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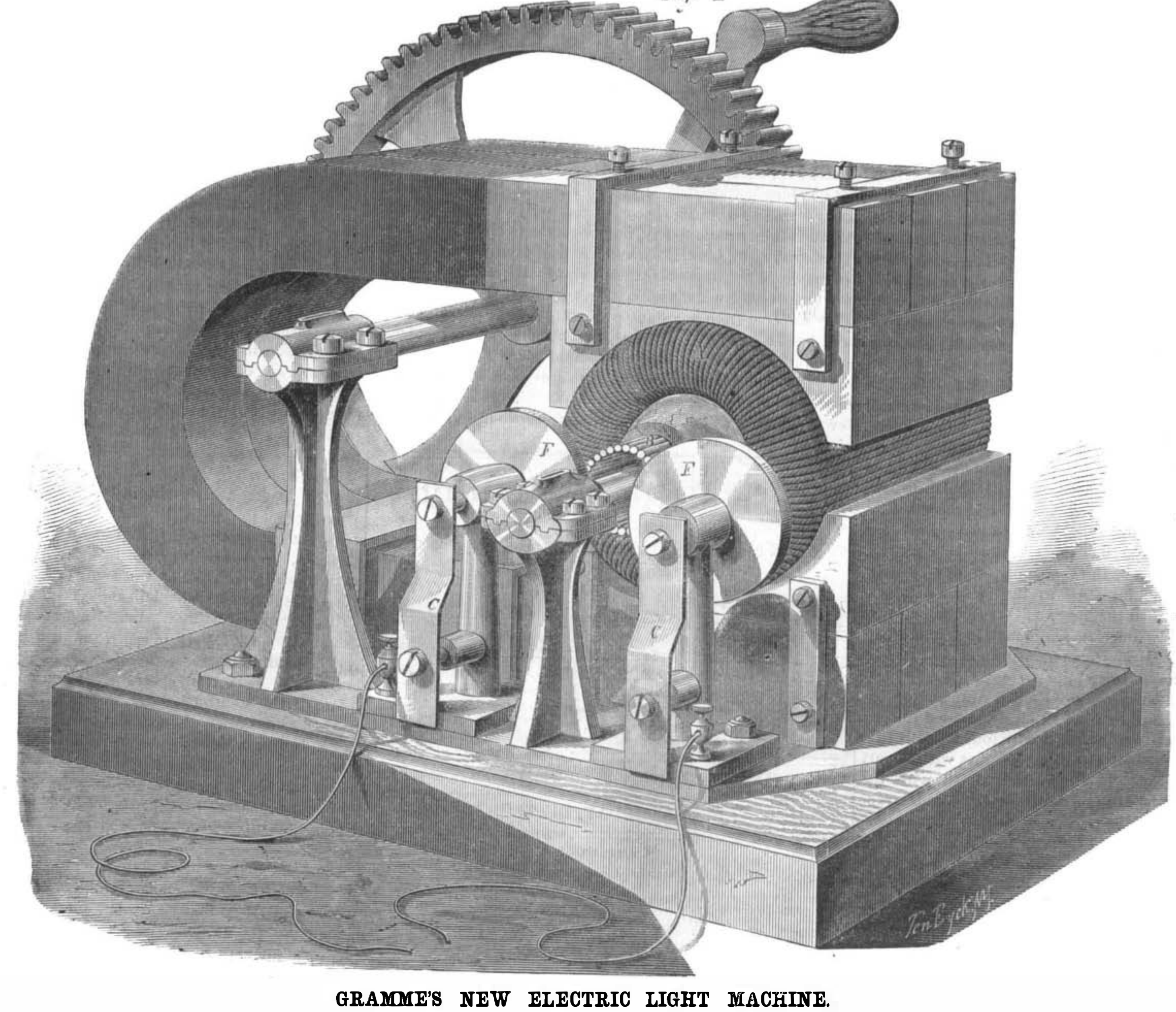
RECENT PROGRESS IN ELECTROMAGNETISM.

Much ingenuity has been wasted upon the problem of converting electricity into mechanical force; or, in other words, of constructing electromagnetic engines destined to drive machinery, to raise weights or to draw loads. Hundreds of such engines have been made, only to demonstrate the conclusion of scientific men, who have long ago given up the problem as incapable of a practical solution. It is not difficult, indeed, to show by a very simple calculation that, in the present state of science, the electromagnetic machine can never compete with the steam engine, because of its far greater cost. The force in the former is derived from the oxidation of zinc in the battery, while that of the latter is due to the oxidation of the carbon in the coal burned under the boiler. Now, 1 gramme of carbon burned will raise the temperature of 8,080 grammes of water 1° centigrade, while 1 gramme of zinc will only raise 1,300 grammes to the same extent. Thus carbon would seem to be 6·2 times as effective as zinc. After the oxidation of the zinc in the battery, the solution of the oxide in the sulphuric acid produces an additional quantity of force (or heat) capable of raising 335 grammes more, which must be added to the 1,300 grammes; from this, however, must be deducted the force wasted in decomposing the water in the battery, a force capable of raising 1,060 gramm es of water 1° centigrade. The balance, 575, is 14 times less than the effective force of coal, and yet even this comparatively small amount of force is only attainable in the theoretically perfect battery. Taking into account that coal is about 40 times cheaper than zinc, the odds are 40 times 14, or 560, to 1 against the electromagnetic machine.

While thus any effort to convert electricity into the grosser form of mechanical force must fail, until zinc can be manufactured about 600 times more cheaply than coal can be mined (which it probably never will be) or until some other source of electricity be discovered, physicists have been eminently successful in reversing the problem: that is to say, converting mechanical force into electricity, and they have utilized the electricity so obtained in the production of the most intense artificial light known. Before describing the immense improvements made very recently in this department of science, it may be well to study the apparatus hitherto employed.

When a piece of soft iron surrounded by insulated copper wire is presented to the poles of a magnet, a momentary electrical current is formed in the wire; and on removing the soft iron from the magnet, another current is formed in the opposite direction. Now, these currents may be made to succeed each other with extreme rapidity by revolving the insulated iron bar before the poles of the magnet, and they may also be made to flow in one direction. The former may be done by steam, and the latter is accomplished by a device called a commutator. Thus a powerful current is produced, capable of showing all the phenomena of the battery in an exalted degree. Machines constructed on these principles have been extensively used to produce the electric light and in electroplating.

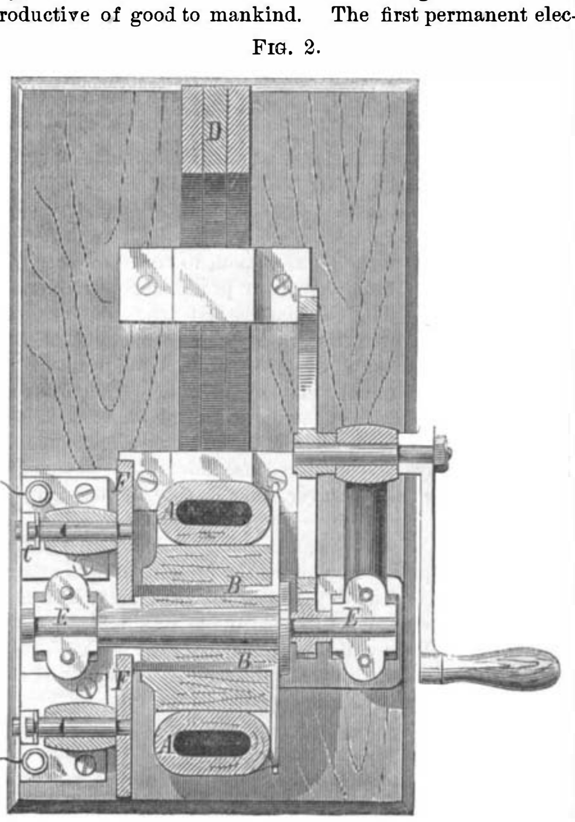
Fig. 1



GRAMME'S NEW ELECTRIC LIGHT MACHINE.

In December, 1858, the electric light was employed for the first time in the illumination of lighthouses, at the South Foreland, England. The magneto-electric machine used was constructed by Professor Frederick H. Holmes. The following April a favorable report was made on the invention by Faraday, who thus had the satisfaction of seeing his discoveries productive of good to mankind. The first permanent electric light was not established, however, until June 6, 1862, at Dungeness. Holmes' machine consisted of 120 permanent magnets, each weighing 50 pounds, arranged on the periphery of two large wheels. A three horse power steam engine revolved 160 soft iron cores surrounded by coils of wire near the poles of the magnets about 100 times a minute. The negative and positive currents were thrown in one direction by means of a commutator, and then conducted through thick wires into the lighthouse tower where they terminated in carbon points, between which the electric arch was formed. The intensity of the electric light, as measured by Fizeau & Foucault, is only 2½ times less than that of the sun; while its cost as compared with the Fresnel lamp then in use was computed to be as 400 to 290.

FIG. 2.



A considerable improvement was made by Wilde, who conceived the idea of causing the current induced in a coil of wire by a permanent magnet to produce a more powerful electromagnet, which in turn was to induce a new and greatly increased current. The current thus generated could be passed around a third magnet, and so on indefinitely, as far as theory was concerned. In practice, however, he found it most advantageous to limit himself to three magnets. When the three armatures of these magnets were driven with a velocity of 1,500 revolutions a minute, it melted a cylindrical iron rod 15 inches long and ¼ of an inch in diameter, which was placed between its poles. With gas carbon points half an inch square, the light generated was equal to 4,000 wax candles. This machine weighed about 3 tuns, and required a seven horse power engine to drive it.

In his latest and most perfect form of machine, completed last June, Wilde employs two wheels of 16 electromagnets each, between which are situated two series, each of 16 soft iron armatures secured to a heavy cast iron disk. The ends of the cores are terminated with iron plates of circular form, which retain the helices in place and somewhat overlap the distance between the poles of the electromagnets. By having the magnetic circuits of the electromagnets and armatures closed for a short distance, and by likewise having the electric circuits closed for a brief interval at the point of no current, the magnetic intensity of the electromagnets is maintained during the rise and fall of the magneto-electric waves transmitted through the helices. These helices are divided into 8 groups of 4 each; one of these groups produces the minor current for the circle of electromagnets, and the rest are joined together for a quantity of 7 and an intensity of 4, to produce the major current of the machine.

This machine weighs only about one tun, while its power is double that of the 4 tun machine described. It may be run at a speed of 300 to 1,000 revolutions per minute.

The Wilde machine is in operation in this city for plating purposes, at Frank Leslie's printing establishment. The machine runs with a velocity of 1,800 revolutions a minute, and will electrotype a number of plates as large as the Illustrated Newspaper in 20 minutes. Wires are also connected with the machine, which lead to the photographic establishment across the street, and on cloudy days they print photographs by means of the electric light produced by the Wilde machine.

The results obtained by these machines and by subsequent modifications certainly leave little to be desired; but the machines themselves, unfortunately, have inherent defects. The currents produced are intermittent; at each revolution, two electrical pulses proceed in one, and two in another, direction. To collect these, a friction commutator is necessary, which wears away very fast. In Holmes' original machine it only lasted from 10 to 20 minutes; and in the later machines, in which over 1,800 revolutions per minute are obtained, there must necessarily be considerable wear and tear wherever there is a metallic contact of moving parts.

These difficulties have been overcome in a machine invented by M. Gramme, of Paris, and recently exhibited before the French Academy of Sciences by M. Jamin. Our engravings illustrate the invention. The principle is as follows: If the north pole of a permanent bar magnet be moved along a soft iron bar surrounded by an insulated wire, it will produce a south pole in the iron bar, which will gradually be displaced from one end of it to the other, following the motion of the bar magnet. The result is a continuous induced current in the surrounding wire. If, now, the soft iron bar be made into a ring, A, and placed between the poles of a horse shoe magnet, D, these poles will of course induce currents in opposite directions, neutralizing each other at two points of the ring, midway between the poles, exactly (according to Mr. Crookes) as if we had two batteries connected in opposition by joining their similar poles. On revolving the iron ring on the journals, E, a continuous current is developed, as in the case of a straight bar, but in opposite directions, because here we have to do with both poles of the exciting magnet. Both these currents will continually neutralize each other at the two mean points. To utilize them, all that is necessary is to connect conducting wires to the insulated wire at the mean points, and they will flow along these wires instead of neutralizing each other; just as in the two batteries above, connecting a disk, F, with each point of contact of the similar poles, will cause the force of the batteries to flow through the conducting wires "quantity-wise." M. Gramme accomplishes this in the following manner:

If the wire wound upon the ring is very thick and there is but a single layer of it, it is sufficient to remove the insulating covering at some point which, in its revolution, is made to touch fixed metallic conductors, F, situated at the neutral points. If, however, many layers of fine wire are used, the following device is adopted: The wire is divided into sections of, say, 300 turns each, there being no break, however, in the wire on passing from one section to another. Each section has its wire exposed at one point, and to this point is soldered a solid bar of brass, B, capable of considerable wear and tear. The bars thus attached to the sections are arranged radially; and when the ring, A, is revolved, several of them simultaneously touch two solid metallic rubbers, F, at the neutral points. More than one bar is made to touch at a time to prevent any break in the current.

The machine exhibited before the French Academy of Sciences derived its magnetism from an electromagnet instead of a permanent one. It was provided with four metallic rubbers, two of which supplied the electromagnet with a part of the current generated. The machine started with the feeble residual magnetism in the electromagnet, which rapidly gained in strength as the velocity increased. A machine of this kind, having 15·4 lbs. of copper wire 0·118 inch thick, decomposes water and fuses 1·04 inches of iron wire 0·036 inch thick when worked by hand. A large machine, driven by a 2½ horse power engine, which was exhibited in London, produced a light equal to about 8,000 candles; and still larger machines are being made, which Mr. Crookes expects to give a light equal to 25,000 candles. Besides the purposes of illumination, such machines, of the smaller sizes, will be of service in telegraphing, electroplating, gilding, medicine, military operations, and chemical decompositions. They are of especial value in electroplating, on account of the constancy of the current. In the galvanoplastic works of M. Christofle, of Paris, it is found that the best machine hitherto known, when moved with a velocity of 2,400 revolutions per minute, only deposits 5·465 ounces troy of silver per hour, while a smaller Gramme machine deposits 9·645 ounces troy of silver per hour with one eighth the velocity.

There will be two of these machines in this country before long, Professor Barker having ordered one for the Stevens Institute of Technology, and one for the University of Pennsylvania. At present electroplating is done in this city in several places by the Wilde machine.

It would be difficult indeed to foresee what further increase in power may yet be obtained in these machines; for investigators are constantly studying the properties of magnets and the means of augmenting their strength.

M. Ruhmkorff, to whom science already owes so much, still continues his experiments in electricity and magnetism. He has presented the following facts to the French Academy of Sciences:

If a bundle of iron wires, covered with thick copper wire giving passage to an intermittent current from a battery, is then wrapped with fine wire for the purpose of obtaining an induced current, that current will have more than double the usual intensity if we wrap the fine wire around the middle of the bundle, where there is no magnetization, instead of wrapping it near one of the poles. He concluded from these premises that he could get still more powerful effects by making a continuous ring of his iron wires, which would then present no poles; but in this he was disappointed, for the induced current gave a spark only 0·1 inch long. On cutting the ring, the spark at once increased to 0·2 inch, although the cut ends came together the moment they became magnetic.

On keeping the ends apart with a plug of wood 0·2 inch in thickness, the spark reached the length of 0·6 inch. With thicker plugs of wood, no further change was produced. It still remains to be seen what practical application can be made of this fact.

Jamin, in studying the magnetism of thin steel plates, found, by magnetizing plates of various dimensions and superposing a number of similarly magnetized ones, that he could construct magnets carrying twenty times their own weight. The thinner the superposed magnetized plates, the more powerful the resulting magnet. His researches will probably reveal the law according to which magnets, having a minimum weight and a maximum carrying force, may be constructed.

It seems, too, as if we were rapidly approaching the solution of the problem of an electrical illumination for our streets and houses. The difficulties hitherto have been: that it is impossible to regulate the intense brilliancy of the electric light, which would be blinding on the street, and of course utterly unfit for lighting our houses; that it is not continuous, but requires the frequent renewal and adjustment of the carbon points, involving expense and complicated apparatus for each lantern; and finally that a separate source of electricity is required for each lamp. All these difficulties are said to have been obviated by the invention of Mr. A. Ladiguin, of St. Petersburgh, which was recently exhibited by Kosloff & Co., the proprietors of his patent, in the Admiralty House of that city. His invention is as follows: Only one piece of carbon, or other bad conductor, connected with the magneto-electric machine is placed in a glass tube exhausted of air, filled with some gas which will not combine with carbon at a high temperature and hermetically sealed. The carbon becomes gradually and equally heated, and emits a soft, steady, and continuous light. One machine, driven by a small three horse power engine, is said to be capable of lighting many hundreds of such lanterns, which will burn under water and in mines as well as in a room. They are free from any danger of explosion, and have the additional advantage, over gas, that they emit no poisonous evaporations detrimental to the health. The inventor calculates that these lamps can be lighted at one fifth the expense of coal gas. If this invention should prove a success, few consumers will mourn the disappearance of gas companies.

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NEW YORK, SATURDAY, DECEMBER 6, 1873.

Contents:

(Illustrated articles are marked with an asterisk.)

NEW YORK AND THE CENTENNIAL.

For several months past extended advertisements have appeared in the journals of this city, announcing a projected scheme of a grand national exposition, to be permanently located in elaborate buildings, in a prominent locality near the Central Park. The originators, last year, obtained the passage of a bill in the State legislature, authorizing them to ask a subsidy of two and a half millions of dollars from the municipal government. After hearing argument on both sides of the question, the Board of Aldermen have refused the appropriation; and as a consequence, the scheme may be considered as indefinitely postponed. We have remarked, however, that during its existence a portion of the press have sought to engender a kind of rivalry between this plan and the coming National Centennial at Philadelphia. In view of the present state of affairs, it is to be hoped that any feeling of jealousy which may have become prevalent will speedily die out, and that the people of New York will render that support to the Centennial which the enterprise justly deserves. The quota of this State is $1,036,600, which it is proposed to raise by issuing stock in shares of $10 each, paying six per cent interest, and secured by sale of tickets, concessions for advertising, etc., and sale of the building—making the investment, as far as can be predicted, a safe and, probably, profitable one.

An immense amount of labor has been accomplished by the Centennial committee, and, from all accounts, the work is progressing rapidly and well. The people of the southern and western States are manifesting no small amount of interest in the scheme, and State and county associations are forming for the purpose not only of raising funds but of securing the most complete possible exhibit of resources and products. A very liberal appropriation has been made by Pennsylvania and the city of Philadelphia, and we understand that still further assistance is contemplated in order to add improvements to Fairmount Park, the site of the exposition buildings. In fact the country has abundant cause to congratulate itself on the favor with which the plan has been received abroad, and the enterprise with which it has thus far been conducted at home. Uniform and flattering success, we might say, has been encountered, were it not that several of the States have manifested a dilatoriness in affording support, which cannot but prejudice the general progress of the undertaking.

The citizens of New York should remember that the selection of the plan of buildings from drawings submitted by Messrs. Vaux & Bedford, a prominent architectural firm of the metropolis, is quite a compliment to the city, yet to be returned; and moreover that their local interests cannot but be furthered by the attraction of immense crowds to a point only four hours distant by rail. The matter is, besides, one of national pride, and hence we trust the patriotism of the people may be relied upon not to allow the Centennial, in point of magnitude and grandeur, to fall below previous exhibitions in Europe, or to prove so unfortunate a financial failure as the recently closed Vienna show.

THE SIGNAL SERVICE REPORT.

The Chief Signal Officer of the Army has recently submitted a very gratifying exhibit of the labors of his bureau during the past year. Thirteen new stations have been added, so that at the present time there are seventy-eight points of observation in the United States, eleven in Canada, and three in the West Indies, the latter being located at Havana, Kingston, and Santiago de Cuba. Three other stations, on the islands of Porto Rico, Guadaloupe and Barbadoes, will also shortly be equipped.

Some very excellent arrangements have been completed for securing to farmers and others, in communities not reached by telegraph, information as regards probable weather earlier than would be afforded were the reports delayed by publication in newspapers. The plan adopted has been to divide the territory of the United States into districts, each district having a distributing point, at or near the center, from which two printed copies of the synopsis and probabilities are forwarded by mail to all post offices within the districts, or which can be reached by sail, steamer, or mail coach by 4 P. M. of the same day. The bulletins are then conspicuously posted in the receiving offices, and 8,982 printed copies of the weather report are thus daily distributed to 4,491 post offices; and the plan thus far has worked admirably.

There are nineteen special river stations from which reports of the depth of water in the principal rivers of the United States are daily made by telegraph, at particular seasons during which danger from freshets may be anticipated. Twenty of the regular stations also furnish river reports, which are of great value as giving constant and accurate knowledge of the condition of channels, and thus adding to the safety and convenience of our river commerce.

For the purpose of studying the phenomena of the upper portions of the atmosphere, stations have been established on Mount Washington, N. H., on Mount Mitchell, N. C., and quite recently a third one on the summit of Pike's Peak, at an elevation of 14,216 feet above sea level.

One of the most valuable additions to the system, which has been made during the past year, is the establishment of a chain of life-saving stations along the Atlantic coast. Signals visible for some distance at sea, serving to warn vessels of probable bad weather, are to be displayed from points twenty-five miles apart from Sandy Hook to Cape May, and it is intended to continue the construction of suitable telegraphic communication along the dangerous coast of Virginia and North Carolina. Without doubt, these points of observation will be of great benefit. They will serve as meteorological stations from which information of the condition of the weather at the sea level can be transmitted; as sites for lighthouses and life boat deposits; as videttes in time of war, to give warning of the approach of an enemy's fleet; as a means of communication with vessels cruising along the coast; and as positions of display of cautionary signals, as already noted.

With reference to international exchanges of meteorological information, General Myer refers to the proceedings of the recent Weather Congress at Vienna. The proposition was adopted, by a unanimous vote of that body, that at least one uniform observation of such character as to be suitable for the preparation of synoptic charts should be taken, and recorded daily and simultaneously at as many stations as practicable throughout the world. It is also stated that arrangements have already been made with Prussia and Turkey to commence, on January, 1874, the exchange of one daily report, taken simultaneously throughout those countries and the United States; and the coöperation of other nations in the system is expected.

THE Chinese coal fields occupy an area of 400,000 square miles. Both bituminous and anthracite coal are found of good quality. In immediate proximity to the coal, large deposits of iron ore occur.