

the theory of dissipation of energy.”¹ Whilst Clausius in Germany and Thomson in England were busy reconciling the truths contained in Carnot’s older researches with the new conceptions firmly established by Joule’s classical measurements, putting both into mathematical and into popular language, correcting our mathematical formulæ as well as our vocabulary, other applications of the new ideas assisted in procuring for them general recognition and acceptance. Rankine² in England, Zeuner³ in Ger-

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Rankine,
Zeuner, and
Hirn.

¹ Lord Kelvin, in a paper read before the Royal Society of Edinburgh, 2nd February 1874, on “The Kinetic Theory of the Dissipation of Energy” (‘Proceedings,’ vol. viii. p. 325 *sqq.*) See also his article in the ‘Fortnightly Review’ for March 1892, reprinted in ‘Popular Lectures and Addresses,’ vol. ii. p. 449 *sqq.*

² The earliest formal treatise on thermo-dynamics was Macquorn Rankine’s article on “The Mechanical Action of Heat” in Nichol’s ‘Cyclopædia’ for the year 1855. The part he took in the development of the new science was practical and at the same time highly speculative. His papers on temperature and elasticity of steam and other vapours, on the expansion of liquids by heat, and on the mechanical action of heat, of dates 1849 and 1850 (see ‘Miscellaneous Scientific Papers,’ ed. Millar, 1881, pp. 1, 16, 234), entitle him to be considered as one of the first—if not the first (see his claim to priority in a letter in Poggen-dorf’s ‘Annalen,’ p. 81, 1850)—to reconcile Carnot’s discovery with the mechanical view. His investigations were peculiar, combining practical applications of great value and important predictions (see Tait’s memoir prefaced to Rankine’s ‘Papers,’ p. xxix) with daring

speculation; his deductions being founded on his theory of molecular vortices. Though he exerted in this country a great influence on the early workers in thermo-dynamics, his theories were scarcely relished in Germany (see Helmholtz’s criticism of Rankine’s methods in 1853, quoted by Helm, ‘Energetik,’ p. 114), where Clausius’s independent and simultaneous researches on the same subject had meanwhile usurped attention. But Rankine’s ‘Manual of Applied Mechanics’ (1857), his ‘Manual of the Steam-engine and other Prime Motors’ (1859), were the first books of practical application in which, through a happy nomenclature and an extensive use of graphical methods (Watt’s indicator diagram and Carnot’s cycle), the new ideas were introduced to a wider circle. See Helm’s estimate of Rankine’s work in ‘Energetik,’ p. 116 *sqq.*

³ Somewhat later than Rankine in this country, Zeuner in Switzerland and Germany, following upon Clausius’s theoretical memoirs, introduced the mechanical treatment of practical heat-problems. His ‘Grundzüge der mechanischen Wärmetheorie’ (1860) was to many a revelation. Appearing about the time when the German mechanical and chemical industries were starting upon a new development,