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INTERESTING REPAIR WORK ON THE STEAMSHIP "EKLIPTIKA."*

By Dr. Alfred Gradenwitz.

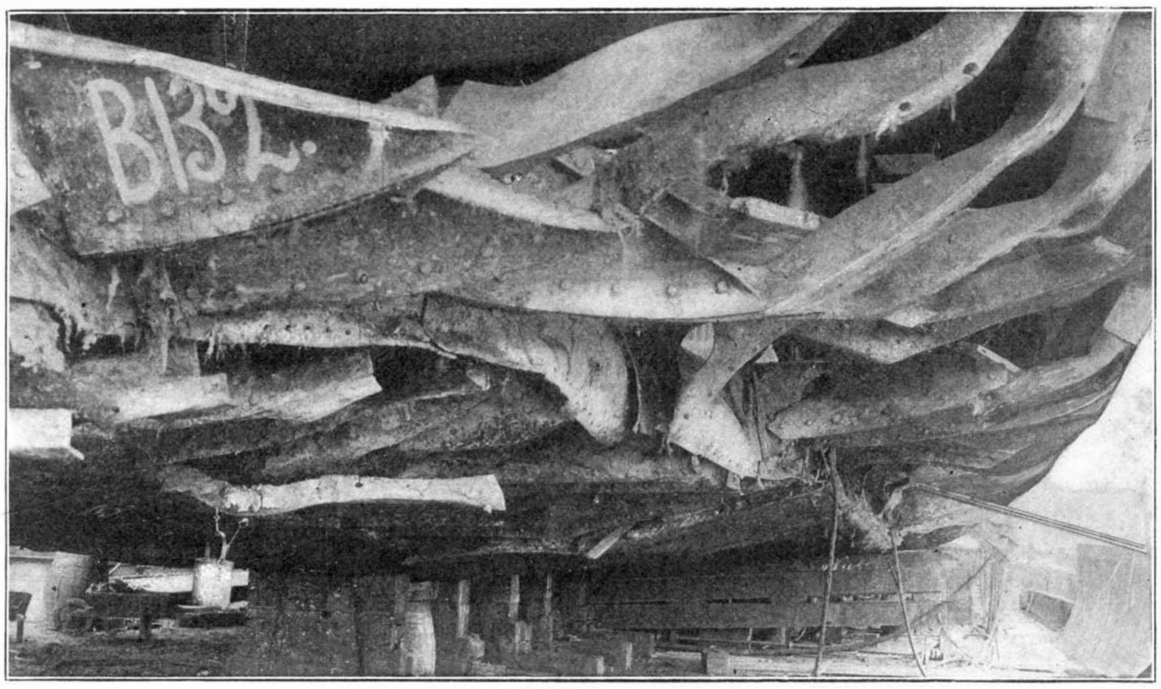
When the self-trimming steamer "Ekliptika," of 2,167 gross registered tons, was sailing from England last year to the Baltic with 3,000 tons of coal, she was stranded by a drift of currents on the Swedish coast, sinking immediately to the rocky sea bottom at a depth of about 16 fathoms.

About one year afterward the Aktieselskabet Moss Værft Bjergnings og Dykker Co. undertook the berthing of the ship, and succeeded, after some months of work, in conveying the ship to their docks in Moss. One of our illustrations shows how the wreck is being raised from the bottom of the sea and conveyed to the neighborhood of the shore by means of four large lighter vessels, to which she was secured by heavy wire cables.

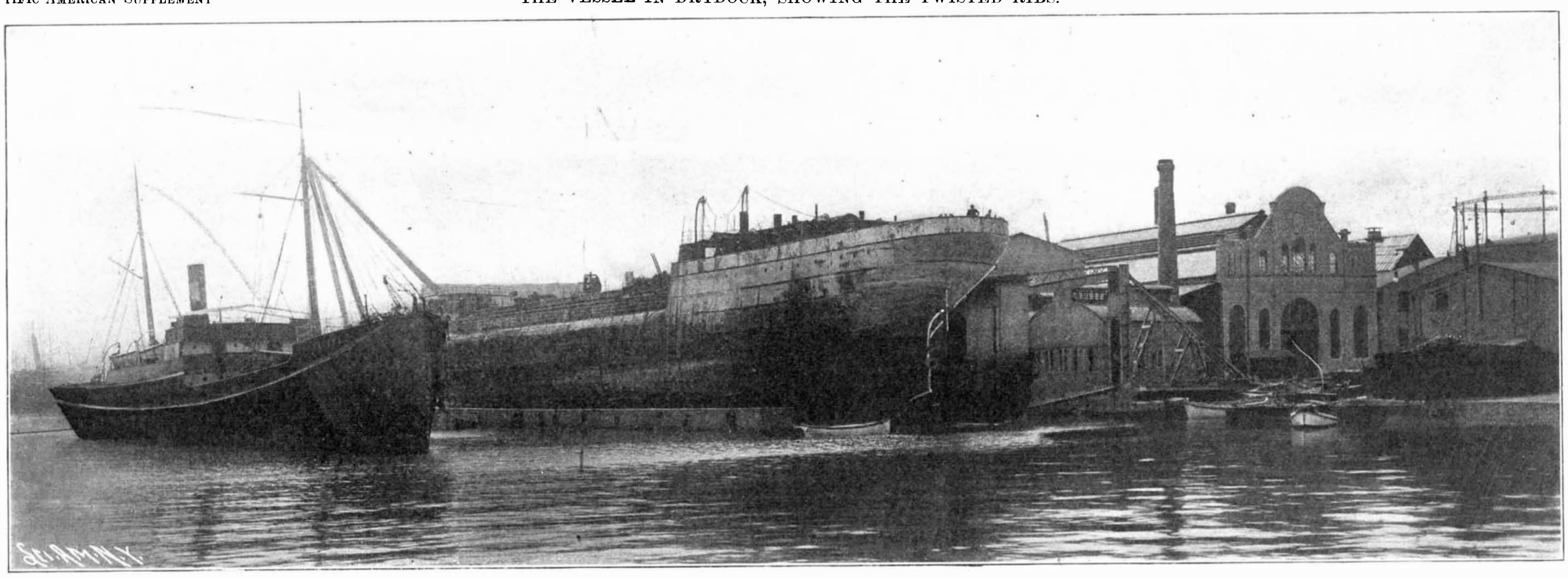
On inspection, the steamer was found to be repairable, this work being intrusted to the builders of the ship, the Flensburger Schiffsbaugesellschaft. This company at the beginning of May sent out their towing steamer "Schiffsbau" to Moss, to fetch the steamship, the necessary divers and diving apparatus being taken on board.

On May 4 the "Ekliptika," being towed by the "Storegut" and "Schiffsbau," hauling steamers, left the Norwegian harbor.

* Specially prepared for the Scientific American Supplement



THE VESSEL IN DRYDOCK, SHOWING THE TWISTED RIBS.



THE "EKLIPTIKA" IN DRYDOCK.

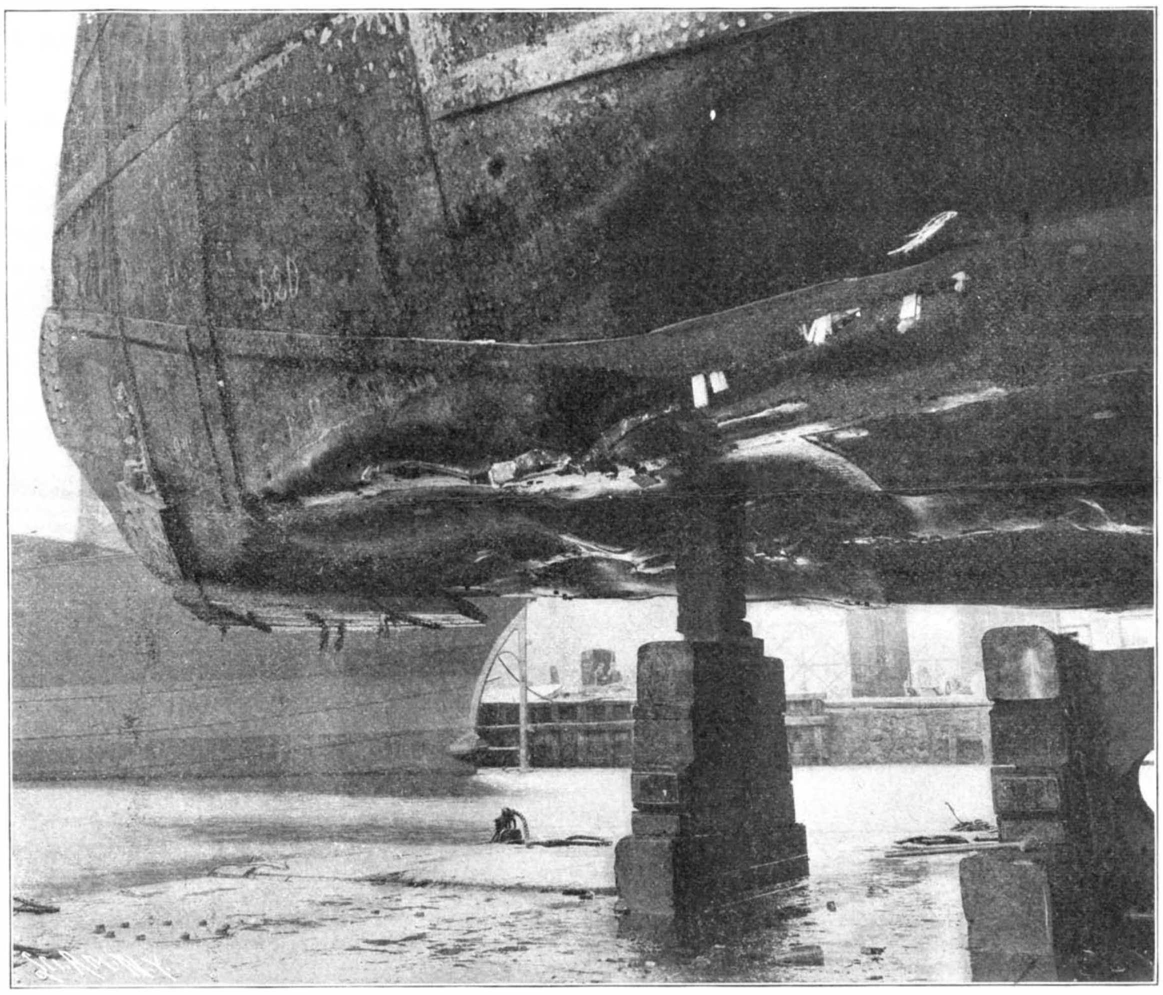
CONVEYING THE WRECK TO THE DRYDOCK BY MEANS OF LIGHTERS.

INTERESTING REPAIR WORK ON THE STEAMSHIP "EKLIPTIKA."

For some time the ship made little water, both the sea and wind being calm. In the course of the day, however, both became rather rough, so that the ship worked heavily and soon sprang a leak. The water entered so violently that, the pump not being able to keep it down, the vessel was towed to Fredericks-haven, where the leak was calked by the divers. Next day the ship proceeded on her way with calm weather, while as evening approached both the wind and sea grew so rough again that the ship began pitching and making much water. The port of Ebertorft had accordingly to be touched, where the divers thoroughly tightened any leakage with pads and sails, when the journey was continued through the Little Belt and Alsensund, no further accidents being met with.

On May 10, late in the evening, the "Ekliptika" arrived at Flensburg and was taken provisionally to the dock, to be better calked, when the damage sustained was found to extend throughout the bottom, from bow to stern, rocks having been struck everywhere. All of the outboard plates, the floor tank and plates were bent. Both the sternpost and stem were broken, while on the port side in the hind part a bad leak was found. All of the hold pillars and hold balks were bent or broken, while nothing was left of the cabin furniture and the berths. All ducts on the deck, charging and discharging devices, boats, hatchways, skylights, and railings were either broken or gone.

After all leakages had been well calked, the ship left the dock. The repair work was begun on June 23, a number of compressed-air machine tools being started immediately on the front part of the ship's bottom after she had been berthed. It being impossible, on account of the many bosses, to bore or to punch every



A VIEW OF THE BOTTOM.

REPAIRING THE STEAMSHIP "EKLIPTIKA."

one of the rivets, the plates had to be cross-stayed athwartships, so that large surfaces were taken off the bottom at a time. After the bulb frames and stringers had been cross-stayed also, the whole of the upper fore-ship rested on a row of stays arranged on both sides of the ship. Both the frames and floor plates as well as the stem were renewed, the tank floor and outside planking partly renewed or riveted; and as the new stern posts had in the meantime been mounted and riveted, the work made such rapid progress that it was possible to complete the bottom by August 6. The ship was floated out of the dock on the 8th, and towed to the wharf, where the work on the deck was continued.

The most difficult part of the work, namely, the reconstruction of the bottom, which is represented by our illustrations, was completed in thirty-nine working days—a remarkably quick repair job.

[Concluded from SUPPLEMENT No. 1507, page 24147.]

DEVELOPMENTS IN MEANS OF COMMUNICATION BY SEA DURING THE NINETEENTH CENTURY.

COINCIDENT with the adoption of iron in shipbuilding was the introduction of the screw propeller, the credit of which is largely due to Thomas Pettit Smith, although many experiments had been made, extending over half a century, after Watt's famous letter to Dr. Small in 1770 containing the oft-quoted words: "Have you ever considered a spiral oar for that purpose, or are you for two wheels?" The sketch accompanying that query clearly showed that the principle of the screw propeller was present to Watt's mind. Smith's classical series of comparative experiments with the "Archimedes" and "Widgeon" brought the advantages of the screw prominently forward, and inaugurated the era of the propelling instrument which has been perhaps the most important factor in the development of steam navigation during the last half century. And yet it is astonishing how little is known about it! These two inventions, or discoveries, or adaptations, or whatever they may be called, rendered possible and promoted the great extensions of ocean navigation to the East, the Pacific, the West Indies, to South Africa, indeed to every part of the navigable globe, which are associated with the names of the Peninsular and Oriental, Pacific, West Indian, Royal Mail, and Union and Currie companies. The first of these deserves more than a mere passing notice as being the first in order of date, and the great link with our vast eastern possessions and Australasian colonies.

A very succinct and interesting historical retrospect of the operations of this company by the chairman, Sir Thomas Sutherland, is to be found in the P. & O. Pocketbook for 1887, supplemented in 1900, the year of its jubilee, from which the following particulars are extracted. Beginning with vessels of about 500 tons the mail service to Gibraltar was opened in 1837—the Indian and other eastern mails being taken on by government steamers to Malta and Alexandria. The time occupied was about a month to Alexandria and two months to Bombay, as against less than 4½ days and 15 days respectively now. Soon the company's operations were extended to Alexandria, and three years later to Calcutta, taking up the Calcutta-Suez portion of the through service. The Bombay service was taken over a few years later from the East India Company, and the China ports and Australia—the latter in 1852—were also included in the sphere of the undertaking, so that the whole East was embraced in a network of ocean lines under one company, forming a sea link with the mother country, interrupted only by the neck of land between Suez and Port Said. The first contracts with the government were for a monthly service. Now the mail steamers of the company run weekly to Bombay and fortnightly to Australia and to China, having been gradually increased in size from about 2,000 tons to 10,500 and in horse-power from 2,000 to 11,000, the increase in speed being about from 10 to 18 knots. The scheduled time from London is now 15 days to Bombay, 32 to Melbourne, and 35 to Shanghai, but the due dates are often anticipated by as much as three days on the longer routes, while the regularity with which the whole business of transport is conducted is one of the greatest tributes to the engineering excellency of modern means of communication by sea. The fleet is now composed of 62 vessels of 365,000 tons register and about 358,000 horse-power, the average size being 5,900 tons.

The long and honorable career of this company has been by no means uncheckered. Probably the most momentous and critical event in its fortunes was the opening of the Suez Canal in 1869, which necessitated a complete reorganization of its business and reconstruction of its fleet. That event coincided with its adoption of the compound engine—somewhat later than some of the other great lines, notably the Pacific Company, which had successfully introduced it in 1856. The great reduction in consumption of fuel which this improvement in marine engineering effected, while it rendered the problem of long-distance steaming easier of solution, had the counterbalancing effect of enormously stimulating competition. The result has been a reduction in rates of freight of a quite unprecedented character. In Sir Thomas's words, "It is a tolerably safe proposition that neither the agricultural interest, nor that of railways, nor any other extensive industry has encountered such a revolution as the mercantile marine has experienced and successfully applied within the last quarter of a century. On this point it is enough to say that eastern freights may be set down at about a fifth of what they were previous to the opening of the Suez Canal."

The directors of the Great-Eastern Company based their calculations of earnings on overhead freights of from £7 to £5 per ton. Goods are now carried by the P. & O. at a rate of less than 1-35 of a penny per ton mile, which works out at about 30s. for Australia and 25s. for China.

Another of the effects of the piercing of the Isthmus of Suez has been the gradual but unrelenting supersession of sailing ships by steam, even on the longest routes, due in great measure to the continuous improvements in marine engineering, tending to increased economy of fuel, to the multiplication of coaling stations, and to cheap conveyance of coal to distant points.

The change is generally attributed to the greater regularity of steam service, but it must be confessed that up to 8 or 9 knots there is little to be complained of as regards variations in the average passages of sailing ships on the great trade routes. The "Thermopylæ" made two consecutive voyages from London to Melbourne, the first in 60 and the second in 61 days; and the famous China clippers in the sixties used to arrive in the Thames within a few hours of one another after leaving China together.

Without attempting to trace the developments in sailing tonnage, it may be sufficient to give the particulars of one of the largest of the modern vessels—the "Potosi"—built in Germany in 1896. Her dimensions are 360 by 49½ by 31 feet; tonnage 4,026; deadweight capacity 6,200 tons; displacement 8,470 tons, at 25 feet draft. Her spread of canvas is over 50,000 square feet, and her average speed on voyages of from 6,000 to 14,000 nautical miles is from 8 to 9½ knots.

The statistics of last year show that while 622 merchant steamships of over 2,200 tons average were built in this country, only 72 sailing ships of 700 tons average were added to the Register, that is to say only 1-28 of the new tonnage was sailing. The figures given to show the growth of steamships in the case of the Cunard and P. & O. companies may be taken as typical of the progress in size and power in the case of the other great lines—the White Star, Union-Castle, Pacific, West Indian Royal Mail, Allan, and Anchor. It is worthy of note that the largest vessels on the longest routes are approximately of about the dimensions of Atlantic steamers built ten to fifteen years earlier, as may be seen by comparing the steamers of the Cape Mail and Australian lines with those of the Cunard and White Star companies. With the development of traffic on the principal trade routes there has sprung up a class of intermediate passenger and cargo steamers of great carrying capacity and moderate speed. The Cunard "Carpathia" may be taken as a type of the class on the Atlantic, and the White Star "Suevic" on the Australian route *via* the Cape. The "Carpathia" has a length of 560 feet, measures 13,500 tons, and steams 15 knots with 8,000 horse-power. She carries 200 second-class and 1,800 third-class passengers. The "Suevic" is 550 feet long, 63 feet broad, of 12,500 tons, and 5,000 horse-power, and steams 13 knots with a coal consumption of 80 tons per day. Sir Wm. White makes a most interesting comparison between this latter steamer and the "Great Eastern," showing that on the conditions which Brunel set before him, namely, of carrying sufficient coal to circumnavigate the world, the "Suevic" could carry 8,000 tons of cargo on the out trip to Australia, and 11,000 tons on the home trip.

In this short summary or retrospect of the growth of merchant shipping during the last century, attention has been directed almost entirely to British vessels and to those of the largest size. The strides made have certainly been enormous, and these few notes give a sufficiently representative view of the developments in size and power. It remains only to further indicate the means by which such growth has been rendered possible, first as regards the materials employed in the construction of hulls and engines, and secondly as regards improvements in design and in the application of well known mechanical principles.

It has already been shown how and when wood was replaced by iron, and the extent to which the change influenced the size of vessels. Brunel was certainly sanguine in his estimate of the properties of the iron of his day, and he was apparently justified in it by the performances of his two creations, the "Great Britain" and "Great Eastern." But in course of time and under stress of competition the material, especially in the form of ordinary ship plates, was found in many cases to be unreliable and uncertain. As a matter of history, it remained the principal material of ship construction for half a century. During that time strenuous efforts were being made to improve the quality of iron, notably by Bessemer as early as 1856, and ten years later by Dr. Siemens; but it was not till the late seventies that the new material, homogeneous iron, or mild steel, made by the Siemens-Martin process came into use. Denny's "Buenos Ayrean" in 1879, for the Allan line, was the first ocean steamer in which it

was used, although the little "Windsor Castle," which plied on the Clyde as early as 1859, was built of steel; the price at that time being, however, prohibitive. The Admiralty led with the "Iris" and "Mercury," built of steel, made at Siemens's Landore works in 1875.

Lloyd's tests for iron were 20 tons with the grain and 18 tons across; and for steel from 28 to 32 tons tensile, with an extension of 16 per cent in 8 inches; and at first a reduction of 25 per cent in scantlings was allowed. But the greatest advantage of steel over iron was its uniformity of strength, which gave confidence to designers, every plate being tested at the works, and in the case of classified vessels, stamped with the certifying mark of the Registration Society. Its greater ductility also enables it to be worked cold in a way impossible in the case of iron.

There is no finality in metallurgical processes, as we are reminded very forcibly in the recent experiments with nickel steel—a material now in the market, and for which Mr. Beardmore claims an elastic limit or yield-point equal to the ultimate or breaking stress of mild steel. That is to say, nickel steel possesses strength within the limits of elasticity of about 30 tons as against 16 tons with Siemens-Martin steel. So that naval architects have here to their hands a structural material nearly twice as strong for purposes of design as what has done such splendid service for the last twenty-five years. What that may mean may be inferred from the fact that the use of steel instead of iron in the structures of the steamers of the mercantile marine of the world has saved at least 2½ million tons in weight, and 12½ million pounds sterling in value; and that at no sacrifice, for steel is to-day 20 per cent cheaper than iron. The saving in coal for propulsion alone due to this reduced weight cannot be far short of 4,000,000 tons per annum, worth, at 15s. per ton, three millions sterling. I do not think these figures are in any way over-stated, and they take no account of savings due to the substitution of steel for iron in the machinery department.

One of the earliest improvements in marine engineering was the adoption of surface condensation—a system which is now universal—and by which the waste steam from the engine is condensed without admixture with sea water, a great gain in safety and economy. About the same time the screw propeller, as we have seen, displaced the paddle, which, in its time, had been considerably improved upon, chiefly by Galloway's device of feathering the floats so that they should always work at an effective angle. But the chief loss of efficiency, particularly in large vessels of considerable carrying power, lay in the great variation of immersion of the floats at light and load drafts. The screw, apart from its inherent greater efficiency, remedied this defect to a certain extent. At any rate the single screw remained the instrument of propulsion *par excellence* for fifty years.

An attempt was made in the White Star steamer "Britannic," in the seventies, to overcome the danger and unpleasantness of racing by the cumbersome device of a raising and lowering propeller, but it was unsuccessful. The best remedy so far is the twin screw—or perhaps one should say the multiple screw.

The twin screw came into extensive use about twenty years ago, when the enormous powers required on the Atlantic made subdivision into two lines of transmission practically a necessity. It soon came to be looked upon as providing a second string in the event of accident in passenger ships, and it is now almost universal for the largest class of steamer even of moderate speed. The question of the relative economy of twin and single screws is still a controversial one. It is pretty generally conceded that on a trial trip in smooth water, and under favorable conditions of draft, the single screw has an advantage of about 10 per cent over the twin; on the other hand, on a voyage with varying conditions of weather and of immersion, it is sometimes claimed that the advantage is reversed, or that it disappears. Sir William White was a pioneer in the advocacy of twin screws, at any rate for the swiftest steamers, and in his address to which I have referred he has the satisfaction of being able to say: "It is pleasant to note that the opinions expressed twenty-five years ago have been fully justified in later practice."

Mention has already been made incidentally of the change from the single to the compound engine; a change which soon after 1860 became general, and continued until in 1880 a further development of expansion in one more stage—the triple-expansion engine—supplanted it. A still further step to quadruple expansion was taken a few years ago, but has not yet made much headway. These changes have been accompanied by continuously increasing steam pressures, modifying the type of boilers and calling for more reliable materials of construction. In the early days of steam the pressure was only a few pounds above the atmospheric, and Brunel was thought rash when he insisted upon 25 pounds for the "Great Eastern." In the days of the compound engine, pressures rose to 100 or 120; and for triple-expansion work from 150 to 200 pounds is about the range. The best quadruples with the ordinary cylindrical boiler are to-day working at 210 pounds. We may take it that the increase of pressure has been 200 pounds corresponding to a rise in the temperature of the steam of 240 deg. F. One of the factors in bringing about these advances has been the introduction of the corrugated flue.

As powers increased there has been a corresponding acceleration of the engines themselves. Revolutions gradually mounted up from 30 or 40 to 50, forty years ago, and now in ocean-going steamers of the largest size from 80 to 90 revolutions are not uncommon, with corresponding piston speeds of over 1,000 feet per minute as against the usual figure in the early days of the screw propeller of 400 feet. These figures, however, shrink into insignificance when we consider the practice with torpedo boats and destroyers. Improved design and better material have reduced the weight of machinery relatively to power developed by about a half. In mail steamers 50 years ago a ton of propelling machinery represented 3 horse-power; now it may be reckoned at 6½ horse-power. Watt's estimate of the duty of his pumping engines was 112 pounds of coal to do the work of ten men working ten hours a day. This works out at about 13 or 14 pounds per hour per indicated horse-power. Early marine engines consumed 9 or 10 pounds; but as pressures were increased this consumption was reduced to 3 or 4 pounds. With compound engines 2½ pounds became normal, and now good triple-expansion engines frequently work at 1¼ pounds, so that ten times the power is now got from each pound of coal.

These are broadly the leading features in the progress made in steam navigation during the century that has passed. There is one advance—the greatest since the days of Watt—which cannot be passed over in silence, although, commercially speaking, it is still on its trial—the steam turbine. The credit of applying the principle to marine propulsion is, doubtless, due to the Hon. Charles Parsons, whose "Turbinia" (1887) was a revelation to engineers. A little boat of 100 feet long—carrying machinery weighing only 22 tons and developing nearly 2,000 horse-power and steaming at the rate of 31 knots—was so far ahead of anything that had then been attempted, that, while the results could not be questioned, there was a distrust in official and business circles, which it took years to overcome. The ill-fated "Cobra" and "Viper" sufficiently proved the great merits of the system. But the Clyde has the merit of adopting it in mercantile work, and the "King Edward" and "Queen Alexandra" are familiar objects of pride on the Firth. In channel service the Parsons turbimotor has proved so efficient and so reliable that it bids fair to entirely supersede engines of the reciprocating type. And the Allan Company is taking the lead among the ocean lines in the adoption of turbine engines in their two new mail steamers of about 12,000 tons and 11,000 horse-power, now under construction in Belfast.

But just as in the case of the compound and triple-expansion engines and of the other epoch-making improvements in marine engineering, a long and discouraging series of experiments extending over many years had to be made before the turbine became practicable. In the forties a great deal of inventive activity was devoted to rotary engines, and several were constructed which proved commercially successful. It is very difficult to procure authentic data of the working of Gorman's, Ruthven's, and Wilson's rotary engines, and also of other types; one, at least, employed in marine propulsion about 1846, but, notwithstanding a possible priority of claim, and notwithstanding the fact that hundreds of patents have been registered dealing with steam turbine engines, Parsons's position as a pioneer is absolutely unassailable.

It has been a source of regret, I might almost say of humiliation, that the leading position for speed on the Atlantic has for the last five or six years been wrested from Britain by Germany. The only British Atlantic mail ship of high speed, after the "Campania" and "Lucania," was the White Star "Oceanic," which made no attempt to lower the record time, while the Germans with their "Kaiser Wilhelm der Grosse," "Deutschland," "Kronprinz Wilhelm," and "Kaiser Wilhelm II." raised the ocean speed from 22 to nearly 24 knots, and to do so had to increase tonnage and horse-power by over 50 per cent.

I do not think it is generally realized that the crack German mail steamers are so enormously ahead of our latest and best. It has been argued that the expense accompanying such revolutionary developments makes them prohibitory, but in to-day's paper you may read the annual financial report of the Norddeutscher Lloyd, recommending a dividend of 6 per cent on their ordinary shares, a rate some of our more reactionary lines would be glad to be able to show.

It is a subject of congratulation that the Cunard Company with the aid of H. M. Government, is about to make an effort to regain our lost supremacy. The particulars of the new steamers have just been published, and as the more recent German steamers have been merely expansions of previously existing types, so with one exception, these new Cunarders are only magnified "Kaisers;" about as much larger than the "Kaiser Wilhelm II." as that steamer is larger than the "Campania." The exception is that Parsons turbines are the motive power, fitted to four shafts. I am sure we all look forward to the results with the utmost interest, and with the most fervent good wishes for the success of the bold venture.

It has been impossible in the short time at my disposal to do more than hint at, or catalogue in chronological order, the various developments "of the new and mighty power," in the words of George Canning: "New at least in the application of its might, which walks the waters like a giant rejoicing in its course, stemming alike the tempest and the tide, accelerating intercourse, shortening distances, creating, as it were, unexpected neighborhoods, and new combinations of social and commercial relations, and giving to the fickleness of winds, and the faithlessness of waves, the certainty and steadiness of a highway upon the land."

NOVEL SALVAGE BOATS.

HIGHLY successful results have attended the tests that have been carried out with the two novel salvage boats that were constructed some time ago for the Nordische Bergunverein of Hamburg. In each of these vessels the stern is provided with a specially sharp-angled slope, which keeps its full width down in the water. The result is that instead of the vessel having to be moored alongside the craft or object to be raised, it can be placed immediately over it. Furthermore, in order to supply additional strength to the stern of the vessel, to cope with this special work, two girders 17 feet 3 inches apart are built into it and reach from end to end, and capable of sustaining a weight of 550 tons. These girders carry eight pairs of pulleys, each with a diameter of 4 feet 5 inches. Ten-inch ropes are used, with a breaking strain of 720 tons. The machinery, in addition to the propelling engines of 600 horse-power, comprises pumping engines, and two air compressors for air pressures of 100 pounds. The latter are utilized for boring and riveting operations, as well as any other temporary repairs that may have to be undertaken in connection with a wreck. Another feature of the vessels is the arrangement for taking in water ballast up to 1,100 tons, to counterbalance the weight lifted at the stern. The pumping capacity of the two vessels is 6,000 and 5,000 tons per hour respectively. The larger vessel is also equipped with a suction pump with a capacity of 17,600 cubic feet of sand per hour, which is equivalent to some 5,000 tons of water.

Two difficult salvage operations have been carried out with these two vessels with complete success, wherein the capabilities of their special design were demonstrated. The larger vessel successfully raised the steamer "Lemnos," which had sunk in the River Elbe. Previous attempts had been made to raise this vessel, but without any success, and the wreck was left hanging over the hole which it had made for itself in the sandy bed of the river. Shortly after the cessation of operations the wreck sank back again, and continued working its way into the sand until it had reached the clay bottom. In some parts within the vessel the sand was found to a depth of 10 feet. Owing to the tidal action of this river, the excavation of the sand presented great difficulties, as the sand removed by one tide was silted back again by the succeeding tide. The silt, however, was effectively kept under by means of the powerful suction pump, the diameter of the pipe of which is 2 feet. After the sand had been withdrawn from the interior of the vessel, blasting operations had to be carried out at a depth of over 30 feet below low water level.

While the larger vessel was engaged in this task, the sister ship was employed in raising the German torpedo boat sunk in the main navigation channel off Cuxhaven by the British steamer "Firsby." The wreck was lying in 78 feet of water. The salvage boat was brought over the wreck, and moored with six anchors, a work which was carried out with considerable difficulty. Owing to the frail nature of the torpedo boat, the lifting hawsers were not carried round the craft, as apprehensions were entertained that they might cut the hull, but steel matting was carried round the boat, and the vessel, representing some 350 tons, completely lifted by means of the auxiliary engines. Owing to the peculiar design of the salvage

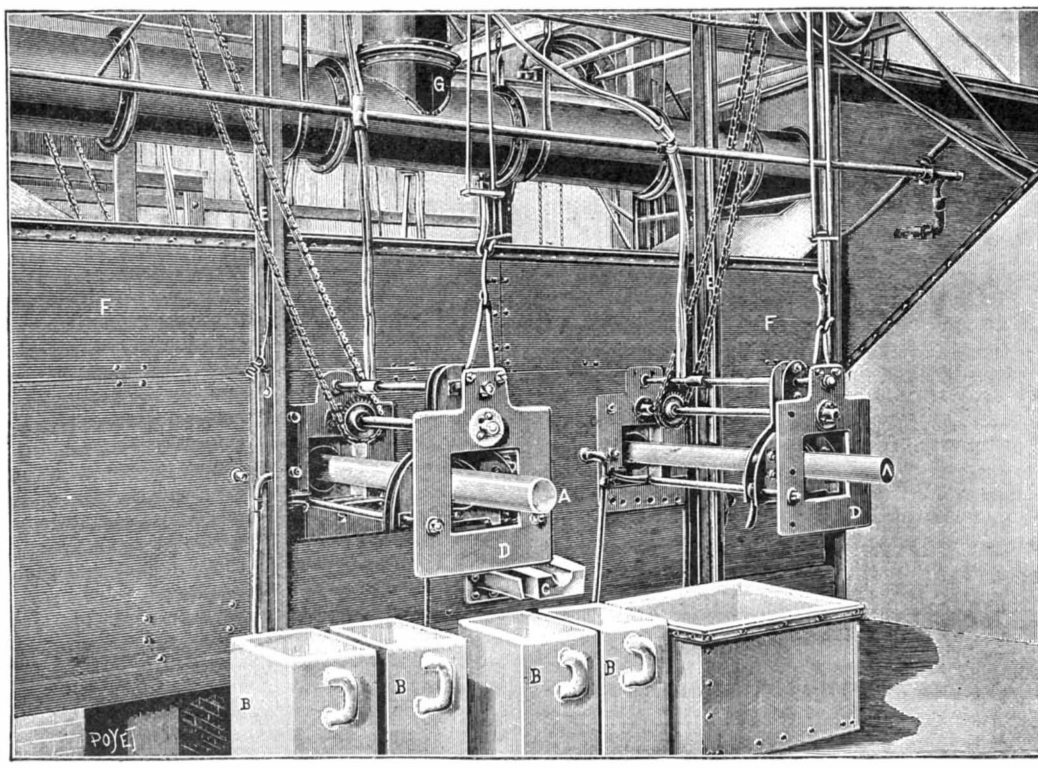
ATLANTIC LINERS.

Vessel.	"Campania,"	"Kaiser Wilhelm der Grosse."	"Oceanic."	"Deutschland."	"Kronprinz Wilhelm."	"Kaiser Wilhelm II."
Built	1893	1898	1899	1900	1901	1902
Owners	Cunard Co.	N. German Lloyd	White Star Co.	Hamburg American	N. German Lloyd	N. German Lloyd
Length (extreme)	622 ft.	648 ft.	704 ft.	684 ft.	663 ft.	706 ft. 6 in.
" (B.P.)	600 ft.	625 ft.	685 ft.	662 ft. 9 in.		
Breadth	65 ft. 3 in.	66 ft.	68 ft.	67 ft.	66 ft.	72 ft.
Depth	41 ft. 6 in.	43 ft.	49 ft. 6 in.	44 ft.	43 ft.	52 ft. 6 in.
Gross tonnage	12,500	14,349	17,274	16,802	15,000	20,000
Load draft	25 ft.	28 ft.	32 ft. 6 in.	29 ft.	29 ft.	29 ft.
Displacement	18,000 tons.	20,880 tons	28,500 tons.	23,620 tons	21,300 tons	26,000 tons
Passengers	1st 600, 2d 400, 3d 700	1st 590, 2d 354, 3d 640	1st 410, 2d 300, 3d 1,000	1st 693, 2d 302, 3d 288	1st 650, 2d 350, 3d 600	1st 775, 2d 343, 3d 770
Boilers	1 S.E. and 12 D.E.	2 S.E. and 12 D.E.	15 D.E.	4 S.E. and 12 D.E.	4 S.E. and 12 D.E.	7 S.E. and 12 D.E.
Heating surface	82,000 sq. ft.	84,285 sq ft.	74,686 sq. ft.	85,468 sq. ft.	93,865 sq. ft.	107,643 sq. ft.
Fire grate	2,630 sq. ft.	2,618 sq. ft.	1,962 sq. ft.	2,188 sq. ft.	2,702 sq. ft.	3,121 sq. ft.
Working pressure	165 lbs.	178 lbs.	192 lbs.	220 lbs.	213 lbs.	225 lbs.
Type of engine	Triple	Triple.	Triple	Quadruple	Quadruple.	Quadruple.
Sets	2	2	2	2	2	4
Cylinders	2 37 in. × 79 in. × 2 98 in.	52 in. × 89.7 in. × 2 96.4 in.	47½ in. × 79 in. × 2 93 in.	2 36.6 in. × 73.6 in. × 103.9 in. × 2 106.3 in.	2 34.2 in. × 68.8 in. × 98.4 in. × 2 102.3 in.	37.4 in. × 49.2 in × 74.8 in. × 112.2 in.
Stroke	69 in.	68.8 in.	72 in.	72.8 in.	70.8 in.	70.8 in.
Speed	22 knots.	22½ to 23 knots	20 knots.	23½ knots.	23½ knots.	23½ to 24 knots
I.H.P.	30,000	30,000	27,000	36,000	36,000	38,000 to 40,000

boat, it was found possible to lift the submerged wreck without waiting for the assistance of a convenient tide.

ELECTRIC FURNACE FOR THE METALLURGY OF COPPER.

Notwithstanding its possession of rich and abundant deposits of copper, Chile produces scarcely more than 20,000 tons of this metal annually, while thirty years ago it furnished double that amount. The situation of the mines in mountainous and difficult regions, the too high cost of fuel, and the want of means of transportation render the extraction of the ore unremunerative with the present facilities. The transportation of the fuel up to the mines, or the carriage of the ore down to a place where it can be cheaply treated, constitute two operations that, as a general thing, render the majority of the Chilean deposits unavailable.



ELECTRIC BLAST FURNACE.

A. Electrodes. B. Ingot molds. C. Iron runner. D. Electrode holders. E. Regulating transmission. F. Furnace body. G. Chimney.

The great number of large and constant waterfalls which, in the vicinity of the mines, allow an immense amount of power to go to waste on the mountains, permitted of the proposition being made to engineers to effect the metallurgy of copper *in situ* by utilizing the water power in conjunction with electric furnaces. This would make necessary the transportation of the finished product solely. With such an object in view, a number of French and Chilean capitalists acquired a whole chain of mines and waterfalls and submitted for study, at Paris, the subject of the construction of an electric furnace for the metallurgy of copper. The work was intrusted to M. Imbert de Vanoy, former head of chemical operations at the works of Terre Noire and, of old, a collaborator with Gramme.

It took years of study to bring the work to a successful issue. Ninety-eight furnaces were constructed and demolished in succession before the creation of a type that permitted of practically applying to smelting works the laboratory method of electric heating devised by M. Moissan. The problem of employing the electric arc for the heating of furnaces used in metallurgy offered great difficulties due to the very properties of the arc; but these have been surmounted in the de Vanoy furnace, which is both a reverberatory and blast one that utilizes the radiant heat in a continuous manner, without direct contact with the electrodes. Two arcs formed between two pairs of huge carbons, about 4 inches in diameter, permit of obtaining a heat of 3,000 deg. C., and over if the furnace remains empty. In this formidable double electric lamp, it is possible to regulate the temperature according to requirements. While the furnace is in operation, two feeders empty buckets of a mixture of ore and flux into hoppers at the two elevated ends of the furnace. When the electric arc forms, it is possible, through a closed but transparent orifice, situated in the center of the furnace, to see the molten material gradually rise and reach the level of a tap hole formed at a certain height in the opposite wall. Through this hole, opened by a tool, flows a sort of very fluid glass, which, upon cooling, assumes the aspect of lava. About an hour after the first passage of the sparks, a tap hole in the lowermost part of the furnace is opened and allows of the outflow of metallic materials in fusion (copper matt), which run in a burning stream into the ingot molds. During this time, the feeders continue to fill the furnace, and another supply of material continues to melt and collect in the crucible of the furnace, the tap hole of which has been closed again. The operation may be continued in this way until the furnace has become completely worn out, that is to say, for nearly a year of incessant work. For a ton of mixed ore and flux per hour, the current necessary is 110 volts and 2,000 amperes, say an output of 440 kilowatts. This, put in the form of dollars and cents, evidently varies according to the conditions of production of the electricity. At the prices paid at Niagara Falls, the cost of electricity for a ton of ore and flux would be $1.96. At this rate, the metallurgy of copper would become very remunerative in the non-exploited mines of Chile and in other mines of countries in which the situation is favorable.

Very numerous experiments made at the works of the electric sector of Issy-les-Moulineaux have all given excellent results. It is therefore permissible to believe that the arrangement devised by M. Imbert de Vanoy has, for the metallurgy of copper at least, solved the problem of the electric blast furnace.—Translated for the Scientific American Supplement from La Nature.

PORTABLE ELECTRIC SEARCHLIGHT PLANT FOR THE BRITISH WAR OFFICE.

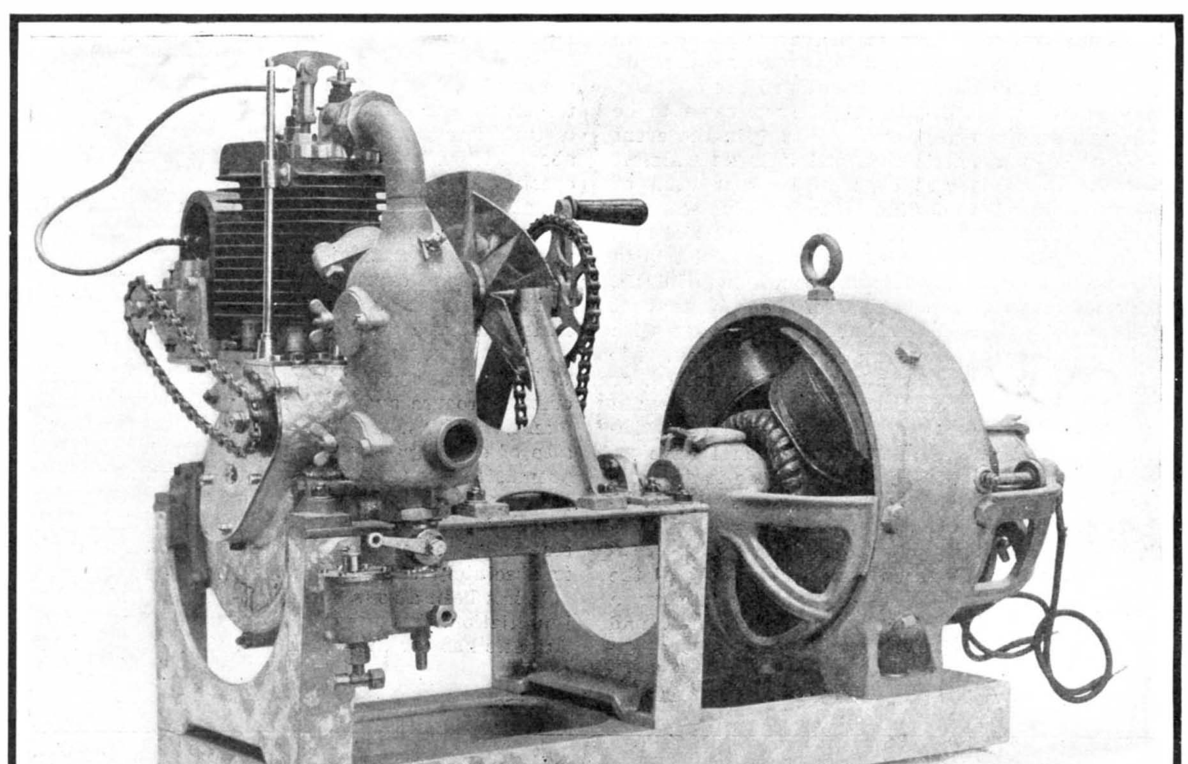
By Emile Guarini.

The Simms Manufacturing Company has recently furnished the British War Office with a plant for generating electricity for searchlights, and which is worthy of a brief description. The dynamo is driven by a 3½-horse-power Simms motor consuming ordinary kerosene or petroleum. The bore of the cylinder is 3 inches, as is also the stroke. The ignition is electric by means of a Simms-Bosch high-tension magneto. The arrangement for the timing of the spark is contained in the interior and forms a part of the magneto machine. Being very simple, it is not apt to get out of order. The pulley, which is of a special form for the reception of a wide V-shaped belt, is so constructed as to afford a maximum of adhesion. Any oil that escapes from the bearings cannot reach the belt.

The inlet and exhaust valves can both be removed by unscrewing two nuts. The carbureter is provided with an automatic mixture regulator that assures a constant proportion of kerosene vapor and air, whatever be the speed of the motor. There is also a particularly large exhaust chamber which prevents back pressure and completely muffles the exhaust. The weight of the motor complete, with sparking apparatus and carbureter, is about 65 pounds, while its height is 20 inches, its length 11, and its width 6. It is cooled by air through the intermedium of a fan actuated by the motor itself.

The dynamo is of the Electric Construction Company type.

The plant was tested for six hours in the presence of several attaches of the War Office, and it was found that the current developed after running for that length of time under full charge was 16 amperes at 75 volts, the number of revolutions being from 1,450 to 1,500 per minute.



THREE-AND-ONE-HALF-HORSE-POWER AIR COOLED MOTOR DRIVING A DYNAMO.

CONTEMPORARY ELECTRICAL SCIENCE.*

Physiological Effect of Radium Emanation.—C. Bouchard, P. Curie and V. Balthazard have examined the effect of radium emanation on the life and the tissues of mice and rabbits. They found that the confinement of the animals in an atmosphere containing radium emanation, but maintained at a constant composition by the renewal of the oxygen and the absorption of the carbonic acid, led to death in a few hours, the cause of death being inflammation of the lungs. The tissues of the animals which had succumbed became highly radio-active, more especially the fur and the lungs. Injection of fluids containing the emanation has no toxic effect.—Bouchard, Curie, and Balthazard, Comptes Rendus, June 6, 1904.

Subjective Phenomena in N-ray Observations.—F. P. Le Roux points out the important part played by subjective effects in many of the usual N-ray observations. The apparent increase of luminosity of a faint patch by a sound may be simply a nerve phenomenon due to the temporary suspension of the fatigue incurred in its contemplation. The author mentions another source of error in observing the effect of anæsthetics. If the faint patch is observed with only one eye, and a bottle of chloroform held closed with the thumb is brought near the nasal orifice on the side of the observing eye, the brightness of the patch diminishes with the slightest inhalation. On opening the other eye, the patch appears as bright as before. The reverse effect is produced by substituting alcohol for the chloroform.—F. P. Le Roux, Comptes Rendus, June 6, 1904.

Microscopic Aspect of Sparking Poles.—B. Eginitis describes some peculiar effects observed on examining the poles of spark-gaps under the microscope. The appearance of knobs of manganese, iron, platinum, and nickel is very different from that of knobs of lead, aluminium, or tin. In the first class of metals, the ends of the poles are decorated with lines of bright points, each of which appears to have acted as the terminal point of a discharge, whereas in the second class the charge seems to proceed from a single point. In the case of lead, drops are formed, and these are sometimes observed to travel upward over the surface of the pole. Under the microscope, the points have the appearance of craters. On increasing the inductance in the circuit, the number of points increases

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

up to a certain amount, and then suddenly decreases. This variation, due to inductance, may, however, be brought about by other means also, such as heating, and the author thinks it is all a matter of temperature, which at a certain point changes enormously with the inductance.—B. Eginitis, Comptes Rendus, May 16, 1904.

ELECTRIC TRANSMISSION DEVICES FOR AUTOMOBILES: THE JEANTAUD AND THE ELECTROGENIA SYSTEMS.*

By the Paris Correspondent of the Scientific American.

In view of the great loss which follows the mechanical transmission from the motor to the rear wheels of an automobile, owing to the considerable amount of gearing which is needed in the car, the attention of inventors has been attracted to the electric method of transmitting the power. Here the mechanical devices are dispensed with, and connection is made from the motor to the rear by an electric method. The car is not only much easier to operate, but the loss of power is claimed to be greatly reduced. Two new devices of this kind have lately been brought out in Paris, one of them by the Jeantaud Company. This is illustrated in the different engravings, the lower one of which shows the chassis. The motor, *M*, is coupled to the rear shaft by an electro-magnetic transmission device, *A*, which gives a variable speed on the rear wheels while the gasoline motor runs at a constant speed. The transmitting device has somewhat the form of a dynamo or motor in external appearance. As shown in the sectional view, Fig. 2, it consists of a cylindrical piece, *M*, which is stationary and fixed to the chassis. This contains a number of projecting pole-pieces with their field windings, *m*. Inside the field which is thus formed, revolves a second cylinder, *A*, which is mounted on the end of the motor shaft, *C*. On the outside of the cylinder is the laminated ring, *N*, which is slotted and forms an armature. For this purpose it is provided with the coils, *N*, and the commutator, *R*. On the inner periphery of the cylinder is fixed a set of pole-pieces, *O*, provided with field windings. Inside the cylinder, *A*, revolves an armature, *P*, which is fixed on the end of the rear shaft, *D*, leading to the differential and by which the movement is transmitted to the rear wheels of the car. The armature, *P*, has a commutator, *S*. Current is sent through the moving field coils, *O*, by means of collector rings, fixed to *A*.

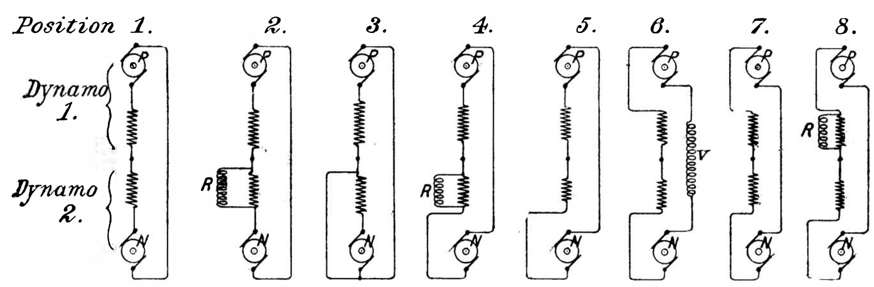


Fig. 1.—COMBINATIONS OBTAINED BY CONTROLLER OF JEANTAUD CAR.

The above combination forms two separate dynamos. The outer dynamo consists of the field, *M*, and the armature, *N*, while the inner dynamo is formed by the field, *O*, and the armature, *P*. The latter armature is caused to rotate at different speeds with relation to the motor-shaft, *C*, by means of the magnetic reactions between the dynamos. The circuits of the two fields and two armatures are brought to the controller, which gives the proper combinations for the different speeds, as well as an electric brake and a reverse.

The device which is thus formed is a most ingenious one, as it affords a method of obtaining variable speeds by a simple combination of electric circuits.

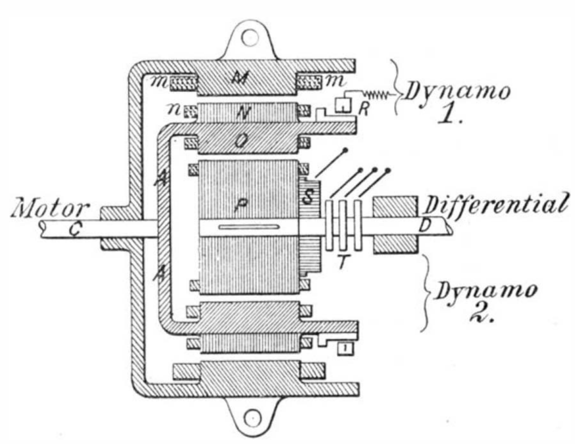
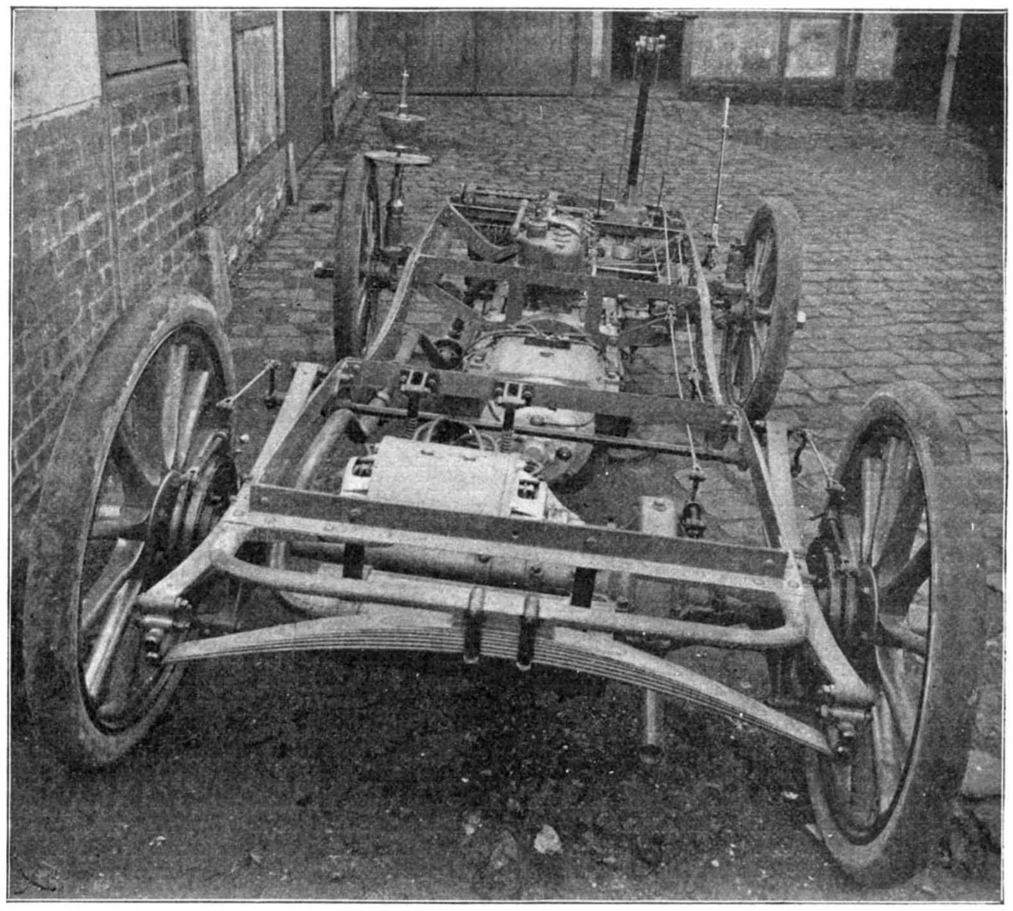


Fig. 2.—CROSS-SECTION OF TRANSMITTING DYNAMO OF JEANTAUD CAR.

These combinations are shown in Fig. 1, which indicates the method of coupling the two dynamos. At the position of full stop of the car, 1, the circuits of the two dynamos are connected in opposition. The two machines are now in series. In the diagram, the upper dynamo is that shown on the outside in Fig. 2, and the lower, that shown on the inside. The electromotive forces which the dynamos tend to develop are now in opposition, and there will be no current in the circuit. In consequence the two dynamos will have no action on each other and the rotation of the shaft, *C*, will have no effect upon the shaft, *D*. The gasoline motor thus ceases to drive the rear wheels, and the car is at rest.

Position 2 gives the start and the slow speed. The

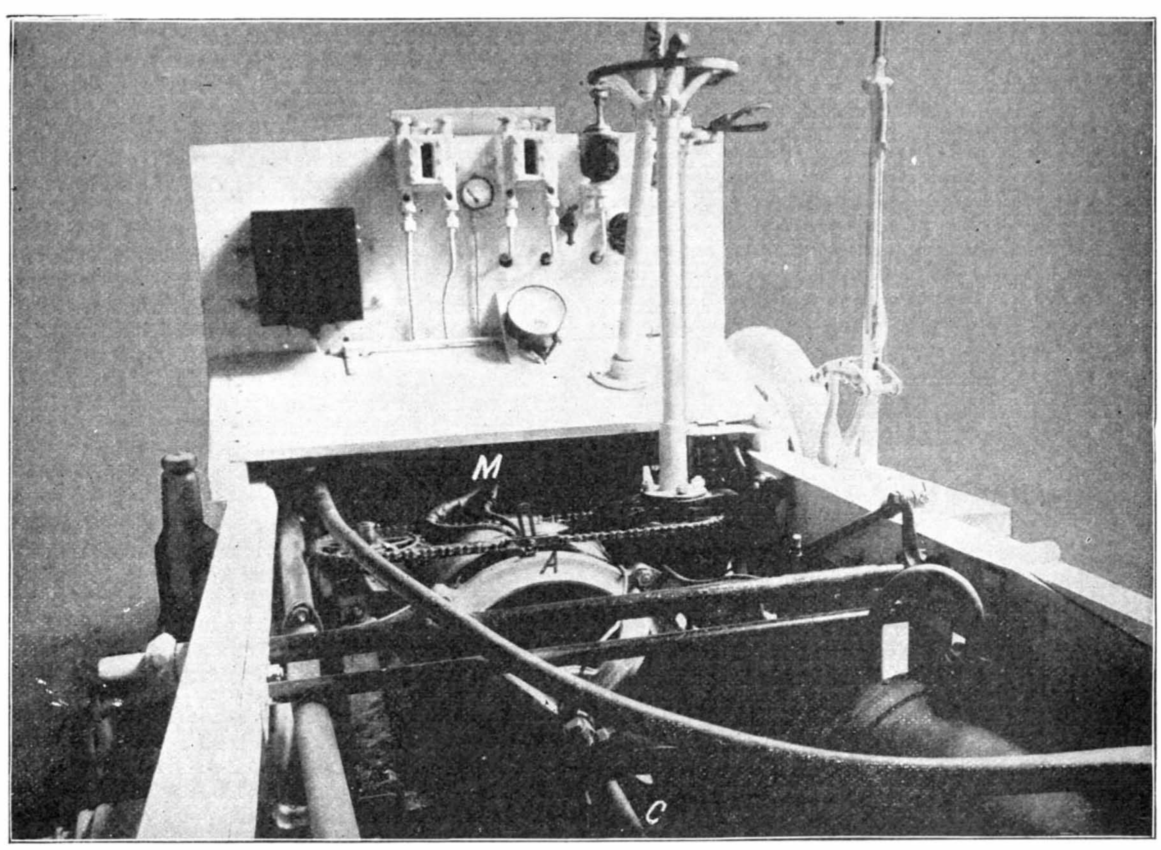


ELECTROGENIA GASOLINE-ELECTRIC CAR, SHOWING GASOLINE MOTOR IN FRONT DIRECT-CONNECTED TO DYNAMO, AND ELECTRIC MOTOR DRIVING REAR AXLE.

circuits are coupled as before, but the field, *M*, of dynamo 2 is shunted by a variable resistance, *R*. This cuts down the strength of the opposing electromotive force generated by dynamo 1. As the opposing force of dynamo 1 is now less than before, the balance between the two machines is destroyed. Owing to the magnetic forces in play, the armature, *P*, now revolves slowly in the same direction as the cylinder, *A*. That is, the gasoline motor drives the rear shaft, *D*, at a slow speed.

At position 3 the speed is increased by lowering the resistance of the shunt until the dynamo 2 is entirely short-circuited. The rotation of the shaft, *C*, causes the field, *O*, to draw the armature, *P*, along with it, and as dynamo 1 is short-circuited, it does not affect dynamo 2, whose two parts, *O* and *P*, revolve at nearly the same speed, seeing that the magnetic action between the two is now at its maximum. There is only the slight difference of speed or slip between *A* and *P*, which is necessary to keep up the current in the dynamo. The gasoline motor thus drives the rear shaft almost the same as if it were coupled to it mechanically.

Position 4 gives a still greater speed. The coupling is the same as in position 2 with the field, *M*, shunted by resistance, *R*. But in this case the armature circuit of the second dynamo is reversed. The electromotive forces of the two machines now act in concert instead of in opposition as before. The armature, *P*, now tends to revolve faster than its field, *O*. This speed becomes greater as the shunt upon *M* is diminished in value up to the point where the shunt is completely cut out. Dynamo 2 is now developing its maximum current, and its armature shaft, *D*, runs at twice the speed of the motor shaft, *C*, on which its fields are mounted. This gives position 5, with which the maximum speed is developed, the car being run as fast as the gasoline motor can possibly drive it.



CHASSIS OF JEANTAUD GASOLINE-ELECTRIC AUTOMOBILE, SHOWING DOUBLE POWER-TRANSMITTING DYNAMO AT A.

An effective electric braking action is obtained with the above system. In position 6 the connections of position 1 are reversed, and the two armatures now work in opposite directions. The circuits between the two machines are closed through a variable resistance,

* Specially prepared for the Scientific American Supplement.

V. The two dynamos act as generators and furnish current whose energy is expended upon the resistance, *V*. This soon lowers the speed of dynamo 1 and the speed is still further reduced by diminishing the resistance of *V* and thus increasing the work of the dynamo. When the resistance is reduced to 0, so that the two dynamos are connected directly together in short circuit, the braking action is strongest, as shown in position 7.

The reverse is obtained by position 8. After the braking action has been secured by position 7, a shunt of high resistance is connected to the field, *M*, of dynamo 1. This is the reverse of position 2, and in this case the opposing electromotive force generated in dynamo 2 is reduced so that the armature of the latter now runs in the opposite direction, and the rear shaft, *B*, is thus turned in the opposite direction to the motor shaft, *C*. The chauffeur can thus drive the car by simply operating the controller handle and can run from a very slow up to a high speed, apply the electric brake, or reverse the car. The controller can be built so as to give any desired number of intermediate positions by using variable resistances, so that the speed changing is operated very smoothly and without shocks.

The Electrogenia car uses a method of electric transmission which is designed on an entirely different principle from the former. Our illustration shows a chassis on which can be seen the different parts. The gasoline motor is at the front of the chassis, as usual. It drives a dynamo, which is mounted directly in line with its crankshaft. The dynamo sends current into an electric motor, which drives the differential on the rear axle. By varying the current by a controller, any number of different speeds can be given to the rear wheels, while the gasoline motor runs at a constant speed. This system has been designed by M. Chemin, a prominent engineer of Paris.

The gasoline motor is of the Aster pattern and gives 12 horse-power. The dynamo is of the shunt-wound type, while the motor is series-wound. It has two circuits for the field and two for the armature. The circuits of dynamo and motor are all brought to the controller, which the chauffeur operates by a hand-wheel. Four positions are used to give the different speeds to the car. These four methods of coupling correspond to four different speeds of the car, while the gasoline motor continues to drive the generator at a constant speed. Intermediate speeds can easily be produced on this system by using auxiliary resistances to vary the current. Another point to be remarked is that when the gasoline motor is slowed down, it reduces the voltage of the generator accordingly, and the car can thus be slowed down to a full stop by a variation in the gasoline motor alone, without having to break the current or otherwise operate the controller. In the same way the car can be started from rest by starting the gasoline motor.

It is claimed that the present electric system of transmission has a much higher efficiency than the mechanical system. Some authorities state that the gear transmission which is in general use on automobiles gives a loss of 50 per cent of the power of the motor. At any rate, the loss is considerable. A series of tests were made upon the Electrogenia car to establish the efficiency of the electric system and compare it with the above. This could be easily done by making the electrical measurements. The gasoline motor, when tested by a Prony brake, gave an average of 11.05 horse-power. The generating dynamo furnished 72 amperes and 95 volts, or 6,840 watts. As the power of the motor is 8,132.8 watts, the efficiency of the dynamo figures 85.78 per cent. A current was sent from the generator to the motor, while a Prony brake was placed on the rear axle. The motor was found to utilize 80.2 per cent of the energy furnished it by the dynamo. The total efficiency of the system is thus 85.78 x 80.2, or 68.8 per cent. Comparing this result with the 50 per cent cited above (and this is no doubt very often less) we have a gain of nearly 20 per cent of the total power, or nearly 40 per cent of the power which the car actually uses. Otherwise stated, with the same gasoline motor but using the electric system, we have more than one-third additional power to be used in running the car.

ON THE PERIODIC ARRANGEMENT OF THE ELEMENTS.*

By Sir WILLIAM RAMSAY, K.C.B., F.R.S.

AT the end of the eighteenth century, after the investigations of Black, Scheele, Priestley, Cavendish, and Lavoisier began to crystallize the previous arbitrary collections of chemical facts into more or less of a system, it became evident that the distinguishing feature of a "compound," as contrasted with a "mixture," was the invariability of its composition. Early in the nineteenth century, Dalton formulated his celebrated hypothesis, by means of which a concrete view was gained regarding the cause of this constancy and invariability of composition. Everyone knows that this "explanation" consisted in the supposition that the combination of two substances, one with another, in definite proportions, involves the union either of one atom of the one with one atom of the other, or of certain small but simple numbers of atoms of the two substances. The atom was regarded, not necessarily as indivisible, but as not having been divided into any smaller particles. The advance made by Dalton consisted chiefly in ascribing to each atom a definite weight; but as he had no data for determining the absolute weight of any one atom, he was obliged to content himself with relative weights, and chose the smallest known to him, that of hydrogen, as an arbitrary unit. This choice has proved to be a just one, for as yet no element has been discovered possessing a lower atomic weight than hydrogen, although it is by no means impossible that such an element may exist.

After the convenience of Dalton's hypothesis had been acknowledged, the labor of chemists was for many years devoted to the determination of the relative values of the "atomic weights" of the elements; or expressed in a manner independent of hypothesis, of their combining proportions. The name of the Swedish chemist, Berzelius, is prominent in this connection. By the analysis of an almost incredibly large number of compounds, he established on a firm basis the constancy of composition of compounds, and the law of multiple proportions. Toward the '40's, therefore, a set of numbers had been collected, which invited an attempt to place them in order, with the view of seeing whether some still more profound law could not be discovered connecting the combining numbers attached to them. Döbereiner, as early as 1817, and again in 1829, pointed out that certain elements had atomic weights which were nearly the mean of those of others which were closely related to them; thus, the mean of the atomic weights of calcium and barium gives a close approximation to the atomic weight of strontium; that of sodium lies near the mean of those of lithium and potassium; and sulphur and tellurium similarly indicate selenium as a middle element. In 1843, Gmelin, who published a "Handbook of Chemistry" which is still a classic, attempted a classification based, not upon numerical relations, but on similarity of properties. For instance, we find the groups—F, Cl, Br, I; S, Se, Te; P, As, Sb; C, B, Si; Li, Na, K; Mg, Ca, Sr, Ba; and so on. In 1851, Dumas gave a lecture before the British Association, in which he showed that not merely is the atomic weight of bromine the mean of those of chlorine and iodine, but that its physical properties, such as its color, its density in the gaseous and in the liquid state, etc., are also half-way between those of the allied elements. In 1852, Faraday criticised Dumas's attempts as "speculations which have scarcely yet assumed the consistence of a theory, and which are only at the present time to be ranked among the poetic day-dreams of a philosopher," and he proceeded: "We seem here to have the dawning of a new light indicative of the mutual convertibility of certain groups of elements, although under conditions which are as yet hidden from our scrutiny."

Passing over attempts by Gladstone, Cooke, Odling, and Strecker, we come to the years 1863 and 1864, when John Newlands, in a series of letters to the Chemical News, announced what he termed the "Law of Octaves." His actual words were: "If the elements are arranged in the order of their equivalents, with a few slight transpositions, it will be observed that elements belonging to the same group usually appear on the same horizontal line. It will also be seen that the numbers of analogous elements generally differ, either by 7 or by some multiple of 7; in other words, members of the same group stand to each other in the same relation as the extremities of one or more octaves in music. Thus, in the nitrogen group, between nitrogen and phosphorus there are 7 elements; between phosphorus and arsenic, 14; between arsenic and antimony, 14; and lastly, between antimony and bismuth, 14 also. This peculiar relationship I propose provisionally to term the 'Law of Octaves.'"

In 1869 and 1870, Lothar Meyer and Dmitri Mendeléeff, independently of Newlands, and also of each other, published papers in which they maintained that the properties of the elements are periodic functions of their atomic weights. This discovery goes by the name of the "Periodic Law," or better, the "Periodic System." The arrangement of Meyer (table), which differs but little from that of Mendeléeff, is the one generally adopted.

If this diagram is rolled round a cylinder, it will form a continuous spiral, beginning with lithium and ending with uranium; but there are certain gaps unfilled, denoted by the sign ?, which, it is believed, represent the places of still undiscovered elements. Indeed, Meyer's original diagram contained a larger number of these; and Mendeléeff, averaging the properties of the elements surrounding such gaps, prophesied the discovery of scandium, gallium and germanium, made at a much later date by Cleve, by Lecoq de Boisbaudran, and by Winckler.

There are many other ways of representing these relations; but, except perhaps in convenience (and questionably even in that), they present no particular advantage, and convey no new knowledge. Only one point must be emphasized. The elements, as arranged above, divide themselves into two "periods"—long periods and short periods. Thus, the seventh member after lithium, sodium, is in its character very like lithium; and again, potassium, the seventh after sodium, presents strong analogies with the two elements named; but it is then necessary to pass over fourteen elements before rubidium is reached, which again closely resembles lithium, sodium, and potassium; and cæsium, the fourteenth element after rubidium, forms the first term of another long period. Copper, silver, and gold are also separated by long periods; and so with the elements in the other columns. To distinguish these in the table, the symbols of the elements in the middle of the long periods are printed toward the left, and those at the beginning toward the right, of the figures denoting the atomic weights.

One other point requires mention. Several instances occur, in which the elements appear to occupy a reversed position. Thus, nickel, with the atomic weight 58.7, follows cobalt, to which a higher atomic weight is ascribed; tellurium precedes, instead of following iodine; and it will be seen that argon precedes potassium. The differences between the various consecutive atomic weights are irregular, and vary between fairly wide limits; and it is quite probable that these differences may occasionally be negative.

In 1894, a new constituent of the atmosphere, which was named "argon," was discovered by Lord Rayleigh and Ramsay; this was followed, in 1895, by the discovery by Ramsay of helium in certain minerals. This gas gives a spectrum in which a brilliant yellow line

I.	II.	III.	IV.	V.	VI.	VII.	VIII.		
Li 7.03	Be 9.1	B 11.0	C 12.0	N 14.04	O 16.00	F 19		*He* *4*	
Na 23.05	Mg 24.36	Al 27.1	Si 28.4	P 31.0	S 32.06	Cl 35.45		*Ne* *20*	
K 39.14	Ca 40.0	Sc 44	Ti 48.1	V 51.2	Cr 52.1	Mn 55.0		*A* *39.9*	
Cu 63.6	Zn 65.4	Ga 70	Ge 74	As 75	Se 79.1	Br 79.95	Fe 56.0	Co 59.0	Ni 58.7
Rb 85.4	Sr 87.6	Y 89	Zr 90.6	Nb 94	Mo 95.0	? 99		*Kr* *81.5*	
Ag 107.95	Cd 112	In 114	Sn 119.0	Sb 120	Te 127.6	I 126.85	Ru 101.7	Rh 103.0	Pd 106
Cs 133.0	Ba 137.16	La 138	Ce 140	Prd 141	Nd 143.5	? 152		*X* *128*	
? 165	? 170	Yb 173	? 176	Ta 183	W 184	? 185	Os 191	Ir 193	Pt 195.2
Au 197.2	Hg 200.3	Tl 204.1	Pb 206.9	Bi 208.5	? 210	? 211		?	
? 222	Ra 225	? 230	Th 232	? 234	U 240	? 242			

is conspicuous. So long ago as 1868 this line had been observed in the solar spectrum by Jansen; it was attributed to the presence of a new element in the sun, by Frankland and Lockyer, and they named the then unknown element "helium." These discoveries were followed by that of three other gaseous elements in atmospheric air, by Ramsay and Travers in 1898; thus five elements were added to the list. All these elements are distinguished by their inertness, for none of them forms compounds with other elements.

The Roman figures at the head of the columns of the periodic table have a certain significance. They show the maximum number of atoms of hydrogen which the elements in each column can combine with or replace, or, as it is termed, their "valency." Thus, an atom of lithium combines with one atom of hydrogen; it can also replace one atom, as when it forms lithium hydroxide, LiOH, in which it has replaced one atom of hydrogen in water, H_2O. So also, magnesium can replace two atoms of hydrogen, for it forms the hydroxide $Mg(OH)_2$. Boron combines with three atoms of hydrogen, carbon with four; phosphorus, although it can combine with only three atoms of hydrogen, can replace five; for it forms a chloride PCl_5, in which it has replaced the five atoms of hydrogen in five molecules of hydrogen chloride, 5HCl. Sulphur forms a hexafluoride, and iodine a heptafluoride, in which they replace six and seven atoms of hydrogen respectively, in 6HF, and in 7HF. Only one of the elements of the eighth group appears to be able to replace 8 atoms of hydrogen, namely, osmium; it forms a tetroxide, OsO_4, thus replacing the eight atoms of hydrogen in four molecules of water, $4H_2O$. But the new gaseous elements of the atmosphere form no compounds, and have no valency, as the power of replacing or combining with hydrogen is termed. They thus form a column by themselves; and it was interesting to ascertain whether their atomic weights would form a series like those in the other columns. In this case, the atomic weight could not be determined by the usual process of determining the ratio in which the elements combine with hydrogen; hence a different method was adopted, depending on the known fact that equal numbers of molecules of gases occupy equal volumes under the same conditions of temperature and pressure; and making

* Technics.

use of an argument relating to the number of atoms in such molecules. The atomic weights were:

Helium	Neon	Argon	Krypton	Xenon
4	20	39.9	81.5	128

These numbers, as will be seen on reference to the table, fit in the eighth column; the symbols and atomic weights of these gases are printed in italics. They form the initial members of the first, second, and third short series, and of the first and second long series.

Some doubt exists as to the place to be assigned to hydrogen, the element with lowest atomic weight. Both Mendeléeff and Meyer shirked placing it. It may be that it should be placed at the head of the fluorine column; but there are equally good, or perhaps better reasons for believing that it is the first member of the lithium column.

Many attempts have been made to devise some mathematical relation between these atomic weights. So long as there was reason to doubt the accuracy of the experiments by means of which the atomic weights have been determined, some such relation as the following had considerable probability in its favor: Taking the differences between the atomic weights of the elements in the first column, lithium, sodium, potassium, rubidium, and cæsium, they are

Na — Li = 23 — 7 = 16;
K — Na = 39 — 23 = 16;
Rb — K = 85 — 39 = 46 = (3 × 16) nearly;
Cs — Rb = 133 — 85 = 48 = (3 × 16).

The differences are 16, 16, 3 × 16, and 3 × 16. Now there are compounds of carbon and hydrogen, which possess the formulæ, CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, C_6H_{14}, etc.; and as the atomic weight of carbon is 12, and that of hydrogen 1, the sum of the atomic weights, or, as they are called, the molecular weights, are respectively 16, 30, 44, 58, 72, 86, etc., with a common difference of 14. We see therefore, that a set of compounds may so differ in molecular weight as to present a regular series, with a common difference. Nothing was more likely, then, than that sodium should be regarded as a compound of one atom of lithium with one atom of an unknown element of atomic weight 16, or with two atoms of an unknown element of atomic weight 8; while potassium might be looked upon as a compound of an atom of lithium, with four atoms of the element of atomic weight 8; and so on. But, unfortunately for this simple theory, the differences between the atomic weights of the elements are not exactly equal. Instead of 16, the real difference between the atomic weights of lithium and sodium is 16.02; between potassium and sodium, 16.09, and so on. In other groups the divergences are still more striking.

The cause of this irregularity has, therefore, to be sought. In seeking for a clue, the first question is: Are the atomic weights invariable? A further question is: Is weight invariable? Does a body always possess the same weight under all conditions? For example, would the weight of a body remain the same, if it were to be weighed at different temperatures? Or, if electrically charged, would its weight remain unaltered.

It is a very difficult problem to weigh an object at a high temperature. If the balance, as is usual, contains air, convection currents are produced by the ascent of air heated by the warm body, and the body apparently weighs too little. If the whole balance were uniformly heated, the weights would be at the same temperature as the substance weighed; and it is to be presumed that both they and the substance would alter in weight equally, and still remain in counterpoise. And if the balance case be pumped empty of air, as was done by Crookes in determining the atomic weight of thallium, other phenomena intervene, which, however interesting in themselves (they led Crookes to the invention of the radiometer), are very disconcerting; for attractions and repulsions, which completely disturb equilibrium, are produced by the slightest variations of temperature. However, some curious calculations have been made by Hicks in dealing with Baily's experiments on the attraction of leaden balls by masses of lead—experiments which afford data for calculating the density of the earth. At a high temperature the attraction appeared to be less than at a low one; and as the attraction of the earth is the cause of weight, supposing these experiments to be correct, and the deductions legitimate, it would follow that weight is altered by temperature. The subject is well worthy of further experiment.

Again, interesting experiments have been made by Landolt, as regards constancy of weight. Having sealed up in an inverted U-tube, two substances capable of acting on each other, such as silver nitrate and sodium chloride, each substance in solution occupying one limb of the tube, he weighed the tube with the utmost accuracy; the possible error might be one part in a million. On inverting the tube, the two solutions mixed, and the reaction took place. It was again weighed. For long, Landolt supposed that he had detected small changes in weight, sometimes negative, sometimes positive; but he was able to trace these changes to the porous nature of glass. On employing tubes made of fused quartz, no change of weight could be detected after the reaction was over. Apparently, therefore, no change of weight takes place as the result of a chemical reaction, provided nothing leaves or enters the vessel in which the reaction goes on.

A very ingenious experiment of Joly's deserves mention. It was designed to try whether any change of mass occurs on mixing two reacting bodies, and the disposition of the apparatus was somewhat like that devised by Landolt. But instead of utilizing the attraction of the earth in order to estimate whether the mass had changed or not, the inertia of the substances and of their mixture was determined. The vessel containing the substances to be mixed was suspended to the arm of a torsion-balance, the arm of which was at right angles to the direction of motion of the earth, which is known to be at the rate of about 30 miles a second through space. If matter had been created during the chemical change, then the created matter would not partake of the earth's velocity, and a retardation, made manifest by the rotation of the arms of the torsion-balance in one direction, would have been observed; and if, on the other hand, matter had been destroyed, an acceleration would have shown itself. The experiments were entirely negative; hence it may be concluded, confirmatory of the experiments of Landolt, that no change in mass is produced by a chemical reaction. A variation in weight or in inertia has not been observed.

There is one curious discrepancy which still remains unexplained. The density of nitrogen gas has been very accurately determined by two very competent observers—Lord Rayleigh and Leduc. They both agree in their results to one part in 10,000. Now it is known, for reasons into which we cannot enter here, that the molecules of both nitrogen and oxygen consist each of two atoms; and as it is also certain that equal volumes of gases contain nearly equal numbers of molecules, when measured under similar conditions of temperature and pressure, the relative weights of these gases correspond to the relative weights of the atoms. The word "nearly" has been used; for a slight correction must be introduced in order to secure exact correspondence. Hence the atomic weight of nitrogen, referred to that of oxygen taken as 16, as is now customary, must be 14.002, since that is the density of nitrogen referred to oxygen as 16, after the necessary correction has been made. But this number does not correspond with the atomic weight of nitrogen obtained by the celebrated chemist Stas, as the result of the analysis of such compounds as potassium nitrate, when he determined the ratio between the quantities of nitrogen and oxygen in the molecule KNO_3. Both he and, quite recently, one of the most skillful of analysts, to whom we owe in recent years many exact determinations of atomic weights, Theodore Richards, agree in ascribing the number 14.04 to nitrogen as its atomic weight. The difference does not appear very great; but yet it amounts to one part in 370: and the error of experiment is not likely to be greater than one part in 10,000. This discrepancy is one of the most curious of chemical facts, and it would well repay further investigation. It may be added that the determination by Gray of the density of nitric oxide, a compound containing one atom of nitrogen in combination with one atom of oxygen, entirely corroborates the results of Lord Rayleigh and Leduc. Experiments are now in progress to combine a weighed quantity of nitric oxide with oxygen, so as to cause it to take up one other atom of oxygen, and to find the increase in weight; and also to remove from it the atom of oxygen, and to find the weight of the oxygen removed; we may, therefore, hope for some explanation of the above discrepancy at no distant date.

The writer of this article was so much impressed by the consideration of this discrepancy, that some years ago, in conjunction with Miss Aston, an attempt was made to find whether the fact of a compound having been formed with absorption, instead of, as is commoner, with evolution of heat, had any influence on the proportions of the elements which it contained. For this purpose the salts of a curious acid derivative of nitrogen named hydrazoic acid, HN_3, were analyzed; but there is reason to distrust the results, for it is possible that decomposition occurred during the preparation to some small extent, and so may not have led to trustworthy conclusions. But such as they were, they were in favor of the supposition that the atomic weight of nitrogen in such compounds is less than in those formed with evolution of heat, like the niter analyzed by Stas and by Richards.

An entirely new light has been thrown on the numerical relations of the atoms by the remarkable discovery of radium by the Curies, and by the discovery by Rutherford and Soddy, that what are termed the "rays" from its salts, as well as from those of thorium, are produced by gases resembling in their inertness the gases of the argon group. These gases, moreover, have the extraordinary property that they are transient, although they change in very different intervals of time. Whereas the gas from thorium is half gone in about a minute (that is, has changed to the extent of one-half into some other substance or substances), that from radium requires about four days before it has undergone half the change of which it is capable. A third gas has been obtained from a radio-active element to which the name "actinium" has been given by its discoverer, Debierne; this gas has an extraordinarily short life, for the total duration of its existence is only a few seconds. The spectrum of the gas from radium has been mapped by Ramsay and Collie; the amount of gas produced from a known weight of radium bromide has been measured by Ramsay and Soddy; and they, too, proved that one of its products of decomposition is the lightest gas of the argon group, helium. At first, the spectrum of the emanation from radium shows none of the characteristic lines of helium; but in the course of a few days the helium spectrum appears in full brilliancy. Here, evidently, is a case of the transformation of one element into another; no doubt there are other products than helium, but what they are remains for the present unknown. If they were elements like iron, for example, there are at present no known means delicate enough to detect the extremely minute amount which would be produced. These gases from radium, thorium, and actinium are self-luminous, and shine brilliantly in the dark; and they also possess the power of altering air and other gases with which they are mixed, so that they acquire the property of discharging an electrified body; the air is said to be "ionized." But a still more remarkable property is their giving off heat during their change into other elements, the amount of heat being enormous when their extremely small quantity is considered. Thus, the radium emanation (the name applied to the gas which is continuously evolved from salts of radium during their existence of about 1,100 years; for, at the end of that time, the change is complete, and no more radium is left as such), during the 28 days of its decomposition, gives off no less than three million times the heat which would be evolved during the explosion of an equal volume of a mixture of oxygen and hydrogen in the proportion requisite to form water. Now, if radium is disappearing, it must be continually in process of formation, else there would be none on the surface of the earth; it would all have disappeared and have been changed into other bodies in 1,100 years. As radium is always associated with uranium, it appears not unreasonable to suppose that uranium, too, which is a radio-active element, is slowly changing into radium; and there appears to be definite ground for the surmise that polonium, the first of the radio-active elements, also discovered by Madame Curie, which has a life of little more than one year, is a product of the decomposition of radium, with which it is always associated. It may be mentioned, too, that all minerals containing uranium contain more or less helium.

It will be noticed, on referring to the periodic table, that all the radio-active elements, that is, all those which are undergoing change of the nature described, have very high atomic weights. That of uranium is 240; that of thorium, 232; and that of radium, 225. Now, it is a commonplace of the organic chemist that it is not possible to build up compounds of carbon and hydrogen of unlimited complexity; indeed, it is doubtful if any compound has been prepared containing more than 54 atoms of carbon. Attempts to prepare them lead to failure, owing to their decomposing at the ordinary temperature into compounds containing a smaller number of atoms. And it is probable that more complex hydrocarbons, as such compounds are termed, would, if they could exist, decompose with evolution of heat. Such a decomposition appears to present analogy with the change which an element like radium is undergoing. It is in process of change into other elements of lower atomic weight; and in changing, it evolves heat, in amount enormously greater than that produced by any change of a compound into a mixture of simpler compounds. But the matter is complicated by another phenomenon—that of discharging, with almost inconceivable velocity, particles which appear, according to J. J. Thomson, to be identical with negative electricity. These "corpuscles," as they have been termed, imbed themselves in the vessel in which the radio-active body is confined; and, owing to their extreme minuteness, they may even pass through the walls of the containing vessel. Indeed, the opposition to their passage has been shown to depend merely on the density of the matter of which the confining walls are composed; gold, which is denser than lead, stops their passage better than lead; for a similar reason lead is better than iron, iron better than glass, and so on. Thomson has calculated that the mass of one such particle is approximately one-thousandth of that of an atom of hydrogen.

This new chemistry is just at its commencement. It dates from 1896, when Becquerel showed that compounds of uranium evolved some sort of radiation, which would impress a photographic plate. It is still too early to formulate any definite statement relating to its connection with the irregularity in the numerical sequence of the atomic weights; yet it may be permissible to speculate, aided by the recent discoveries. When two elements combine, heat is generally evolved; now heat is only one form of energy, and the combination of elements may be so carried out as to be accompanied by other kinds of energy—for instance, by the production of an electric current. Conversely, when a compound is resolved into its elements, it is generally necessary to impart energy to it; and the element may, therefore, be said to "contain" more energy than its compounds. Now, as Ostwald has pointed out in his "Faraday" lecture, the progress of discovery has kept pace with the amount of energy with which it was possible at the time to load a compound; and he cited the discovery of the metals of the alkalies, sodium, and potassium, by Davy. It was because Davy had at his disposal the powerful battery of the Royal Institution, that he was able to convey enough energy into caustic potash to isolate from it potassium, hydrogen, and oxygen. If we assume that radium, as may be possible, is produced by a spontaneous change in uranium; and if we also assume that radium contains more energy than uranium; then, as such a spontaneous change must be accompanied, on the whole, by a loss of energy, there must be formed other bodies from the uranium which contain less energy than it does. Such a substance may be iron, which is generally found in company with uranium. If we could concentrate energy into iron, it might be possible to convert it into uranium.

But there is another side to this question. The nature of the energy required appears to be electric in character. Now, it is almost certain that negative electricity is a particular form of matter; and positive electricity is matter deprived of negative electricity—that is, minus this electric matter. The addition of

matter in any form would, according to all experience, increase mass; it would also increase weight. It is, therefore, conceivable that an element may consist of a compound of two or more elements of lower atomic weight, plus a certain quantity of negative electricity. This might account for the approximate numerical relations which subsist between the atomic weights of the nearly related elements; and also for the fact that the relation is not an exact one, but only approximate; for the difference between the actual atomic weight, and that which would follow if one element were a compound of other elements of lower atomic weights, would be caused by the addition of a certain number of electric atoms to the molecule.

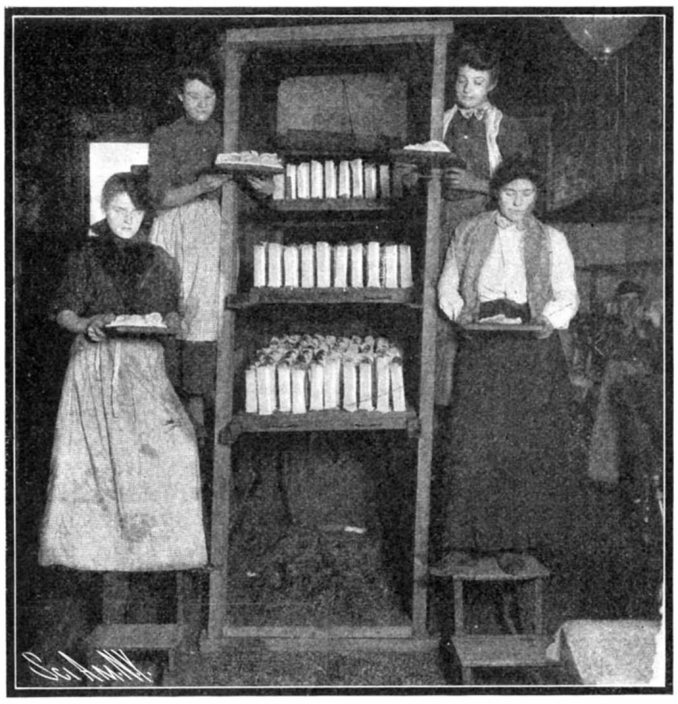
It must be confessed, however, that the basis for speculations like these is a slender one; the sole ground is the undoubted fact that radium produces an emanation, which spontaneously changes into helium; and also that, in doing so, the emanation parts with a large number of corpuscles carrying negative charges. Nevertheless, enough is known to prove that there is a wide field for experiment, and that the harvest will be a rich one; further, the reapers' task will be one of extraordinary interest.

Purifying Castor Oil.—Deacidify the crude oil with alcoholic alkalies, remove the soap thus formed first with dilute methyl alcohol, ethyl alcohol, or acetone, and after that in the well-known manner with water. For instance: Take 100 kilogrammes of castor oil which may have the acid value 12, and agitate it continuously for a time in a solution of 2 kilogrammes of ammonia soda dissolved in 100 kilogrammes of 50 per cent alcohol. When this fluid is left to itself, in a short time it separates into two layers, an upper stratum of oil and an under stratum consisting of an aqueous alcohol solution of soda and soap. After being drawn off the stratum of oil is now washed with spirit of wine of 40 per cent or 50 per cent proof, which has been warmed to 40 deg. or 50 deg. C. until a sample of the oil shaken with water no longer forms an emulsion. Now shake it up vigorously with warm water several times, and dry it. If the original material was free from aldehydes, then the result of the above purifying process will be a light, clear thick oil free from taste or odor.—Oesterreichischer Chemiker u. Techniker.

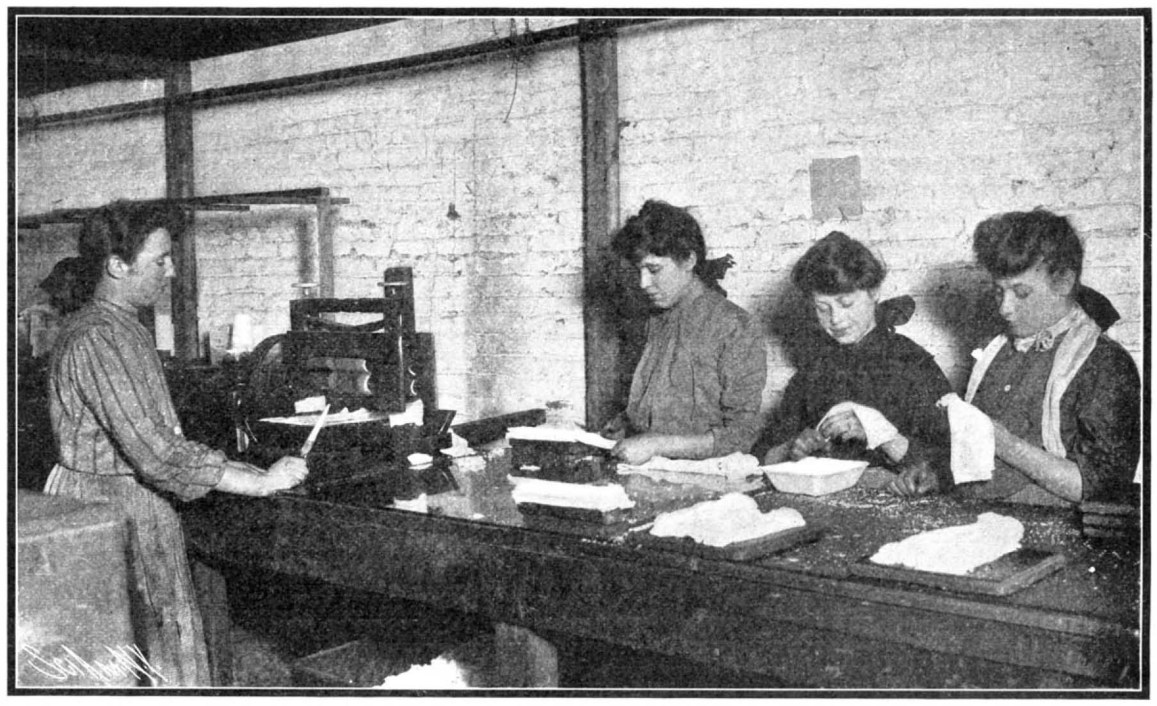
THE MAKING OF AN INCANDESCENT MANTLE.*

By Day Allen Willey.

One of the most interesting modern industries, and one which is notable for the number of delicate processes which attends it, is the manufacture of incandescent mantles for illumination by means of gas. While the general term for these articles is Welsbach, after the famous chemist whose discoveries produced a revolution in the industry, there are several different kinds, although the refractory properties of the majority originate from a few elements. In the experiments of Welsbach, which resulted so successfully, cotton fabric was saturated with a solution which contained the oxides of zirconium, lanthanum, and yttrium. The latter substances represented 20 per cent each, and the former 60 per cent of the compound. Later it was discovered that cerium formed an excellent substitute for lanthanum, the element being obtained in cerite earth.

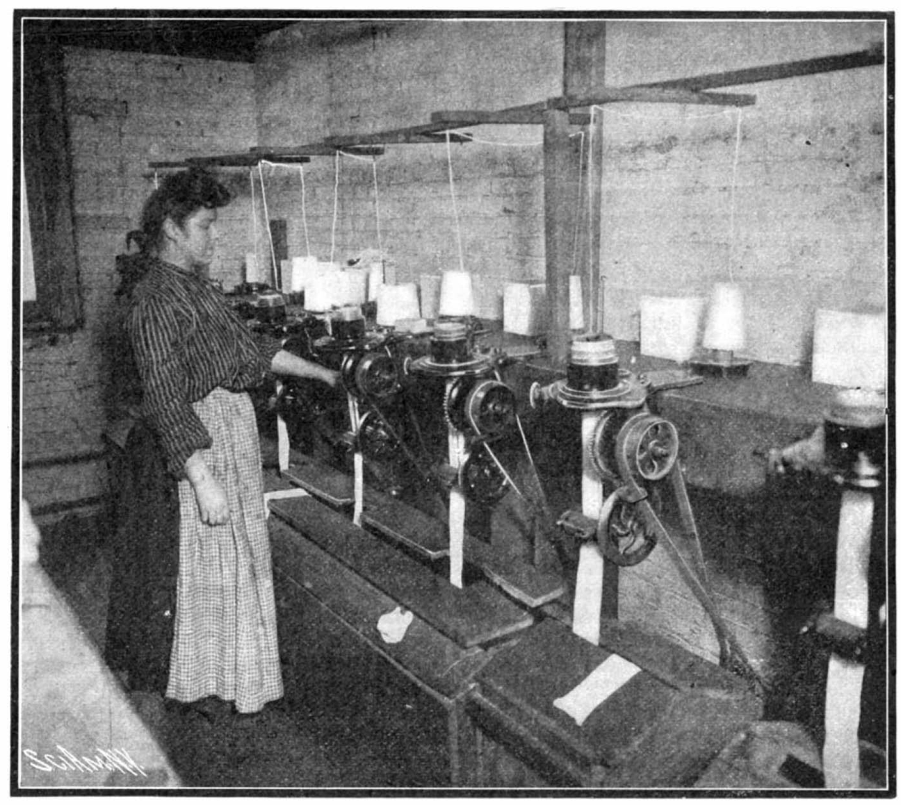


DRYING MANTLES AFTER BEING SHRUNK ON THE MODELS.



CUTTING THE MANTLES INTO THE PROPER LENGTHS BEFORE SHRINKING THE FABRIC.

APPARATUS FOR IMMERSING MANTLES IN THE HEAT-RESISTING COATING SOLUTION.



FORMING THE FABRIC FOR THE MANTLES.

THE MAKING OF AN INCANDESCENT MANTLE.

As the experiments progressed, Welsbach utilized thoria as a substitute for zirconia, and in utilizing it discovered its great value as a basis in mantle construction. In later processes thoria combined with ceria was found to produce the most brilliant and at the same time the most durable illumination, where the elements were combined under proper conditions, and to-day the best grades of mantles are composed of these elements, as well as alumina treated with chromic acid. Thoria in itself has practically no illuminating properties, although it is an interesting fact that in the present manufacture of mantles, as carried on in this country, from 97 to 99 per cent of it is used in connection with ceria, the proportion of the latter element ranging from nine-tenths to three per cent, but even this small amount is sufficient to give the mantle the brilliancy which makes it so popular. In combining the elements, it is necessary to have a certain temperature, also what the chemist terms an exact air adjustment, otherwise the quality may be seriously affected. Upon the temperature and air adjustment depend largely the percentage of ceria which is added to the thoria. From time to time other substances have been added to those mentioned, with a view of improving the quality of the light. They include silicic acid, oxide of arsenic, and antimony, but apparently have failed to raise the standard.

The fabric utilized in the modern gas mantle is principally cotton, although ramie fiber has been employed with success in Germany. Before the refractory salts are applied to the fabric, however, it is first carefully freed from impurities by immersing it in several baths. In the factories turning out the highest grades of mantles, the cotton is first immersed in dilute alkali, then in dilute acid, and finally washed thoroughly with distilled water, for it is necessary to remove every particle of foreign matter if it is to be perfect. The thoria and ceria are combined in a solution in which nitric acid is employed. Into the solution the mantles are dipped, suspended from racks, each rack being gradually immersed by hand until the mantles are thoroughly covered. After removal they are dried by being exposed to currents of warm air, after which a solution containing collodion may be added before firing or after the mantle has been reduced to a skeleton composed of oxides in the retort.

The fact that the fabric with its chemical coating must be "burned off" is one reason why so few of the elements available for making it incandescent can be employed. Some of the salts which might be available shrink it, when heat is applied, to such an extent that a mantle of very large size is required to obtain the oxide shell of the proper proportions. Other salts are volatilized to such an extent that the thread of oxide gradually disappears, and the mantle becomes worthless. The principal advantage of thoria as a base, aside from the fact that it gives forth such an illumination when combined with ceria, is the small

* Specially prepared for the Scientific American Supplement.

extent to which it shrinks when the nitrate fabric is converted into oxide, and the length of time the mantle retains its shape. In fact, the thoria oxide resists temperature better than any other which has been tested for this purpose, although thoria in its pure state emits a light of only one-half candle-power to every foot of gas consumed. When alumina is used as a base, its power depends upon the proportion of oxides of chromium which are produced by combining it with chromic acid, as already stated.

In firing the mantles, an oven made of sheet metal is generally utilized, being fitted with hooks on which the mantles are hung. When the oven is filled, the chemically-treated fabric is set afire and reduced to an oxide skeleton, all of the inflammable material being destroyed. Heat is again applied to the mantles, for the purpose of hardening the shell and giving them more durability. In a second oven they are exposed to air heated to a comparatively moderate temperature, remaining merely long enough to become thoroughly impregnated with the air, after which some kinds are given the finishing bath of collodion mixed with a certain proportion of varnish. This hardens, and assists in preserving the shape, but the inflammable portion is burned off when the gas flame is first applied to the mantle.

One of the most interesting processes connected with the industry is the manufacture of the fabric. The cotton in the form of yarn is literally knit into cylindrical shape by machines specially designed for the purpose. The warp is so thin, however, that it is transparent when held between the eye and a strong light, and the cylinder is open at both ends. The original size of the cylinder depends somewhat upon the kind of salts with which it is being treated, but the principal size averages about two inches in diameter. The cylinders come from the knitting machines in lengths of about eighteen inches, and are cut down to the dimensions desired before shrinking by hand, the upper end, into which the wire hoops are to be set, being partly closed by crimping. After going through the cleaning baths, the cylinders are molded by being drawn down over wooden models shaped like the mantle, a process which is performed entirely by hand.

The bulk of the thoria used in the manufacture of mantles in this country comes from the mountainous district of North Carolina, where it is found in monazite. It appears in the form of sand, caused by the disintegration of primitive rocks, and is found in various proportions ranging from 1 to as high as 16 per cent of the composition. The collection of monazite forms quite an important industry in the State named. It is shipped in boxes and barrels to the mantle factories, to be treated by chemical processes necessary to secure the salts.

Although but a small quantity of labor-saving machinery is employed in the manufacture of mantles, some of the American plants produce 10,000 to 12,000 daily, though they employ not over sixty hands. The majority of the operators are girls, for the reason that their touch is so much more delicate than that of men, and they can handle the material with less danger of breaking it, although as it is, the loss from this cause amounts to a large sum annually in all of the factories producing these articles.

MANUFACTURE OF COMPOUNDS IMITATING IVORY, SHELL, ETC.

Caseine, as known, may act the part of an acid and combine with bases to form caseinates or caseates; among these compounds, caseinates of potash, of soda, and of ammonia are the only ones soluble in water; all the others are insoluble and may be readily prepared by double decomposition. Thus, for example, to obtain caseinate of alumina, it is sufficient to add to a solution of casein in caustic soda, a solution of sulphate of alumina; an insoluble precipitate of caseine, or caseinate of alumina, is instantly formed.

This precipitate ought to be freed from the sulphate of soda (formed by double decomposition), by means of prolonged washing.

When pure, ordinary cellulose may be incorporated with it by this process, producing a new compound, cheaper than pure cellulose, although possessing the same properties, and capable of replacing it in all its applications.

According to the results desired, in transparency, color, hardness, etc., the most suitable caseinate should be selected. Thus, if a translucent compound is to be obtained, the caseinate of alumina yields the best. If a white compound is desired, the caseinate of zinc, or of magnesia, should be chosen; and for colored products the caseinates of iron, copper, and nickel will give varied tints.

The process employed for the new products, with a base of celluloid and caseinate, is as follows: On one hand caseine is dissolved in a solution of caustic soda (100 of water for 10 to 25 of soda), and this liquid is filtered, to separate the matters not dissolved and the impurities.

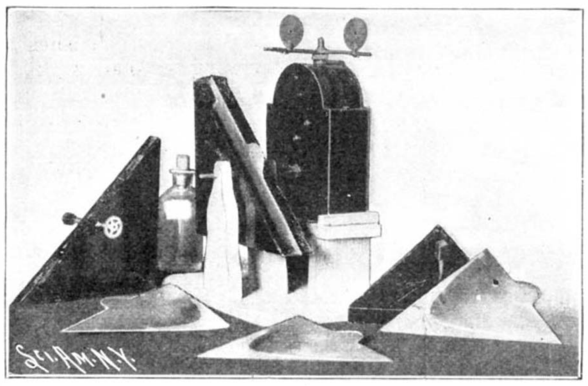
On the other hand, a salt of the base of which the caseinate is desired is dissolved, and the solution filtered. It is well not to operate on too concentrated a solution. The two solutions are mixed in a reservoir furnished with a mechanical stirrer, in order to obtain the insoluble caseinate precipitate in as finely divided a state as possible. This precipitate should be washed thoroughly, so as to free it from the soda salt formed by double decomposition, but on account of its gummy or pasty state, this washing presents certain difficulties, and should be done carefully. After the washing, the mass is freed from the greater part of water contained, by draining, followed by drying, or energetic pressing; then it is washed in alcohol, dried or pressed again, and is ready to be incorporated in the plastic mass of the celluloid.

For the latter immersion and washing, it has been found that an addition of 1 to 5 per cent of borax is advantageous, for it renders the mass more plastic, and facilitates the operation of mixing. This may be conducted in a mixing apparatus; but, in practice, it is found preferable to effect it with a rolling-mill, operating as follows:

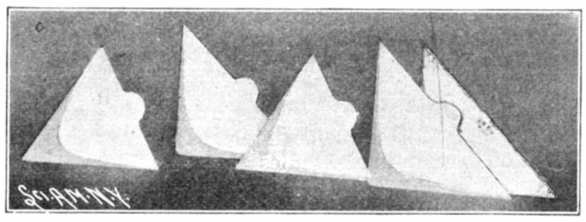
The nitro-cellulose is introduced in the plastic state, and moistened with a solution of camphor in alcohol (40 to 50 parts of camphor in 50 to 70 of alcohol for 100 of nitro-cellulose) as it is practised in the celluloid factories.

This plastic mass of nitro-cellulose is placed in a rolling mill, the cylinders of which are slightly heated at the same time as the caseinate, prepared as above; then the whole mass is worked by the cylinders until the mixture of the two is perfectly homogeneous, and the final mass is sufficiently hard to be drawn out in leaves in the same way as practised for pure celluloid.

These leaves are placed in hydraulic presses, where they are compressed, first hot, then cold, and the block thus formed is afterward cut into leaves of the thickness desired. These leaves are dried in an apparatus in the same way as ordinary celluloid. The product resembles celluloid, and has all its properties. At 90 to 100 deg. C. it becomes quite plastic, and is easily molded. It may be sawed, filed, turned and carved without difficulty, and takes on a superb polish. It burns less readily than celluloid, and its combustibility diminishes in proportion as the percentage of caseinate increases; finally, the cost price is less than that of celluloid, and by using a large proportion of caseinate, products may be manufactured at an extremely low cost.—Le Revue des Produits Chimiques.



THE HYPERBOLOGRAPH.



RESULTS OBTAINED WITH THE HYPERBOLOGRAPH.

MODEL OF SNAGBOAT "GENERAL WRIGHT" AT THE ST. LOUIS EXPOSITION.

By the St. Louis Correspondent of the Scientific American.

Among the fine display of models showing the work of the army engineers, which formed one of the most attractive features in the Government Building at the St. Louis Exposition, was the excellent model of the snagboat "General Wright," which forms the subject of the accompanying illustration.

During the yearly floods of the Mississippi, when the river overflows its banks, many large uprooted trees and logs are carried down the Mississippi Valley; and as the water recedes, a great many of them are stranded on the bars and shoals of the river, where they form a serious obstruction and menace to navigation. So numerous are these logs and heavy, that a powerful steamer of special construction has been built for the purpose of removing them. The "General Wright," as she is called, is built with a hull which is double in the forward portion, to admit of handling the trees and snags, and single in the after portion. It is 160 feet in length and no less than 100 feet in width, the form being practically that of a double-bowed scow. The vessel is driven by two separate engines, one on each side, operating each its own paddlewheel. To enable it to navigate in shallow water, its draft is only two feet. It is provided with four derricks, operated by powerful independent steam engines. The forward derrick, whose two legs are pivoted at the stem of the two bows of the vessel, is provided at its upper end with a massive steel hook which, when the derrick is lowered into the water, secures a firm hold on the log or other obstruction that is to be moved. The steamer then backs away, dragging the log with it. When a very large tree or snag is to be removed, it is drawn up between the two hulls and sawn into short lengths, which are thrown overboard and allowed to float away, the root being drawn up on the beach, above high-water mark. The superstructure of the boat contains full accommodations for the officers of the Survey Board of the United States Army Engineers, and for the crew. When it is not in service, the boat is tied up at St. Louis.

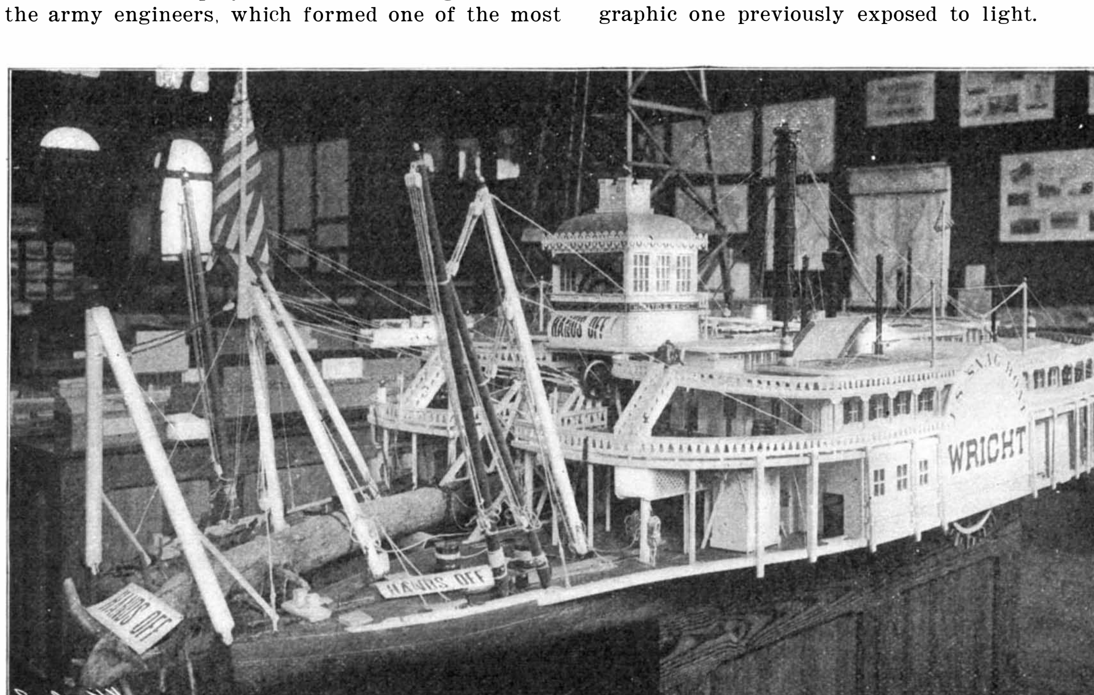
ESTANAVE'S LIQUID HYPERBOLOGRAPH.

By the Belgian Correspondent of Scientific American.

Although the mathematical sciences are essentially abstract, experimental verifications in geometry and mechanics may prove of great utility, not as substitutes for abstract demonstrations, but for rendering the assimilation thereof easier. It is for the purpose of experimental verification that the liquid hyperbolograph has been devised by M. Estanave, of Paris.

In this apparatus, in addition to the experimental verification of the property of the tangent to a branch of a hyperbola, there is obtained in a concrete manner a tracing of a curve by the envelope of its tangents. This is a characteristic of this apparatus, for in the majority of the instruments that are employed for tracing curves, the curve is defined not as an envelope of its tangents, but as the trajectory of a point.

The apparatus consists essentially of a triangular prismatic receptacle having at the summit the angle of the asymptotes of the hyperbola to be traced. The receptacle is movable around a horizontal axis parallel with the edge at the summit. Its motion, which must be quite slow and continuous, is effected through an appropriate clockwork movement. In order to fix the various positions of the free surface of the liquid of the receptacle upon a plane surface, M. Estanave, in a preliminary series of experiments, used copper plates and a solution of a salt of mercury. The bichloride or nitrate gave very pronounced deposits of mercury upon the copper previously cleaned with emery. Iron plates also may be employed with a solution of sulphate of copper. The receptacles are of japanned zinc, with angles of 90 deg. and 60 deg. at the apex. It would be possible also to use receptacles of various angles analogous to the prism of various angles employed in optics. It is possible to obtain images upon paper by putting a developer into the receptacle and replacing the metallic plate by a photographic one previously exposed to light.



MODEL OF SNAGBOAT "GENERAL WRIGHT," USED FOR CLEARING OBSTRUCTIONS FROM THE MISSISSIPPI.

GOVERNMENT EXHIBIT, ST. LOUIS EXPOSITION.

ON MOUNTAINS AND MANKIND.

By DOUGLAS W. FRESHFIELD.*

A GEOGRAPHER or traveler who has been called upon to preside over the meetings of our section of the British Association may be excused for feeling some hesitation as to the character he shall give to the address which custom compels him to deliver. He cannot but be aware that his audience, while it includes not a few experts, probably far better qualified than himself to take the chair, is composed mainly of those whose concern in geography can only be a general and occasional one.

To compose a summary of the geographical events of the year would be a simple and obvious expedient, were I not conscious that in this I have been forestalled by the indefatigable president of the Royal Geographical Society. To consider the progress of geography, during, say, the last quarter of a century, might be instructive to "the general." On the other hand, on his special subject your president may possibly be able to add something to the common stock by way of observation or suggestion.

Bearing in mind the, from the point of view of posterity, almost excessive energy with which the nineteenth century carried on the exploration of the globe, narrowing in every direction the field left to our explorations and our imaginations, 1904 may so far be counted on as an "annus mirabilis" in the annals of geography. We have seen the successful return, if not as yet to our own shores, to safe seas, of the most important expedition ever sent south poleward. In the success obtained by Capt. Scott and his comrades, we have welcomed a full justification of the course taken in putting the supreme command and direction of the undertaking in the hands of an officer of His Majesty's navy. "England expects every man to do his duty," and I will not indulge in hyperbolical praise, which must be distasteful to men who have shown in trying circumstances the daring, the cheerfulness, and the resourcefulness which we are accustomed to associate with the British navy. We have every reason to expect that the results obtained by the energetic and capable men of science attached to the expedition will be of wide bearing and interest, but to attempt to estimate them to-day would be obviously premature.

The current year has been distinguished by a, perhaps, even more remarkable geographical event. His Majesty's government, not satisfied with the laurels it has won in the Antarctic, has embarked on a second geographical adventure on a larger scale and at a far greater cost (which, however, will presumably be borne by India). It has sent forth a gold medalist of the Royal Geographical Society, Col. Younghusband, with a numerous escort, to reach the forbidden capital of Tibet. The saffron-vested monks on the "golden terraces" of the Pota La have seen the glimmer of British bayonets on the horizon, and the castle-palaces of Lhasa will, we hope, open to the military explorer their mysterious halls, hitherto known to us best by the descriptions of that entertaining traveler, my friend Chandra Das.

But the fruits of these great expeditions are not yet ripe. I must leave them to be plucked by my successors. I do so with regret, for I should have listened with a peculiar interest to an account of the fascinating land, over whose peaks and pastures I lately gazed from the Pisgah heights of the Jonsong La.

To review the progress of geography during the last twenty-five years, the time that has passed since I first joined the council of the Royal Geographical Society, is tempting. The retrospect would on the whole be encouraging. The past quarter of a century, if not an era of the most extensive discoveries, has been an era of profitable occupation—I mean profitable in the scientific and not in the commercial sense, though the two are frequently connected—of the ground seized by the great pioneers in Africa, in the backlands of North America, and elsewhere. And when we come to consider the manner in which the results of modern exploration are recorded, what an advance we find! Compare the geographical publications of Great Britain in 1880 and 1904; take the most conspicuous instance, those of the Royal Geographical Society at the two periods. Consider the way in which our lectures and literature are now illustrated by the aid of photography, new processes, and the lantern. Petermann's Mitteilungen was for long the one first-rate geographical magazine in Europe. We have now, as we ought to have had long before, a journal that rivals it.

Take a wider survey. Look at maps, beginning with the Ordnance Survey. Compare the last issues of the one-inch maps, with all the advantages of color-printing, over their doubtless (except as to roads) accurate, but far less intelligible predecessors. Consider the maps private firms, Messrs. Bartholomew and Messrs. Stanford, have provided us with; note the new editions of "Murray's Guides."

The correction and completion of maps by new explorations is always desirable. But it is even more important that a sound system for the delineation of natural features should be adopted both for government surveys and general maps. I begin to look forward to a time when glaciers will no longer be represented, as they were on the early Indian and Caucasian surveys, without their heads or tails—that is, without either their névés or their moraine-cloaked lower portions or with rivers rising above them and flowing through them. In time, perhaps, every closet cartographer will recognize that glaciers do not lie along the tops of lofty ridges, but descend into valleys. In these matters I have had many an arduous struggle. It is cruel that a poor man should be set to delineate snow mountains who has never seen one, and when "a week at lovely Lucerne" can be had for £5 5s. it is inexcusable.

In my schooldays there was an exercise of memory known to us by the contemptuous appellation of "Jog," which boys and masters united to depreciate and despise. This sentiment is now confined to a few elderly generals and headmasters. Geography flourishes as a branch of science under the august shadow of the elder universities. At Oxford we have produced Mr. Mackinder and Dr. Herbertson, Mr. Grundy, Mr. Hogarth, Mr. Beazley. We have started a school of geography and a school of geographers. At Cambridge a Board of Geographical Studies has been established. I may quote what Sir C. Markham said three months ago:

"The staff of the new geographical school at Cambridge will consist, instead of one reader, of several lecturers and teachers, who will cover the various departments of the science. A diploma in geography will be granted as at Oxford. But Cambridge goes a step further than Oxford, by introducing geography into the examination for the B.A. degree. The importance of according geography such a position in the studies of the universities must be evident to all, and must be specially gratifying to those who, for more than thirty years, have fought hard, amid much discouragement, to have geography recognized as a university subject. It will be interesting to see how the Board of Geographical Studies at Cambridge will draw up the detailed regulations for the degree and the diploma, what steps will be taken to secure a competent staff to cover the whole field of our science, and especially to train young university men for practical work in the field. We have every reason to expect that the results will prove satisfactory.

"The Geographical Association of Teachers, of which Mr. Mackinder and Dr. Herbertson are active members, is doing much to enlighten teachers with regard to the capabilities of the subject, to raise its standard, and to introduce improved methods of teaching. An interesting and useful conference was held last winter at the Chelsea Polytechnic, under its auspices, and in connection with the conference there was an excellent exhibition of appliances used in teaching geography, the usefulness of which was increased by sending it to various provincial centers."

In primary schools many teachers are furnishing excellent instruction, and are instructing themselves in the handbooks provided by our friends Dr. Mill and Mr. Chisholm and others. In the higher branches of education the problems of scientific geography are studied, and teachers are encouraged to develop the geographical aspects of other subjects, such as archæology, history, commerce, colonization on the one hand, botany and natural history on the other. We have moved forward and upward, but do not let us flatter ourselves that we have as yet reached any considerable eminence. Probably many more of our countrymen can read a map in this generation than could in the last. A small percentage, I am glad to notice, are not hopelessly bewildered even by contour lines.

We are learning our geographical alphabet. In time we may, as a nation, be able to read and to understand what we read. We shall recognize that ability to use a map and judge ground is a considerable safeguard against a waste of life and disasters in war, and that an acquaintance with the features of the earth's surface and geographical distribution is an invaluable help to a nation in the commercial rivalries and struggles of peace.

When the question of establishing geography at Oxford was being discussed, Dr. Jowett (who had himself somewhere in the fifties suggested the erection of a geographical chair) asked me if I believed geography could be taught so "as to make men think." We should, I believe, "think imperially" to more purpose if we also took pains "to think geographically." But I will not detain you and use up my time by going in any detail into the progress of geography. I might find myself only repeating what others have said better. And as to one important branch, perhaps the most important branch, geographical education, on which I addressed this section at Birmingham some fifteen years ago, I feel myself debarred by the fact that the association has now a section specially devoted to education.

I have determined on the whole, therefore, to run the risk of wearying some of my listeners by inviting your attention to the place in geography of the natural objects which have had for me through life the greatest and most enduring attraction. I propose to talk about mountains, their place in nature, and their influence, both spiritual and material, on mankind.

We have all of us seen hills, or what we call hills, from the monstrous protuberances of the Andes and the Himalaya to such puny pimples as lie about the edges of your fens. Next to a waterfall, the first natural object (according to my own experience) to impress itself on a child's mind is a hill, some spot from which he can enlarge his horizon. Hills, and still more mountains, attract the human imagination and curiosity. The child soon asks, "Tell me, how were mountains made?" a question easier to ask than to answer, which occupied the lifetime of the father of mountain science, De Saussure. But there are mountains and mountains. Of all natural objects the most impressive is a vast snowy peak rising as a white island above the waves of green hills—a fragment of the arctic world left behind to commemorate its past predominance—and bearing on its broad shoulders a garland of the Alpine flora that has been destroyed on the lower ground by the rising tide of heat and drought that succeeded the last Glacial epoch. Midsummer snows, whether seen from the slopes of the Jura or the plains of Lombardy, above the waves of the Euxine or through the glades of the tropical forests of Sikkim, stir men's imaginations and rouse their curiosity. Before, however, we turn to consider some of the physical aspects of mountains, I shall venture, speaking as I am here to a literary audience, and in a university town, to dwell for a few minutes on their place in literature—in the mirror that reflects in turn the mind of the passing ages. For geography is concerned with the interaction between man and nature in its widest sense. There has been recently a good deal of writing on this subject—I cannot say of discussion, for of late years writers have generally taken the same view. That view is that the love of mountains is an invention of the nineteenth century, and that in previous ages they had been generally looked on either with indifference or positive dislike, rising in some instances to abhorrence. Extreme examples have been repeatedly quoted. We have all heard of the bishop who thought the devil was allowed to put in mountains after the fall of man; of the English scribe in the tenth century who invoked "the bitter blasts of glaciers and the Pennine host of demons" on the violaters of the charters he was employed to draft. The examples on the other side have been comparatively neglected. It seems time they were insisted on.

The view I hold firmly, and which I wish to place before you to-day, is that this popular belief that the love of mountains is a taste, or, as some would say, a mania, of advanced civilization, is erroneous. On the contrary, I allege it to be a healthy, primitive, and almost universal human instinct. I think I can indicate how and why the opposite belief has been fostered by eminent writers. They have taken too narrow a time limit for their investigation. They have compared the nineteenth century not with the preceding ages, but with the eighteenth. They have also taken too narrow a space limit. They have hardly cast their eyes beyond Western Europe. Within their own limits I agree with them. The eighteenth century was, as we all know, an age of formality. It was the age of Palladian porticoes, of interminable avenues, of formal gardens and formal style in art, in literature, and in dress. Mountains, which are essentially romantic and Gothic, were naturally distasteful to it. The artist says "they will not compose," and they became obnoxious to a generation that adored composition, that thought more of the cleverness of the artist than of the aspects of nature he used as the material of his work. There is a great deal to be said for the century; it produced some admirable results. It was a contented and material century, little stirred by enthusiasms and aspirations and vague desires. It was a phase in human progress, but in many respects it was rather a reaction than a development from what has gone before. Sentiment and taste have their tides like the sea, or, we may here perhaps more appropriately say, their oscillations like the glaciers. The imagination of primitive man abhors a void, it peoples the regions it finds uninhabitable with aery sprites, with "Pan and Father Sylvanus and the sister Nymphs," it worships on high places and reveres them as the abode of Deity. Christianity came and denounced the vague symbolism and personification of nature in which the pagan had recognized and worshiped the Unseen. It found the objects of its devotion not in the external world but in the highest moral qualities of man. Delphi heard the cry "Great Pan is dead!" But the voice was false. Pan is immortal. Every villager justifies etymology by remaining more or less of a pagan. Other than villagers have done the same. The monk driven out of the world by its wickedness fell in love with the wilderness in which he sought refuge, and soon learned to give practical proof of his love of scenery by his choice of sites for his religious houses. But the literature of the eighteenth century was not written by monks or country-men, or by men of world-wide curiosity and adventure like the Italians of the Renaissance or our Elizabethans. It was the product of a practical common-sense epoch which looked on all waste places, heaths like Hindhead, or hills like the Highlands, as blemishes in the scheme of the universe, not having yet recognized their final purpose as golf links or gymnasiums. Intellectual life was concentrated in cities and courts, it despised the country. Books were written by towns-men, dwellers in towns which had not grown into vast cities, and whose denizens therefore had not the longing to escape from their homes into purer air that we have to-day. They abused the Alps frankly. But all they saw of them was the comparatively dull carriage passes, and these they saw at the worst time of the year. Hastening to Rome for Easter, they traversed the Maurienne while the ground was still brown with frost and patched untidily with half-melted snowdrifts. It is no wonder that Gray and Richardson, having left spring in the meadows and orchards of Chambéry, grumbled at the wintry aspect of Lanslebourg.

That at the end of the eighteenth century a literary lady of Western Europe preferred a Paris gutter to the Lake of Geneva is an amusing caricature of the spirit of the age that was passing away, but it is no proof that the love of mountains is a new mania, and

* Read before Section E of the British Association for the Advancement of Science.

that all earlier ages and peoples looked on them with indifference or dislike. Wordsworth and Byron and Scott in this country, Rousseau and Goethe, De Saussure and his school abroad broke the ice, but it was the ice of a winter frost, not of a Glacial period.

Consider for a moment the literature of the two peoples who have most influenced European thought—the Jews and the Greeks. I need hardly quote a book that before people quarreled over education was known to every child—the Bible. I would rather refer you to a delightful poem in rhyming German verse written in the seventeenth century by a Swiss author, Rebman, in which he relates all the great things that happened on mountains in Jewish history: how Solomon enjoyed his Sommerfrische on Lebanon, and Moses and Elias both disappeared on mountain tops; how kings and prophets found their help among the hills; how closely the hills of Palestine are connected with the story of the Gospels.

Consider, again, Greece, where I have just been wandering. Did the Greeks pay no regard to their mountains? They seized eagerly on any striking piece of hill scenery and connected it with a legend or a shrine. They took their highest mountain, broad-backed Olympus, for the home of the gods; their most conspicuous mountain, Parnassus, for the home of poetry. They found in the cliffs of Delphi a dwelling for their greatest oracle and a center for their patriotism. One who has lately stood on the top of Parnassus and seen the first rays of the sun as it springs from the waves of the Ægean strike its snows, while Attica and Bœotia and Eubœa still lay in deep shadow under his feet, will appreciate the famous lines of Sophocles, which I will not quote, as I am uncertain how you may pronounce Greek in this university. You may remember, too, that Lucian makes Hermes take Charon, when he has a day out from Hell, to the twin-crested summit, and show him the panorama of land and sea, of rivers and famous cities. The Vale of Tempe, the deep gap between Olympus and Ossa, beautiful in its great red cliffs, fountains, and spreading plane trees, was part of a Roman's classical tour. The superb buttresses in which Taygetus breaks down on the valley of the Eurotas were used by the Spartans for other purposes besides the disposal of criminals and weakly babies. The middle regions—the lawns above the Langada Pass, "virginibus bacchata Lacænis Taygeta"—are frequented to this day as a summer resort by Spartan damsels. The very top, the great rock that from a height of 8,000 feet looks down through its woods of oaks and Aleppo pines on the twin bays of the southern sea, is a place of immemorial pilgrimages. It is now occupied by a chapel framed in a tiny court, so choked with snow at the beginning of June that I took the ridge of the chapel roof for a dilapidated stoneman. I have no time to-day to look for evidence in classical literature, to refer to the discriminating epithets applied in it to mountain scenes.

A third race destined apparently to play a great part in the world's history—the Japanese—are ancient mountain lovers. We are all aware that Fusiyama to the Japanese is (as Ararat to the Armenians) a national symbol; that its ascent is constantly made by bands of pilgrims, that it is depicted in every aspect. Those who have read the pleasant book of Mr. Watson, who, as English chaplain for some years at Tokio, had exceptional opportunities of travel in the interior, will remember how often he met with shrines and temples on the summits of the mountains, and how he found pilgrims who frequented them in the belief that they fell there more readily into spiritual trances. The Japanese minister, when he attended Mr. Watson's lecture at the Alpine Club, told us that his countrymen never climbed mountains without a serious, that is to say, a religious, object.

India and China would add to my evidence had I knowledge and time enough to refer to their literature. I remember Tennyson pointing out to me in a volume of translations from the Chinese a poem, written about the date of King Alfred, in praise of a picture of a mountain landscape. But I must return to the sixteenth and seventeenth centuries in Europe; I may go earlier—even back to Dante. His allusions to mountain scenery are frequent; his Virgil had all the craft of an Alpine rock-climber. Read Leonardo da Vinci's "Notes," Conrad Gesner's "Ascent of Pilatus"; study the narratives of the Alpine precursors Mr. Coolidge has collected and annotated with admirable industry in the prodigious volume he has recently brought out.

It is impossible for me here to multiply proofs of my argument, to quote even a selection from the passages that show an authentic enthusiasm for mountains that may be culled from writers of various nations prior to 1600 A. D. I must content myself with the following specimens, which will probably be new to most of my hearers.

Benoit Marti was a professor of Greek and Hebrew at Bern, and a friend of the great Conrad Gesner (I call him great, for he combined the qualities of a man of science and a man of letters, was one of the fathers of botany as well as of mountaineering, and was, in his many-sidedness, a typical figure of the Renaissance). Marti, in the year 1558 or 1559, wrote as follows of the view from his native city:

"These are the mountains which form our pleasure and delight" (the Latin is better—"deliciæ nostræ, nostrique amores") "when we gaze at them from the higher parts of our city and admire their mighty peaks and broken crags that threaten to fall at any moment. Here we watch the risings and settings of the sun and seek signs of the weather. In them we find food not only for our eyes and our minds, but also for our bellies"; and he goes on to enumerate the dairy products of the Oberland and the happy life of its population. I quote again this good man: "Who, then, would not admire, love, willingly visit, explore, and climb places of this sort? I assuredly should call those who are not attracted by them mushrooms, stupid, dull fishes, and slow tortoises" ("fungos, stupidos insulsos pisces, lentosque chelones"). "In truth, I cannot describe the sort of affection and natural love with which I am drawn to mountains, so that I am never happier than on the mountain crests, and there are no wanderings dearer to me than those on the mountains." "They are the theater of the Lord, displaying monuments of past ages, such as precipices, rocks, peaks and chasms, and never-melting glaciers"; and so on through many eloquent paragraphs.

I will only add two sentences from the preface to Simler's "Vallesiæ et Alpium Descriptio," first published in 1574, which seem to me a strong piece of evidence in favor of my view: "In the entire district, and particularly in the very lofty ranges by which the Valais is on all sides surrounded, wonders of nature offer themselves to our view and admiration. With my countrymen many of them have through familiarity lost their attraction; but foreigners are overcome at the mere sight of the Alps, and regard as marvels what we through habit pay no attention to."

Mr. Coolidge, in his singularly interesting footnotes, goes on to show that the books that remain to us are not isolated instances of a feeling for mountains in the age of the Renaissance. The mountains themselves bear, or once bore, records even more impressive. Most of us have climbed to the picturesque old castle at Thun and seen beyond the rushing Aar the green heights of the outposts of the Alps, the Stockhorn, and the Niesen. Our friend Marti, who climbed the former peak about 1558, records that he found on the summit "tituli, rythmi, et proverbia saxis inscripta una cum imaginibus et nominibus auctorum. Inter alia cujusdam docti et montium amœnitate capti observare licebat illud:

Ὁ τῶν ὀρῶν ἔρως ἄριστος.

"The love of mountains is best." In those five words some Swiss professor anticipated the doctrine of Ruskin and the creed of Leslie Stephen, and of all men who have found mountains the best companions in the vicissitudes of life.

In the annals of art it would be easy to find additional proof of the attention paid by men to mountains three to four hundred years ago. The late Josiah Gilbert, in a charming but too little known volume, "Landscape in Art," has shown how many great painters depicted in their backgrounds their native hills. Titian is the most conspicuous example.

It will perhaps be answered that this love of mountains led to no practical result, bore no visible fruit, and therefore can have been but a sickly plant. Some of my hearers may feel inclined to point out that it was left to the latter half of the nineteenth century to found Climbers' Clubs. It would take too long to adduce all the practical reasons which delayed the appearance of these fine fruits of peace and an advanced civilization. I am content to remind you that the love of mountains and the desire to climb them are distinct tastes. They are often united, but their union is accidental, not essential. A passion for golf does not necessarily argue a love of levels. I would suggest that more outward and visible signs than are generally imagined of the familiar relations between men and mountains in early times may be found. The choicest spots in the Alpine region—Chamonix, Engelberg, Disentis, Einsiedlen, Pesio, the Grande Chartreuse—were seized on by recluses; the Alpine baths were in full swing at quite an early date. I will not count the Swiss Baden, of which a geographer, who was also a Pope, Æneas Silvius (Pius II.) records the attractions, for it is in the Jura, not the Alps; but Pfäfers, where wounded warriors went to be healed, was a scene of dissipation, and the waters of St. Moritz were vaunted as superseding wine. I may be excused, since I wrote this particular passage myself a good many years ago, for quoting a few sentences bearing on this point from "Murray's Handbook to Switzerland." In the sixteenth century fifty treatises dealing with twenty-one different resorts were published. St. Moritz, which had been brought into notice by Paracelsus (died 1541), was one of the most famous baths. In 1501 Matthew Schinner, the famous Prince Bishop of Sion, built "a magnificent hotel" at Leukerbad, to which the wealthy were carried up in panniers on the backs of mules. Brieg, Gurnigel, near Bern, the baths of Masino, Tarasp, and Pfäfers were also popular in early times. Leonardo da Vinci mentions the baths of Bormio, and Gesner went there.

It is not, however, with the emotional influences or the picturesque aspect of mountains that science concerns itself, but with their physical examination. If I have lingered too long on my preamble I can only plead as an excuse that a love of one's subject is no bad qualification for dealing with it, and that it has tempted me to endeavor to show you grounds for believing that a love of mountains is no modern affectation, but a feeling as old and as wide-spread as humanity.

Their scientific investigation has naturally been of comparatively modern date. There are a few passages about the effects of altitude, there are orographical descriptions more or less accurate in the authors of antiquity. But for attempts to explain the origin of mountains, to investigate and account for the details of their structure, we shall find little before the notes of Leonardo da Vinci, that marvelous man who combined, perhaps, more than anyone who has ever lived the artistic and the scientific mind. His ascent of Monte Boso about 1511, a mountain which may be found under this name on the Italian ordnance map on the spur separating Val Sesia and the Biellese, was the first ascent by a physical observer. Gesner with all his mountain enthusiasm found a scientific interest in the Alps mainly if not solely in their botany.

The phenomenon which first drew men of science to Switzerland was the Grindelwald glaciers—"miracles of nature" they called them. Why these glaciers in particular, you may ask, when there are so many in the Alps? The answer is obvious. Snow and ice on the "mountain tops that freeze" are no miracle. But when two great tongues of ice were found thrusting themselves down among meadows and corn and cottages, upsetting barns and covering fields and even the marble quarries from which the citizens of Bern dug their mantelpieces, there was obviously something outside the ordinary processes of nature, and therefore miraculous.

Swiss correspondents communicated with our own Royal Society the latest news as to the proceedings of these unnatural ice-monsters, while the wise men of Zürich and Bern wrote lectures on them. Glacier theories began. Early in the eighteenth century Hottinger, Cappeller, Scheuchzer, that worthy man who got members of our Royal Society to pay for his pictures of flying dragons, contributed their quota of crude speculation. But it was not until 1741 that Mont Blanc and its glaciers were brought into notoriety by our young countrymen, Pococke and Windham, and became an attraction to the mind and an object to the ambition of the student whose name was destined to be associated with them. Horace Benedict de Saussure, born of a scientific family, the nephew of Bonnet, the Genevese botanist and philosopher, who has become known to the world as a mountaineer and the climber of Mont Blanc, came twenty years later. In truth he was far more of a mountain traveler and a scientific observer, a geological student, than a climber. When looking at his purple silk frock-coat (carefully preserved in his country house on the shore of the Lake of Geneva), one realizes the difference between the man who climbed Mont Blanc in that garment and the modern gymnast, who thinks himself *par excellence* the mountaineer.

De Saussure did not confine himself to Savoy or to one group, he wandered far and wide over the Alpine region, and the four volumes of his "Voyages" contain, besides the narratives of his sojourn on the Col du Géant and ascent of Mont Blanc, a portion of the fruit of these wanderings.

The reader who would appreciate De Saussure's claim as the founder of the scientific exploration of mountains must, however, be referred to the List of Agenda on questions calling for investigation placed at the end of his last volume. They explain the comparative indifference shown by De Saussure to the problems connected with glacial movement and action. His attention was absorbed in the larger question of earth structure, of geology, to which the sections exposed by mountains offered, he thought, a key; he was bitten by the contemporary desire for "A Theory of the Earth," by the taste of the time for generalizations for which the facts were not always ready. At the same time, his own intellect was perhaps somewhat deficient in the intuitive faculty; the grasp of the possible or probable bearing of known facts by which the greatest discoverers suggest theories first and prove them afterward.

The school of De Saussure at Geneva died out after having produced Bourrit, the tourist who gloried in being called the Historian of the Alps, a man of pleasant self-conceit and warm enthusiasm, and De Luc, a mechanical inventor, who ended his life as reader to Queen Charlotte at Windsor, where he flits across Miss Burney's pages as the friend of Herschel at Slough and the jest of tipsy Royal Dukes. Oddly enough, the first sound guess as to glacier movement was made by one Bordier, who had no scientific pretensions. I reprinted many years ago the singular passage in which he compared glacier ice to "cire amollie," soft wax, "flexible et ductile jusqu'à un certain point," and described it as flowing in the manner of liquids (Alp. J., ix. 327). He added this remarkable suggestion foreshadowing the investigations of Prof. Richter and M. Forel: "It is very desirable that there should be at Chamonix some one capable of observing the glaciers for a series of years and comparing their advance and oscillations with meteorological records." To the school of Geneva succeeded the school of Neuchatel, Desor and Agassiz; the feat of De Saussure was rivaled on the Jungfrau and the Finsteraarhorn by the Meyers of Bern. They in turn were succeeded by the British school, Forbes and Tyndall, Reilly and Wills, in 1840-60.

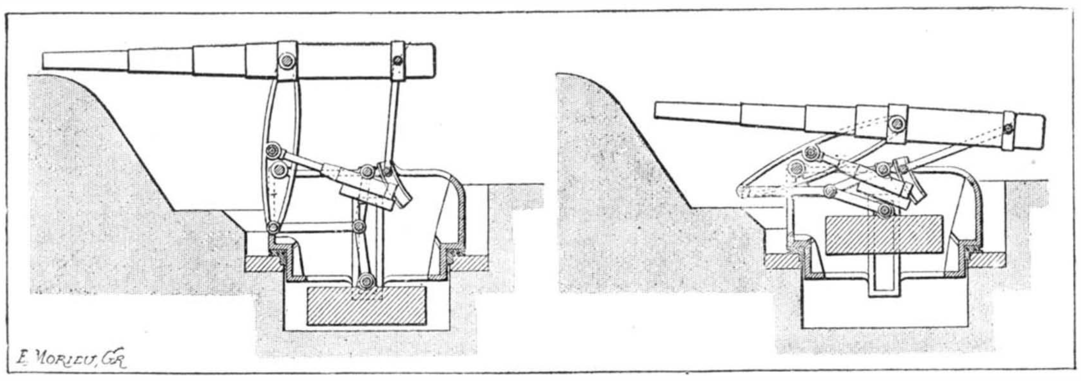
(To be concluded.)

ACTION OF ANÆSTHETICS ON N'-RAYS.—J. Becquerel has shown that sources of N-rays are deprived of their activity by the action of anæsthetics, such as chloroform and ether. But this result is not entirely convincing, owing to the fact that those bodies themselves emit N'-rays, which would in any case mask the N-rays. J. Meyer has, therefore, devised a crucial experiment. It consists in stretching a wire in a tube of chloroform vapor. Both the stretching and the chloroform produce N'-rays, and if there were no action of the anæsthetic as such, there should be simply an increase of the effect. But there is, on the contrary, a diminution of the sum of the two effects as

soon as the vapor bathes the wire. Hence there is a true anæsthetic action.—J. Meyer, Comptes Rendus, May 30, 1904.

DISAPPEARING GUN-CARRIAGES.

THE most exaggerated optimism would utterly fail to suggest to us that the art of war is really to fall into desuetude. Land and naval artillery in particular is for the moment the subject of a melancholy notoriety, which it shares, moreover, with torpedoes of all kinds and varieties. Since the guns that arm the turrets of armor-clads possess so formidable a power and so wonderful a precision, it may be asked how it will be possible for coast batteries to be maintained; not that they cannot be so well served as regards power, but because they have the disadvantage of occupying an invariable position and of forming a target too easily struck if it is visible, or if preliminary reconnaissances have permitted of locating its site with some degree of accuracy.



FIGS. 1 AND 2.—KRUPP 21-CENTIMETER GUN MOUNTED UPON A DISAPPEARING CARRIAGE.

Now, it is not difficult to ascertain the fact that all French coast batteries, exclusive of those of comparatively recent dates, are installed without any precautions as to concealment. The line of their parapet profiles, the geometrical contour upon the sky, and the guns themselves, established *en barbette*, boldly display their black mass above the crest. That is to say, that if a squadron should suddenly make its appearance, it would very quickly regulate its fire against such targets, the position of which, moreover, is easily taken by those pseudo-tourists that every nation in time of peace sends upon excursions to its neighbors under the pretense of pleasure, yachting, etc. A military attaché at Paris, Capt. Bently Mott, in an article in the Journal of the United States Artillery, remarks that many batteries elevated upon the coast of France, and in which the guns are in barbette, form admirable targets, the details of which can, with a good field-glass, be seen from a distance of five miles at sea. Let us hasten to say that there are other batteries of ours that are perfectly invisible, and these are generally the ones designed for indirect fire.

The progress of artillery, nevertheless, calls for great prudence. It becomes indispensable to select the site of all batteries in such a way that their outline shall be confused with the general aspect of the landscape at distances of from two to five miles. The guns themselves should make their appearance only at exactly the time at which they are to be fired. Such a precaution, joined to the use of smokeless powder, should certainly suffice to render an attack difficult and the fire of a squadron uncertain.

In order that a gun may appear and disappear rapidly, it must be mounted upon a disappearing carriage. The method seems to be as simple as it is efficacious, and, if it is not generally utilized, it is doubtless because an apparatus of this kind, aside from its evident advantages, presents a few inconveniences in the eyes of specialists, who have raised objections that up to the present have prevailed against it.

The partisans of the disappearing carriage are nevertheless pursuing their studies of it with a view to finding a strong, practical apparatus that the bursting of a shell will not suffice to put out of order. It is in the United States that this kind of carriage finds most favor. A proof of this is found in the answer made by artillery officers at a consultation held by the Committee upon Ordnance and Fortifications as to the advisability of adopting the disappearing carriage for coast defense. Out of the eighty-four officers who expressed an opinion, sixty were favorable to it, at least as regards low batteries. Despite this, the committee decided to suspend the manufacture that had been begun; and this shows that the type is not yet perfect. Nevertheless, studies and experiments are still in progress.

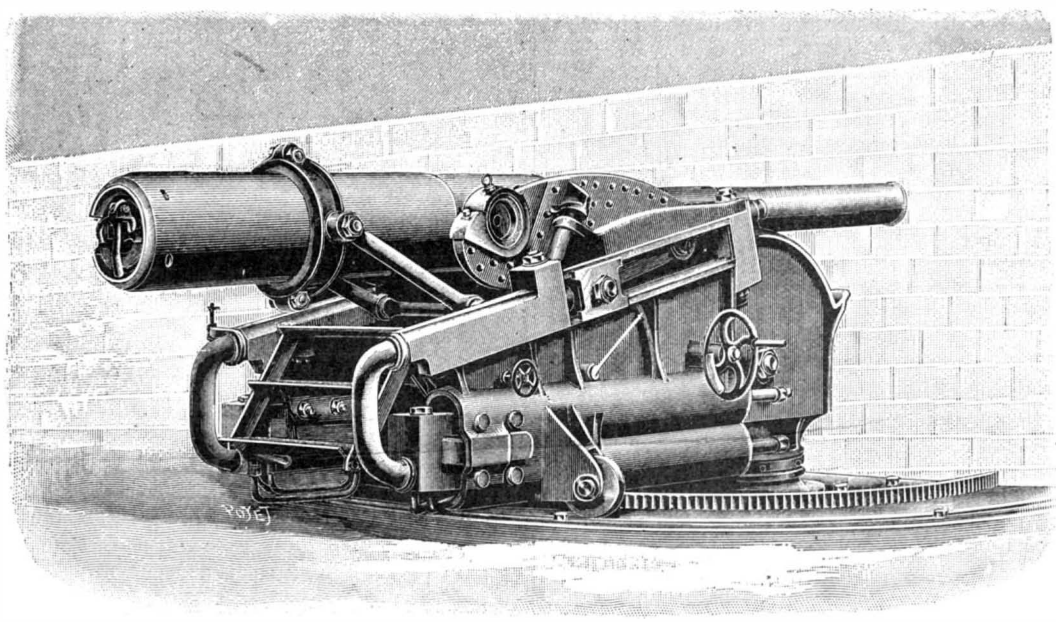


FIG. 4.—SAINT-CHAMOND CARRIAGE. DISAPPEARING POSITION.

In principle, in a disappearing carriage, the gun is raised by means of two systems of cranks arranged in parallel. The front system seizes the trunnions and the rear one is fixed to two auxiliary trunnions which are themselves attached to the piece by a special hoop. Seen in profile, the piece and the cranks form the three sides of a jointed parallelogram which is closed at the base by a jointed frame parallel with the axis of the gun. It thus suffices to regulate the inclination of the frame in order that the piece shall be pointed upwardly. When the cranks stand vertically, the chase of the gun exceeds the parapet, and the piece is in the firing position. The recoil of the gun after firing has the effect of turning the cranks backward and lowering the entire arrangement beneath the crest; but, at the same time, the force of the recoil is utilized for setting a recuperator, whether it be a hydraulic, pneumatic, or hydro-pneumatic brake, or even a series of Belleville disks. This recuperator stores up the energy necessary for the automatic replacing of the gun in battery as soon as the operation of loading is finished. The weight of the gun, which is considerable, is balanced by a counterpoise that ascends when the piece descends, and reciprocally. We illustrate herewith three types of disappearing carriages. Figs. 1 and 2 show a carriage for a 21-centimeter piece exhibited at Dusseldorf by the Krupp establishment. After the gun has been loaded and pointed, it suffices to open a valve in order to liberate the counterpoise, which, in descending, brings the piece to its firing position. Such return to battery is at first rapid, but the brake slows up the motion toward the end, and the firing is done automatically at the moment at which the gun reaches the end of its travel. The entire operation consumes but four seconds. Figs. 3 and 4 represent an analogous carriage constructed in France by the Compagnie de Saint-Chamond, and which is particularly strong and well balanced.

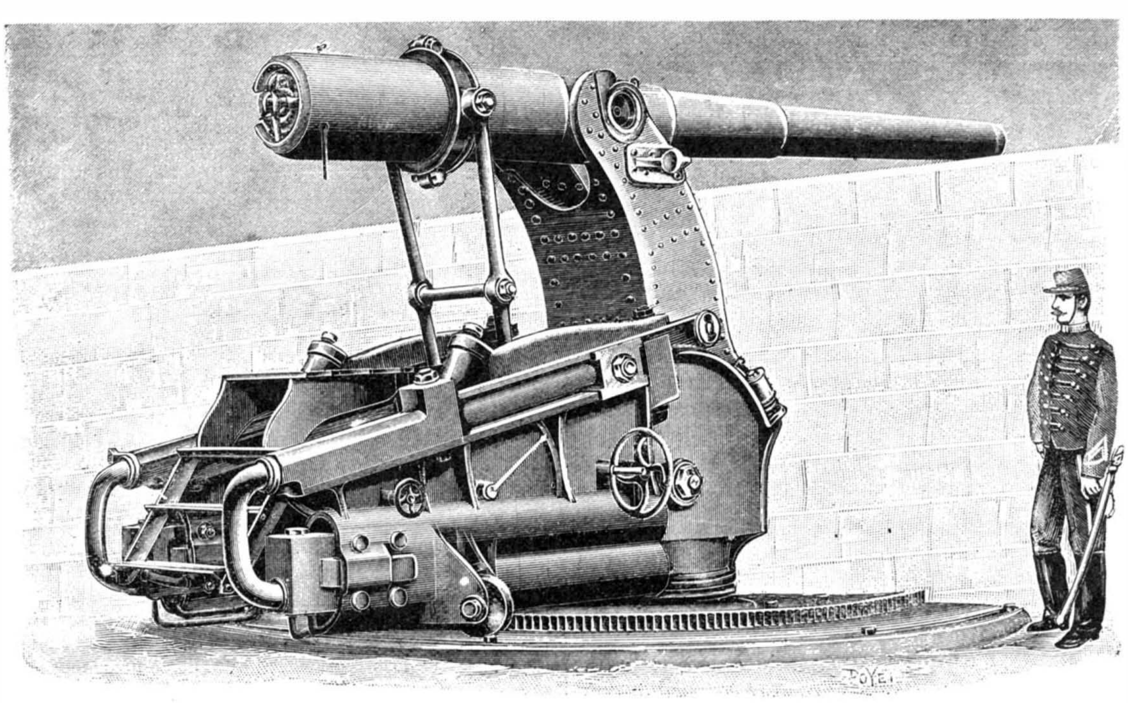


FIG. 3.—GUN MOUNTED UPON A SAINT-CHAMOND CARRIAGE. FIRING POSITION.

THE INFLUENCE OF THE MOON ON WEATHER.

THE question whether the different positions of the moon have any influence on rainfalls is discussed by Mr. G. Lamprecht in the Naturwissenschaftliche Wochenschrift. The author draws attention to the fact that, though this question could be easily answered by any meteorological station, it has so far remained unanswered.

The following calculations are made by the author: The moon traverses its elliptical orbit round the earth in 27.55 days on an average; and its position in the ellipse is determined by the angle formed by the direction of the actual position of the moon with the major axis of the ellipse, this angle being measured from the direction of the last perigee. The difference in direction is called the anomaly, the interval of 27.55 days between two subsequent perigees being termed anomalistic month. Now as the earth will meanwhile complete along with the moon about 1-13th of its revolution round the sun, the time elapsing between two subsequent new moons, the so-called synodical month, will be 29.53 days, nearly two days longer. The angle in the synodical month, as counted from the new moon, is called phase.

The perigee of the month will thus retrocede in the synodical month; if at any time the perigee coincides with the new moon, it will afterward be displaced to the last quarter and then to the full moon. This is evidenced by the following figures:

Perigee.	New Moon.	Difference.
April 26, 1904.	April 15.	11 days
May 22, 1904.	May 15.	7 days
June 17, 1904.	June 13.	4 days
July 15, 1904.	July 13.	2 days
August 12, 1904.	August 11.	1 day
September 9, 1904.	September 9.	0 days

On May 22, 1904, the perigee coincides with the first quarter, and on September 9 with the new moon.

Now if the influence of either the synodical or anomalistic motion of the moon on the weather be investigated separately, this is found to be *nil* on an average in a decade, whereas an extraordinarily strong influence is noted when the new moons and full moons are separated according as they do or do not coincide with the perigee. The author expresses in hundredths the positions of the moon in every one of these cycles, calculating their difference from the beginning of the month. The observations are next arranged according to tenths of the difference between the mean anomaly and mean phase. For the value 0 of this period, the perigee thus coincides with the new moon, for 0.25 with the last quarter, for 0.50 with the full moon, and for 0.75 with the first quarter, the duration of this double period being 411.79 days.

The author uses the monthly data of rainfalls first

of forty North German stations in the course of the thirty-eight years from 1857 to 1894, and second of about ninety-eight stations on Java and Madeira in the interval between 1879 and 1902.

The following results are obtained: Both in North Germany and on Java, apart from other factors, drought may be expected in the case of the perigee of the moon being nearer to the new moon than to the full moon, and *vice versa*. This rule applies to any country where the greatest amounts of rainfalls coincide with the highest position of the sun,

These results are confirmed by the dry weather of last summer, the difference between the mean anomaly and mean phase being equal to 0.84 for the beginning of July of 1904. It should be mentioned that this remarkable coincidence was predicted by the author.

CARBURETERS.

By J. S. V. BICKFORD.

AT one of the recent shows one of the exhibitors remarked to me that he did not believe there were five men in the world who knew anything about carbureters. Though this statement is, of course, metaphorical and too drastic, there is a certain truth underlying

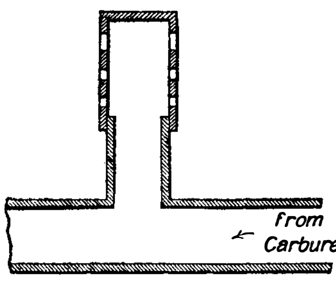


Fig. 1

it if one is to judge by some of the arrangements we see exhibited and patented, so that an examination into the function and construction of this piece of apparatus from the theoretical side may not be without interest.

I propose to confine myself to the spray type of carbureter, though I by no means intend it to be inferred that I pin my faith entirely to that type.

As every one knows, the original Mybach carbureter consists in principle of a jet of small size in the induction pipe of the motor, in which the petrol is maintained at a constant level by a suitable arrangement—see Fig. 7. The petrol is then sucked from this jet by the force of the induction blast and the consequent vacuum and rush of air, both effects probably having an effect on the delivery of petrol. Speaking generally, the greater the blast of air and vacuum the greater will be the delivery of petrol, which so far as it goes is all right, for the faster the engine travels and the more the throttle is open the greater will be the blast, so that the greater the demand for petrol the greater will be the supply. In practice, however, it is found that the supply, though increasing with the demand, does not increase in the correct proportion, so that the mixture is not satisfactory at all speeds. It may be taken as an axiom that the carbureter which will give a constant richness of mixture at all rates of supply will be correct, though it is true that it may be ad-

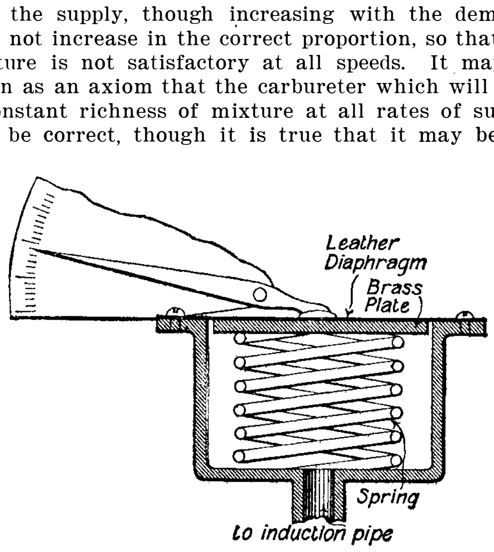


Fig. 2

visable to vary the mixture under certain conditions. It is found also in practice that the original type of Mybach carbureter gives too rich a mixture at high rates of supply if the proportions are correct at the lower rates. What, then, must be done to make the carbureter give a constant richness of mixture?

To comply with our axiom the carbureter must be so made that it will add a definite proportion of petrol to all the air passing through it, and the air passing through the carbureter will depend on two things: (1) The speed of the engine; (2) the position of the throttle valve.

The fact that the supply of petrol must be regulated by these two factors has been overlooked by many inventors who have sought to regulate the supply of petrol by the speed of the engine alone, and this has resulted in partial failure. For instance, suppose we have a given engine traveling with open throttle at 200 revolutions per minute. There will be a certain quantity of mixture passing through it per unit of time. If, now, we increase the speed to 800 revolutions, and adjust the throttle so that only one-quarter charge is taken per stroke, the total quantity of mixture per unit of time will be the same as before, though the speed of the engine will be four times as great. Obviously, therefore, any apparatus which depends on the speed of the engine alone will fail as soon as the throttle comes into play.

The following variables may reasonably be depended on for regulating our carbureter: As has been shown already, the primary factor on which we must depend is the quantity of air being induced, and in consequence the most obvious variable to use is the vacuum produced. This is the arrangement of the Krebs carbureter and many others.

Another variable which we may use is the exhaust

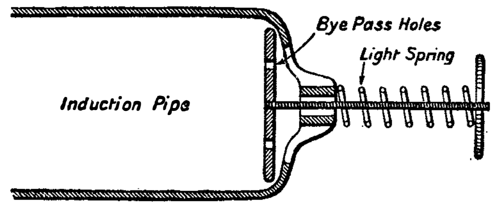


Fig. 3

pressure, which will depend both on the speed of the engine and the quantity of mixture—used as in the new Wolseley carbureter.

Yet another is a combination of the cylinder pressure and the speed—or what is the same thing, a combination of the cylinder pressure and anything which varies with the speed, such as the position of the governor.

Yet another possible factor would perhaps be the velocity of the induction or exhaust.

Let us first consider the suction pressure of the induction. It may at once be conceded that the vacuum in the induction pipe does not vary sufficiently in accordance with known law to allow us to use any simple rules for the construction of our carbureter. In other words, it must be constructed on some empirical rule, and were I given the job of experimenting to this end I should first arrange a by-pass pipe into the supply pipe of an engine fitted with an ordinary spray car-

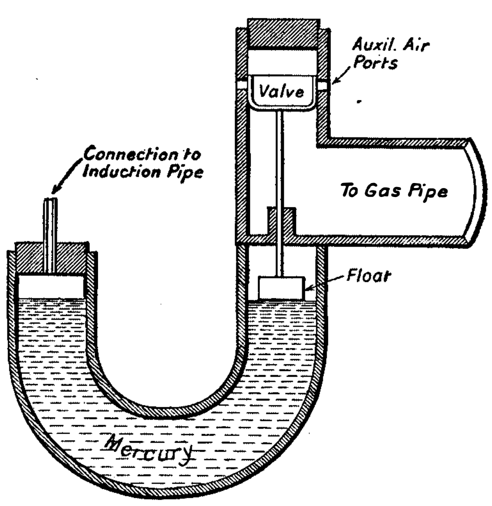


Fig. 4

bureter so disposed that pure air could be added to the mixture supplied by the carbureter, and this pipe I should cover by a movable cap provided with a number of uniform circular openings—as Fig. 1. These openings would be so arranged that the cap could be adjusted—by sliding it vertically—to open one at a time. In addition to this, I should connect up to the supply pipe a diaphragm arrangement somewhat similar to Fig. 2, and having an attachment to measure the distension of the diaphragm. I should then run my engine at various speeds, and adjust my movable cap until I obtained the maximum speed under given load with the maximum of auxiliary air supply, when it might safely be inferred that the petrol supply for that speed was a minimum. I should also note at each speed the distension of the diaphragm, and tabulate the results. I should then co-ordinate the results, and construct an apparatus in which the tabulated dis-

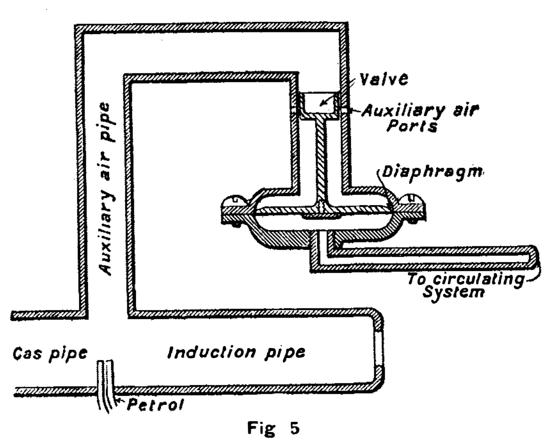


Fig 5

tension of the diaphragm would give the corresponding auxiliary air opening. This would give the Krebs carbureter as I should imagine it to have been evolved. Of course, I do not wish to lay claim to the ability to design and invent the Krebs carbureter; the above outline is only given as an indication of my idea of the method adopted by the inventor in designing it. As this carbureter depends on the vacuum only, and that in turn depends solely on the amount of mixture taken by the engine, whether this be regulated by the speed or the throttle, this carbureter in theory should be perfectly effective at all speeds and powers.

There is another method of utilizing the suction of the induction, which is very commonly used. As has been said, it has been found that the ordinary carbureter gives too much petrol at high speeds. In other words, the vacuum is disproportionately large at these speeds and rates of feed. If, therefore, we can partly destroy the vacuum at high feeds we should probably obtain as good a result as if we added pure air to the super-charged mixture from the carbureter. This end is sought to be accomplished in many machines by placing a leaky induction valve in the mouth of the supply pipe—Fig. 3. The effect is supposed to be as follows: At starting and slow speeds the valve does not open at all, all the air being supplied by the leakage—which is usually secured by boring holes through the valve; but as the speed rises and the vacuum increases, the valve opens and lets in more air. By this means the vacuum is mitigated. It is to my mind, however, in the last degree unlikely that the correct reduction of the vacuum is obtained by this plan. I believe that considerably better results could be had by the experimental method already indicated. The procedure would be exactly as before, except that the cap would be placed on the induction pipe itself instead of on a by-pass. A combination of the noted

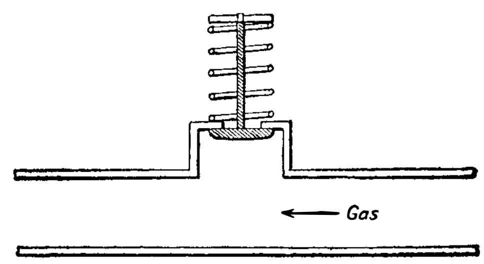


Fig. 6

positions of the cap and the distensions of the diaphragm would then give the desired apparatus.

If the exhaust pressure be used the method of procedure would be exactly as before, and as the richness of the mixture is supposed to remain constant the exhaust pressure would depend solely on the speed and the quantity of mixture in the cylinders per stroke; or, in other words, on the quantity of mixture per unit of time, so that this is a satisfactory variable to deal with. The Wolseley Company has recently brought out a carbureter on this principle. There are, of course, many other ways in which the pressure of the gases can be used besides the diaphragm. The Crossley people use a cup full of mercury, the level of which depends on the suction as in a barometer, and a float on the mercury carrying a valve regulates the air. This arrangement is shown diagrammatically in Fig. 4. In the actual Crossley carbureter two concentric chambers take the place of the U-tube, and a throttle valve is combined with the carbureter.

Another method which might give good results would be to make the level of the petrol in the jet depend on the suction. The actual level would of course have to be determined by experiment, but the matter should not be difficult. The idea of making the orifice of the jet depend on the suction might do if the closing arrangement worked outside, and therefore above, the jet; but the jet is already so small that it is not practical to introduce anything in the nature of an internal needle. The Mercedes people already use an external valve to close off the petrol in their

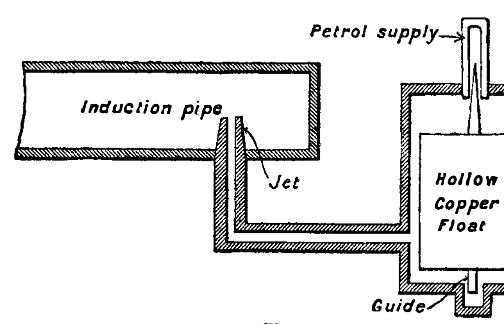


Fig. 7

carbureter, so that it would seem that this method is practicable.

The Napier people have recently introduced a carbureter in which the supply of air to the carbureter is increased as the pressure of water in the circulating system, i. e., the square of the speed of the engine, increases. To my mind this is not a good arrangement, and my opinion seems to be borne out to some extent by the fact that Mr. Napier has recently patented a modification of this idea, in which the supply of air to the carbureter depends both on the water pressure and the suction. The objection to the system is that it does not take into account the throttling of the engine. Suppose the engine is running at 500 revolutions, and the mixture is right. If the speed be increased to 1,000 revolutions and no adjustment is made, too much petrol will be supplied; but here the hydraulic regulator comes in and increases the air-inlet orifice, and thereby reduces the vacuum and restores the proportions, at least in theory. Now, suppose the car to have been climbing a hill and suddenly to reach level ground, the driver throttles, and the speed remains the same. The hydraulic regulator does not alter, but the mixture to the engine has been reduced. The result will be too poor a mixture. This is not necessarily a bad thing, for it is recommended

that when the engine is running light the mixture shall be weaker than at full power, so that the success of the apparatus, or otherwise, is quite open to demonstration, and it is certainly highly spoken of. Yet, in theory, its success would appear to depend rather too much on chance.

In the latest Napier patent, as I remember it, the arrangement is to allow the suction of the air to act on one side of the diaphragm controlling the air inlet, and the hydraulic pressure to act on the other, Fig. 5. It is not easy to see what would be the effect of this in practice. Of course, the whole thing would depend on the actual relative pressures. Assuming the mixture to be right at any given speed with the throttle open, if the speed were doubled the suction of the induction and the pressure of the water would both increase; and as these effects are acting on opposite sides of the same diaphragm, and are in opposite directions—one a suction and the other a pressure—their effect would be cumulative. Now, suppose the speed to remain constant and the throttle to be brought into play. The water pressure would be unchanged and the suction would be reduced so that the diaphragm would collapse to some extent, whereas in the original Napier hydraulic regulator no change would take place. The effect of this would be slightly to mitigate the impoverishment of the mixture, as compared with the original hydraulic regulator; and if it be a fact that the latter supplied too poor a mixture when throttled, while at the same time a somewhat poorer mixture is desired when throttled than when running fully opened out, it is quite possible that this combination may supply the desired mixture. This is the only carbureter which is also able to take knowledge of both the speed of the engine and the position of the throttle that I know of. The Krebs carbureter, of course, would not "know" whether the engine was running slow fully open, or fast partly throttled, and would supply an exactly similar mixture in both cases, provided the supply of air were the same. The new Napier, on the other hand, would supply different mixtures in the two cases. I have not heard anything about the action of this carbureter in practice.

I have heard it questioned whether it is advisable to introduce all these complications into a motor car, and it seems to me that the question is very much open to doubt. Certainly it is not worth introducing any considerable complications into a car simply for the sake of economy, for they are almost all used for pleasure purposes, and what the user inquires about is, first, reliability; second, reliability; and third, ditto. After this he looks for absence of noise and vibration, but only after reliability first, second, and third. The Morse people have recognized this in their carbureter, which has simply an ordinary induction valve controlling the auxiliary air supply, Fig. 6. Obviously it is more or less a matter of chance if this introduces the correct amount of fresh air, but if it approximates to it, it probably does all that is required in practice. No one seems yet to have tried the idea of placing half a dozen small induction valves in the supply pipe opening at different pressures, though the idea has some points to recommend it. For instance, their opening could be very readily experimentally determined.

It does not seem to have been pointed out yet how the throttling of an engine may affect its economy. Some of the larger engines on the market must run most of their time on the half throttle, so that the absolute pressure in the cylinder at the end of the suction stroke will be about 7½ pounds per square inch, or, in other words, there will be a back pressure of this amount. Now the absolute effective pressure is only 70 pounds per square inch, and the vacuum represents 10 per cent of it. Every ounce of back pressure tells absolutely on the power turned out, so that this back pressure would represent 10 per cent loss of power to the engine, which is dead waste. Some of this would of course be given back on the compression stroke, but, in practice, I take it, very little. The only way which seems practicable to overcome this is to follow Mr. Dugald Clerk's suggestion, and introduce a full charge of fresh air every stroke, and let the charge of the fuel come in later and later, as the power demand falls. So far, nothing on these lines has come out.

In the abstract the ideal carbureter is a gasholder full of a correct mixture, from which the engine may draw as it desires, and this condition is somewhat met in the surface-contact carbureter, such as the Lanchester; but it seems open to question if such an arrangement will give a perfectly uniform mixture at all speeds of air flow. It may be remarked in passing that the Lanchester carbureter works with a wick, so that there is no fractional distillation of the petrol, leaving a heavy and useless residue behind.

The best modern carbureters have now been brought to a very high state of perfection, allowing the petrol engine to be nearly as flexible as a steam engine, so that the day is probably not far distant when the car will be fitted with one speed only for all ordinary purposes. As it is, the latest Mercedes can be run almost anywhere on its 50-mile per hour gear, and the speed can be then reduced by the engine to a little over five miles per hour. In the direction of economy, however, much remains to be done.—The Engineer.

There has been very little mountain sickness among the men employed in constructing the Eiger Tunnel, on the Jungfrau, although the height already reached is 9,840 feet above the sea. It is hoped to get through to the south side of the mountain, 10,824 feet above the sea, about the end of this year.

FORMATION OF VEGETABLE EARTH OR HUMUS.

M. C. J. Koning has been making a series of researches upon the formation of vegetable earth, which is rich in organic matter and comes from the rotting of leaves and *débris* of vegetable matter. We may ask what is the nature of such a transformation which starts with complex albuminoid bodies and finally ends in forming nitrogenous products which are much simpler in character and which the plants can assimilate as food. The process is partly aided by the earthworms which digest the vegetable cellulose and give off excretions, but even in this case, the leaf must have been transformed to a certain extent, and again it is known that the humus can be formed even in the absence of the earthworms. The phenomenon is generally attributed to the action of bacteria, and M. Koning now shows that spores play an essential *rôle* in effecting the change. He was led to search for the bacteria and spores, outside of the soil or the humus, and found them on the leaves which had recently fallen and those which still formed part of the tree, and even in the air. From the air he succeeded in collecting 21 different varieties of spores. He found 42 kinds on the oak leaf, 27 on the leaf of the beech, and 12 on pine needles. The relation of these numbers is of interest, as we find that the leaves which serve best for the formation of humus are placed in the same order of progression as those which afford the greatest number of spores. Among the spores, there are two varieties which are always found in the humus. One of these was found to be constantly present on all leaves and in the air. It is the *Trichoderma koningii*. The other kind, the *Cephalosporium koningii* seems to be confined to the humus. The experimenter had the idea that these two kinds of spores were specially efficacious in transforming the vegetable matter into humus, and for this reason he took up their complete study. The trichoderma has a very rapid growth and forms a felt-like substance of pale yellowish green color and a characteristic odor. The color becomes darker with age. The other form, the cephalosporium, is found on the leaves and especially just before they fall from the tree. One fact to be noted is that the character of the spore formation on each leaf varies according to the age of the latter and from the nature of the spores we can predict the death of the leaf at a greater or less interval of time. It seems that the leaf thus offers a more or less favorable propagating ground for these elements of destruction which are brought by the wind, by flies, which are covered with them, as well as by moths and caterpillars. Immediately after the fall of the leaves, the trichoderma commence to flourish and have an active existence during the whole of the humification process. It can be easily isolated from the air or from the woody matter of the soil. The spore is thus a parasite of the leaves, from which it assimilates the carbon. It begins to decompose the body of the leaf by means of an enzyma, cytase, which attacks the cellulose. That the decomposition of the cellulose is a necessary factor in the humification process was put in evidence by the author, who buried a cellulose paper in the ground for different periods of time up to one year. The paper was attacked under these conditions and gave the characteristic reactions of cellulose to a much less extent or even failed to give them altogether, especially in the case of the blue color with chloro-iodide of zinc. He found the same effect in the case of wood which was buried in the ground for a long time. The wood seemed to be the same as regards its structure, but it had changed in character, and now failed to give the characteristic reactions, such as the red color with phloroglucine and hydrochloric acid. This led him to suppose that a special substance, lignine, is found in the wood which gives these reactions and is attacked and decomposed in the soil in the same way as cellulose, while the wood itself does not appear to be altered. He finds that pectic compounds are also attacked.

The humus itself and the substances which go to form it do not appear to have been studied to any great extent. These bodies, together with the ulmic and humic acids, only seem to give a moderate amount of food to the trichoderma, and they seem to take only the nitrogen. The spores fructify to a greater extent under the influence of the visible rays, and therefore light is not without playing a certain part in these phenomena, although its *rôle* is indirect and of an uncertain nature. One striking fact which he observed is that the characteristic odor of the humus, which is attributed by many authors to different volatile products, is also quite characteristic in the trichoderma. While it may not be alone in giving off the odor, it certainly contributes not a little in making it so strong. The investigations seem to show that this first variety of spores commences to prepare the humification of the leaf while it is still living and attached to the tree. However, it needs a high temperature in order to flourish, or +30 deg. C., and when winter comes its vitality must be very much lessened. It commences again in the next warm season to act upon the leaf, which has now become partly decomposed. But during the winter and commencing with autumn its action has been succeeded by another variety of spore whose favorable temperature is much lower, being +18 deg. C. This spore is only found after the leaf is dead, as it cannot flourish on the living leaf. The humus, on the contrary, forms an excellent medium for it. This second variety, the cephalosporium, secretes digestive diastases and draws nitrogen from the products of albuminoid decomposition and the ammoniacal salts of inorganic and fatty acids. This spore no doubt contributes for the greater part to the transformation of the cellulose which leads to the production of humus. M. Koning made a very complete biological and chemical study of it, and found that along with the former variety it has the faculty of living and nourishing itself at the expense of the carbon contained in certain substances which are considered as bactericide and fungicide, such as are found in organic decomposition. It seems therefore that it is the spores, rather than the bacteria, which have the office of rendering to the soil the products which can be assimilated by a future vegetation, beginning with the complex compounds of the anterior vegetation. But it is not to be affirmed that there is an entire absence of bacterian action, and the two spores which have been already studied are not the only ones active among the great number of organisms which are contained in the humus of the forest.

EXCAVATIONS IN CRETE.

M. Louis Pernier has lately made a report concerning the excavation which the Italian archæological expedition is making at Phaestos, in Crete, under the direction of M. Halbherr. The Italian expedition has been on the ground for several years past, devoting a considerable time to exploring the site of the ancient city of Phaestos, and has brought to light the greater part of the Mycænean palace which occupied the acropolis. The city contained, in fact, three elevated points which were crowned with palaces or temples. Before proceeding any further with clearing out the principal palace it was thought advisable to explore the pre-Mycænean layers and the necropolis, as these afforded some very interesting discoveries. As to the palace itself, it offers a striking analogy with that of Gnossos, but it is even of a more vast construction and in some respects is better preserved. Like the palace of Gnossos, it has replaced a more ancient edifice and there remains a thick neolithic layer which shows that the site was occupied from the most ancient times. The ruins of the palace which still remain testify as to its former grandeur. It contained a central corridor, storehouses with jars containing supplies, the *megaron* of the men, a portico on the east side of large construction, the *megaron* of the women, then a grand staircase which leads to the *hyperoön*. The large chamber, which has benches or seats, decorated with triglyphs, must also be mentioned. Among the smaller objects are a bench in gypsum which was placed below the eastern portico, and a niche decorated with frescoes in geometric designs.

As at Gnossos, the double ax appears as a characteristic sign in the decoration of the palace. Inscriptions are found, which are engraved in the linear characters which are also found in the former palace. Many lamps and vases came to light, along with bronze objects. Among the latter are sickles, knives, and a fibula with an arc of serpent form which was found in the upper Mycænean layer. The vases of the pre-Mycænean epoch are of the class known as Kamarès, and of these as many as forty whole specimens were found. M. Pernier divides these into four classes according to the material and technique. One vase has the form of a horse. Among other objects are a small idol of limestone and a painted statuette of a woman in terra cotta. A specimen of great interest is a shell which is decorated with a bas-relief containing three demons with heads of cow, horse, and pig, respectively, followed by a bird-headed demon. A tablet of terra cotta contains the figure of a cow, along with an inscription in linear characters. One of the vases which were found shows a transition from the Kamarès to the Mycænean style. Many other objects were discovered; among these are a large bowl and a table or altar for pouring libations. M. Pernier states that the *motif* of the bas-relief on the shell is almost identical with that which is found on the gold ring of Mycænae, and we have other analogous scenes of the same epoch which no doubt represent a procession of masked persons. Such *motifs* have been employed by different peoples in Australia, India, etc.

Mr. Rufus Richardson, who visited Phaestos and Gnossos in turn, states that the site of Phaestos is magnificent and the palace itself grandiose. The plan of construction is clear and accords in many points with that of Gnossos, so that it will throw considerable light upon the latter. It is very fortunate that the two excavations are going on at the same time. He thinks that Gnossos is the most important palace, but other savants express the contrary opinion. However this may be, it is certain that we have a series of unusual revelations, which will offer food for reflection during a long period.

The chronology of Phaestos and Gnossos raises some interesting questions. The ancient writers tell us, and this is confirmed by Egyptian chronology, that the culminating point of the Mycænean civilization occurred near 1400 B. C. But as to its beginnings we are not so certain. Mr. Evans states that back of the present palace of Gnossos another one formerly existed, and some of its blocks were used for the second. The former palace belonged to the epoch of the so-called Kamarès pottery, and must go back to 2000 B. C. But even this palace must have succeeded a still more ancient building, seeing that neolithic pottery has been found at a depth of 22 feet or more. The palace of Phaestos is likely to give some discussion as to the question of the Labyrinth. Mr. Evans explains it as the "palace of the double ax" (*labrys*), seeing that he found this sign repeatedly at Gnossos. But as the same sign is often found at Phaestos along with many other signs whose meaning is not clear, the name Labyrinth can hardly be

claimed for Gnossos exclusively. In fact Minos might have had several "labyrinths," allowing this word to signify "palace" in that language. The presence of the double ax on such sacred objects as the gold ring of Mycænae seems to show conclusively that it must be recognized as a symbol. Besides this symbol we have others no doubt, which perhaps go back to the origin of writing.

ENGINEERING NOTES.

At Algiers the construction of an outer harbor in the Bay of Agha continues steadily, and is to be finished by the end of this year. It will form a basin open only to the southeast. The works already completed comprise 42½ acres of quays, with a jetty 200 yards long, while another jetty, 300 yards in length, protects the works. The harbors at Bono and Bougie are also to be considerably improved.

A new file-cutting machine, invented by a German, has been taken up by several firms in Sheffield. The chief characteristic of the machine is that it will cut half-round blanks, as well as flat ones, and is adaptable for cutting any length and shape of rasp. The blank is firmly secured, half-round side upward, to a rocking bed, which brings every successive punching line to the same distance below the chisel. There are ingenious devices for waving each line of punches, for lightening the blow as it approaches the tapered end of the blank, and for putting the lines of punches in echelon transversely across the face of the blank, as well as undulating them longitudinally. In this way the desired irregularity is secured on the rasp, and when used on wood, leather, or soft metal, it leaves no straight lines. Coarse horse rasps are punched 300 punches a minute, fine rasps at 600. The machine requires little power.

The opening of the Circum-Baikal Railroad took place September 23. The building of it has been one of the most notable feats in railroad construction. Probably no work of such difficulty was ever so quickly executed—some two years ahead of the time set before the war. Its importance to the Russians cannot easily be exaggerated, and its opening (doubtless it cannot be called completed yet) so early in the season immensely strengthens the position of the Russian army in Manchuria, which can not only be reinforced but supplied for the winter before winter sets in, which in that terrible climate limits materially the efficiency of a railroad; though, the snow-fall being light on most parts of the line, there is less hindrance from the blockades than we might be led to expect. The new railroad is strongly occupied by troops, and is worked strictly as a military line. So far, only freight trains run over it, passengers crossing by the ferry in a fraction of the time required by rail, the distance by lake being less than 40 miles, against 250 by rail.

It will be interesting to see how the experiment which is being made by the North-Eastern Railway Company with a motor-lurry for the collection and distribution of heavy traffic in agricultural areas will result. About a couple of years ago the Lancashire and Yorkshire Railway, at their Salford goods yard, made a trial with motor-wagons for the collection of goods, but as these were afterward abandoned their running could not have proved a success. Whether the improvements that have been made in the design of these wagons since the Lancashire and Yorkshire experiments were made will result in their successful operation by the North-Eastern Railway Company, only time can prove. The lurry is of 5 tons burden, with a trailer capable of carrying 2½ tons, and will run between villages in the neighborhood of York. It is intended that the lurry shall convey consignments of lime, stone, and other commodities for delivery to the farms, and return with produce to be forwarded by rail. If the experiment should prove successful, the service will be extended.

At various times during the construction of the Simplon Tunnel work has been retarded by the influx of water from underground springs. In the autumn of 1901 a stream of water burst into the Italian workings, and, attaining a discharge of nearly 8,000 gallons per minute, speedily converted the two headings into canals. Several months elapsed before the flow could be overcome, and no sooner had this been effected than a tremendous fall of rock took place. Timber struts and shores, of 20 inches diameter, were repeatedly broken like tinder, and the boring machinery had to be dismounted on three successive occasions. Finally the unstable rock was held up by means of heavy steel frames placed at intervals of from 1 to 3 feet apart. The experience of the Italians has been unfortunate throughout, for they have had to deal with floodings, rock slips, high temperatures, and exceedingly hard strata. It now appears that the turn of the Swiss engineers has come, as only last week a spring of boiling water was tapped, with a discharge estimated at 18,000 gallons per minute. This new influx has resulted, unhappily, in serious loss of life, and, in the opinion of a Swiss engineer who has investigated the condition of the workings, it is open to question whether the tunnel will ever be completed. At the present time we cannot accept this report as final, but it is undoubtedly most difficult to deal with a formidable spring of hot water in space so confined as that offered by the headings of the tunnel. As about 10 miles, out of the total length of 12 miles 458 yards, have already been driven, it would be singularly unfortunate if the final abandonment of the work were to become necessary. We still hope that the indomitable energy and great resources of the engineers, which have served to overcome so many difficulties in the past, may once more triumph over adverse circumstances.

ELECTRICAL NOTES.

The imperial Canadian authorities are bringing wireless telegraphy under government control because in time of war it is manifestly desirable that wireless communication should be under the same supervision as the mails and ordinary telegraphy. A suggestion has been received from the British government that Canada should do likewise. It is understood that measures will be taken in that country to control wireless telegraphy. There is a clause in the Marconi charter which gives the right to the government to appropriate it in the course of time, and it is understood that no additional charter will be granted.

Mr. F. P. Bolshaw, the inspector of weights and measures for the city of Liverpool, England, has invented an ingenious electrical apparatus for stamping glass tumblers, which is a great improvement upon the old manual and pedal sand-blast apparatus. By means of this new device it is possible for one man to stamp 1,800 glasses per hour, as compared with an output of 360 glasses by two men per hour. Considering that over 2,400,000 glasses are stamped every year by the weights and measures department of the city, the economy in labor and expense effected by this new system is apparent. One feature of the electrical machine is that two glasses can be stamped simultaneously.

A new method of driving and regulating clocks electrically by the use of selenium cells has been devised by Herr K. Siegl. The Ruhmer selenium cell, in an exhausted pear-shaped bulb, was placed in the focus of a parabolic cylindric mirror, so that the light from an incandescent lamp could impinge upon the cell whenever a second pendulum passed its lowest point, at which a slit in a card fastened on the pendulum coincided with a slit on a fixed screen. The effect on the selenium is made to actuate an electro-magnet—placed just to one side of the point of highest velocity, owing to the lagging of the cell—so that an impulse is imparted to the pendulum at the right instant. Another selenium cell can be used for imparting motion to a series of other electrically-operated clocks, which can be of the step-by-step type. A clock on these lines has given satisfaction, and demonstrated that an electric clock without contacts can be made.

The lesson of the use of Niagara Falls for generating electricity has been put to world-wide application. Throughout the world falling water, according to a paper read before the British Association by Mr. Campbell Ewinton, yields to man's use an energy equal to 1,483,390 horse-power, of which Great Britain figures for only 11,906 horse-power. The British Aluminium Company gets 7,000 horse-power from the Falls of Foyers, and it expects presently to procure 17,000 horse-power from Loch Leven. The North Wales Electric Power Company is about to tap Lake Llydaw, on Snowdon, and hopes to obtain 8,200 horse-power for every working day of nine hours. Finally, the Scotch Water Power Syndicate is peering round in quest of waters that it can imprison at lofty levels and so generate electric power. From Loch Sloy, 757 feet above Loch Lomond, it is going to get 6,600 horse-power, and at Ardlui, higher up, it proposes to get further energy. Even a modest stream that drops several hundred feet may be a source of power.

In a paper recently published in Glaser's Annalen für Gewerbe u. Bauwesen, Prof. v. Borries records some observations made by himself as to the wear and tear of electric railway rails on the Berlin electric elevated and underground and the Berlin and the Frankfort tramways. As regards the former, waves 80 to 150 millimeters in length and 0.8 millimeters in depth were found at the starting sections of the western track, while in the central section a still smaller wave formation (400 to 500 millimeters in length) and a perfect smoothness of the rails throughout considerable intervals were noted. The strongest wave formation was observed in the braking section, when wave lengths beginning with values of 100 to 150 millimeters and assuming finally values of only 20 millimeters were found. On the eastern track a considerably stronger wave formation (mostly 60 to 120 millimeters in length) was observed. On both tracks, however, there was no apparent regularity. On the Berlin tramway a very slight formation of waves was noted only exceptionally, while on the Frankfort tramway, according to statements of the managers, waves are produced only at places where the rails are loose. The above observations are accounted for on the hypothesis that the cause of similar waves is to be looked for in vertical vibrations of the rails as produced by the cars running along them. Where the acceleration of these vibrations is turned downward, the wheel pressure will be lower, a wave crest being produced, while with upward acceleration the wheel pressure will be stronger, so as to produce a wave hollow. A wave length would accordingly correspond to the distance traversed by the train during one vibration of the track. This hypothesis agrees with the fact that the wave length varies with the running speed as well as with the difference in consecutive waves according to the different resistivity of the rails and the duration of a vibration resulting therefrom. It should be stated that the western section of the Berlin elevated railway has softer rails, liable to perform longer oscillations. As there is a high uniformity of speed at a given place, the weight and load of these trucks, etc., these effects may very well be produced under every wheel at the same place in the same way, so as to eventually give rise to the production of waves. To obviate this production of waves in the surface of the rails, the author therefore suggests designing the cars in a less uniform way, so as to have conditions similar to those obtaining on normal railways.

TRADE NOTES AND RECIPES.

To Make Wooden Vessels Acid and Chloride Proof.—Take 6 pounds of wood tar and 12 pounds rosin, and melt them together in an iron kettle, after which stir in 8 pounds finely-powdered brick dust. The damaged parts must be cleansed perfectly and dried, when they may be painted over with the warm preparation or filled up and drawn off, leaving the film on the inside.—Färber and Wäscher.

Liquid Bottle Lac.—Liquid bottle lac is prepared by dissolving 250 parts shellac in 750 parts spirit (96 per cent) and 75 parts sulphuric ether. Shake frequently while dissolving. When the solution is finished, add 125 parts thick turpentine, as well as 75 parts boracic acid, and shake well again. For coloring take suitable aniline colors soluble in spirit. If the lacquer is not desired transparent, add 250 parts very finely pulverized soapstone, but in this case it will be necessary to stir the lacquer up well before use.—Farben Zeitung.

Lubricants.—An excellent lubricant for heavy bearings can be made from either of the following receipts:

	1.	2.
Paraffin	6 lb.	8 lb.
Palm Oil	12 lb.	20 lb.
Oleonaphtha	8 lb.	12 lb.

The oleonaphtha should have a density of 0.9. First dissolve the paraffin in the oleonaphtha at a temperature of about 70 deg. C. Then gradually stir in the palm oil a little at a time. The proportions will show that receipt No. 2 gives a less liquid product than receipt No. 1. Quicklime may be added if desired.—Le Journal du Petrole.

To Make a Steam Cylinder Lubricant.—To obtain a very viscous oil that does not decompose in the presence of steam even at a high temperature, it is necessary to expose neutral wool fats, that have been freed from wool-fatty acids, such as crude lanoline or wool wax, either quite alone or in combination with mineral oils, to a high heat. This is best accomplished in the presence of ordinary steam or superheated steam at a heat of 300 deg. C. and a pressure of 50 atmospheres, corresponding to the conditions in the cylinder in which it is to be used. Instead of separating any slight quantities of acid that may arise, they may be dissolved out as neutral salts.—Chem. Zeitung.

Solder for Glass.—Glass is one of the most universally employed bodies. It is transparent, can be readily cleaned, and is not attacked by commonly-occurring substances. Glass only possesses one annoying drawback (outside of its fragility): It is difficult to solder together with other materials, wood or metal. But even in this regard necessity has finally led to the discovery of the right thing. Melt tin, and add to the melted mass enough copper, with constant stirring, until the melted metal consists of 95 per cent of tin and 5 per cent of copper. In order to render the mixture more or less hard, add ½ to 1 per cent of zinc or lead, whereby an excellent solder for glass is obtained.—Deutsche Maler Zeitung.

To Make Mosaic Pictures.—The picture is composed upon strong paper laid down horizontally, and affixed thereto by means of paste, with the face laid downward. Later the paper thus covered is cut into single numbered pieces, held before the freshly-applied mortar, and pressed into it in such a manner that the joints between the mosaic stones are perfectly filled up. Then the soaked paper is scraped off, and the picture becomes visible. In order to color the shining mortar, the different parts are painted with their main color. The mosaic stones are then freed from the paint by washing with acid, while the colors remain on the mortar, so that the joints are no longer visible at a distance.—Der Dekorationsmaler.

Gold Bronze Varnish.—This product should be applied only when entirely free from acid, otherwise the acid forms verdigris in combination with the bronze. The acid is removed from the resin in the following manner: Pour 1,000 grammes of petroleum benzine over 250 grammes of powered dammar and shake it often until dissolved. To this add 250 grammes of a 10 per cent solution of caustic soda, shake the whole vigorously for ten minutes, and allow to stand; pour off the upper benzine gum solution from the lower aqueous sodium resinate solution, and shake up the former again vigorously with 250 grammes of a 10 per cent solution of caustic soda, and let it stand until it clarifies and separates into strata. The dammar gum solution is now free from acid. For the making of the gold bronze varnish, take one liter of the deacidified dammar resin solution, add about 250 grammes of bronze. A second process runs as follows: Mix 100 grammes of powdered dammar resin with 30 grammes of calcined soda, melt them, and retain them in the melted state from two to three hours, having stirred them well together. After they cool off, grind up the cloudy mass and add 9 cubic centimeters of coal-tar benzine, and dissolve the soluble particles out of the batch by frequent shaking. To the filtrate then add from 300 to 400 grammes of bronze powder; if well

prepared, the bronze powder will remain in suspension for a long time; if the varnish be too thin, however, it soon settles to the bottom, and then a part of the solution must be evaporated in order to bring it up to the proper consistency to hold the metallic powder in suspension.—Kraft und Licht.

SELECTED FORMULÆ.

Practical Receipts for the Making of Varnish.—

Spirit Varnish.—This is preferably made by a cold process, and requires less technical knowledge than the preparation of fatty varnishes. The chief dependence is upon the choice of the raw materials. These raw materials, copal, shellac, etc., are first broken up small and placed in a barrel adapted for turning upon an axis, said turning to be effected with a crank, by hand, or with a belt and pulley from a power shaft. The barrel is of course simply mounted in a frame of wood or iron, whichever is the most convenient. After the barrel has received its quota of raw material, it may be started and kept revolving for twenty-four hours. Long interruptions in the turning must be carefully avoided, particularly in summer, for the material in the barrel, when at rest, will, at this season, soon form a large lump, to dissolve which will consume much time and labor. To prevent the formation of a semi-solid mass, as well as to facilitate the dissolving of the gum, it would be well to put some hard smooth stones into the barrel with the varnish ingredients.

Bicycle Dipping Varnish (*Baking Varnish*).—Take 50 kilogrammes of Syrian asphalt, 50 kilogrammes of copal oil, 50 kilogrammes of thick varnish oil, and 105 kilogrammes turpentine oil, to which add 7 kilogrammes of drier. When the asphalt is melted through and through, add the copal oil and heat it until the water is driven off, as copal oil is seldom free from water. Now take it off the fire and allow it to cool; add first the siccative, then the contingents of turpentine and linseed oils, which have been previously thoroughly mixed together. This bicycle varnish does not get completely black until it is baked.

A Ground Varnish for Bicycles.—Take 100 kilogrammes of the above dipping varnish and mix it well with 500 grammes of lamp black, then grind it once through the mill.

Polishing Varnish, White, No. 1.—To 30 kilogrammes of bleached shellac, add 8 kilogrammes of Venetian turpentine, 1 kilogramme of light gum benzoin, and mix it all together in 45 kilogrammes of spirit.

Polishing Varnish, White, No. 2.—To 8 kilogrammes of bleached shellac, add 20 kilogrammes of light Manila copal, 6 kilogrammes of thick French turpentine, 1 kilogramme of light gum benzoin, and dissolve this in 45 kilogrammes of spirit.

Polishing Varnish, Brown. I.—Take 20 kilogrammes of light yellow shellac, 6 kilogrammes of sandarac, 6 kilogrammes of thick turpentine, 1 kilogramme of medium gum benzoin, and mix with 45 kilogrammes of spirit.

Polishing Varnish, Brown. II.—With 10 kilogrammes of yellow shellac mix 20 kilogrammes Manila copal of medium grade, 6 kilogrammes of thick turpentine, 1 kilogramme of medium gum benzoin, and dissolve the whole in 45 kilogrammes of spirit.

Asphalt Varnish. I. (for safes and the like).—Take 50 kilogrammes of melted amber, with 100 kilogrammes of Syrian asphalt (chips), 25 kilogrammes of copal oil, 75 kilogrammes of thick varnish oil, 10 kilogrammes of siccative, and 175 kilogrammes of oil of turpentine. The combination is effected in the manner described above under dipping varnish.

Asphalt Varnish. II.—150 kilogrammes Syrian asphalt (chips), 65 kilogrammes Thuringian asphalt, 50 kilogrammes of hardened resin, 30 kilogrammes thick varnish oil, 10 kilogrammes siccative, and 260 kilogrammes pine oil. Combine as above.

Asphalt Varnish. III.—100 kilogrammes hardened resin, 80 kilogrammes Thuringian asphalt, 70 kilogrammes Cuban asphalt (chips), 70 kilogrammes rosin oil, 20 kilogrammes siccative, 100 kilogrammes pine oil, and 15 kilogrammes benzol. Combine as above described.

Tinctures for Russian Polishing Varnish.—Take 14¼ kilogrammes of orange-colored shellac and 10½ kilogrammes of spirit. When dissolved allow it to stand from eight to ten days quietly, so that it may settle; decant the clear liquid from the top, and filter the remainder through felt.

Russian Polishing Varnish. I.—With 110 kilogrammes of the above tincture mix 12½ kilogrammes of light Manila copal, 12½ kilogrammes sandarac, and 12 kilogrammes of Venice turpentine. Placed all together in a revolving barrel, these three ingredients dissolve into a uniform fluid. Filter through a brass sieve and stand aside in a wooden vessel.

Russian Polishing Varnish. II.—Take 80 kilogrammes of the above tincture, and with it mix 9 kilogrammes of pale Manila copal, 9 kilogrammes of sandarac, 8 kilogrammes of thick turpentine, 18 kilogrammes of American resin, and 20 kilogrammes of spirit, and place them all together in a revolving barrel until uniformly dissolved, when they may be treated as in No. 1. When it is a question of making black polishing varnishes, either I. or II., black dye is added according to need. To 100 kilogrammes of the polishing varnish I. or II. add 2 kilogrammes of aniline black (nigrosine) to the compound when it is placed in the revolving barrel.

A Paper Varnish.—Mix 60 kilogrammes of American resin with 20 kilogrammes of Manila copal, 6 kilogrammes of thick turpentine, and 80 kilogrammes of spirit—Farben Zeitung.

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