

he found in the ideas expounded by Poncelet, Sadi Carnot, and Clapeyron, the means of accomplishing the object. We now see how there lay, in the fundamental problem of thermo-dynamics, the unifying idea of sciences hitherto far apart and working on independent lines and with independent standards of measurement, speaking, as it were, separate languages. And what was the new idea which lay concealed in Sadi Carnot's forgotten pamphlet? ¹ In Carnot's original memoir it appears as an axiom at the beginning of his reflections. "The production of motion," he says, "in steam-engines is always accompanied by a circumstance on which we must fix our attention. This circumstance is the re-establishment of equilibrium, or level, in the caloric—that is to say, its passage from one body where the temperature is more or less elevated,

¹ The story of Sadi Carnot's memoir is not less curious than that of Mohr's first paper. It was first given by Lord Kelvin in his earliest article, "On an Absolute Thermometric Scale" (1848), reprinted in 'Math. and Phys. Papers,' vol. i. p. 100), and "An Account of Carnot's Theory" (1849, *ibid.*, p. 113). He had in 1845 searched in vain for the 'Puissance motrice du Feu' in all the bookshops of Paris. In 1848 he obtained a copy from Lewis Gordon in Glasgow. It was known to him before through Clapeyron's memoir in the 14th vol. of the 'Journal de l'École polytechnique' (1834). Sadi Carnot published his memoir as a pamphlet in 1824. It has since been republished by his brother, Hippolyte Carnot ('Réflexions sur la Puissance motrice du Feu et sur les Machines propres à développer cette Puissance,' Paris, Gauthier-Villars, 1878), with important posthumous papers, from which, *inter alia*, it is evident that

Carnot, before he died, had abandoned the material theory of heat, and actually, by an unknown process, calculated the mechanical equivalent of heat as 360 kilogram-mètres. As in several other cases, so also in that of Sadi Carnot, the line of reasoning initiated by Laplace, and brilliantly developed by his school, militated against the acceptance of the dynamical as opposed to the material conception of the phenomena of heat; and M. Bertin, in his "Rapport sur le Progrès de la Thermodynamique en France" ('Recueil de Rapports,' &c., p. 5) could write in 1867: "Il faut bien l'avouer, parceque c'est la vérité: nous sommes restés longtemps, je ne dis pas rebelles, mais étrangers aux nouvelles idées: elles nous sont restées trop longtemps inconnues, et encore aujourd'hui, on peut regretter qu'elles n'occupent pas une place plus considérable dans notre enseignement scientifique."