

the boiling points and molecular volumes of isomers is given, while two pages later are set out the results of Stadel, which lead to the opposite conclusion, a conclusion which is much more generally true than that of Schiff, as the reader may verify by referring to the tables of physical constants given towards the end of the chapter.

The author may purposely have left matters in this condition, his idea being merely to indicate the gist of what has been done on the different questions. Indeed the present condition of subjects like molecular volume is so unsatisfactory as to prevent any very definite conclusions being stated. Nevertheless, if such abstracts as are given had on various occasions been supplemented by a statement of opinion as to the nett upshot of the whole discussion, there is little question that the average student would have found the mastering of several portions of the "Lehrbuch" a task of less difficulty than at present it is.

On p. 387, lines 2, etc., a volume-change due to oxygen is attributed to hydrogen: typographical errors are somewhat numerous, as could hardly be otherwise in a work of this kind.

To complete the second edition of the "Lehrbuch," Part 2 of the second volume, which treats of chemical affinity, has still to be published. Its appearance will serve to complete a work which goes further than any other to show how chemistry and physics must be united in the endeavour to arrive at the real nature of material phenomena.

J. W. RODGER.

#### CLARK ON THE STEAM ENGINE.

*The Steam Engine: a Treatise on Steam Engines and Boilers.* By Daniel Kinnear Clark, M.Inst.C.E. (London, Glasgow, Edinburgh and New York: Blackie and Sons, Limited, 1892.)

THE author of this book holds the first place among those who many years ago made the locomotive an object of scientific study. His famous work on railway machinery is still of prime importance, holding as it does an honoured place in many drawing offices. The present work consists of two ponderous volumes of some 800 pages each, and claims to be a comprehensive, accurate, and clearly written text-book, fully abreast of all the recent developments in the principle, performance, and construction of the steam engine. This no doubt is a very large claim to make for any work, but when one remembers who the author is, one is bound to admit that no one is more capable of carrying out so important a scheme.

Besides the author's many researches in locomotive engineering particularly, we notice that the numerous published records of investigation and practice have been made use of. This is certainly as it should be, and having been judiciously done adds greatly to the value of the work as a book for reference.

The work is divided into four main sections:—(1) The principles and performance of steam boilers; (2) the principles and performance of steam engines; (3) the construction of steam boilers; (4) the construction of steam engines. These main sections are again subdivided into many chapters.

The vast amount of information to be gathered from these pages may be imagined when it is noted that the first section alone takes up some 373 pages. Most of this space is absorbed by descriptions of experiments with special types of boilers, mechanical and other means of stoking, the prevention of smoke and the relative efficiency of various kinds of coal. Besides this the properties of steam are discussed, and the question of the economical combustion of fuel is very thoroughly gone into. The second section is an excellent treatise on the general behaviour of steam in the cylinder, and here we find evidence of the great experience of the author in this subject, particularly in the handling of the indicator diagram and the many lessons to be learnt from it when properly understood. The third section deals with the construction of steam boilers and concludes the first volume. Here we find a collection of reports and original matter of a valuable description embracing the whole subject. It is a pity that the classical researches of the late Mr. P. W. Willans find no place in the volume, because he, of all engineers, studied the thermodynamics of steam thoroughly, and his contributions to science on this subject are invaluable. It may be noted that his central valve high-speed engines find no place in the work. This also is to be regretted, because this type of engine is rapidly coming to the front, both as an economical machine and a trustworthy motor particularly for electric lighting by direct driving, the Glasgow Corporation Electric Lighting Station being among the latest to be fitted with these engines.

The first volume may be roughly said to contain most of the theoretical part of the subject, and the second volume the description of many types of stationary, marine, and locomotive engines. This volume begins with a very complete description of the various valve gears in use and the distribution of steam by ordinary and other slide valves, also the construction and modes of working of the many governors in use. Further on stationary engines for general purposes are described and very fully illustrated. We miss from these excellent examples the many types of high-speed engines used for driving dynamos, centrifugal pumps, fans, &c. Many of these have reached a high state of efficiency and might have been included with advantage.

Chapter lx. deals with British and foreign types of locomotives. We are not surprised to find that the many chapters on the locomotive are by far the best in the whole work. The author may be said to have grown up with the locomotive and to have made it his own particular study; to this day the plucky man who rode on the buffer beams of the old Edinburgh and Glasgow four-wheeled engines taking indicator diagrams is often quoted on that line, now part of the North British system.

The paper read by the late Mr. William Stroudley on the construction of locomotive engines, &c., before the Institution of Civil Engineers contains probably the most recent and trustworthy information at present available on this subject. The author has done well in making the quotations he does from this source. Of the British locomotives illustrated all are of most recent design. The table of types of American engines made by the Baldwin locomotive works is interesting, and the illustrations are good; but what is the use of giving the

reputed weight of trains hauled without quoting the average speed? Surely the one can be of little service without the other. Continental locomotive practice is well represented in the types in use on the St. Gothard railway. Of peculiar types of locomotives perhaps the six-coupled double bogie Fairlie engine is a good example. This engine, designed by Sir Alexander M. Rendel for the Mexican Railway Company, is stated to be able to haul a train weight of 3600 tons on the level. The engine when fully charged carries 2850 gallons of water, and has 300 cubic feet of room for coal, and weighs 92½ tons. On regular duty the engines run on a section of road which, for a length of fourteen miles, has many gradients of 1 in 25, with curves of 350 feet radius. More recent Fairlie engines supplied to this company weigh 93 tons 16 cwt. in running order, and are reported to do their work admirably.

We now come to the description of the different types of compound locomotives in use. These are practically all included in the Webb and Worsdell types in use in this country. Of the Webb type we find the Dreadnought class, and, in the appendix, the Greater Britain, thoroughly described and well illustrated.

At the present time the London and North-Western Railway Company have eighty-three compound locomotives of Mr. Webb's design at work, the total mileage of which since 1882 up to the end of December, 1892, was 22,854,037 miles, with an average consumption of 35·1 lbs. of coal per mile. This includes not only the fuel consumed in actually working the train, but also 1·2 lbs. used in raising steam and all fuel consumed whilst the engine is standing or shunting. The description of the Worsdell type of compound is equally clear, and is well illustrated by the Great Eastern and North Eastern locomotives. Why, however, are the Worsdell intercepting and starting valves alone described and illustrated? when this type of valve is seldom if ever used outside the North-Eastern Railway, the Worsdell Von Borries, Lapage, disc automatic valve being generally adopted in its place. Sixty Worsdell compound goods engines of the Mogul type have recently been sent to India, the cylinders being respectively 20 inches and 28 inches in diameter, stroke 26 inches, and the coupled wheels 5 feet 1½ inches in diameter. These engines and tenders weigh about 95 tons in running conditions.

In the addenda to the second volume there is some interesting information in reference to the construction of American locomotives and boilers, and details are freely illustrated. Following this is a description of the Vaclain compound locomotive as made by the Baldwin locomotive works. Then comes a short description of the Westinghouse brake—a very good break no doubt; but why should not the Vacuum brake find a place in the volume?

These volumes cannot of course be appreciated without careful study. They are a perfect mine of information, partly original, partly derived from contributions to the proceedings of various technical institutions and societies. The illustrations are excellent, and the typography remarkably clear. The work should be welcomed, both by the student and the engineer, as the best text-book on the steam engine and boiler yet published.

N. J. LOCKYER.

### A LIFE OF LOUIS AGASSIZ.

*Louis Agassiz: his Life and Work.* By Charles Frederick Holder, LL.D., &c. (Leaders in Science.) (G. Putnam's Sons, New York and London.)

WITHOUT a Life of Louis Agassiz a series of histories of leaders in science would be incomplete. Fortunately materials are not lacking, for in addition to the "Life and Correspondence" edited by his widow, there are numerous sketches and accounts of particular aspects of the man. The present volume tells the main incidents of his life and work, pleasantly and succinctly, and presents us with a clear outline of a remarkable personality. The book is well printed and the illustrations are not few. Some are good, others are not specially connected with the text, two are failures. Both relate to Switzerland. One is 'a sensational picture of Agassiz' "descent into the heart of a glacier," where he is being lowered down into a crevasse, while the text clearly shows that he descended a *moulin*. The other represents "Agassiz on the pinnacle of the Jungfrau." We think that this must be a studio composition, for the "pinnacle" is not very like what we have seen, and the topography of the view is incomprehensible.

Agassiz was a sturdy Swiss lad, uniting, as became a Neuchâtelais, something of French versatility with German tenacity of purpose; a close and keen observer delighting in every aspect of nature, happily neither "crammed" nor forced as a boy. When only twelve years old he was an omnivorous collector, and was more than this, a close student of his treasures.

Intended for commerce, he prevailed upon his parents to let him attend a course of classes at the University of Lausanne, then to proceed to Heidelberg and Munich as a student of medicine. At the age of twenty-three he had obtained the degree of doctor in that faculty as well as in philosophy. By this time, however, he had determined to devote himself to science, having already made his mark by his work on fresh-water fishes. After some stay in Paris a professorship was ultimately created for him at Neuchâtel, which he held until a visit to America ended in his accepting a post at Cambridge, Massachusetts, and settling down in the United States. But before leaving his native land he had become famous also by his studies of glaciers; still it was in the New World that the most important part of his life's work was done. Apart from the immense impulse which he gave to the progress of science in the United States, his explorations along the coast of Florida, in Brazil, on both coasts of South America, all supplied abundant material for study, which was worked up with unflagging industry.

The book, in short, is a marvellous record of work accomplished. We read in it of incessant labours in the lecture-room, the laboratory, and the field, yet the list of his books and scientific papers appended to this volume is perfectly appalling. Of the former there are thirty-nine, large and small; the list of the latter occupies twenty-two and a-half pages, each containing about ten entries, on the average. But this incessant activity, mental and physical, wore out even the sturdy Switzer, careful as he had always been in exercising the body. Cuvier's last words