

by the growing importance of the steam-engine, in which those laws operated in a practical form. James Watts, the main improver of that machine, was thus a great contributor to speculative knowledge, as well as to practical power. Many of his improvements depended on the laws which regulate the quantity of heat which goes to the formation or condensation of steam; and the observations which led to these improvements enter into the induction of latent heat. Measurements of the force of steam, at all temperatures, were made with the same view. Watts's attention had been drawn to the steam-engine in 1759, by Robison, the former being then an instrument-maker, and the latter a student at the University of Glasgow.¹⁶ In 1761 or 1762, he tried some experiments on the force of steam in a Papin's Digester;¹⁷ and formed a sort of working model of a steam-engine, feeling already his vocation to develop the powers of that invention. His knowledge was at that time principally derived from Desaguliers and Belidor, but his own experiments added to it rapidly. In 1764 and 1765, he made a more systematical course of experiments, directed to ascertain the force of steam. He tried this force, however, only at temperatures above the boiling-point; and inferred it at lower degrees from the supposed continuity of the law thus obtained. His friend Robison, also, was soon after led, by reading the account of some experiments of Lord Charles Cavendish, and some others of Mr. Nairne, to examine the same subject. He made out a table of the correspondence of the elasticity and the temperature of vapor, from thirty-two to two hundred and eighty degrees of Fahrenheit's thermometer.¹⁸ The thing here to be remarked, is the establishment of a law of the pressure of steam, down to the freezing-point of water. Ziegler of Basle, in 1769, and Achard of Berlin, in 1782, made similar experiments. The latter examined also the elasticity of the vapor of alcohol. Betancourt, in 1792, published his Memoir on the expansive force of vapors; and his tables were for some time considered the most exact.

¹⁶ Robison's *Works*, vol. ii. p. 113.

¹⁷ Denis Papin, who made many of Boyle's experiments for him, had discovered that if the vapor be prevented from rising, the water becomes hotter than the usual boiling-point; and had hence invented the instrument called *Papin's Digester*. It is described in his book, *La manière d'amolir les os et de faire cuire toutes sortes de viandes en fort peu de temps et à peu de frais*. Paris, 1682.

¹⁸ These were afterwards published in the *Encyclopædia Britannica*; in the article "Steam," written by Robison.