THE MANUFACTURE OF ELECTRIC LIGHT CARBONS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649326129

The Manufacture of Electric Light Carbons by O. G. Pritchard

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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Reprinted from "THE ELECTRICIAN,"
WITH ADDITIONAL CHAPTERS.

PRICE ONE SHILLING AND SIXPENCE,
Post Free 1s. 9d.

LONDON:
"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LIMITED,
SALISBURY COURT, FLEET STREET, E.C.

1890.

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INTRODUCTION.

THAT hitherto we have been unable to cope with France, Austria, Germany, or Bohemia in the production of electric-arc-carbon candles is seen by the fact that our supplies continue to be drawn from Continental manufacturers. Paris claims good makers, such as Carré, Sautter-Lemonnier, Lacombe, Gaudoin, and others, but their prices being high in great measure precludes their adoption on a large scale. Germany boasts Herren Siemens and Schmeltzer, Austria Herr Hardtmuth, and the Apostle carbon comes to us from Bohemia. These carbons have of late years been much reduced in price, and leave little or nothing to be desired. From America we obtain the Brush carbon, solid and coppered, which eventually we may expect to see superseded by the cored uncoppered carbon. Other large makers might also be mentioned, to whose specialities I need not now refer. Up to the present we stand committed to Siemens, Hardtmuth, and Schmeltzer, who, between them, and the Apostle carbons, divide the honours and the profits. There are other first-rate makers, but they are but little known to me, and have not as yet introduced their carbons on so large a scale as the German makers. Strenuous efforts have been made during the past ten years to introduce a home-made article, efficient and good, but failure alone appears to have waited upon endeavour. This has led to the idea that carbon-candle making can never become an English industry. The writer has, however, produced carbons on a scale of some magnitude which were testified by experts to be quite equal to those of the foreign makers; and he now publishes the whole process employed by him, and the results of eight years' experiments and experience, in the hope that the arc-light carbon industry may eventually be profitably introduced.

The difficulties in the way of producing a perfect carbon, like all other difficulties, vanish with close application to the subject. The various processes, so easily detailed and explained, however, have only been perfected after many years' devotion to the subject and large expenditure of funds. How not to do it is the antecedent to all discoveries; and every inventor, or would-be discoverer of hidden processes, has to learn that only by the continuous registration of negative results can he hope to achieve positive success. I think it will be instructive and also interesting to explain the many faults to which carbons are prone, to diagnose the maladies, and to point out the cause of failure, the necessary preliminary to a cure. The *ultima thule* of carbon perfection, perhaps, has not yet been achieved. Yet I am of opinion that, with the elimination of the faults hereinafter described, a carbon will be produced as near perfection as the severest critic can wish for.

I think we get the carbon and the light in their worst form in the Jablochkoff system. The varying displays of blue, red and yellow and green lights certainly afford a great choice of colouring, but are undesirable, to say the least.

This system, however, being a thing of the past, need not occupy our time. Hissing, also, may now be said to be like the dodo—dead. We come, however, to a serious defect in the little gaseous flame that is sometimes seen to travel round the point of the positive carbon whenever the arc lengthens beyond the normal, and which throws a dark shadow upon the bowl. This defect may be also enhanced by a faulty lamp not answering quickly to the change in the amount of current, and not allowing the arc to become shortened. This has been attributed to the lamp; but seeing that by removing the carbon, and placing a good carbon in circuit, the effect ceases, the fault must be attributed to the carbon, and upon investigation it will be found to arise from the presence of occluded gases in the body of the carbon. This, again, arises from the improper nature of the material employed, which renders the carbon incapable of receiving or retaining the compression to which it had to be submitted in the press; or it may arise from want of due saturation in an after process, whereby the want of compression is got over, and the pores containing these occluded gases are filled with carbonised matter. All or some of these may be assigned as reasons.

But the original fault lies in the material employed. I make this statement with boldness, and further assert that the purest carbon is incapable of yielding a good carbon candle unless it possesses qualities which have to be imparted to it mechanically. The nearest approach which Nature affords for a proper material is gas-retort carbon, inasmuch as the grain is hard, good, and so well fitted to the purpose. But this material is too impure for use, and is expensive to purify, which prevents its adoption. When the preparation of material is touched upon, this will be more clearly understood. Now, the grain and character of the material, outside and beyond its purity, are matters of moment. By way of more fully illustrating my meaning, let me take the purest lampblack, perfectly suitable *per se* for carbon-making as regards purity, yet, owing to the absence of grain, it cannot be made to retain its compression; it occludes gases, and the perfection of the carbon is destroyed, and its life considerably shortened. As far as my experience reaches, I should say that a 10-millimetre carbon (cored positive), 42 volts, 8-ampere current, $\frac{3}{16}$in. arc, gives the highest results. If the arc lengthen to $\frac{1}{4}$in., red flames are produced in the best carbons I have tested.

Conductivity is of the greatest importance: the greater the facility with which the current passes, the better the light and the less the E.M.F. required. Thus I think I may state, without experimental data to go upon, but by observation only, that a candle of high conductivity will give as good a light with a 6-ampere current and 38 volts as one of lower conductivity using 42 volts and 8 amperes. Indeed, when the conductivity is very low, the current will not produce the arc, and the carbon becomes intensely heated. This conductivity depends entirely (given pure carbon) on the length of time to which it has been submitted to the firing process. Graphite appears to owe its peculiar condition of high conductivity to its lengthened subjection to Nature's forces, unapproachable by human efforts. Great pressure, continuous and intense heat protracted over long periods, even if possible, would prove commercially impracticable; yet I entertain no doubt that carbon submitted to a white heat, such as would melt wrought iron, for a whole week, would produce a candle more graphitic in character and possessing higher conductivity than one that had been subject to such treatment for a less period. As I deal with the subject of firing, and my special economic arrangements for so doing, this subject will be more fully dealt with.

I would like to mention (as it may not be thought sufficient to take the raw graphite ignorant of the amount of pure carbon it contains) a method of testing this raw material. This, indeed, should be done repeatedly, and samples kept, marked with the results of the analysis. By this means experience will be gained, and the look will almost be sufficient guide. Take and pulverise a small sample taken from the bulk, and dry it well at a temperature of 380° F., so as to make sure that all the moisture has been driven off. Take one gramme of this powder and 20 grammes of oxide of lead, also well dried; mix them thoroughly together and pour them into a hard glass test-tube, five or six inches long and half-an-inch diameter. Weigh the tube and its contents carefully, and submit the tube to a white heat under a Fletcher's blowpipe until all gases are driven off and the contents completely fused. Allow the tube to cool, and weigh the residue in the tube. The weight lost is carbonic acid, the oxygen of which has been taken from the lead oxide, while the carbon is all that there was in the graphite. For every 20 parts of loss there must have been 12 parts of carbon.

Again, the duration of the positive carbon is a matter of moment, since it is *de rigueur* that the waste should not exceed 1in. per hour; and as this is now an accomplished fact, it has become a necessity. For some inscrutable reason, foreign makers supply only 10in. positives unless otherwise ordered, so that with 1in. in the holder, and something to spare to save the lamp from heating, little is left besides the 8in. required for eight hours' light. I have met with no material in its native state capable of reducing the consumption to this standard; the prepared material employed by the writer satisfies these conditions.

Another defect, and one which makes the otherwise perfect carbon valueless, is curvature. This takes place in drying and firing. If not properly or sufficiently dried, carbons will not only bend during the firing process, but break into several pieces. The method of avoiding this will find its place further on. With lampblack carbons, fully 50 per cent. will be curved, but with the prepared material described at length,