THE WORK OF OCTAVE HALLAUER.

The distinguished physicist and engineer, G. A. Hirn, sends to the writer from his sick-bed, where he has been lying, as his amanuensis pathetically writes, '*malade depuis plus d'un mois*,' a biographical sketch of his hardly less distinguished and talented assistant, Octave Hallauer. This paper was read before the Société industrielle de Mulhouse on the 30th of January last. Mr. Hallauer died on the 5th of December, of typhoid-fever. He was born at Metz, Jan. 21, 1842, was educated there, and received the degree of bachelor of science in 1860. He continued his studies in mathematics, and entered the technical school at Mulhouse at the age of twenty, making a specialty of applied mechanics. He became, at his graduation, an 'apprentice-engineer' at Bitschwiller, in the establishment of Stehelin, and afterward joined Leloutre, the agent of the house of Grafenstaden, as his aid and secretary, at Mulhouse. Later, he became the assistant engineer of the Association des propriétaires d'appareils à vapeur, and afterward, January, 1875, the engineer of the Messrs. Hartmann.

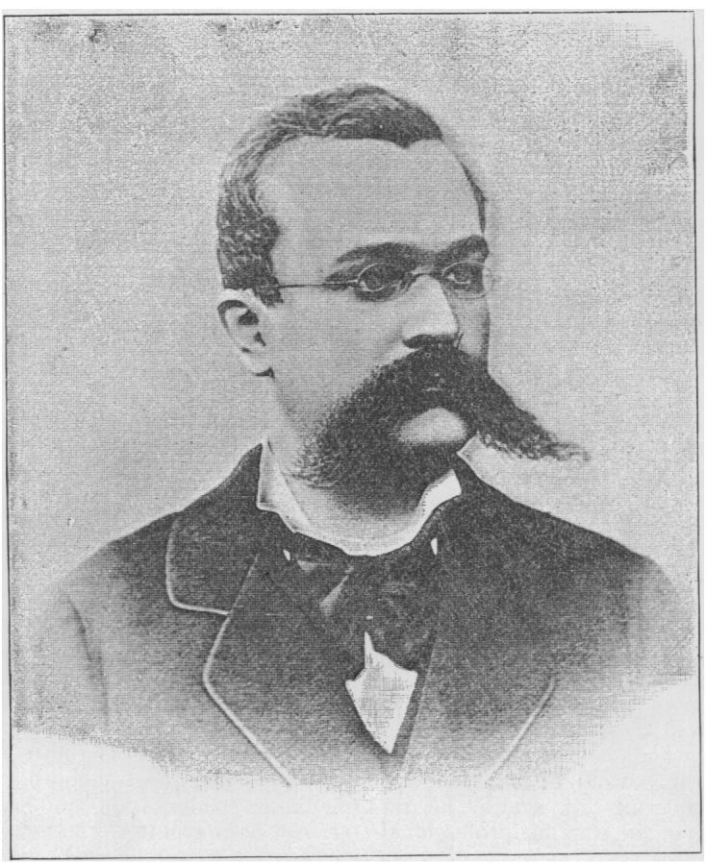
During the Franco-German war, Hallauer served with the French as a lieutenant, and fought in the armies of the Loire, of Orleans, and other sections of the French army of defence. He was present in the deadly fight at Villersexel, and, after the defeat of the army, took his forces across the Jura Mountains, and retired to Lyons, where he arrived, sick and exhausted, with the portion of his command thus saved. Recovering his health, he resumed, at the close of the war, his professional work.

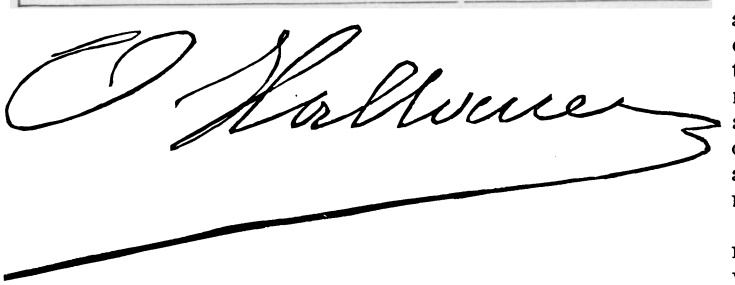
During the campaign, and at intervals, as opportunities offered, Hallauer frequently varied the more serious work which came to him, by the practice of an accomplishment in which he excelled, — that of the painter. His sketch-book was filled with studies of the beautiful scenery of the district in which occurred the operations in which he was engaged.

The long series of experiments upon the steam-engine in which Hallauer engaged, and which have made him famous, were commenced in 1868. The history of the development of the theory of the steam-engine (which now, thanks to the investigations of such men as Hallauer, is at last likely to become soon satisfactorily complete) may be divided, according to Hirn, into three distinct periods: 1°. That in which it was assumed that the heat entering the motor simply traversed the system, unchanged in amount, and acting only by its 'head,' as in the case of falling water, finally reached the condenser without loss in quantity, — simply lowered in temperature, and hence, in head available for purposes of impulsion; 2°. That in which it became recognized, that, in addition to the necessary depression of temperature, there is always, also, an actual loss of heat by transformation into mechanical energy; 3°. The experimental period, — that in which it at last became known that the heat supplied to the engine, in addition to these two changes, becomes seriously modified in its availability by its interaction with the walls of the steam-cylinder; which surfaces take up heat from the entering steam, and transfer it to the exhaust side without deriving from it useful effect.

The first period dates from before the time of Carnot. The second period was opened in 1852 by the labors of Clausius and of Rankine. The third period has only been entered upon within a few years past, the experiments of Hirn and Hallauer having furnished a very important part of the basis for the new treatment of the subject. The writer would distinguish these two later periods as those of the 'ideal' and of the 'real,' in the theory of the steam-engine. Clausius and Rankine, and other writers on the theory of heat-engines, have usually taken no cognizance of the expenditures of steam, other than those involved in the thermodynamic relations of energy, and ignore the usually greater demand for steam to supply wastes of heat in the steam-cylinder by the processes now familiar to every engineer, as invariably occurring in every heat-engine, — those caused by 'cylinder-condensation' and leakage. The latter can be prevented: the former may be ameliorated, but can never be wholly prevented, and will probably rarely, if ever, be reduced to such an extent that it may be neglected in the theory of the engine. It usually takes place to such an extent as to render the values of efficiency of fluid, and of engine, and of estimated 'duty,' obtained by the purely thermodynamic treatment, far from correct, and often very absurd. This fact has in many cases induced practically expert engineers to regard the current works on thermodynamics as devoid of value and practical interest, forgetting that the correct statement and application of one set of natural laws never can be valueless, even when, as here, other laws may be implicated in the same set of phenomena; which may be equally essential to a complete and correct theory, and which laws may be less well determined, and their operation less precisely understood. The first essential step

having been taken, it becomes a duty, not to ignore that, but to seek the knowledge needed before the next step can be taken. In this department also, as in others, the theorist has often failed to realize, that, although his mathematically deduced conclusions indisputably follow from his assumed premises, the latter may be, nevertheless, so far different from the conditions of actual work as to render his deductions practically valueless and absurd.





The last-mentioned of the two classes of phenomena are now becoming well recognized as essential elements in the action of all heat-engines, and it will not be long before investigators now at work will bring into view all the facts needed in the task of tracing out the laws controlling this method of expenditure of heat; and its introduction into the theory of the steam-engine will promptly follow. The writer has already endeavored to frame a closely approximate theory of the steam-engine on this basis, using the facts already known, and taking expressions for this method of waste which experiments already made indicate to be tolerably exact; sufficiently so to permit their use in design until further research shall give us more precise, though perhaps less convenient, expressions. The results so attained accord very satisfactorily with experience. This last period in the history of the theory of heat-engines has been inaugurated by the very valuable labors in Great Britain of Professor Cotterill, who seems to have been the first author to take up the new phase of the subject with the intention of making practically useful application of existing knowledge; and, on the continent of Europe, by the interesting, if somewhat warm, discussion of the defects of the theory of the second period, between Messrs. Hirn and Hallauer, on the one hand, and Professor Zeuner, on the other; and also, in this country, by the attempt to rationalize the accepted theory to which allusion is made above.

The experiments upon which we are to-day dependent in this work of revolutionizing the theory of heat-engines, and which have revealed the limitations to which the economical application of heat as a motor in the steam and other heat engines is subject, began with James Watt, who a hundred and twenty years ago, by his investigation of the action of steam in the cylinder of the Newcomen engine, revealed

the fact and the importance of that waste by cylinder-condensation which is only to-day becoming recognized as an essential element in the theory of the 'real' steam-engine of the engineer, as distinguished from the 'ideal' engine of the authors of the theory of thermodynamics, and which is recognized as imperatively demanding consideration, if that theory is to be made of practical use in engineering. Watt's discovery of this 'cylinder-condensation' led him to the invention of his separate condenser, and of the long-neglected but now familiar steam-jacket, — an attachment which was, for many years, only seen upon the Watt or Cornish engine, and was almost never used elsewhere. It has now come in with the compound engine, and is familiar to every engineer. Watt also found that this action placed an early limit to the gain derivable by expansion.

The work of Watt in the systematic experimental study of the steam-engine was not taken up by his successors in the profession until about the beginning of the present half-century, or a little later, when Hirn in France, and Isherwood and the navy department in this country, began the work which has now become classic. Defective as some of this earlier work may be by some regarded, it was of inestimable value; and Hirn, and his assistant and colleague, Hallauer, will never be forgotten as prominent among the pioneers in this all-important line of research. Mr. D. K. Clarke of Great Britain, one of the first of the new race of engineers, interested alike in theory and in experiment, familiar alike with the science and the practice of engineering, must be placed beside these investigators as having persistently called attention to the loss of energy revealed by them, and by his own investigation of the wastes occurring in the steam-cylinder of the locomotive. This work began, in his case, as long ago as 1855.

Hallauer was one of the first to recognize, and frankly to admit, the defects of the 'ideal' treatment of the theory of the steam-engine, and was as prompt in his acceptance of the inevitable as was his preceptor. As Hirn says, breaking away from the old system, his progress was rapid and satisfactory. Seizing with avidity experimentally determined facts, he held fast to the knowledge thus acquired, and demanded that theory should precisely conform to fact. His work upon the compound engine was especially fruitful; and his knowledge of theory, and his skill in its application, rendered his work at once available. He studied also the data given him by Widmann, relative to the performance of marine engines, and deduced, from his examination of the phenomena here revealed, the proper methods of increasing their efficiency. Uniting, in a rare degree, the practical sense with the intellectual cast of mind of the scientific man, he was able to make his work immediately and most effectively useful.

Referring to his personal character, Hirn describes him as possessing the most admirable qualities. Kindly, affectionate, modest, and yet intellectually great, Hallauer united with these prepossessing characteristics the most irrepressible energy and mental force. The last words in the eulogy by his friend Hirn are those of personal regard and of deepest affection.

Hallauer wrote many papers,[1] the first being an account of the method adopted by Hirn for determining the quality of steam by means of the calorimeter. The greater number were descriptive of his experimental investigations. He was an honorary member of the Société industrielle de Mulhouse, and of the American society of mechanical engineers, and was a member of the Société des ingénieurs civils de Paris. The writer wishes to add to the eulogy of Hirn, if it be possible to so add to it, this tribute of kind remembrance of one who, even were he not so distinguished a colleague in the professional fraternities, would none the less demand the most earnest expression of admiration, esteem, and respect.

Robert H. Thurston.

THE SYNOPTICAL FLORA OF NORTH AMERICA.

The second portion of Professor Gray's 'Synoptical flora of North America' has appeared, six years after the publication of the first part, which contained the gamopetalous orders following Compositae. The present instalment of this important work — the most important contribution (with the exception, perhaps, of the Genera plantarum of Bentham and Hooker) made in late years to systematic botany — treats of the plants of North America (exclusive of Mexico) belonging to the families which precede those elaborated in the previous volume, which took up the 'Flora' where it was left more than forty years ago, at the end of the second volume of Torrey and Gray's 'Flora.' The present publication is devoted to an elaboration of the families (Caprifoliaceae to Compositae) embraced in the second volume

[1] Published by Gauthier-Villars, Paris.