THE ELECTRIC LIGHT.

No. I.

Not many years have elapsed since the production of light by electricity ranked only as a lecture experiment. In this stage the electric light possessed no commercial value whatever. It is not our purpose now to trace the history of the discovery that electricity could be made to produce light. It will be enough to say that the labours of various inventors have so far developed the lecture experiment, that the electric light can now be used with great advantage for numerous purposes, such as the illumination of lighthouses, forts, ships of war, public rooms, railway stations, and factories. For the last purpose it is now extensively employed in France, and its use is extending in this direction. We propose in this and succeeding articles to explain briefly what the electric light is, how it is produced commercially, and how it can be employed to the most advantage by those who possess workshops, foundries, shipyards, or factories; and we shall endeavour to make all we have to say on the subject as simple and intelligible as possible, so that no difficulty may be found in applying to a practical purpose such information as we are in a position to communicate to our readers. In carrying out this object we shall avail ourselves largely of a very excellent work—*Eclairage à l'Electricité, Renseignements Pratiques*, by M. Hippolyte Fontaine, recently published in Paris by Baudry.

There are three methods by which light may be produced by electricity—putting on one side as having nothing to do with our present purpose the heating of a platinum wire white hot. The first consists in the employment, as conductors of a current of electricity, of two rods of carbon, held a short distance apart, between the extremities of which play a series of brilliant sparks, which form a species of flame known as the "voltaic arc." The second consists in rendering luminous a rod of carbon interposed between two carbon conductors of a section much greater than that of the rod. The third consists in the production of a peculiar, faintly luminous, flame in tubes from which the air has been exhausted. To this last we shall not refer further, except to say that its use for mining purposes has been more than once suggested, nor shall we speak just now of the second device; we shall confine our attention entirely to the first system, as that may be regarded as the only method of producing the electric light which at present possesses any commercial importance.

The electric lamp, then, consists of a pair of carbon rods called "electrodes," why so called we need not stop to explain, seeing that almost every author writing on electricity thinks it his duty to tell us the old story of the "amber" and its Greek name. If two rods of carbon be placed with their ends in proximity, and a current of electricity of sufficient power be sent through them, an intense light will be produced. The amount of the light will depend on the intensity of the current, the nature of the electrodes—for other materials than carbon can be used — and the medium which surrounds them. The colour of the light varies with the material of which the electrodes are composed or according to the presence of various metals. The appearance of the electric flame varies with the form of the electrodes. Thus if a coke point is attached to the positive wire and opposed to a plate of platinum, the flame takes the form of a cone, while between two carbon points it has the shape of an egg. The length of the flame depends more on the intensity of the current than on anything else. Thus Davy, who may be said to have discovered the electric light in 1813, obtained with 2000 pairs of zinc and copper plates a light 0·11m. long. Despretz made, in 1850, a series of experiments which showed that the length of the flame increases more rapidly than the intensity of the current. Thus, the flame produced by 100 Bunsen cells is nearly four times as long as that produced by fifty cells. It will not be out of place to state here that for commercial purposes batteries are never used now, electricity being obtained in a far cheaper way. But the fact remains that considerable advantage accrues as regards the quantity of light given by augmenting the intensity of the current, no matter how that current is obtained.

Although electrodes of very various materials may be made to produce the electric light, in practice carbon points only are employed. It will be readily understood that these play so important a part that it is necessary great care should be taken in preparing them. Several patents have been taken out with the object of producing good carbon electrodes. Thus, in 1846, Messrs. Staite and Edwards patented a process of making electrodes of sugar and powdered coke, mixed, moulded to shape, pressed, and burned. In 1849 M. Le Molt patented electrodes made of two parts animal charcoal, two parts wood charcoal, and one part of pitch. Various improvements have been effected recently, and among the best made are those of Carré, Archereau, and Gaudoin. Those who require further information on this subject we must refer to M. Fontaine's book, to which we have already called attention.

It is now time to say something more in detail of the curious phenomena which, taking place between the ends of the two carbon electrodes, supply the electric light. Fig. 1 is a diagram, showing the position of the electrodes as ordinarily employed.

The two sticks of carbon, usually round and about ⅜in. in diameter, are fixed in two supports, with their points at a small distance apart, and are united with the source of electricity by two wires. Fig. 1, it must be understood, is intended simply to show the principle involved. The electric lamp is in practice a much more elaborate apparatus, as will be seen further on.

Fig. 2, copied from M. Fontaine's work, shows, full size, the electric light as far as it can be shown on paper. The light results from the incandescence of a jet of particles detached from the electrodes and projected in all directions. The projection, however, mainly takes place from one electrode toward the other, and more especially from the positive to the negative pole. The positive electrode always has a temperature much higher than that of the negative electrode, and thus while the latter is heated only to a dull red at a small distance from the point, the positive electrode is at a white heat for a considerable way up. Both electrodes waste away, as may be imagined, but the positive electrode is dissipated twice as fast as its fellow. The light resembles a trembling, or vibrating flame, of an egg shape. From time to time we

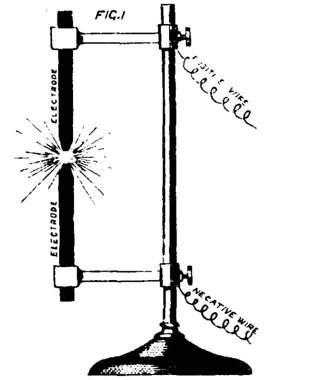


DIAGRAM OF ELECTRIC LAMP

may see a brilliant spark cast from one electrode to the other. Upon each of the carbons may be noticed little liquid incandescent globules *g*, showing that some mineral particles present in the carbons are fused by the heat. These are never seen when the carbon is pure. It will be understood that in observing the electric light darkened

FIG. 2

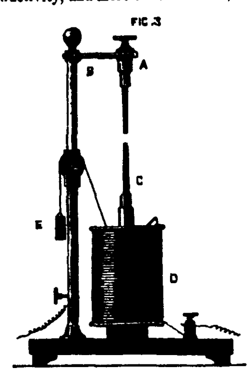
THE ELECTRIC LIGHT—FULL SIZE.

glasses must be used, for the unprotected eye could not endure the glare.

"The voltaic arc," says M. Fontaine, "is a portion of the electric circuit, possessing all the characteristics of other portions of the circuit. The molecules entrained constitute between the two points a movable chain, possessing more or less conductivity, and more or less heated, according to the intensity of the current on the one hand, and the nature and the distance apart of the electrodes on the other. *What occurs is precisely as though the electrodes* were united by a wire or a carbon rod of very small section; and thus it may be said that the light produced by the voltaic arc and that produced by incandescence are results of the same cause, namely, the heating of a bad conductor interposed in the circuit."

As regards the quality of the electric light, a remarkable similarity exists between it and that of the sun. Thus it excites the combination of chlorine and hydrogen. It effects changes of colour in certain salts; it possesses the property of imparting phosphorescence. It can be used by the photographer and the dyer.

FIG. 3

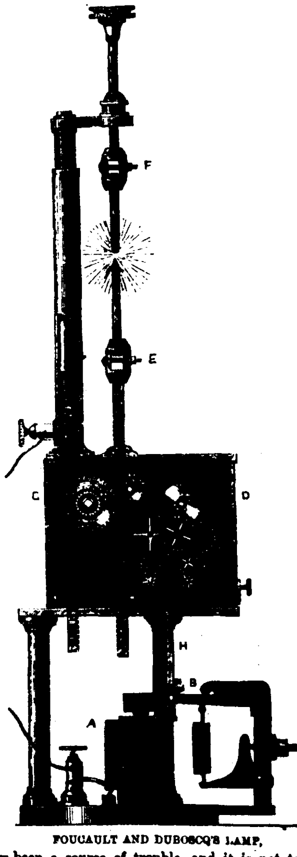


ARCHEREAU'S LAMP.

To sum up, then, it is to be understood that the electric light is produced when two carbon points are placed close to each other, and a strong current of electricity is sent through them. The current breaks off, as it were, particles of carbon, which, momentarily suspended between the two electrodes or carbon rods, are raised to a dazzling white heat. Why this should be so, it forms no part of our purpose to explain here. The explanation may be sought in any good work on electricity, in so far as it can be supplied at all. When we have stated that the production of light from electricity is a result of a change in the manifestation of a form of energy, we have said almost all that need be or can be said briefly on the subject.

We now come to a very important department of our subject. In order that an apparatus for producing light may be serviceable in factories or workshops, it is essential that it should give a continuous illumination, the intensity of which should vary but little. As will be seen further on when we come to speak of the machinery employed to supply electricity, this supply can be rendered as constant in amount and intensity as may be desired. The producing apparatus, so to speak, will give little trouble in this respect; but the using apparatus—that is to say, the lamp—behaves very differently. It has

FIG. 4



FOUCAULT AND DUBOSCQ'S LAMP.

always been a source of trouble, and it is not too much to say that this trouble has only been barely disposed of. We have explained that the carbon electrodes waste away, but it is necessary to the production of the light that the points should remain constantly at an all but invariable distance from each other. We have seen that the positive electrode wastes twice as fast as the negative electrode. If this were not so, and all the carbon which one electrode lost went to its fellow, little harm would be done, one electrode losing as much as the other gained. In practice this does not take place, and the distance between the electrodes increases continually until it becomes so great that the current will no longer leap over it. Then the lamp is extinguished, and to re-light it the points must be brought again into contact, and once more separated to the proper distance. In such a lamp as that shown at Fig. 1, this operation would have to be performed every few minutes. It is not surprising, then, that measures were taken at a very early period in the history of the electric light to render the lamp automatic in the sense that it would of itself adjust the position of the carbons. The ordinary spring candle lamp used with carriages affords an example of the automatic adjustment of a *locus* of incandescence in a given place. Of course the same means could not be used to obtain the required end with the electric lamp; but the idea involved is much the same, and springs have been and are used for the adjustment of electrodes. Some of the many devices which have been tried are extremely complex in appearance or in reality. We illustrate in Fig. 3 the electric lamp of M. Archereau, because it is the