lines were obtained. A further series of experiments dealt with the radium emanation. This was condensed in a liquid-air tube, and the liquid air was then removed by the pump. The tube showed no trace of helium, but showed a new spectrum, probably that of the emanation itself. After standing for four days, the helium spectrum appeared, and the characteristic lines were observed identical in position with those of a helium tube thrown into the field of vision at the same time. On the following day, some further lines appeared, including the three new lines present in helium obtained from radium before. A confirmatory experiment gave identical results.—Sir W. Ramsay and F. Soddy, Proc. Roy. Soc., August 15, 1903.

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

JAMES SMITHSON.*

By SAMUEL PIERPONT LANGLEY.

THE founder of the Smithsonian Institution was known in his earlier years as James Lewis Macie, his mother, Elizabeth Keate Macie, being at the time of his birth, in 1765, the widow of James Macie, a country gentleman of an old family resident at Weston, near Bath. She was of the Hungerfords of Studley, a great-grandniece of Charles, Duke of Somerset, through whom she was lineally descended from Henry the Seventh, and was cousin of that Elizabeth Percy who married Hugh Smithson (who later became Duke of Northumberland, and by act of Parliament took the name of Percy).

An unverified story represents Smithson's mother as at one time hoping to have contracted a marriage with the Duke of Northumberland, and seeking, for that purpose, a divorce from her husband, which he successfully opposed; but, in any case, the subject of our sketch, who only apparently after his mother's death applied to the crown for permission to take the name of Smithson, describes himself in his final will as "son to Hugh, first Duke of Northumberland, and Elizabeth, heiress of the Hungerfords of Studley, and niece of Charles, the proud Duke of Somerset."

We need not, then, practise a reticence which Smithson himself did not desire to observe, especially since the facts are already public. There is, indeed, the further reason that it is especially to these facts that the foundation which bears his name is due, for Smithson always seems to have regarded the circumstances of his birth as doing him a peculiar injustice, and it was apparently this sense that he had been deprived of honors properly his which made him look for other sources of fame than those which birth had denied him, and constituted the motive of the most important action of his life, the creation of the Smithsonian Institution.

By the student of human nature every man's conduct is judged in reference to its determining motives, and if we try Smithson's from the point of view of his own time, not of ours, we shall not judge too hardly the fact that the circumstances of his birth and his feeling that he was by right a Northumberland and a Percy were a subject of pride to him as well as of pain. He once wrote:[1]

"The best blood of England flows in my veins; on my father's side I am a Northumberland, on my mother's I am related to kings,[2] but this avails me not. *My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten.*"

It has been wondered that Smithson should have left his fortune for the purpose he did, but not by those who have considered the sentence placed here in italics, where we surely scarcely need to read between the lines to see the genesis of the institution which perpetuates the name he bore, in place of the titled one he was denied.

It will be observed from facts given later that it was only under circumstances which showed that he had no right to the name of Macie (which seems to have been first imposed upon him under circumstances which left him free to change it) that he in later life had that of Smithson, to which he had every moral right, legally confirmed to him. After pointing out that the change was obtained under circumstances which do him no discredit, we are chiefly concerned with this sense of the injustice under which he labored from its after results; for if the kind of pride which dictated the first sentence I have above quoted be one which, from the point of view of the present day, attracts little sympathy, we can feel more with the worthier spirit which resulted from it, and in which he wrote the second. We are in no way concerned with the ancestral honors or titles of the Percys, as such; but if there be anything in heredity, we may supplement our limited knowledge of him by some consideration of that very remarkable man, the first Duke of Northumberland, whose child Smithson declared himself to be, and undoubtedly was; for the father was remarkable, not in having been born great, but in having achieved greatness—at least a greatness of that sort which his less fortunate son must always have envied him.

Hugh Smithson, the father of the founder of the Smithsonian Institution, was the son of Langdale Smithson, who, according to another unverified tradition, occupied for a time the then relatively unconsidered position of a medical practitioner. The Smithsons, however, were an old family, which was, in fact, remotely connected by lineage with the Percys. As country gentlemen they were reared in the habit of personally managing their estates; and, notwithstanding his culture and his refined and artistic tastes, the business aptitude of his race was strong in Smithson's father.

The entertaining story of his courtship of the granddaughter of "the proud Duke" of Somerset is told in the "Annals of the House of Percy," and it is not necessary to repeat it here further than to remark that in it, as in everything else, he showed the tact, persistence, and ability which raised him from the position of a private gentleman to one of the first dukedoms of England at a time when such a transition was regarded as transcending all possibility, and became the subject of wonder after it had happened.

As a landlord, Sir Hugh Smithson (as he afterward became)[3] had been conspicuous for good management. After his marriage to the heiress of the Percys he restored Alnwick Castle, and lived there so expensively that Horace Walpole wrote of the new groom and bride that they would soon have no estate left; but the prophecy was falsified by the marked ability of the future Duke, who, though he continued to maintain what was even then considered magnificent state, showed such extraordinary administrative capacity as enabled him not only to keep undiminished but to very greatly increase the important possessions which became his wife's after their marriage; for at the date of Sir Hugh Smithson's marriage, in 1749, the rent rolls of Alnwick Castle amounted to £8,607, while in 1778 they had increased to £50,000, and all this while a liberal and even magnificent scale of expenditures appears to have been adopted.[4]

If he be a benefactor to mankind who makes two blades of grass grow where one grew before, then the new Lord of Northumberland did indeed entitle himself to the gratitude of those within the influence of his kindly rule.

"He found the country almost a desert," says the Bishop of Dromore, "and he clothed it with woods and improved it with agriculture."[5] For more than twenty years he is said to have planted annually over twelve hundred trees; he imported specimens of hitherto unknown timber, fruits, and flowers from various parts of the world, and expended large sums not only in the reclamation and drainage of lands, but in the improvement of the dwellings of his laborers, at a time when the physical comfort or moral well-being of the poor rarely occupied the thoughts of the lords of the soil.

He showed a like ability in his dealings with the crown, which procured him the unprecedented step from the baronetcy to the dukedom, and in every part of his life (with which we are not further concerned here) he showed himself an exceptionally able man.[6]

American history and poetry remember his son, the half-brother of Smithson, who—

"Fought for King George at Lexington,
A Major of Dragoons,"[7]

and who, it might be added, saved to the king the remnant of his forces, which, without Percy's timely succor, would have been utterly destroyed. As an indication of family traits, it may be interesting to note the memorable action of the half-brother of Smithson, and his modest description of it.

General Gage had placed him in command of the camp formed at Boston, whence he writes to his father on July 5, 1774:

"As I cannot say this is a business I very much admire, I hope it will not be my fate to be ordered up the country. Be that as it may, I am resolved cheerfully to do my duty as long as ever I continue in the service. If I do not acquire any degree of reputation in it, it will be my misfortune, but shall never be my fault."

Throughout the ensuing winter he remained in the camp around Boston, whence on April 20 he writes to inform his father of the first bloodshed which was the prelude of the War of the Revolution:

"I was ordered out yesterday morning to cover the retreat of the Grenadiers and Light Infantry who had been sent upon an expedition up the country.[8] I had with me my brigade and two pieces of cannon. We met them at a town[9] about fifteen miles off, sharply attacked and surrounded by the rebels, and having fired away all their ammunition, I had the happiness of saving them from inevitable destruction, and arriving with them at Charlestown, opposite Boston, at eight o'clock last night; not, however, without the loss of a great many, having been under an incessant fire for fifteen miles. The rebels, however, suffered much more than the king's troops. I have not myself received even the least scratch, and I beg that you will not either of you be uneasy on my account."[10]

Lord Percy was too good a soldier to fall into the error of despising his enemy. He had never shared in that contemptuous estimate which Englishmen, ignorant of the country and its population, had formed of the military capacity of the American colonists, and which led the King, under the prompting of such advisers as Lord North and Lord George Germain, to declare that all resistance would collapse on the first menacing advance of half a dozen English regiments.

"Whoever," he writes to his father, "looks upon them as merely an irregular mob will find himself much mistaken; they have men amongst them who know what they are about, having been employed as rangers against the Canadians and Indians . . . nor are their men devoid of the spirit of enthusiasm, as we experienced yesterday, for many of them concealed themselves in houses and advanced within ten yards to fire at me and the other officers, though they were morally certain of being put to death themselves in an instant."

The father died in 1786, and was buried in Westminster Abbey, where he is described as "the most high puissant and most noble prince Hugh Percy, Duke and Earl of Northumberland, Earl Percy, Baron Warkworth and Lovaine, Lord Lieutenant and Custos Rotulorum of the Counties of Middlesex and Northumberland and of all America, one of the lords of His Majesty's most Honorable and Privy Council and Knight of the most noble Order of the Garter, etc., etc., etc."; but we are here concerned with these honors only as an evidence of the character of the man who did not inherit, but who conquered them by the force of his will.

Let us, after noting the essential qualities of his race in the father and brother, return to the immediate subject of our memoir, the date of whose birth is fixed by the Pembroke College record as 1765. His mother, Elizabeth Hungerford Keate (Macie), is described in the will of Penelope Keate, grandmother of Smithson, in a bequest dated July 13, 1764, as "my daughter, Elizabeth Macie, of Bath, widow," so that at this time her husband was already dead. This fact, only recently ascertained, is important in the estimate it leads us to put on one of the principal actions of Smithson's life, his taking of his father's name instead of that of Macie, by which he was previously known.

Something of the facts of the young man's birth were generally surmised, and we shall see that he was apparently not allowed as a youth to even describe himself as Macie's son, a thing to be remembered in connection with his subsequent action in taking the name of Smithson.[11]

There has been found no record of the Macies at Weston in the years preceding his birth; there is no reference to him in the accessible archives of the Northumberland family, nor do we know more of the subsequent circumstances of his mother than that she inherited the property of the Hungerfords of Studley in 1766, on the death of her brother, Lumley Hungerford Keate—a matter of interest as indicating the probable source of a considerable portion of the Smithson bequest.

We have after this no knowledge of the founder of the institution until his name is entered in 1782 as James Lewis Macie, a Gentleman Commoner, at Pembroke College, Oxford, but entered in a way which, as the copy of the record indicates, omitted the prescribed form of stating the name of the father, which others were obliged to comply with.

He was at this time but a lad, and as we are assured only very powerful influence could have procured permission for this departure from rule, we may presume that his action, whether acceptable or not to him, was dictated by an authority to which he had in any case to yield.

In 1894 I ascertained through the kindness of Chester Waters, Esquire, that Rev. Frederick Brown had occupied himself during a large part of his life with the biographies of the Hungerford family, and learned from his surviving daughter that his manuscript was deposited in the British Museum. This manuscript (which is numbered 33,412), I, with Dr. Cyrus Adler, spent some time in examining, with the results here given. Among other facts I learned that Smithson was born in France, and was brought to England for his education, and naturalized. I further was fortunately led to consult the Oxford records, which show that he in his early years entered as a Gentleman Commoner at Pembroke College, where he matriculated in 1782, his age then being given in the registry, here appended,[12] as seventeen, so that

* Reprinted from "The Smithsonian Institution, 1846-1896. The History of its First Half Century." Edited by G. Brown Goode.

1 Rhees's "Smithson and his Bequest." "Smithsonian Miscellaneous Collections," Volume XXI.

2 Dr. Goode pointed out in his "Account of the Smithsonian Institution," written for the Atlanta Exposition, that "Smithson was of royal descent, through his maternal ancestor, the ill-fated Lady Jane Grey, great-grand-daughter of King Henry VII, grandniece of Henry VIII, and cousin of Elizabeth. His ancestor in the ninth generation, Edward Seymour, the first Duke of Somerset and Protector of England, was the brother of Queen Jane Seymour and the uncle of King Edward VI."

3 He succeeded to the title of Baronet on the death of his grandfather, Sir Hugh Smithson, which took place in 1729.

4 See "Annals of the House of Percy," by Edward Barrington de Fonblanque, London, 1887, Volume II, page 531, and Appendix XXVI.

5 See "Annals of the House of Percy," by Edward Barrington de Fonblanque, London, 1887, Volume II, page 531, and Appendix XXVI, citing Collins's [Peerage] 5th edition.

6 The Duke showed the independence of his character, as well as the soundness of his judgment as a statesman, by opposing the party in power upon the question of war with the Colonies, obtaining leave of absence for his son, Lord Percy, who was ordered to America. Of this, however, Lord Percy refused to avail himself, contending that he could not at such a juncture withdraw. He accordingly embarked for Boston in the spring of 1774, and his journal and letters during the succeeding years throw light upon many of the incidents of the struggle.

7 The fact that the heir of the house of Percy commanded the force of the British troops which saved the retreat from Concord made a strong impression upon the fathers of New England who fought on the memorable day, and is often mentioned. This association of the story of the defeat and pursuit of the British troops with the name of Percy, in the minds of the rustic victors, is alluded to by Lowell:

"Old Joe is gone, who saw hot Percy goad
His slow artillery up the Concord road. . . .
Had Joe lived long enough, that scrambling fight
Had squared more nearly with his sense of right,
And vanquished Percy, to complete the tale,
Had hammered stone for life in Concord jail."

8 The memorable expedition to Concord, which gave rise to the battle of Lexington.

9 Lexington.

10 "Annals of the House of Percy," Volume II, page 552.

11 In 1880, when Mr. Rhees's memoir was prepared, the date of Smithson's birth, obtained from an erroneous inscription on his tomb, was 1754, which would have placed it eleven years earlier than the actual event, during the married life of Mr and Mrs. Macie, and put a less favorable construction on young Macie's action in taking the name of Smithson from that it bears, under the circumstances which are now for the first time detailed.

12 Coll: Exon: 25°. Carolus Ofspring Blackall 17 Theophili de Dodbrooke Com: Danmon: } Cler: Fil:.

Coll: Wad: 26°. Robertus Harbin 17 Swayne de Newton Com: Somerset: Arm: Fil: Maii 1°.

Coll: Hert: Gulielmus Bragge 17 Joannis de Dillington Com: Somerset: Arm: Fil:

Coll: Wadh: 2do. Joannes Higgins 19 Joannis de Dicheatt Com: Somerset:——Gen: Fil:

Coll: Mert: 3°. Henricus Lloyd 18 Erasmi de Civitate Vigorniensi Gen: Fil·

this matriculation record shows him to have been born eleven years *later* than was supposed. This is material, for it will be seen from what has preceded that his memory is thus cleared of the imputation under which it at one time seemed to rest, of his having adopted the name of Smithson in circumstances where a son should have remained silent.

We have also an authentic contemporary portrait of him in the dress of an Oxford student, here reproduced [omitted in this reprint], which, it is interesting to observe, confirms the age thus given, by representing him as a mere youth.

Nothing material is remembered of his life at the college, except a tradition that he was the best chemist and mineralogist of his year, though in his journal, when but a youth of nineteen, he gives a description of a geological tour in 1784 through Oban, Staffa, and the Western Islands, in company with De St. Fond, "the celebrated French philosopher," and the Italian Count Andrioni, in which he carried on observations on the methods of mining and manufacturing processes, made with all the minuteness which the conditions of the journey permitted. The journal indicates that the tour at that time was undertaken, if not at any considerable risk, yet not without a considerable amount of privation and self-denial, such as would not be met by the modern traveler, and shows that he was far more occupied with science than with the ordinary pleasures of so youthful a tourist. We learn also that the young student was noted for diligence, application, and good scholarship, attracting attention by his proficiency in chemistry, then a novel study, while his vacations were ordinarily passed in such excursions as that just referred to, and devoted to the collection of minerals and ores, which it was his favorite occupation to analyze. At Oxford, then, at a time when the study of physical science was almost unknown in the university, he appears to have already conceived that devotion to scientific research which characterized all his future life.

He was graduated at Pembroke College, with the degree of Master of Arts, on May 26, 1786, as James Lewis Macie, and admitted as a Fellow of the Royal Society on April 26, 1787, on the following recommendation:

"James Lewis Macie, Esq., M. A., late of Pembroke College, Oxford, and now of John Street, Golden Square—a gentleman well versed in various branches of Natural Philosophy, and particularly in Chymistry and Mineralogy, being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed, do, from our personal knowledge of his merit, judge him highly worthy of that honor and likely to become a very useful and valuable Member.

RICHARD KIRWAN,
C. F. GREVILLE,
C. BLAGDEN,
H. CAVENDISH,
DAVID PITCAIRN."

Cavendish, whose name appears here, was the eminent physicist, and, as we learn elsewhere, was an intimate friend.

Smithson's lodgings were for some time in Bentinck Street, where Gibbon wrote much of his "Decline and Fall of the Roman Empire." Here he apparently prepared his first scientific paper, which was signed James Lewis Macie, and was read on July 7, 1791, before the Royal Society. It is entitled "An Account of Some Chemical Experiments on Tabasheer."[13] We learn of him incidentally in 1792 as journeying from Geneva to Italy through the Tyrol, and find him in the same year in Paris writing from the Hôtel du Parc, Rue de Colombier, a letter in which he expresses sentiments which represented what would have been then called advanced Jacobinism. "*Ca ira*," he says, "is growing the song of England, of Europe, as well as of France. Men of every rank are joining in the chorus. Stupidity and guilt have had a long reign, and it begins, indeed, to be time for justice and common-sense to have their turn . . . the office of king is not yet abolished, but they daily feel the inutility, or rather great inconvenience, of continuing it and its duration will probably not be long. May other nations, at the time of their reforms, be wise enough to cast off, at first, the contemptible incumbrance." Smithson here shares the opinion of a large and influential portion of Englishmen of the time in which he wrote, but the excesses of the French Revolution, which immediately followed, caused a general revulsion of feeling, and it would not be fair to argue from this youthful expression as to his maturer judgment.

The date of his application to the Crown for permission to take his father's name has not been ascertained, but in the will of his half-sister, Dorothy Percy, he is referred to as "Macie" in 1794 (eight years after his father's death). The name of Smithson is first certainly known to have been used by him in connection with his second communication to the Royal Society, "A Chemical Analysis of Some Calamines,"[14] by James Smithson, Esquire," read November 18, 1802.

Coll: Di. Jo. Bap. 4°. Thomas Keck 17 Samuelis de Civitate Londin:——Gen: Fil:

changed to Smithson

Coll: Pemb: 7° Jacobus Ludovicus Macie 17 de Civit: Londin:—Arm: Fil:

Coll: Ball: 8°. Hon. Archibaldus Cathcart 18 Caroli de Aloa Com: Clackmanan: Baros. Fil

Coll: Di: Jo: Bap. 9°. Thomas Dethick 17 Thomae de Bombay apud Ind: Orient: Arm: Fil

Coll: On: Nas: 10mo. Arthurus Townson 18 Joannis de Bentham Com: Eboracensi —— Pleb: Fil

Coll: Christi 10mo. Calverley Joannes Bewicke 17 Benjamin de Clapham Com: Surriae Gen: Fil:

Coll: Magd: 11°. Isaacus Williamson 21 Josephi de Withburn Com: Cambr: Gen: Fil:

[13] Philosophical Transactions of the Royal Society of London, Volume LXXXI, part II, page 368.

In this paper the author remarks that "Chemistry is yet so new a science; what we know of it bears so small a proportion of what we are ignorant of; our knowledge in every department of it is so incomplete, consisting entirely of isolated points, thinly scattered, like lurid specks on a vast field of darkness, that no researches can be undertaken without producing some facts leading to consequences which extend beyond the boundaries of their immediate object."

The Abbé Haüy had advanced the opinion that calamines were all mere oxides or "calces" of zinc. Smithson's analysis completely overthrew this opinion, and established these minerals in the rank of true carbonates, while his remarks on the action of the ores of zinc before the blowpipe evince much discernment; and the paper, on the whole, is altogether a creditable one.[15]

At this period he seems to have ceased his contributions to the Royal Society, and later we find his name more frequently in the "Annals of Philosophy," a journal of high character, where there is a communication from him dated Paris, May 22, 1819, on "Plombe gomme," and about the same time a paper on a native sulphuret of lead and arsenic, with numerous other papers, among which is one in 1822, "On the Detection of Very Minute Quantities of Arsenic and Mercury," where he contributed a method which was generally used by chemists until quite modern tests superseded it. The papers[16] in all number twenty-seven, of which eight here cited were published in the "Philosophical Transactions of the Royal Society," between the years 1791 and 1807, one in the "Philosophical Magazine" in 1807, and eighteen in "Thomson's Annals of Philosophy," between 1819 and 1825, and these all give the idea of an assiduous and faithful experimenter, an impression enlarged by the last one of the series, bearing date of June, 1824, which contains some observations on the formation of the Kirkdale Cave, forcibly combating (with what was then originality) the theories of the time, which referred the bones there found to "The Deluge."

"The most notable feature of Smithson's writings from the standpoint of the modern analytical chemist," says Prof. Clarke,[17] "is the success obtained with the most primitive and unsatisfactory appliances. In Smithson's day chemical apparatus were undeveloped, and instruments were improvised from such materials as lay readiest to hand. With such instruments, and with crude reagents, Smithson obtained analytical results of the most creditable character, and enlarged our knowledge of many mineral species. In his time the native carbonate and silicate of zinc were confounded as one species under the name 'calamine;' but his researches distinguish between the two minerals, which are now known as Smithsonite and calamine respectively.

"To theory Smithson contributed little, if anything; but from a theoretical point of view the tone of his writings is singularly modern. His work was mostly done before Dalton had announced the atomic theory, and yet Smithson saw clearly that a law of definite proportions must exist, although he did not attempt to account for it. His ability as a reasoner is best shown in his paper upon the Kirkdale bone cave, which Penn had sought to interpret by reference to the Noachian deluge. A clearer and more complete demolition of Penn's views could hardly be written to-day. Smithson was gentle with his adversary, but none the less thorough for all his moderation. He is not to be classed among the leaders of scientific thought; but his ability, and the usefulness of his contributions to knowledge, cannot be doubted."

(To be continued.)

[14] Philosophical Transactions, Volume XCIII, page 12.

[15] Smithson's subsequent communications to the Philosophical Transactions are six in number:

"An Account of a Discovery of Native Minium," submitted in a letter dated from Cassel, in Hesse, March 2, 1806. (Volume XCVI, part 1, page 267.)

"On the Composition of the Compound Sulphuret from Huel Boys, and an Account of its Crystals," 1808. (Volume XCVIII, page 55.)

"On the Composition of Zeolite," 1811. (Volume CI, page 171.)

"On a Substance from the Elm Tree, called Ulmin," 1813. (Volume CIII, page 64.)

"On a Saline Substance from Mount Vesuvius," 1813. (Volume CIII, page 256.)

"A few Facts relative to the Coloring Matter of Some Vegetables," 1817. (Volume CVIII, page 110.)

A paper by him "On Quadruple and Binary Compounds, particularly Sulphurets," was also published in the "Philosophical Magazine," 1807. (Volume XXIX, page 275.)

[16] These papers were collected and edited by William J. Rhees, and are contained in Volume XXI of the "Smithsonian Miscellaneous Collections," under the title of "The Scientific Writings of James Smithson" (1879).

[17] Communication from Prof. Frank W. Clarke, Chief Chemist, United States Geological Survey.

MELTING SLEET ON A THIRD RAIL.

By W. A. DEL MAR.

FROM time to time electric heating as a method for removing sleet from the contact rail has been suggested. The idea seems an excellent one at first thought and engineers have been tempted to make experiments with the view to finding the quantity of electrical energy required for the purpose. These experiments have always shown that the energy required to heat the rail is exceedingly large, and principally on this account the method has never been adopted. The object of this article is to show why this large amount of energy is required.

It is a difficult matter to show just what expenditure of energy would be necessary to raise the temperature of the rail a certain number of degrees, but it is easy to show that a large amount can be expended without appreciably affecting the temperature.

When one pound of water has its temperature raised one degree Fahrenheit above the air, it absorbs about one thermal unit, equivalent to 0.2835 watt-hour. The specific heat of iron being only about 0.114 that of water, one pound of rail will absorb but 0.323 watt-hour when its temperature is raised one degree. Now, it can be assumed that in order to melt ice from a contact rail, the temperature must, under fairly normal conditions, be raised at least ten degrees Fahrenheit. A system for heating the rail which would fail a few degrees below freezing point would scarcely be worth installing, so that this assumption of ten degrees rise is quite a moderate one. From the figures given above it appears that in order to heat one pound of rail ten degrees Fahrenheit in one hour, 0.323 watt-hour would have to be used, regardless of the losses by radiation, convection, etc. On a 100-pound rail this amounts to 10.75 watts per foot on the assumption that no heat is lost in any way whatsoever; but in actual cases the losses are very great.

The heat radiated from a square foot of rusty iron is found by experiment to be about 0.7 B. T. U. per hour per degree Fahrenheit difference of temperature between the iron and air—provided that such difference does not exceed 30 deg. This is equivalent to 0.198 watt per square foot per degree. Now, on one foot of 100-pound rail there are 2.08 square feet of surface. Hence, the radiation per foot of rail will amount to 0.412 watt per degree. This does not allow for losses by convection, evaporation, etc. Assume that in heating the rail ten degrees the average difference between the air and rail is five degrees. The radiation will then be at the rate of about 2.1 watts. If this quantity be added to the heat used in raising the temperature of the iron, a total of nearly 13 watts is obtained as the power necessary to heat one foot of 100-pound rail ten degrees in one hour. On a railway having fifty miles of 100-pound contact rail, this would amount to 3,432 kilowatts, assuming a dry rail, no ice to melt, and no loss by evaporation and convection. This quantity has to be greatly increased in order to supply energy for melting the ice.

One pound of ice at 32 deg. F. requires the expenditure of 142.65 B. T. U. to melt it without raising its temperature. This is equivalent to 40.44 watt-hours. Hence, in order to melt one pound of ice in one hour, 40.44 watts are required. A deposit of sleet or snow one-eighth of an inch thick covering two-fifths of the surface of a 100-pound rail, weighs about half a pound per foot. Hence on 50 miles of contact rail there would be 132,000 pounds, which if to be melted in one hour would require a provision for that period of 5,280 kilowatts. This is assuming a heating efficiency of 100 per cent; that is, neglecting losses by convection, radiation, etc.

In case of a sleet deposit, it would of course not be necessary to melt a film one-eighth inch thick, for if a film, say 1-100 inch thick were melted, the remainder would be so loosened as to be easily removed with a brush or scraper. A film 1-100 of an inch thick on 2-5 of the rail surface would weigh 10,560 pounds on 50 miles of 100-pound rail. Assuming a heat efficiency of 100 per cent, this would require to melt it in one hour, a provision of about 427 kilowatts. This would merely supply the latent heat in melting. If the rail were kept 10 deg. F. hotter than the air, the radiation in one hour would require at least 550 kilowatts, assuming a perfectly dry rail. In order to heat the rail 10 deg. F. in one hour about 2,830 kilowatts are required, assuming no losses. Thus the minimum power required to melt 1-100 of an inch of sleet from 50 miles of 100-pound rail, amounts to at least 3,800 kilowatts. This neglects two of the greatest sources of heat loss, namely, by evaporation and by wind convection. It is possible that there might be conditions under which it is not necessary to heat the rail 10 deg. F., but a sleet-melting system would not be worth installing if it could fail at such a moderate temperature as 10 deg. below the freezing point, besides which in practice the ice would have to be melted in much less than one hour.

Experiments with contact rails have shown that if the rail is kept moist with water 10 deg. hotter than the air, the temperature of the rail will not rise even if 16 watts per square foot are expended on it. With 100-pound rail this is 32 watts per foot length. This power on fifty miles of rail amounts to about 8,500 kilowatts. Thus practice shows that an expenditure of 8,500 kilowatts on 50 miles of 100-pound rail has no effect in heating the rail, regardless of the important matter of melting ice.

It might be suggested that it is useless to heat so much rail at a time; that in fact it might be better to heat one section at a time and then go on to another. This is impossible, however, owing to the low heat storing quality of iron. As shown above, the heat capacity of a foot of 100-pound rail is only 10.75 watt-hours, a quantity that would be dissipated in a few minutes. Not only is the cost of energy for electrically heating the third rail enormous, but the cost of apparatus for generating, transforming and distributing this energy is quite absurd, considering the doubtful value of the system under the best conditions.

Contrast the electrical method with the use of hot water. One pound of ice at the melting point can be

melted by using 142.65 B. T. U. A deposit of ice ⅛ inch thick on 2-5 of the surface of 50 miles of 100-pound contact rail weighs 132,000 pounds. To melt this 18,829,800 B. T. U. are required. If water at 180 deg. F. be used, 104,590 pounds will be required. This is about 1,700 cubic feet at a heating efficiency of 100 per cent. Assuming the heating efficiency to be only 10 per cent, the number of cubic feet required will be 17,000. If the ice be below the freezing point, a few cubic feet must be added to this. Suppose it to amount to 20,000 cubic feet, which can be contained in a few tank cars of moderate size. Of course, in order to prevent this water freezing on the rail, it must contain salt or some other substance that lowers the freezing point of water. There are serious objections to the hot water method, but these may yet be overcome, and then the sleet scare will be relegated to the past with the scores of other bugbears that have worried engineers and set inventors to work on ideas barren and futile.—Electrical World and Engineer.

THE PANORAMIC TELESCOPE.*

I. INTERNAL ARRANGEMENT OF THE PANORAMA TELESCOPE.

THE panorama telescope, made by C. P. Goerz, of Berlin and New York, owes its name to the characteristic of giving the full or complete view of the field of 360 deg. without compelling the observer to move either himself or the eyepiece of the instrument from its original, and if desired permanently fixed, position.

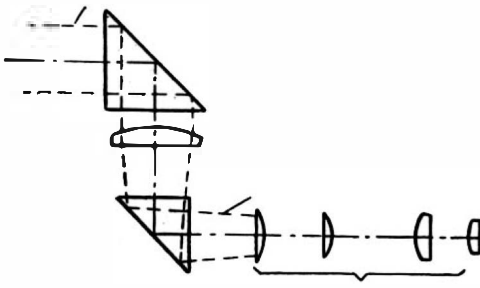


Fig. 1.—Simple Terrestrial Eyepiece, Looking Forward.

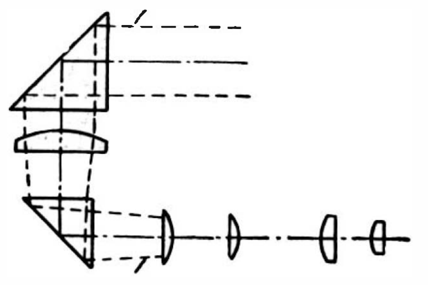


Fig. 2.—Simple Terrestrial Eyepiece, Looking Backward.

While in an ordinary telescope turning about a vertical axis or pivot the field lying about the observer can be swept only by a corresponding movement of the instrument, the ocular end included, thus compelling the observer to follow it around, in other words, to change his position about the standard throughout the complete circle; in the case of the instrument which we now present the ocular end and, as a consequence, also the observer, remains fixed. To make the use of such an instrument practical in every particular the image obtained, aside from the magnification, must of necessity present itself in all respects as if it were seen by the unaided eye.

If to obtain the panoramic effect in an ordinary terrestrial or celestial telescope we should make use of the construction indicated in Figs. 1 and 2, which shows a combination of reflecting prisms, of which the one placed before the objective is adapted to revolve on a vertical axis, the image upon the retina would

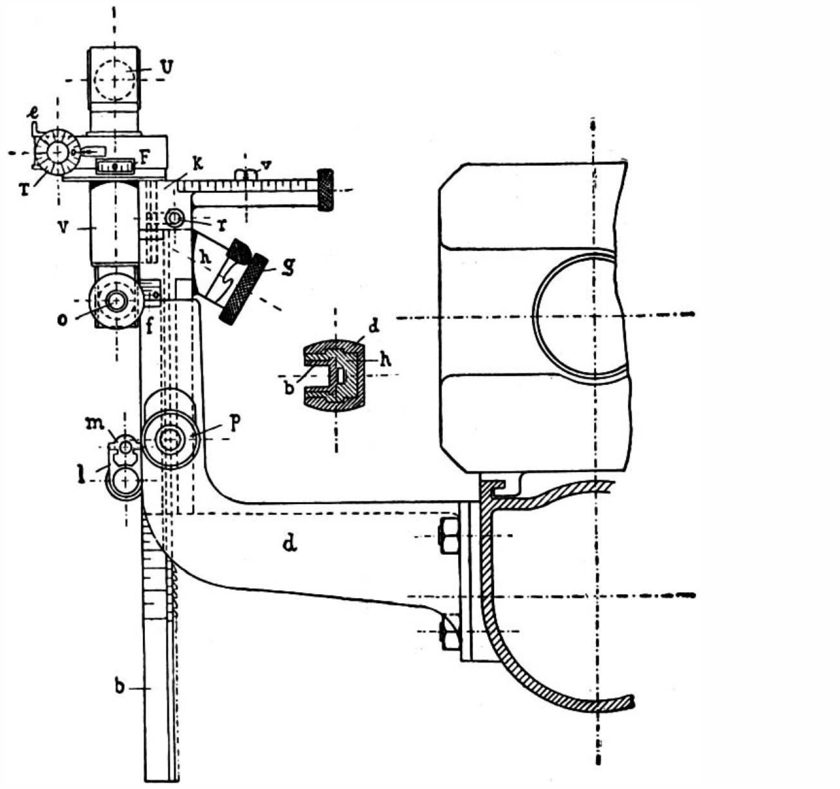


Fig. 5.—Front View of Telescope and Quadrant Attached to Arm of Gun.

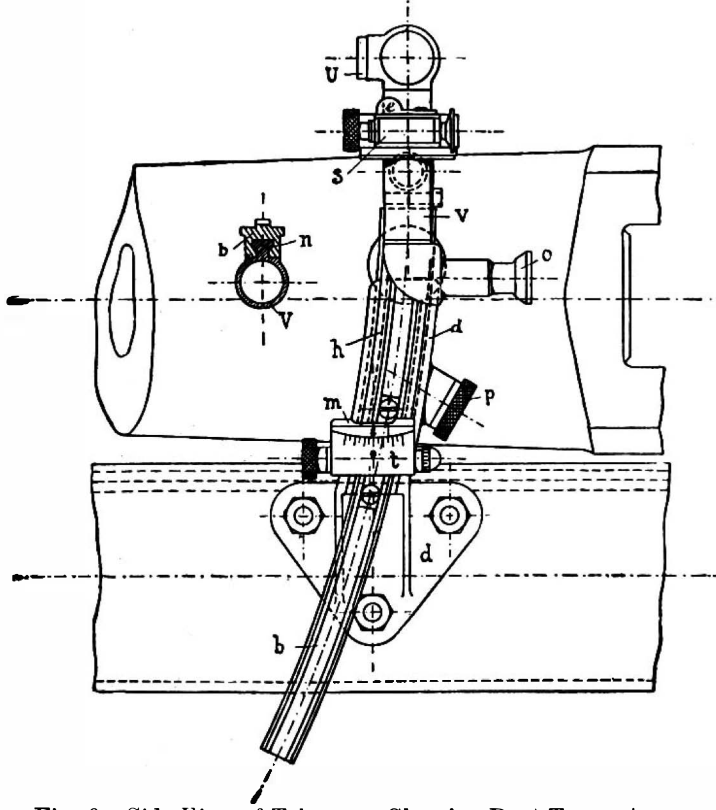


Fig. 6.—Side View of Telescope, Showing Bent Tangent Rod.

suffer a torsion equivalent to the angle of inclination, or that made by the respective radius of the circle upon the axis of the instrument. To explain more clearly: what appears at the top of the image viewed as in Fig. 1, after the turning of the prism through an arc of 180 deg. will be seen at the bottom in Fig. 2; in other words, it will have suffered a complete inversion of 180 deg.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

For the interior optical construction then of such a panorama telescope, a combination of prisms must be selected which shall—

1. *Give an erect image;* which means that instead of the long unwieldy terrestrial eyepiece the simple eyepiece of a celestial telescope must be used.

2. *Maintain the image, even when sweeping the field about the observer, in its proper position,* i. e., that it shall always appear to the observer as if seen by the naked eye.

From a number of combinations fulfilling these requirements we shall select, and give below, those which prove themselves the most suitable to the development of a panoramic telescope, for the purpose for which it is chiefly intended, viz., the aiming of field guns.

In Fig. 3 we present such a combination, which consists of the following optical elements: A prism of total reflection, *A*, an image-erecting prism *B*, the objective *C*, a gable reflecting prism *D*, and the astronomical eyepiece *O*. It is easy to follow the course of the rays which, from the object, fall upon the prism *A*, are reflected upon the prism *B*, which *effects the erection in one direction.* Having passed through the objective *C* a lateral torsion is effected by the prism *D*, an image of the object is formed in its true position upon the ocular screen *E*, where it is magnified by the astronomical eyepiece *O*. The peculiarity of the prism *B*, with its quadrilateral cross section, consists in that while it turns through an arc of 180 deg. upon its major axis, the image is made to revolve through 360 deg., that is, the image turns just twice as fast as the prism.

To retain the image in its normal position then, it becomes necessary to cause the prism *B* to follow the prism *A* with only half the angular speed of the latter. For this purpose, the prism *A* is mounted in the barrel *V*, which is provided with a circular rack on its lower end and fixedly attached to the snail drum *H*. This is in turn revolvably supported upon the box *K*, which is screwed to the casing *V* on the inside and attached in the same manner on the outside to the cap *G*. In the casing *V* is likewise revolvably mounted the tube *L* provided with a circular rack at its upper extremity. This tube *L* carries at its upper end the mounting for the prism *B* and at its lower extremity the socket for the objective *C*. Both the upper and lower circular racks are engaged by a double pinion *M* and the gearing is calculated to give the tube *B* just half the angular speed maintained by the prism *A*.

By referring to Fig. 6 the screw *S* is fixed to the cap *K*, which through the medium of a pinion engages the teeth of the worm drum *H*. By turning this screw the reflecting prism *A*, together with the prism *B*, may be made to describe a complete revolution about the central position, or position of the observer, bringing every point of the circular field into view, thus providing the panorama effect.

Where it may be necessary to reconnoiter from behind a shield in the field or coast defenses or upon vessels of war, the instrument enables the observer to maintain an unchanged position and to present so small a target that the probability of being hit by the enemy's projectiles would be very remote.

As a sighting telescope for field guns or larger ordnance, for direct as well as for indirect range finding, the panorama telescope is peculiarly adapted, as will be fully set forth in the following section; and as such it forms a complement to the hydraulic recoil cylinder with shield. Of course the general construction of the instrument, such as the arrangement of its parts, its size, the optical and mechanical combination, depends much upon the nature of the functions it will be required to perform. While for a stable or fixed point of observation, a relatively large field, high magnifying

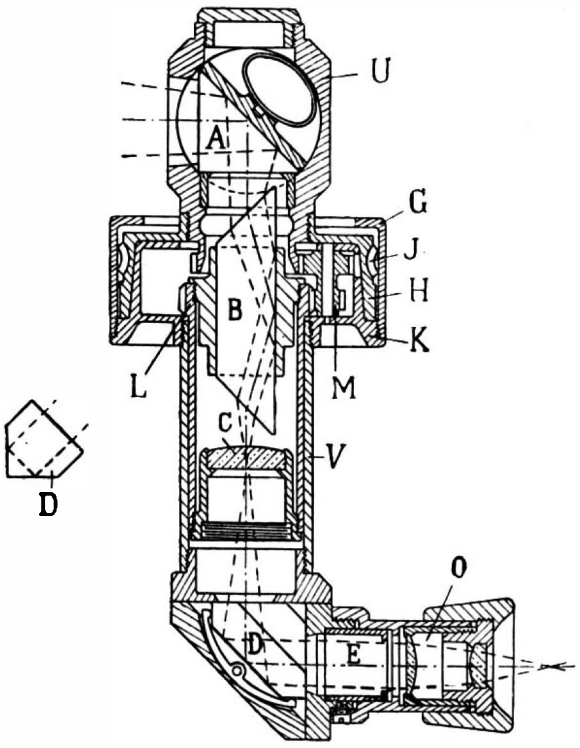


Fig. 3.—Panorama Telescope, Showing Arrangement of Simple and Compound Prisms. Fig. 4.—Exemplifies the Lateral Torsion of D.

power, precision in reading off the position of the optical axis, play the chief rôles, and shape, size and weight become of minor importance; the reverse is true where a sighting glass is needed for a field piece; for here the instrument must be compact in form, light in weight, and above all provided with substantial and strong securing devices for both lenses and prisms.

II. THE APPLICATION OF THE PANORAMA TELESCOPE TO ARTILLERY.

The application of telescopes as sighting instruments for large and small guns is not new, but up to within a few years it has consisted mostly of attaching a small spyglass with cross hairs over the objective to marine, coast-defense, or fortress guns, and this almost exclusively for direct sighting. With the increase in the effective range of the field gun it became necessary to employ a sighting glass that should permit the man behind the gun to recognize marks farther away and scarcely discernible to the naked eye, to follow up the effect of each shot, and thus to make the most perfect use of the greater precision attained.

So long as it was impossible to do away with the recoil and shock transmitted to the carriage after each shot, all attempts at a practical solution of the sighting problem were of little avail. In spite of the most approved and substantial construction in the mounting

of the lenses and prisms, there occurred as a consequence of the violent shock after each discharge such an alteration in the telescope attached to the gun that exact sighting was greatly impaired. The removal of the glass before each discharge and the subsequent replacing of it, where much care was needed to provide for an exact replacement in its former position, reduced the rapidity of fire. When the spade and

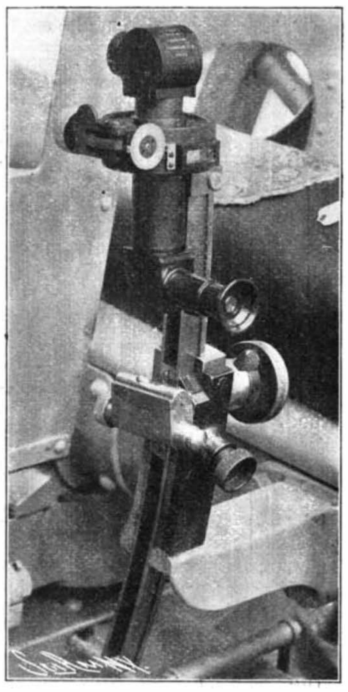


Fig. 7.—Apparatus Attached to a Field Gun.

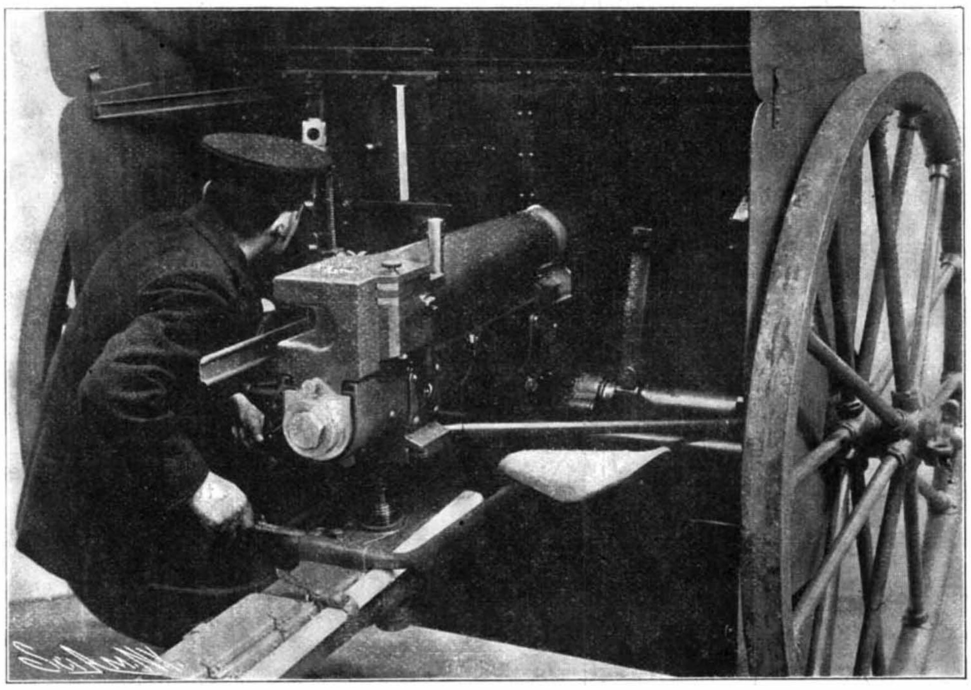


Fig. 8.—Manipulation of a Field Gun. Observer now Looking at an Auxiliary Target Behind and to the Right of Him Protected by a Shield.

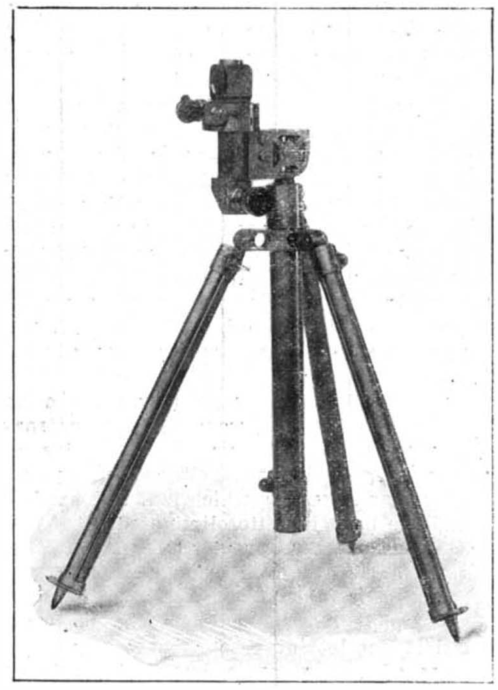


Fig. 12a.—Tripod Rest for Panorama Telescope, Showing Adjustment for Height.

spring-pressed spike gave place to the recoil cylinder, and shocks to the carriage and permanent displacement of the gun were obviated, it became possible to furnish the fieldpiece with an optical sighting arrangement in which all the faults might be eliminated. At the same time, by a corresponding improvement in the sighting appliances, a greater effort was made than heretofore to facilitate the indirect aiming of the gun as well as to increase the precision of the indirectly aimed shot.

To this end the sighting instrument, as a whole, was arranged to turn upon a vertical axis and combined with adjusting devices which would permit of the aiming at an object within the field and at the same time provide means of reading off the position of the optical axis with reference to the axis of the bore. As a matter of fact, the requirements are not wholly met either by the arrangement first applied to the new French field pieces nor those which have been attached to the latest telescopes; for the directions in which

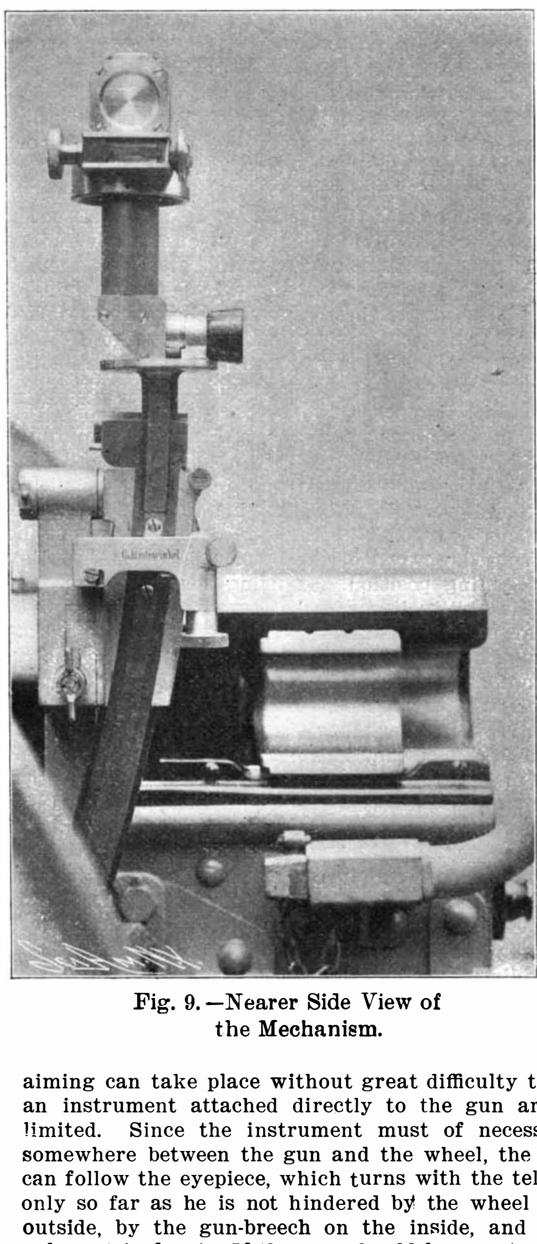


Fig. 9.—Nearer Side View of the Mechanism.

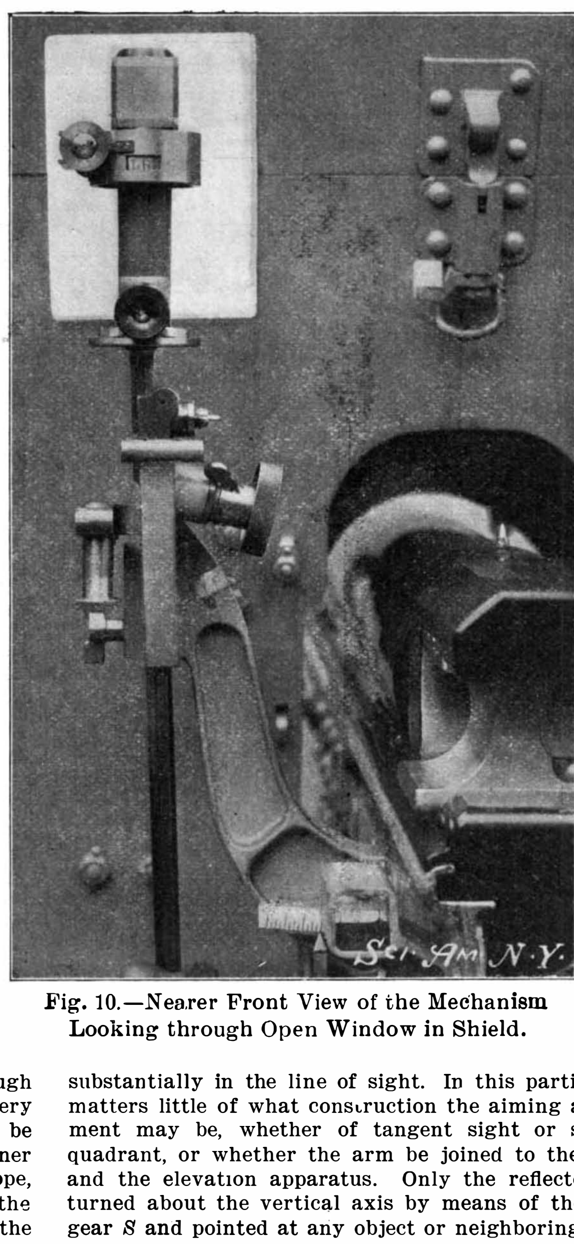


Fig. 10.—Nearer Front View of the Mechanism Looking through Open Window in Shield.

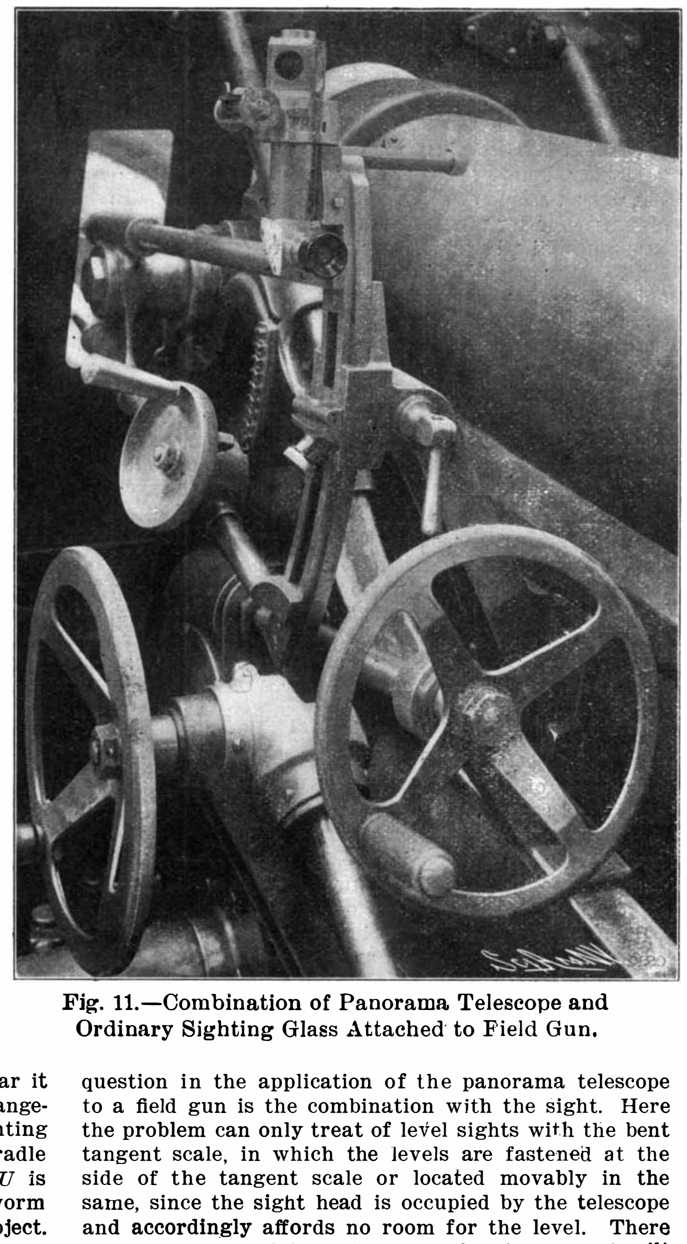


Fig. 11.—Combination of Panorama Telescope and Ordinary Sighting Glass Attached to Field Gun.

aiming can take place without great difficulty through an instrument attached directly to the gun are very limited. Since the instrument must of necessity be somewhere between the gun and the wheel, the gunner can follow the eyepiece, which turns with the telescope, only so far as he is not hindered by the wheel on the outside, by the gun-breech on the inside, and by the axle seat in front. If the gun should happen to be provided with a protective shield, which will be the case without exception in the future, there would be no possibility of sighting toward the rear.

As soon as the telescope has moved from its 0 point parallel with the axis of the gun to the one side or the other the gunner must leave his accustomed place at the gun breech to look over the field. When this occurs he will not only abandon his protection but also be so far removed from the training cranks that he cannot attend to them with his own hands. While the gunner is looking through the glass another man must work the gun in accordance with the observer's instructions, which from the very start precludes rapid work.

If the advantages which the modern recoil gun, in its present and future shape, presents are to be enjoyed to their fullest extent, the gun must be provided with a sighting apparatus which shall satisfy the following requirements:

The tube of the telescope must be so designed that the gunner can aim at any desired point within the circular field before him without leaving his place at the gun.

As will be seen from the opening description these requirements are met in an ideal manner by the panorama telescope. While the ordinary sighting glass, as already mentioned, turns as a whole about a vertical axis, in the case of the panorama telescope (Figs. 5 and 6) the tube *V*, and with it the eyepiece *O*, remain substantially in the line of sight. In this particular it matters little of what construction the aiming arrangement may be, whether of tangent sight or sighting quadrant, or whether the arm be joined to the cradle and the elevation apparatus. Only the reflector *U* is turned about the vertical axis by means of the worm gear *S* and pointed at any object or neighboring object. To attain a more rapid motion, with the hand for instance, this worm gear may be thrown out by the small eccentric lever *e*; a small spring secures the toothing. The reading or placing of the telescopic axis is done through the little window or glass-covered opening *F*, where may be seen a scale upon the circumference of the worm drum *H* (Fig. 3), in connection with the drum scale *T* on the worm gear. The first is graduated into 64 parts upon its periphery and the latter into 100. One whole turn of the worm gear corresponds to one division in the first scale so that one division of the worm gear drum means 1-6400 of the whole circle, or about 1-1000 of the radius of the worm drum. The zero point corresponds to that position of the optical axis of the telescope which agrees with or is parallel to the long axis of the gun.

The bringing into position of the telescope provided with cross hairs for lateral sighting as well as for making lateral corrections is therefore effected by turning the worm gear *S* in the same manner as is done in ordinary sights by the movement of the sighting slide with notches. The vertical distance between the eyepiece and the reflector is so calculated that the observer may look right back over his own head. With a four-fold magnifying power, and a true field of vision of 10 deg., the telescope is rendered more attractive in appearance and compact in form and the brightness and definition of the image are increased—all that is essential in a glass for field or siege guns. The first question in the application of the panorama telescope to a field gun is the combination with the sight. Here the problem can only treat of level sights with the bent tangent scale, in which the levels are fastened at the side of the tangent scale or located movably in the same, since the sight head is occupied by the telescope and accordingly affords no room for the level. There are many ways of fastening it to the sight but it will

depend whether the ordinary aiming glass is to be applied at the same time as the panorama telescope. For the sake of possible replacement and the opportunity to apply either it is necessary to choose a simple mode of application. In Figs. 5 to 10 are shown combinations of the panoráma telescope with the sights as they are arranged at present in the newest guns turned out by Krupp. In Figs. 5 and 6 the arm is as usual supplied with a driving screw at its head and a sighting disk on one side of the bar. The outside is provided with a slot into which a dovetailed slide *N*, fixed to casing of the telescope, is entered from the top and held in position by a spring bolt. By pressing the bolthead it is possible to remove the telescope. In the views shown in Figs. 6 and 7 picturing a gun provided with the panorama telescope, the telescope is placed upon the tangent scale in place of the sighting head. Both the telescope and the sighting head are mounted in the above-mentioned manner and may be used upon occasion. The first arrangement affords the application of both means of sighting conjointly, that is, it makes possible the transition from one mode of laying or aiming to the other quickly and without further manipulation. The second arrangement demands a small aiming chart within the protecting shield. Either combination provides in this manner for the application of both the aiming telescope and the ordinary aiming appliance—bead and slot; while in Figs. 9 and 10 the arrangement presents only the application of the panorama telescope, which is firmly fixed upon the arm, and the bead is quite eliminated.

Means are thus provided for laying the aiming line very high, so that if the upper part of the shield be removed or folded down the terrain can be viewed in a complete circle about the gun position. The scale rod is not let into the Aufsatz arm, which is fixedly attached to the cradle, but in a special casing which is revolvably joined to the arm and thereby makes by means of a swinging gear the compensation possible for the oblique standing of the wheel.

From the above descriptions the use of the head provided with the panorama telescope may be easily seen.

If it be a question of direct aiming then the sight will first be set to suit the ordered distance and the sidewise movement effected by the turning of the worm gear *S*, Fig. 6. As in ordinary aiming through the slot and over the bead, the cross wires and therewith the gun itself, will be brought to bear upon the object by means of the elevating and sidewise-moving appliances. To gain an approximate aim the ordinary sighting may be advantageously used. Corrections for elevation are accomplished by raising the breech slide and lateral corrections may be effected by turning the reflector gear *S*, Fig. 6. It is in indirect aiming that the panorama telescope takes the place of the aim. After the line of vision in the telescope has been brought to correspond with the long axis of the gun in the given direction by turning the reflector, the giving of the side direction upon the auxiliary object will be accomplished in the same manner as by the direct aiming process. In Fig. 8 we show a gunner operating a gun with a shield, and he is upon the point of aiming the gun upon an auxiliary target placed behind and to the right of him wherein he can manipulate the various hand wheels from his seat as if he were aiming direct at the object. The elevation is obtained in this case by means of the levels.

While direct aiming comes frequently in use with field guns, be it by means of slide and bead or with the telescope, with mortars and heavy siege guns indirect aiming is oftener the rule. In consequence of the erection of the heavy ordnance in well-prepared places, in batteries or behind natural cover, where they are not only masked from the enemy's view but where the gunners are also unable to see the enemy from the gun, the ability to adjust the gun by means of points in the rear plays an important part. Just this sort of range finding is greatly simplified by the use of the panorama telescope, it being quite indifferent whether the aiming be done at previously placed range stakes or at auxiliary targets situated in the rear.

The arrangement of the sighting telescope in general will not be the same as one corresponding with the kind used upon these guns which, especially on guns of the latest models, provided with the tubular recoil, differs essentially from those customarily placed upon field guns. In Fig. 11 a combination of the panorama telescope with a sighting quadrant is shown as it is generally employed to-day on mortars and position guns. The sighting quadrant is revolvably attached to the prolongation of the left pivot of the cradle or the cradle support. As in a field gun, there is also provided here, besides the telescope, a sighting apparatus consisting of the slot and bead, and the head of the graduated scale is consequently arranged exactly as in the ordinary sight. The aiming glass, when in use, is placed upon the outer side of the head, and by means of a spring bolt firmly maintained in the dovetailed slot.

Attached to the sighting quadrant is a worm gear which meshes into a toothed segment screwed upon the carriage and it is by means of this gearing that the quadrânt can be made to turn upon the bearing of the gun independently of its momentary elevation, and thus direct the line of sight upon the desired target. In this mânner, too, the graduated arc is moved to correspond with the field angle and there remains only the giving to the gun of the necessary elevation corresponding to the range, which is easily accomplished by manipulating the hand wheels. The reading of the quadrant can now be taken by means of a pointer which is attached to the gun itself or its cradle and passed over the face of the scale. If the target be invisible then the field angle can be gotten rid of by means of a movable level placed on the graduated scale, the bubble being brought to rest by turning the whole sighting quadrant, whereby the field angle will be totally eliminated.

Direct aiming can be accomplished either over the slot and bead or through the sighting glass; indirect aiming, however, is always done through the telescope, to accomplish which the gun pointer takes his place upon the step where he is in a position to conveniently reach and handily manipulate all the wheels provided for the training mechanism. As an auxiliary target by day it would be the most practical to select an object lying at a convenient distance in the field and one which is visible from all the guns.

For night firing it would be better to erect a target behind each gun or a battery of guns upon a position which had been proven correct by the firing during the day, and to which all the guns could be adjusted. The corresponding individual adjustments must of course be noted. At night a lighted lantern could be hung in the center of the day bull's eye. With a small side light from a dark lantern the cross-hairs of the telescope could be made visible and they could then be brought to bear upon the light hung upon the target. The application of the panorama telescope thus offers an advantage in combination with these guns which is, that the method of pointing the gun, either for direct or indirect aiming, even by night, is always the same and is independent of other requisites, notably, the existence of a platform with hypothetical arrangement of the gun position. This last circumstance is especially favorable to the newest position guns with tubular recoil, which may be fired without an expensively erected platform. In the guns of earlier construction and still in use, even in those in which the sighting appliance is attached to the barrel or tube of the gun itself, the panorama telescope can be advantageously used either alone or in combination; or alterations be made which, as in the case of the protractor, will afford a rapid removal of the telescope before the firing of the shot and an equally expeditious replacing of the same. It goes without saying that, to be effective, great care must be exercised to replace it each time most exactly.

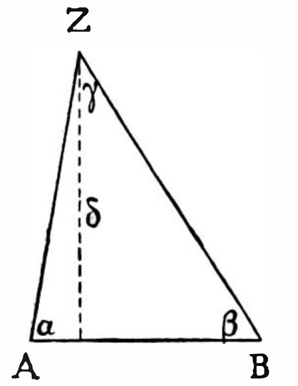


Fig. 12.—Triangle to Obtain the Range of Z from Points A and B.

III. THE PANORAMA TELESCOPE AS A BATTERY TELESCOPE.

The fundamental conditions for a successful bombardment are the rapid and reliable finding of the range as well as determining the elements of aiming, i. e., giving the lateral measurements and elevation.

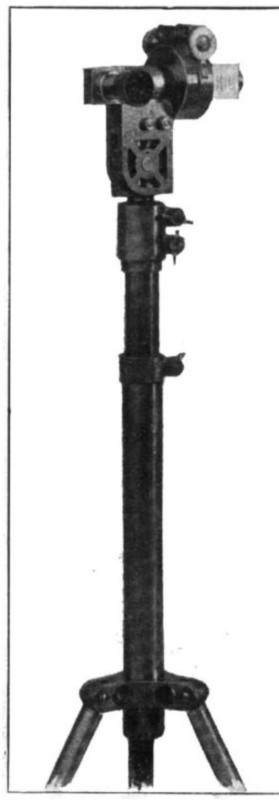


Fig. 13.—Tripod Rest Elevated with Panorama Telescope in a Horizontal Position.

In direct aiming the only thing necessary is the elevation corresponding to the distance, but with indirect pointing there are other requisites, such as the determination of the field angle, as also the angle which the line of sight makes with the axis of the gun about which the reflector of the sighting glass must turn, in order that the tube of the gun may look in the proper direction while the glass itself is pointed at the auxiliary target. According to the position taken up by the battery relative to its immediate surroundings as well as the means at his disposal furnished by the battery outfit, the battery chief will select for the determination of this angle the method which will permit him to bring his guns at the earliest possible moment into action. From what has gone before it will not be difficult to see that also for this purpose the panorama telescope constitutes a most valuable aid.

As far as the determination of the elevation is concerned this can only be approximately done. Even when the distance is not only estimated but obtained from actual measurement from the chart by means of a chart wheel the proper elevation is eventually obtained by noting successive shots. In many cases, however, the time required for thus finding the range may be greatly shortened. The application of the panorama telescope for this purpose is identical with the Jantier system of measuring distances, so long used by artillerists.

If the target lie directly in front of the battery and can be seen from it, then, for example, the two end guns, *A* and *B*, will be pointed, by command of the battery chief, at a certain point, *F*, with the reflector standing at *O*. Then by turning the reflector gear the panorama telescope will be brought to bear upon the same point. Thus both the base angles α and β in the triangle *A B F* may be read to the 0/00. By subtracting their sum from (3200 0/00) 180 deg. the angle at γ is obtained also in 0/00. Now the ratio of the known base line, *A*, *B*, to its opposite angle γ, is the same as γ to 1000 or the desired distance in meters or

$$\delta = \frac{A\ B \times 1000}{\gamma}.$$

Now if the distance between the two guns *A* and *B* be measured with a tape and found in meters and divided by the value of γ the exact range will be found in kilometers.

If, however, the target cannot be seen from the battery, a similar procedure may be put into effect by mounting two panorama telescopes upon stands which permit the target to be brought into view.

Having a panorama telescope at hand and with the reflector placed at 0, bring the target into view. Now turn the reflector 90 deg. (1600 0/00) and place a stake in the line of sight at *B* a predetermined distance from the observation point *A*. Now set up a stake at *A* and transfer the panorama telescope to *B* and measure the angle β. This obtained γ is the difference between 1600 and β. Having this difference in 0/00, divide it into the measured distance between *A* and *B*, and as before we have the range in kilometers. In a similar manner is found the lateral element. Suppose the target can be seen from but one of the guns of the battery; then the simplest way, after pointing this gun, with telescope reflector set at 0, at the target, will be to turn the reflector, either with the gearing or, throwing this out, turn it more rapidly by hand, upon an auxiliary target set up in some convenient place by the chief of battery. From the scale the angle can now be read in 0/00, and this, with due consideration for a final and necessary correction caused by the relative positions of the guns, both from the object and from the other guns, as well also as from the auxiliary target, will be communicated to each gunner in the battery. Should the battery be placed behind a protecting crest so that the target cannot be distinguished from any of the guns, it will then become necessary, moving from one of the guns in the direction of the object either to advance to the crest, or to make use of a caisson favorably situated or of an observation-ladder of sufficient height to look over the crest in order to bring the object into view through a panorama telescope. Either one of the above having been accomplished the observer may proceed as in the first instance. With this method of obtaining the angle it is not essential to start with 0 point of the telescope; it being sufficient to find the difference between the two angles of direction from the observer to the real and the auxiliary objects. In cases of this kind the ability to see in the rear makes the panorama telescope peculiarly adaptable for the purpose. To avoid drawing the enemy's attention upon the work, the finding of the angle may be done from the crown of the crest either in a kneeling or a reclining position. If using the panorama telescope the ability it confers of turning the reflector to the rear upon an auxiliary target so placed and thus avoiding the necessity of crawling around the instrument and being exposed to the enemy's fire permits the observer to proceed safely and quietly with his work. It is obvious that were an ordinary instrument in hand the necessary movement about the instrument would make its use from a caisson or an observation ladder prohibitive. The most practicable method for sustaining the telescope is a substantial rest placed upon a tripod to which the telescope is fixed, much after the manner employed upon the arm of the gun. A similar arrangement can of course be attached to an observation ladder. Corresponding to the various necessary or desirable positions of the observer, whether standing, kneeling, or lying prone, the rest must be capable of adjustment. Again the head of the rest or stand should be so constructed that the panorama telescope could be used if required either upright or horizontally (at an angle of 90 deg. from its normal position). On the side of the reflector is provided a spirit level for this adjustment. In this way a great many observations may be made which will greatly lessen the work of the chief of battery. In observing the effect of the shot, having first pointed the telescope upon the object, any lateral deviation in the bursting of the shell, after the cross hairs have been directed to the

point of explosion, can easily be read from the drum and the necessary lateral correction be communicated to the respective gun. The expanse of the object to be bombarded and the separation of the individual targets can be quickly measured and the division of the fire advantageously ordered. When the telescope is turned down 90 deg. the height at which the shells burst can also be measured, for the reflector then turns upon a horizontal axis. For the determination of the land angle, the object must first be brought into view and then the reading of the drum noted. Then without further change in the position of the telescope the bubble in the spirit level on the reflector must be brought to the center. The difference between the two readings of the drum gives the land angle between the position of the observer and that of the target in 0/00. In the same way the land angle between the observer and the gun may be obtained in case this should become necessary to a more exact determination of the land angle between the gun and the target.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Trade in British India.—While the native is favorable toward things American, and will buy where he can get the cheapest (cheapness seems to be more attractive than quality), in most instances he is controlled in one way or another by British influence.

The great railways and steamship lines that carry the traffic are under control of the government; the importing houses are largely English, and the official influence, a power in itself, is, of course, British.

In later days the lines of colonial trade have been materially tightened and everything possible is naturally thrown to the mother country.

The British Indian tariff duty is quite low, averaging 5 per cent ad valorem. All machinery worked by electric, steam, water, or other power, except manual labor, is free of duty.

In view of the little effort made to sell American goods in India, one is surprised that we sell as much as we do; our goods are practically selling on their own merit. American agencies and branch houses, under American management, in India can be numbered on the fingers of one hand; while Germany numbers her commercial houses, under the management of well-trained staffs, by dozens, and "made in Germany" has become a by-word.

Germany, France, Austria and Italy have lines of steamships running to this port and the East.

For more than a century England has taken the bulk of India's raw products, and in turn has sold her large quantities of British manufactured goods, thereby greatly aiding in building up her mighty commerce, as well as enriching her home people. American general trade with India is, however, gradually increasing, though the total amount in value has not changed greatly in the past five years. In 1899, when exports from the United States to India were exceptionally large, mineral oil formed the great bulk of the exports. During the last few years, however, there has been a great falling off in oil importations into this country from the United States. Notwithstanding this big decline, the aggregate of American importations into India did not decline, as the decrease in oil has been substantially counterbalanced by large importations of manufactured products.

Five years ago kerosene oil formed over one-half of the amount of our total sales at Bombay. Since then American kerosene has gradually lost the market here. Russian and Burmese oil, being cheaper, though inferior in quality, has been able to successfully meet the competition of the Standard Oil Company, so that during the last year the Standard Oil Company entered at this port only one-thirtieth of its imports of five years ago. It therefore speaks well for American trade to be able to say that other American products and manufactures have so increased in their sales that the general average of our total sales remained nearly the same.

We should, however, sell India much more than we do, and would, did we make it a business to do so. We should not expect the representatives of other countries handling competing lines of goods to take much interest in pushing our goods.

In order to increase our trade, there are several ways that suggest themselves; but the one way that appeals to me perhaps more than any other is to establish American branch houses under American management, place reliable and capable agents in the field, and then conform to the demands of the trade.

First study the field; if that is found inviting, come to stay, and not merely to relieve overproduction at home or until home markets are more favorable. The American manufacturers who are selling goods successfully in India are those who have placed their agents and branch houses here permanently.

The American bicycle has been on the market for some years and is quite popular. The American automobile is considerably in demand and should meet with a good trade, because it is more reasonable in price and neater and freer from noise than the machines offered by manufacturers of other countries.

The American sewing machine and clock are great favorites. The man who establishes an American shoe store in Bombay, handling exclusively American shoes, has a fortune assured him; especially if he comes before the Germans have adopted the American last and have flooded the market with an American shoe "made in Germany."—William Thomas Fee, Consul at Bombay, India.

Cuban Fruit in the United States.*—Our trade in fruits with the United States may one day attain proportions much greater than those of to-day. Cuba, favored by shortness of distance and exquisite quality of its products, occupies a favorite place among the countries exporting tropical fruits—an industry offering a new and endless source of riches. Not long ago the industrial situation in Jamaica was sufficiently critical to cause a fall in its sugar trade and in the banana trade. It owes its prosperity in great part to the encouragement of the trade in fruits, which constituted 50 per cent of its exports, sugar never going beyond 10 per cent.

Consumption of fruits has developed in such an extraordinary manner in the United States that during the fiscal year ended June 30, 1902, the value of fruit importations of the United States amounted to $21,500,000, while thirty years previous to that time importations amounted to $13,000,000. In 1870 only $7,000,000 were imported. The imports of bananas alone into the United States in 1902 amounted to $7,300,000, drawn from the following sources; British West Indies, $3,400,000; Costa Rica, $1,500,000; Honduras, $700,000; Colombia, $560,000; and only $530,000 from Cuba, against $1,500,000 in 1892. The value of the lemons, sweet and sour, imported into the United States from Italy amounts to more than $3,000,000. Of the oranges imported—$400,000 worth—the preference is given those from the British West Indies. Of cocoanuts the United States imported from the British West Indies, $325,000; Colombia, $483,000; Cuba, $175,000; total, $832,000.

With these figures before our eyes we can feel assured that the United States will consume our production of fruits in much larger quantities than we can supply them. And if Italy, from the other side of the ocean, can send to the United States more than $3,000,000 worth of lemons in a single year, Cuba, situated within three days of their leading ports, blessed with a climate and soil of an exceptional character for the cultivation of oranges, offers a wide field in which to obtain great results. If in the years 1892 and 1893 Cuba exported to the United States bananas to the value of $1.500,000, it will not be difficult to equal this amount again or even to surpass it. The British West Indies, which in the same period sent only $1,300,000 worth, sends to-day of the same fruit $3,000,000 worth.

Commercial Representatives for the Orient.—It is probably not a very difficult task to find German manufacturers who are not enthusiastic about the Oriental trade for the reason that they have, at one time or other, suffered losses through being made victims of unscrupulous eastern agents who wheedled them into business transactions by misrepresentations and chicanery. Sometimes, probably, the real blame must be attached to the manufacturer for having permitted himself to be an easy mark and for not inquiring into the standing and reputation of the man with whom he was to deal. Yet it must be conceded, in view of the past experience of exporters who have done business with the East, that the choice of reliable commercial representatives is by no means an easy undertaking. The necessity of having a trade representative in the Orient cannot be questioned. Even in cases where business is done directly with firms, it is said to be advisable to employ a representative at the same time. There are a thousand and one things which require attention and which cannot be properly attended to by long-distance correspondence.

In a recent article in the Austro-Hungarian Export Review, the question of the selection of commercial representatives for the Orient is dwelt upon and many valuable suggestions given for the exporter interested in the eastern trade.†

Just what sort of a representative it may be politic for a European firm to engage depends largely upon the nature of the goods in which business is to be done. If a business is to be conducted upon a wholesale plan it is wisest to attempt to engage a "big representative," who has been in the business for a long time and can show unmistakable proof of honesty and business integrity. Generally it is difficult to engage such firms, because very frequently they are already in the service of some prominent competitor who came first upon the field. Then also they are as a rule, crowded with work, as men with unblemished reputations who are capable of running a large wholesale business in the Orient for a European exporter are rare and cannot be picked up every day. But it is said that though these big representatives may be reluctant to undertake any more European business, if they can be prevailed upon to do so great confidence may be placed in the results. Business may pick up but slowly at first, but there is no need to worry about the execution of contracts.

In case of articles which are to be pushed in the markets upon a small scale, and mainly in the retail trade, the engagement of some smaller representative is said to be advisable. It is especially in such cases that great circumspection is necessary in making a choice. While it may be comparatively easy to choose a reliable agent among the largest firms of the place, this is not the case where smaller firms are under consideration. Many of these have been upon the blacklist for years, yet manage to cover up their tracks so shrewdly that the unsuspecting are easy prey, and even the most circumspect tread on dangerous ground.

* Translated in the Bureau of Statistics from El Economista Mexicano of September 10, 1903.

† The term "Orient" is generally used in German papers in a narrow sense, as confined to the immediate East or the Levant, though the points here brought out apply equally well to the far East.

If great care is taken one may find a firm of young men who are reliable, enterprising, and energetic.

These facts, as they are disclosed in the Export Review already referred to, ought to be sufficiently plain to show that oriental representatives cannot wisely be engaged through the mails and without the most scrutinizing investigation. To strike a choice among those who offer themselves through correspondence is the height of folly, unless they are in a position to produce indisputable evidence of their responsibility and integrity, preferably guaranteed by some well-known and prominent eastern firm which has consented to act as a sort of protector.

Under date of August 18, 1903, I submitted a report upon the opportunities for exporting American hosiery to the Orient by way of Germany* and called attention to the intelligence of the oriental buyer in matters pertaining to his business and the thoroughness of his knowledge of textiles and textile prices. The eastern buyer is known to possess unusual natural keenness and business ability, and where he combines with this a bent to trickery and sharp practice he becomes a dangerous man to deal with through long-distance correspondence. For this reason the facts here presented cannot be too seriously taken to heart by American exporters to the East who are new in the field and who desire to shield themselves from loss.—J. F. Monaghan, Consul at Chemnitz, Germany.

The United States the World's Educator.—Not only in political and international law, but in the realms of science, mechanics, economics, and business methods, the United States is becoming the high school for the other nations of the world.

This is shown by the numerous agricultural and commercial commissions, experts in manufacturing, students of political economy, scientists, ministers of state and chiefs of governmental bureaus, managers of industrial concerns, banks, etc.—all from the highly cultured European countries—visiting the United States for the sole purpose of studying American working methods.

With far-seeing men in Europe it has become a matter of firm belief that it is strictly essential to study American ways, means, and methods before the education of higher craftsmen or managers of industrial or public works, etc., can be called complete.

The statements which Mr. Goldberger, Dr. Salamansohn, and other chiefs of great German financial institutions; Wilhelm von Polenz, the author; Minister of State von Rheinbaben and his accompanying counselors and experts, have made, and which were published by the press and discussed at meetings of economic bodies in Germany, caused deep interest in that country and in all industrial circles of Europe. As a result, numerous visits from other experts, bankers, managers, and scientists are to follow, all with the same aim: "To study the United States; to see how the Americans do it."

Three of the most prominent men of German finance and mechanical science are now proceeding to the United States for this purpose. They are Director Dernburg, of the Bank of Commerce and Industries; Director Winterfeld, of the Berlin Commercial Company; and Privy Councilor von Rathenau. The two first named represent great banking and promoting institutions, and Mr. Rathenau is director-general of the greatest electrical works in Germany.—Simon W. Hanauer, Deputy Consul-General at Frankfort, Germany.

Bids for Belgian Freight Cars.—A telegram has been received from Brussels, Belgium, informing German manufacturers that the Belgian State railroads are about to ask for bids upon 3,200 freight cars and 100 locomotives, in addition to a large quantity of other railroad supplies. Detailed information, in book form, may be had by applying to the Bureau Central des Renseignements, Rue des Augustins, 15, Brussels, Belgium.—Brainard H. Warner, Jr., Consul, Leipzig, Germany.

Peg-Making Machines.—Under date of October 17, 1903, United States Consul F. D. Chester, of Budapest, Hungary, reports that the Commercial Museum in that city desires a list of American manufacturers and exporters of wooden-peg-making machines. Such manufacturers should communicate with Consul Chester directly.

* See Daily Consular Reports No. 1758 (September 25, 1903).

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

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

ENGINEERING NOTES.

According to the Iron Age an engine, in use at the works of the Solvay Process Company, in Syracuse, N. Y., recently completed a continuous run of 22 months, during which period it had not once been stopped. Its speed was 250 revolutions per minute, which makes 15,000 per hour, 360,000 per day, nearly 11,000,000 per month, and a grand total for the 22 months of some 241,000,000 revolutions without a stop.

The Supervisors of Fayette County are conducting some valuable experiments, the object of which is to determine the true worth of crude oil for preventing dust on highways. The oil is sprinkled in quantities over comparatively smooth stretches of the roadway, and then covered with a layer of sand about one-half an inch thick. In the course of a few days the oil has partially penetrated the roadbed, and the lighter oils have evaporated. The sand is then compressed by means of a heavy roller. The resultant road is said to be dustless, waterproof, elastic, and thoroughly durable. The cost per mile of one of these roads is quite small. About one hundred barrels of oil, costing sixty-two cents per barrel, are used to the mile. A thousand barrels of sand were required for the one-mile test. The road rollers which are used cost the most.

In answering the inquiry of a correspondent who wants a copper alloy giving a higher tensile strength than manganese bronze, governmental specifications, which call for 72,000 pounds per square inch, the Metal Industry says: "Among the common alloys manganese bronze is undoubtedly the strongest alloy, although it is difficult to always obtain the high tensile strength. Aluminium brass, composed of copper 63.33 per cent, zinc 33.33 per cent, and aluminium 3.34 per cent, has given over 80,000 pounds per square inch in sand castings, but is more difficult to cast on account of its greater shrinkage. Undoubtedly the strongest known copper alloy, although not a bronze, is one composed of copper 63.33 per cent, nickel 33.33 per cent, and aluminium 3.34 per cent. From 95,000 pounds to 100,000 pounds per square inch may be obtained in castings.

In the twentieth year of Queen Elizabeth, a blacksmith, named Mark Scaliot, made a lock consisting of eleven pieces of iron, steel, and brass, all of which, together with a key to it, weighed but one grain of gold. He also made a chain of gold consisting of forty-three links, and, having fastened this to the lock and key, he put the chain about the neck of a flea, which drew them all with ease. All these together, lock and key, chain and flea, weighed only one grain and a half. In the beginning of the twentieth century a good machinist can make a drill 0.0135 of an inch in diameter; the whole length 0.750 of an inch; the length of twist 0.1875 of an inch, it being about the size of a No. 10 cambric needle. Such drills are used almost exclusively by watchmakers, are complete in every respect, and will drill a hole as accurately as a one-inch drill.

Already considerable benefits are being reaped in Egypt from the dams and irrigation works which were recently completed on the River Nile. By means of the Assouan reservoir the flow down the river was supplemented in June last to the extent of 20,000,000 tons of water per day, which practically doubled the available supply at the most critical period of the year for the irrigation of summer crops. Without this discharge of water, great difficulty would have been experienced in saving the cotton crops. The irrigation of rice, which had been prohibited in previous years, was again permitted, and land for planting the durah crop was irrigated a month earlier than had ever been the case before. In Middle Egypt 170,000 acres of basin land had been converted for crops, and each year more will be taken in hand up to a final total of about 350,000 acres in two years. This land has increased in rental value $15 per acre, and in actual value $150, while the cost of all drainage and irrigation works is only $20 per acre. The result is an annual increased rental of upward of $2,500,000 on these converted basin lands alone.

At the Royal United Service Institution, London, Fleet Engineer G. Quick, R.N., recently delivered an address on "Screw Propulsion for Warships." He stated that multiple propellers, which were employed nearly 50 years ago, were again being brought into notice by the turbine system. For nearly 30 years he had advocated triple propellers with three isolated engine-rooms, in order to obtain as much security as possible for some portion of the propelling power during battle. There were, in his opinion, a dozen good reasons for the adoption of triple propellers in large high-speed ships for every single reason urged against them. He could not consider that certain foreign powers—such as Russia, France, and Germany—had been hasty and injudicious in adopting triple propellers for their large warships. Germany alone had nearly forty large ships built and building with triple propellers, and he hoped that England would soon give them a trial in some large ships. The introduction of triple screws in vessels where there was an installation of 20,000 horse power was just as logical a development of machinery design as the introduction of twin screws was a generation ago. The naval strategists of Germany, Russia and France had found that the tactical advantages alone were sufficient to demand the installation of three screws, since ships with triple screws had a maneuvering power which could not be secured by ships fitted with only two screws.

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