

**THE "WESTMINSTER"
SERIES. GLASS
MANUFACTURE**

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The "Westminster" Series. Glass Manufacture by Walter Rosenhain

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WALTER ROSENHAIN

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The "Westminster" Series

GLASS MANUFACTURE

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BY

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*SECOND EDITION
LARGELY REWRITTEN*



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PREFACE TO THE FIRST EDITION

THE present volume on Glass Manufacture has been written chiefly for the benefit of those who are users of glass, and therefore, makes no claim to be an adequate guide or help to those engaged in glass manufacture itself. For this reason the account of manufacturing processes has been kept as non-technical as possible; no detailed drawings of plant or appliances have been given, and only a few illustrative diagrams have been introduced for the purpose of avoiding lengthy verbal descriptions. In describing each process the object in view has been to give an insight into the rationale of each step, so far as it is known or understood, and thus to indicate the possibilities and limitations of the process and of its resulting products rather than to provide a detailed guide to the technique of the various operations. The practical aim of the book has further been safeguarded by the fact that the processes described in these pages are, with the exception of those described as obsolete to the author's definite knowledge, in commercial use at the present time. For this reason many apparently ingenious and beautiful processes described in earlier books on glass have not been mentioned here, since the author could find no trace of their employment beyond the records of the various patents involved. On the other hand the reader must be warned to bear in mind that the peculiar conditions of the glass manufacturing industry have led to the practice on the part of manufacturers of keeping their processes as secret as possible, so that the task of the author who would give an accurate account of the best modern processes used in any given department of the industry is beset with great difficulties. The author has endeavoured

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to steer the best course open to him under these circumstances, and he would appeal to the paucity of glass literature in the English language as evidence of the difficulty to which he refers.

In addition to these difficulties, which arise largely from considerations of a commercial nature, the writer of a book on glass is further confronted with technical difficulties of no inconsiderable order. As already indicated, the aim of the present author has been to describe processes from the point of view of principles and methods rather than as mere rule-of-thumb descriptions of manufacturing manipulations, but in doing this he is met at every turn by the fact that from the scientific side the greater part of the field of glass manufacture is a "terra incognita." In making this statement the labours of many eminent scientific workers are by no means forgotten, but the entire field is so large and beset with such great experimental difficulties that even the labours of a list of investigators that includes the names of Fraunhofer and Faraday, Stokes, Hopkinson, Abbé and Schott, have resulted in little more than an accumulation of empirical data which, while they have been productive of great direct practical results, have left the science of glass still in a very elementary condition. To take two examples in illustration of this fact we may mention the question of the connection between chemical composition and any of the physical properties of glass, such as refraction and dispersion of light, and on the more mechanical side the question why all processes, such as rolling or moulding, which involve the contact of hot glass with metal result in a roughening of the glass surface. The former question has been studied by several of the investigators named above, Schott and Abbé having particularly devoted an enormous amount of labour and money to the study of the question, with results which have proved disappointing from the scientific point of view. By prolonged experimenting and the employment of a costly system of trial and error an important series of novel and useful glasses has been produced by these workers, but no law by whose aid the optical properties of a glass of given chemical composition could be predicted has yet been discovered, and as a summary

of the known facts only the vaguest general principles are available for the guidance of those who wish to produce glasses of definite properties. The same applies in a similar degree to most of the other properties of glass, with the exception, perhaps, of density and thermal expansion; attempts to generalise from the known data of a limited number of glasses generally meet with unqualified failure. The conclusion which one is forced to admit is that the fundamental principles underlying the nature and constitution of glasses have yet to be discovered. A study of the other question mentioned above as an example of the limitations of our knowledge leads to the same conclusion; an almost endless succession of inventors have busied themselves with devices for overcoming the roughening action of rollers and moulds upon glass, but without any real success. A long list of other examples of the same kind could be given, our knowledge of the physical and chemical principles underlying many of the phenomena met with in glass manufacture being deplorably deficient. It will thus be seen that to write a truly scientific account of glass manufacture is at the present time impossible, and the reader is asked to bear this in mind if he should find the chemical or physical explanations given in this book less frequent or less adequate than could be desired.

Having dwelt somewhat emphatically on the limitations of our present scientific knowledge as applied to glass manufacture, it is perhaps scarcely necessary at the present time to emphasise the fact that this state of affairs should act as the strongest incentive to further investigation of the whole subject. The difficulty, however, lies in the fact that such investigation can scarcely be carried on by voluntary workers in ordinary laboratories, but must be undertaken with the active help of glass manufacturers at their works. Glass is essentially a substance that cannot be satisfactorily handled in small quantities, particularly so far as all the phenomena connected with its production and manipulation while hot are concerned; the influences of containing vessels, of furnace gases and of rapid cooling are all enormously exaggerated if ounces instead of hundredweights

or tons of glass are used for experimental purposes, and these influences and others of the same nature vitally affect all the results of small-scale laboratory operations. The progress of our scientific knowledge of glass—and the consequent development of the glass industry from its present state where rule-of-thumb and “practical experience” still hold excessive sway—lies in the hands of those concerned in the industry itself. It must be admitted that to undertake such work involves the expenditure of much time and money on the part of a manufacturer, while the field is so large and the problems so complicated that any adequate return cannot be promised for the *immediate* future; on the other hand the very size of the field and the difficulty of the problems offers the promise of the greatest ultimate reward; a really important scientific discovery in connection with glass would be certain to bring in its train industrial developments whose limits it is impossible to foresee. The industrial success of the glass-works of Schott in Jena is often quoted as a brilliant example of commercial success resulting from purely scientific investigations in this actual field; an example of still greater magnitude is furnished by the success of the aniline dye works of Germany, which are built up on purely scientific achievements. The glass industry as a whole, supplying some of the absolute necessities of modern life, should be capable of offering the greatest rewards to success, and the example of other industries has shown that *ultimate* success is bound to reward properly-conducted and perseverant scientific research. Nowhere is this more urgently needed than in the whole field of glass manufacture.

The author is indebted to Mr. W. C. Hancock for valuable assistance in the reading of proofs and various suggestions in connection with the contents of this book.

PREFACE TO THE SECOND EDITION

IN the eleven years which have elapsed since the first edition of this book was written, the Glass Industry has undergone very great development; so far as the British industry is concerned, most of this development has—under the stimulus of war—been crowded into the period of the four years 1915 to 1919 inclusive, and much of this represents a supreme effort made under adverse conditions, an effort of which the glass manufacturers of Great Britain have good reason to be proud. In endeavouring to revise the present work in such a manner as to bring it into reasonable conformity with the present position of the industry while not too greatly exceeding the original framework, it has not been possible to deal with the history and development of each process. All that has been attempted is to introduce brief accounts of modern developments—of which the automatic blowing-machine of the Owens type may be taken as an example—and to modify expressions of views and anticipations where these have not been borne out by the course of events.

Perhaps the most important modification introduced into the book is the chapter (Chapter IV.) dealing with *Refractories*. This subject has assumed a position of such fundamental importance in relation to glass manufacture that treatment in considerably greater detail appeared to be justified.

Some typical analyses of various kinds of glassware are given in an Appendix; the author has preferred to group them together in this