In establishing his fundamental equations, Dr. Whiting, like Van der Waals, treats the molecules as elastic spheres which attract one another when not in contact. The cohesive effect of the molecular attraction is regarded by both as proportional to the square of the density. It is, in fact, represented by the same term $\left(\frac{a}{v^2}\right)$ in equations (1) and (2). This effect is deduced by Dr. Whiting from the hypothesis of a molecular attraction varying inversely as the fourth power of the distance, by supposing a body to expand so that every distance is increased in the same ratio; but such an expansion is entirely unlike any which actually occur in fluids, since it increases the distance within which the centres of molecules do not approach one another. We shall probably come much nearer to the case of nature, if we suppose that the average number of molecules in a fluid, which are between the distances r and $r + dr$ from a given molecule, varies as the density of the fluid. This supposition will evidently make the cohesive effect of the molecular attraction vary as the square of the density. It would seem that any agreement of experiment with the indications either of equation (1) or of equation (2) should be regarded as confirmatory of this law of the distribution of the molecules rather than of any particular law of attraction.

THURSTON'S FRICTION AND LOST WORK.

THIS volume combines characteristics not too often found in a work on this or kindred subjects. It is thoroughly scientific in method, as well as in the treatment of separate problems. It is eminently practical in results, as well as in the selection and range of the problems considered. It is clear, accurate, and minute in the details which give completeness to its discussions, and make them readily available for actual use. It is not merely or principally a compilation. While it brings together the formulae and results of the standard writers and experimenters upon friction, its laws, modifications, and effects, it also includes the author's own elaborate experiments, made with a view to their bearing upon questions of daily and vital importance to the engineer and the student. The conclusions drawn from these experiments, being always subject to comparison with the facts and knowledge gained by the author in a wide and extensive engineering practice, are rational and reliable. The book comprises eight chapters. The first explains the object of mechanism, the manner of computing work and power, the laws of the persistence and transformation of energy, and the relation of lost work to the efficiency of mechanism. In the second chapter, the theory and laws of friction are developed. The problems which arise in practice are taken up one by one, clearly analyzed, mathematically solved, and the applications of the resulting formulae pointed out.

The next three chapters form an exhaustive treatise on the lubricants used for reducing friction; their nature and relative values; the means of applying and using; methods of analyzing, inspecting, and testing them. Cuts of the best lubricators in use, and also of the apparatus used in making physical tests; tables giving physical and chemical properties of oils, their color reactions, density, specific gravity, and viscosity; and diagrams showing the relations of viscosity and lubrication, and effects of temperature upon viscosity, accompany the text. Oleography and electrical conductivity are noticed as methods of identifying various oils. The nature and effects of friction, and the kinds and properties of lubricants, having been thus fully discussed, the author proceeds to the subject of experiments, from which must be obtained the values of constants which enter into all the formulae. Upon the correctness of these values depends the accuracy of results obtained by calculation from the formulae developed by the theoretical investigations.

The sixth chapter relates to experiments of two kinds: First, those designed to ascertain the relative amounts of friction between different surfaces under varying conditions; to determine constants, or suggest the value and form of empirical formulae, applicable to friction of both solids and fluids. Second, experiments with machines for testing lubricants, with cuts and descriptions of oil-testing machines. The mathematical theory and method of using Thurston's machine are given in detail, together with tables showing records of oil-tests made by the author with his machine. The seventh chapter gives results of experiments with lubricants, showing their effects in modifying friction; their endurance under different conditions of pressure and velocity; and the effect of changes of pressure and velocity upon the coefficient of friction.

It is impossible to give in a brief review an adequate idea of the minuteness of detail with which the wide range of problems and experiments are discussed. The reader may expect to find, substantially, all that is known upon these subjects through the investigations of earlier writers, supplemented by the results of

Friction and lost work in machinery and mill-work. By R. H. THURSTON. New York, *Wiley*, 1885. 12+365 p., illustr. 8°.

the author's own work in his professional practice, and in carefully conducted experiments.

A somewhat novel feature of the book, and one which will commend it to the manufacturer and mill-owner, is the closing chapter on 'The finance of lost work.' The lost work, the cost of the lubricant, the quantity used, and the saving or loss of energy effected by the change of one lubricant for a better or a poorer, are represented by symbols, and embodied in equations, by which general principles, as well as special results, are reached. The application of these equations is illustrated by the solution of several problems.

While the author points out the need of more extended experiments in some directions, and warns the reader against drawing conclusions too hastily from insufficient data, it would seem that the method outlined, and so extensively pursued, covers the whole ground of investigation required for the complete solution of all questions relating to losses due to friction in mechanism.

DARWIN'S BIOGRAPHY.

SOME men are great, and some men famous: a few are both, and among them Darwin is pre-eminent. Greatness is a quality, fame a circumstance, which greatness, unhelped by fortune, cannot secure. In this century, there have been many great intellects celebrated to the votaries of science for their achievements, yet not famous with the public. Darwin is not solitarily pre-eminent: of his own generation we may count a number his compeers. He stands high aloft, yet he is even overtopped in sheer greatness by his greatest contemporaries; but, among them all, not one equals Darwin in deserved fame. The influential importance of a discovery is measured neither by the ability of the discoverer, nor by the magnitude of the difficulties overcome. There have been other intellectual efforts as successful and grand in their making and results, as that which established the Darwinian theory, but, in our time, no other of equally profound far-reaching and lasting significance to mankind.

In studying Darwin we have to bear in mind to separate the greatness of the man from the fame of his influence. The time has not yet come to fully estimate the man — we must await the biography promised by the family; but we are already able to appreciate the directness and force of his intellect, his noble candor, his courage under suffering, and, above all, his insatiable love of knowledge and research; we can appreciate also the revolution of belief he caused.

If a poet were to imagine forth a career, which without adventurous incident, or participation in the great affairs of nations, should stir the world, he might, if a great artist, conceive a character at once simple and noble; endowed with irrepressible love of knowledge; given over to study; indefatigable in gathering facts, and always marshalling them into logical phalanxes, making the front and flanks of his evidence alike impregnable: he would place this character aside from the bustle of the world, and perhaps add ill health to the conditions to enforce closer retirement, and accentuate the obscurity of secluded labor; and the poet-artist would endow his created man with means, that his life might be altogether devoted to study, without pecuniary harassments to impede the absolute concentration of mental effort. Last of all, the poet's conception includes a great idea. For year after year the toil would continue, unheeded but prosperous, until the long-growing thought becomes a proven generalization — the whilom mystery of nature is clarified. At last the result is given to the world; it turns the minds of men topsy-turvy; all civilized nations are convulsed with the turmoil of discussion, angry and turbulent: the suddenly famous philosopher maintains his retirement; he withholds himself from all share in the profitless fury he has aroused; he does not swerve from the continuation of his unobtrusive labors, but repeatedly re-enforces by more facts and more logic his published generalization. In a few years the vituperation, which was hurled at him in unmeasurable quantity, ceases; yet a little while, and his due is paid — fully: the world, that had but just now reviled him, turns about and acknowledges the mighty progress the one man has accomplished for all. Now the work is finished: the rich recompense of universal gratitude has been earned and received. Then the life closes, honored by every class and in every country. At his death it is already known that this student's name will henceforth mark the century in which he lived, because the kings, generals, and politicians of his time are all less than the unpretentious investigator.

Our supposed poet, the maker of this his-

Charles Darwin und sein verhältniss zu Deutschland. Von Dr. ERNST KRAUSE. Mit zahlreichen bisher ungedruckten briefen Darwins, zwei portraits, handschriftprobe, u.s.w., m. lichtdruck. Leipzig, *Günther*, 1885. 8+236 p. 8°.