THE ELECTRIC ARC LIGHT

BY

CLARENCE WILLIAM MORGAN.

THESIS OUTLINE.

The Electric Arc Light.

1. Introduction.

   History and Uses of Electricity.

   Electric Lighting.

2. The Arc Lamp.

   History of

   Inventors

   Mechanism

   Regulators.

3. The future of the Arc Lamp.

The Electric Arc Light.

A student in a physics class, when asked by his professor, what electricity was, gave the following definition:- "Electricity is a wonderful something, of which we know nothing".

This definition would by no means suffice, in this modern age of enlightenment and culture, To be sure, it may be regarded as a wonderful something, but it cannot be held that it is a thing of which we know nothing. We do know a great deal about electricity and are constantly broadning our knowledge of it.

Tho we can form no brief, concise definition of electricity, yet the greater mass of the people of the world have had an introduction to it, in one form or another. It is by its effects that it is known. Who has not seen this wonderful form of matter dart from cloud to cloud, or from cloud to earth, and seen and heard the effects produced by it? Or we might also say; who has not heard of Benjamin Franklin and his kite and key experiment?

The phenomena of electricity was first observed in the cloud as lightning. These same phenomena were artificially produced, six hundred years before the Christian Era, by rubbing pieses of amber, (or in Greek electron, whence the name.) Thus we see that electricity is not a recent discovery. It has been known for over two-thousand five hundred years. But no extensive experiments were made with it until the beginning of the nineteenth century, when it was taken up by Davy, Foucault, Franklin,& others, until at the present time there is scarcely an art in which this agent is not employed in one way ot another.

But the two chief capacities in which electricity finds most extensive use at present are those of motive power and lighting.

Electric lighting may be divided into two kinds viz: 1. Incandescent lighting, in which the light is produced in a glass vacuum, by the resistance which a carbon filament offers to the passage of the electric current; and 2. Electric Arc lighting, in which the light is produced by the resistance of the air to the passage of a current between two carbon pencils.

Electric Arc lighting may properly be divided into three periods, viz:

1. That prior to 1876.
2. That from 1876 to 1901.
3. That of the future.

Arc lighting had its beginning with the beginning of the nineteenth century. In 1810, Sir Humphrey Davy produced the first arc light. He discovered that when two small carbon pencils, attached to a source of electricity, were brought together and then separated a small distance, a spark would dart across from one carbon to the other, producing a most brilliant arc light. The flame thus produced is broad and conical in the middle, hence the name, arc light. He also discovered that the arc would continue to glow if placed under water. The arc thus produced remained only an interesting laboratory experiment until 1844, when Leon Foucault took up the experiment and advanced it materially; He succeeded in producing a steady, brilliant light.

At this early period the only available source of electricity known, was the battery. Thus electric lighting on the large scale was impracticable. But with Faraday's & Henry's wonderful discovery of magneto-induction, a great impetus was given, not only to the development of the arc light, but to electrical experiments in general.

Many arc lamps varying in efficiency were invented.

For sixty years after Davy's discovery, few if any practical results accrued from this laboratory experimenting. Until 1876 there was hardly an arc light in operation. Its use for this purpose on an extensive scale was yet, merely a matter of conjecture. Among the foremost, if not the greatest, of the electric expermenters of this period, was Charles F. Brush. The results he achieved, aroused world wide interest.

Mr. Brush, while working on his father's farm became interested in electricity. He entered the Shaw Academy in Ohio at the age of thirteen years. Here he began his first experimental work. He afterward entered and was graduated from the Cleveland High School and from Ann Arbor in 1869, from which he received his degree Ph. D. He soon afterward established a laboratory at Cleveland wherein he conducted chemical experiments. In 1873 he entered the iron business, but still found some time to devote to his electrical investigations and in 1876, completed his first dynamo. This invention, being so novel and perfect a piece of mechanism, made him famous, the world over. His thorough knowledge of mechanics and electricity combined with his ability and genius made the Brush Company the most successful of all corporations in the manufacture of electrical apparatus. Brush did but little experimenting. He would work the whole apparatus out theoretically then make the design and it was ready for the manufacturer. So perfect was Mr. Brush's mental image of the proposed piece of apparatus that in nearly every instant, the first machine made from his drawing was perfect in nearly every detail and ready for use.

When this great inventor had successful constructed the dynamo, he turned his attention to other phases of the work, viz:- the con-

struction of lamps, the manufacture of carbons and insulation of wires. His methods of insulation are widely used at present. The first electric light station in the world used Brush's apparatus. There was scarcely any phase of the electrical light work in which the intellect of this great genius was not active. He was an untiring worker. He worked in his drafting room before working hours in the morning, and in his laboratory after shop hours in the evening. He was a firm believer in the old Latin proverb; "Labour improbus omni vincet".

But when all the apparatus for electric lighting had been constructed, there was not found ready sale for them. People as yet knew not the value and convenience of this lighting system. A few were sold to the factories and woolen and cotton mills in New England prior to 1880.

The first public places lighted were the Court House in Wabash, Indiana and the water tower in Chicago.

One of the first electric light companies was organized in New York in 1879, by the wealthy class, who had interests in the New England mills. Companies were soon organized in all the large cities in the east which have expanded and increased until to-day, the capital invested in this business amounts to several millions of dollars and the number of lamps to many thousand. These first few establishments gave a new impulse to electric lighting and in the last two decades the electric lighting system has spread all over the world. Manila has just completed a station of ten thousand incandescent, and three hundred arc lights. Nearly every town of five thousand inhabitants is now lighted with the electric arc . One manufacturing company has produced in its factories over one hundred and fifty thousand arc lamps and five thousand arc dynamos. Another has manufactured one hundred thousand arc lamps, from its beginning up to 1894. Four hun-

dred thousand is given as the estimate number of arc lights in operation in 1894.

Carbons.

Sir Humphrey Davy used pencils of charcoal extinguished in water or mercury. These gave a very satisfactory light but fused too rapidly for commercial use.

Foucault used carbons made from deposits of gas retorts. These were very much denser than Davy's carbons but contained more foreign matter, which caused a variable and unsteady light.

The method used at present for the manufacture of carbon is due to Carré' and Gauduin. It consists in preparing a suitable ~~paste~~, pulverizing, compressing, passing through a die to make it the proper shape and then baking it. The paste consists of fifty parts, pure powdered cake; twenty parts calcined lamp black and thirty parts, cane sugar and gum. The carbon after being taken from the die is baked several times, being plunged into boiling concentrated syrup or caramel between bakings.

In order to maintain the arc in the center of the carbon tips, or centering the arc as it is called, a condition which is very necessary to afford stability to the arc,- a core of some material of a little better conductivity is sometimes inserted. Owing to the expense the cored carbons are but little used and when employed are used only for the positive pencil. The purpose of this core is to conduct the current to the tip of the carbon and thus prevent the carbon from heating throughout its entire length which of course would be a waste of the electro-motive--force.

Daniell proved that the tips of the carbons must touch in order to establish a current between them and then be slightly separated before the light would be produced.

In 1850, Despretz discovered that just before the carbons volatilized they became very soft and plastic. The volatization of the carbons gives to the electric arc a very feeble but characteristic odor, consisting of carbon dioxide, carbolic acid gas and very small quantities of nitrogen compounds.

The manufacture of carbons for these lamps is a very extensive business itself. In 1883 the Brush factory turned out three million carbons and in 1893, twenty-six million. The National Carbon Company have just completed an enormous factory in Cleveland, for the sole purpose of manufacturing carbons, which has a capacity of two billion five hundred million carbons per year.

Prior to 1883, carbons were sold at from $70 to $80 per thousand, while in 1893, the cost was reduced to, from ten to twelve dollars per thousand.

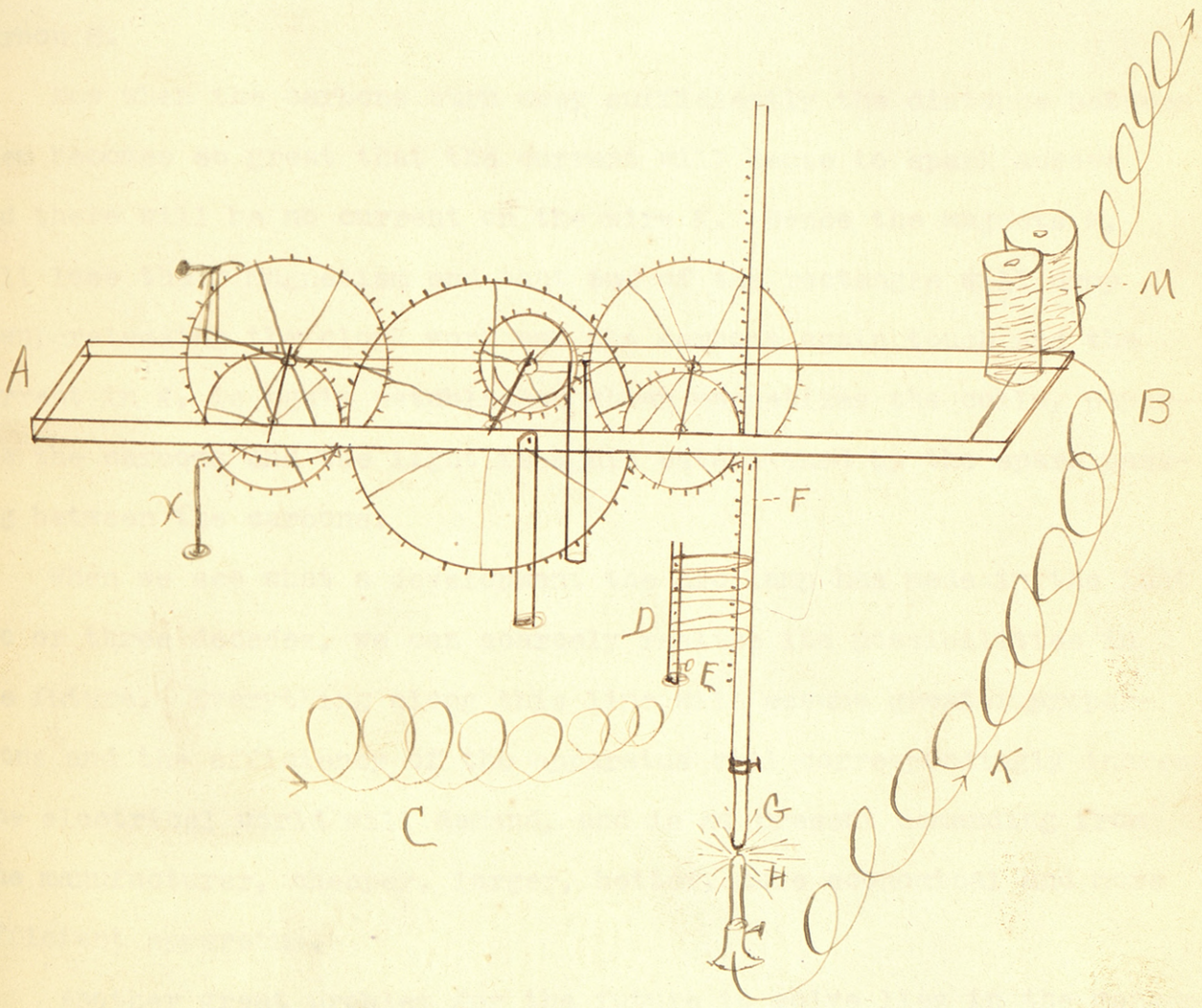
To maintain this study of light the carbons must be kept at a proper distance from each other. Since the carbons undergo waste by fusion, some means is necessary for keeping them at this proper distance. There have been many devises for this purpose, but he one in most general use at present, is that which operates by means of a magnetic clock work, in which the force is gravity and the regulation is affected by means of electro-magnets in shunt circuit.

Mechanism of Lamp.

The clock work of this lamp is set in a rectangle A B, (see diagram) which is pivoted near the center, allowing vertical movement. The brass rod F which supports the carbon is hung, by means of cogs, on one of the wheels and by its weight furnishes the power to run the clock work. When the current is not passing, the carbons are always touching. The wire, bringing the current from the dynamo, is fastened to a post D, and this post is connected to the rod F, which

supports the carbon, by means of copper strips E, which simply press against the rod F, thus allowing it to slide freely.

Suppose, now, a current to be passed through C. It flows on through D, E, F, G,



Suppose, now, a current to be passed through C. It flows on thru D, E. F. G. and K to the magnets M, causing them to become magnetized. These magnets draw that end of the pivoted rectangle up and throw the other end down onto the hook X, which locks the clock work and at the same time separates the carbons and produces the light, the current, now having to spark across from the carbon G, to the carbon H.

Now when the carbons burn away sufficiently the distance between them becomes so great that the current will cease to spark across and there will be no current on the wire K. Hence the magnets M, will lose their magnetism and that end of the rectangle will drop down, releasing the clock work and the carbons again touch and the current in K, is again established which magnetizes the coils, separate the carbons and the light is again established by the spark passing between the carbons.

When we see what a development the arc lamp has made in the last two or three decades, we can scarcely realize its possibilities in the future. Everything along this line will assume greater proportions and the efficiency of the apparatus will correspondingly increase. The electrical world will demand, and is at present demanding from the manufacturer, cheaper, larger, better, more economical and more efficient apparatus.

Another great problem for the future to solve lies in the management of local electric light companies. In this modern age it is little we care for glory; dividends are the cry of the hour and how to earn them is the problem.

Electric arc lighting as a business has been developing for the last twenty five years but it has by no means reached perfection. The general principles of this mode of lighting will probably change

but little, but great improvement will be witnessed in its mechanism, materials and efficiency.

The electric arc light is preferable for lighting large areas. Its field is in the factory, large stores and in our streets. The arc lighting of our streets is still in its youth but is rapidly maturing. Its convenience, efficiency and superiority over the old modes of lighting is now fully realized the world over. The old street post with its lamp must go. They have outlived their usefulness. They are to the electric arc as the moon is to the sun. The future, therefore, of the electric arc is secure.