

mechanical value and the availability of heat existed, had to be largely altered, and corrected notions laid down, frequently as a result of prolonged discussion.¹ As an example, I may refer to the controversy between Hirn and Zeuner as to the cause of the great discrepancy between the theoretical and practical figures referring to the work in the steam-cylinder, the so-called "Water or Iron" controversy.²

But whilst it must be admitted that the corrected views regarding the nature of heat—the preservation

¹ The best account of the practical bearings of the mechanical theories of Rankine and Clausius is to be found in Prof. Unwin's "Forrest Lecture," delivered 2nd May 1895, before the Institute of Civil Engineers, and published in the 'Electrician,' vol. xxxv. p. 46 *sqq.* and p. 77 *sqq.* He there refers to the great discrepancy between the "rational" and the "experimental" theories, and to Hirn's experiments and practical results, notably with the "steam-jacket," and his introduction of "superheating" in 1855. "No doubt the rational theory altogether underrated the enormous facility of heat-exchange, which arises out of the contact between a conducting cylinder-wall and a vapour in a condition of the greatest instability, and liable to condense or evaporate on the slightest change of thermal condition" (p. 50). The several controversies through which Clausius defended and gradually elucidated the somewhat obscure statement which he gave of the so-called second law of thermo-dynamics may be studied with advantage in the 2nd edition of his collected Memoirs ('Die mechanische Wärmetheorie,' Braunschweig, vol. i., 1876), where his replies to criticisms of Holtz-

mann, Decher, Zeuner, Rankine, Wand, and Tait are most instructive. A good account is also given in Baynes's 'Lessons on Thermodynamics,' Oxford, 1878, p. 103 *sqq.*

² See Prof. Unwin, *loc. cit.*, p. 79. "On the appearance of Isherwood's researches in 1863, the discrepancy between the rational theory and the results of experiment were recognised by Rankine and others. But the conditions of the steam-cylinder condensation are so complex that for a long time the more theoretical writers practically ignored both Hirn's and Isherwood's results. Zeuner perhaps had pushed the rational theory to the furthest limit of detail, and with the greatest insight into practical conditions. But it was not till 1881 that he began to explicitly admit the largeness and importance of the condensing action of the cylinder. Zeuner then was disposed to attribute initial condensation to the presence of a permanent and not inconsiderable mass of water in the clearance space of the engine. . . . In opening a discussion with Hirn in 1881, Zeuner wrote that if the presence of water in the clearance space was conceded, the Alsatian calculations would be