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### **Electric Illumination**

Two years after Thomas Edison patented his electric light bulb, the 1881 International Exposition of Electricity in Paris, featuring many spectacular lighting displays, showcased the potential of this technology for commercial and domestic use. The accompanying International Congress of Electricians also agreed on international standards for units of electrical resistance, potential and current. In its wake, James Dredge (1840–1906), editor of the British periodical *Engineering*, compiled this illustrated overview of electrical technology and its application to lighting. First published in two volumes between 1882 and 1885, and using material that had previously appeared in *Engineering*, as well as new articles by various contributors, this substantial work reflects the complexities and possibilities of a propitious technological development. Among other topics, Volume 1 covers electrical units, methods of generation, conductors, and various kinds of lamp. The appendices give abstracts of British electrical patents from 1837 to 1872.

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# Electric Illumination

VOLUME 1

EDITED BY JAMES DREDGE



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["ENGINEERING" SERIES.]

# ELECTRIC ILLUMINATION

BY

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AND  
H. VIVAREZ.

EDITED BY

JAMES DREDGE.

*(Chiefly compiled from "ENGINEERING.")*

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With Abstracts of Specifications having reference to Electric Lighting.

PREPARED BY

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## PREFACE.

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**T**HERE is no industrial question which engrosses so much public attention at the present time as that of Electric Lighting. The extensive employment of this mode of illumination in streets and other places of public resort, has familiarised the world at large with its leading characteristics, while the splendid international Exhibition of Electricity held last year in Paris, and, to a less extent, the more recent show at the Crystal Palace; have given a fair idea of the almost endless variety of mechanical combinations by which—with more or less success—the Electric Light can be obtained. The most striking, though probably the least satisfactory, evidence of the lively interest taken by the public in this development of practical science, is to be found in the fact that during the past few months an enormous amount of money has been applied for and obtained, for the formation of public companies, to acquire from different inventors the patent rights of apparatus for the production and utilisation of the electric current. That some of these companies have a useful and profitable career before them is not open to question, but it is doubtful whether few, perhaps if any, of the patents thus sold, are worth the money demanded and paid for them; in some cases because the invention has but small intrinsic value, in others because its originality, and therefore the validity of the patents protecting it, is open to question, and in all, or nearly all cases, because, with the rapid march of invention in this direction, towards which so many able minds are turned, progress is so constant and so quick, that what appears almost boundless in its ingenuity and usefulness to-day, is rendered obsolete by an invention of greater ingenuity and wider usefulness to-morrow.

It is to be regretted, therefore, that the public have rushed after electric lighting speculations with more enthusiasm than good judgment, for this movement must be attended with a certain amount of disappointment and loss, and therefore will be followed by an unreasonable reaction, that may delay for a time the legitimate development of this

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great source of light and energy, which, however, appears certain in the early future, to have applications almost as broad as its most enthusiastic admirers claim for it.

It is of interest to recall briefly what has been done in this direction during the past few years. In this country the modern revival of electric illumination dates from the time when, in 1873, Mr. Conrad Cooke, employing a Gramme generator, installed the signal-light on the summit of the Clock Tower of the Houses of Parliament. The same year in Paris a factory was first lighted permanently, and also in the same year Messrs. Siemens Bros., of Berlin, maintained a signal on the top of the great central dome of the Vienna International Exhibition. Between that date and 1877, when M. Hyppolite Fontaine published his excellent and still standard work, *Eclairage à Electricité*, considerable progress had been made in France. Thus the works of MM. Sautter, Lemonnier and Co., of Paris; of MM. Menier and Co., Noisiel; several cotton factories; the harbour works at Havre, and many other places, had been lighted with success. Of course, long before this time the electric light had been used for lighthouse illumination, but such installations are apart from ordinary industrial applications. The great popular movement, however, dates from 1878, when, during the French Universal Exhibition, Gramme and Jablochhoff rendered some of the most important parts of Paris more brilliant and more beautiful than had been conceived possible, the centre of attraction and admiration having been the Avenue de l'Opera, including the façade of the Grand Opera at one end, and the Place du Theatre Français at the other. At the same time, also, the success of Edison was prematurely trumpeted forth from across the Atlantic, with the disastrous result of temporarily depreciating the value of gas shares to an absurd but alarming extent.

From this time, the applications of electric lighting to industrial purposes progressed rapidly, the number of successful methods increasing also, while the employment of lamps on the incandescence-arc system,—producing light of moderate intensity, though relatively more costly to maintain than that given by the more powerful arc lamps,—indicated a promising means for applications to domestic lighting. It was not, however, till the practically simultaneous announcements of the Swan and Edison incandescence systems, that the problem of applying the electric current to domestic illumination, appeared to be approaching solution. Though little more than two years have passed



since that time, the forms first put forward by both these inventors, now seem crude, clumsy and imperfect, compared to the beautiful productions exhibited last year at the Palais de l'Industrie, and more recently at the Crystal Palace. Both Mr. Swan and Mr. Edison have abundantly proved the entire suitability of their systems,—under proper management,—to domestic lighting, but for popular use, much remains to be done before this result can be obtained, and possibly it will be found that no mode of electric lighting can be thoroughly adapted for domestic purposes, until an efficient system of storage batteries has been devised. Success in this direction appears to be very close at hand, and the question, apart from Planté's investigations, has been studied with highly promising results by Faure, Swan, Sellon, Volekmar, Kabath and others.

It may be assumed, therefore, that the mechanical production of electric currents, and their utilisation as a source of light, has reached that stage of practical development from which it must necessarily advance, with a constantly widening circle of usefulness and efficiency.

The interest excited by the present active progress in invention relating to electric illumination, naturally causes us to overlook that early and very striking period, nearly 40 years ago, when the attention of many inventors was turned towards the same direction as at present. The names of Staite, Wright, King, and a few others are well known, though books hitherto published have done but scant justice to the great ingenuity of these men. There are, besides, a number of other inventors whose ideas are recorded in the Patent Office, which may be studied with advantage now,—especially by inventors,—who will find that there exist from an early date, many patented proposals which clash dangerously with some modern inventions. It would be invidious to give here any examples of early anticipation; the reader may form his own conclusions in studying the following pages.

The reason why inventors of the early period, to which reference has just been made, were baffled, despite their ingenuity, was because they had no cheap and practical mode of generating the current necessary for the production of light, and were obliged to obtain their power from batteries. Yet even in this direction something had been effected: a great deal of very suggestive work was done in the view of utilising battery currents to generate motive power, whereas, the very machines constructed for this purpose would have converted mechanical energy into electricity. Thus, Elias, in 1844, did not dream of generating

currents, but only of utilising them, although the motor he devised might have been made available for the former far more useful purpose. Pacinotti again devised his celebrated machine rather as a motor, than as a generator of electricity. Reference to this volume will show, however, that the idea of converting mechanical into electrical energy occupied the minds of inventors at quite an early date: thus, King and Poole, in 1846; Dujardin, in 1847; Henley, in 1849, and many others, realised the possibility of generating useful currents by making coils revolve in close proximity to permanent magnets. Most of these inventions were imitations, more or less close of Pixii and his followers Clarke, Saxton, Page and Stöhrer, and it was not till 1854 that we find any record of an entirely new departure. In that year Søren Hjørth patented a generator in which the principle of augmenting the power of electric currents by the reaction of electro-magnets upon each other, is described so clearly that it is evident the inventor appreciated the value of the dynamic principle, and thus anticipated by about 13 years, the practically simultaneous discoveries of Varley, Wheatstone and Siemens. With this brilliant exception, and that of another inventor who, in 1858, also proposed “to employ the electro-magnets in obtaining induced electricity which supplies *wholly* or partially the electricity necessary for polarising the electric magnets, which electricity would otherwise be required to be obtained from batteries and other known sources,” inventors confined themselves for another 10 years to the perfection of magneto-electric machines. Among these inventors stand out prominently the names of Holmes and Wilde. A description of the magneto-electric machine of M. Worms de Romilly, which was patented in France, in March, 1866, will be found on page 672. The specification under which the invention was secured, is a very remarkable one, as it contains the first intimation of much that has been done by subsequent inventors. The patent claims three classes of armatures, which are illustrated and described in considerable detail—the ring armature, the drum armature, and a second form of ring armature, in which the wire is coiled upon a deep and narrow ring, so as to present a broad surface of coils to the fixed magnets, at right angles to the axis of rotation. Further, in the principal arrangement described, the field magnets—permanent, not electro-magnets, however—are arranged in a parallel series, and running longitudinally around the armature, and two such series of magnets are employed, one placed without and the other

within the ring, so as to utilise both sides of the coils. The armatures described, suggest at once those of Gramme, of Alteneck and of Schuckert, while the arrangement of the field magnets resembles not a little that of De Meritens and of Jablochhoff; again, the mode of utilising the inner as well as the outer sides of the ring, recalls the recent proposals of Jürgensen and others. Unfortunately, it was impossible to place the notice of this very comprehensive invention in its chronological order, and it has therefore been appended to the end of the book. To place before the reader, a record, as unbroken as possible, of all that has been done by inventors for generating the electric current, and in apparatus for utilising it, as a luminous power, has been one of the main objects of the present volume. To do this with sufficient completeness to satisfy the general reader, would have been comparatively an easy task, but it has been desired to render the work, above all, useful to inventors, and to those interested in invention; for this purpose it was necessary to analyse every patent specification bearing on the subject that has been filed in this country. It would have been impossible within the limits of this volume to have presented abstracts of all patents relating to the subject in question up to the present date; it has been found therefore necessary to divide them, reserving the specifications of the last 10 years for a succeeding volume.

Another object of the present work is to explain in the simplest possible language, and yet without any sacrifice of scientific accuracy, the principles which govern the conversion of mechanical into electrical energy; in other words, the mechanical production of electric currents. This task, as well as that of analysing the subject in a somewhat more advanced method, has been undertaken, and it is hoped with success, by Professor Silvanus Thompson. The chapter on the Voltaic Arc is by Mr. M. F. O'Reilly, and contains a large amount of information, part of which has never before been published, while the remainder lies scattered through many books. These three chapters—the Voltaic Arc, the Mechanical Production of Currents, and the Theory of Dynamo-electric Generators, together with the preceding ones on Electrical Units, and the Measurement of Currents—will, it is hoped, be found to contain much useful matter, expressed in such a way as to be clearly comprehensible to the non-technical reader, but without any sacrifice of practical value. The remaining contents of the volume naturally divide themselves into GENERATORS of Electricity; CONDUCTORS, for the distribution of the

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current; CARBONS, and the various apparatus for utilising the latter, in connection with the current, either in the form of ARC, INCANDESCENCE-ARC, or INCANDESCENCE Lamps.

It is too much to hope that all systems hitherto proposed or carried into practice, have been included in these pages, but it is believed that the omissions, inadvertently made, are few and unimportant, and that a large number are now presented to the reader for the first time, many of them being of special interest.

With reference to the Appendix containing the ABSTRACTS of PATENT SPECIFICATIONS on subjects bearing on electric lighting, it may be permitted to speak with more confidence than of the body of this work. Of the usefulness of a faithful abstract of this nature there is no doubt, and that it has been both faithfully and ably executed, the professional reputation of the gentleman—Mr. W. Lloyd Wise—who undertook the heavy work, is an ample guarantee. As it was found impossible to publish, as has been said above, abstracts of all patents up to date, in the present volume, an ample index of those bearing on the subject from 1872 to 1882 has been appended, together with a list of all United States' patents connected with electric lighting.

The present writer finds it an agreeable task to acknowledge in detail the assistance he has received in the preparation of this work, other than that already referred to. He has to thank Mr. Conrad W. Cooke for contributions on some of the more important systems,—notably those of Brush, Edison, Weston, De Meritens and Maxim,—and for the interesting description of the Pacinotti machine, as well as for many valuable suggestions. To M. Vivarez he is indebted especially for the chapter on the Jablochhoff system, the account of the manufacture of the Jablochhoff candle, for a part of the chapters on Electrical Units and on Conductors, as well as for the descriptions of some generators and lamps. In addition to the chapter on the Voltaic Arc, Mr. M. F. O'Reilly has rendered aid in collecting information on the early generators, and in the description of the successive inventions of Gramme. The kind assistance of Mr. J. Munro and Mr. B. A. Raworth is also acknowledged. Recognition should be given to various printed sources whence information has been drawn; these are Fontaine's *Eclairage à Electricité*; the Comte du Moncel's *Applications de l'Electricité*; *La Lumière Electrique*; and Dr. H. Schellen's *Die magnet-und dynamo-elektrischen Maschinen*; the publisher of the latter book has kindly furnished several engravings.

A large proportion of the present work is reproduced from what has already appeared, scattered through the pages of *ENGINEERING*; it has, however, been subjected to careful revision, and in many cases to considerable amplifications. About one-third, however, besides the Abstracts of Specifications, appears in these pages for the first time.

It is intended that this volume shall be followed by a second, dealing largely with Applications of the Electric Light, as well as with a number of cognate subjects, it has been found impossible to touch upon here: such as Cost of Production and Maintenance, Photometry, Secondary Batteries, Accessories, Motive Power, &c.

JAMES DREDGE.

OFFICES OF "ENGINEERING,"  
*August, 1882.*

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