legislation on the subject of steam-engines. The French experiments were made in 1823, under the direction of a commission consisting of some of the most distinguished members of the Academy of Sciences; namely, MM. de Prony, Arago, Girard, and Dulong. The American experiments were placed in the hands of a committee of the Franklin Institute of the State of Pennsylvania, consisting of Prof. Bache and others, in 1830. The French experiments went as high as 435° of Fahrenheit's thermometer, corresponding to a pressure of 60 feet of mercury, or 24 atmospheres. The American experiments were made up to a temperature of 346°, which corresponded to 274 inches of mercury, more than 9 atmospheres. The extensive range of these experiments affords great advantages for determining the law of the expansive force. The French Academy found that their experiments indicated an increase of the elastic force according to the fifth power of a binomial 1 + mt, where t is the temperature. The American Institute were led to a sixth power of a like binominal. Other experimenters have expressed their results, not by powers of the temperature, but by geometrical ratios. Dr. Dalton had supposed that the expansion of mercury being as the square of the true temperature above its freezing-point, the expansive force of steam increases in geometrical ratio for equal increments of temperature. And the author of the article Steam in the Seventh Edition of the Encyclopædia Britannica (Mr. J. S. Russell), has found that the experiments are best satisfied by supposing mercury, as well as steam, to expand in a geometrical ratio for equal increments of the true temperature.

It appears by such calculation, that while dry gas increases in the ratio of 8 to 11, by an increase of temperature from freezing to boiling water; steam in contact with water, by the same increase of temperature above boiling water, has its expansive force increased in the proportion of 1 to 12. By an equal increase of temperature, mercury expands in about the ratio of 8 to 9.

Recently, MM. Magnus of Berlin, Holzmann and Regnault, have made series of observations on the relation between temperature and elasticity of steam.²⁰

Prof. Magnus measured his temperatures by an air-thermometer; a process which, I stated in the first edition, seemed to afford the best promise of simplifying the law of expansion. His result is, that the

²⁰ See Taylor's Scientific Memoirs, Aug. 1845, vol. iv. part xiv., and Ann. de Chimie.