

laid down an hypothesis more special than was necessary. Lagrange³ considers the vibration of open flutes as "the oscillations of a fibre of air," under the condition that its elasticity at the two ends is, during the whole oscillation, the same as that of the surrounding atmosphere. Bernoulli supposes⁴ the whole inertia of the air in the flute to be collected into one particle, and this to be moved by the whole elasticity arising from this displacement. It may be observed that both these modes of treating the matter come very near to what we have stated as Newton's theory; for though Bernoulli supposes all the air in the flute to be moved at once, and not successively, as by Newton's pulse, in either case the whole elasticity moves the whole air in the tube, and requires more time to do this according to its quantity. Since that time, the subject has received further mathematical developement from Euler,⁵ Lambert,⁶ and Poisson;⁷ but no new explanation of facts has arisen. Attempts have however been made to ascertain experimentally the places of the nodes. Bernoulli himself had shown that this place was affected by the amount of the opening, and Lambert⁶ had examined other cases with the same view. Savart traced the node in various musical pipes under different conditions; and very recently Mr. Hopkins, of Cambridge, has pursued the same experimental inquiry.⁸ It appears from these researches, that the early assumptions of mathematicians with regard to the position of the nodes, are not exactly verified by the facts. When the air in a pipe is made to vibrate so as to have several nodes which divide it into equal parts, it had been supposed by acoustical writers that the part adjacent to the open end was half of the other parts; the outermost node, however, is found experimentally to be *displaced* from the position thus assigned to it, by a quantity depending on several collateral circumstances.

Since our purpose was to consider this problem only so far as it has tended towards its mathematical solution, we have avoided saying anything of the dependence of the mode of vibration on the cause by which the sound is produced; and consequently, the researches on the effects of reeds, embouchures, and the like, by Chladni, Savart, Willis, and others, do not belong to our subject. It is easily seen that the complex effect of the elasticity and other properties of the reed and of the air together, is a problem of which we can hardly

³ *Mém. Turin*, vol. ii. p. 154.

⁴ *Nov. Act. Petrop.* tom. xvi.

⁵ *Journ. Ec. Polyt.* cap. 14.

⁶ *Mém. Berlin*, 1753, p. 448.

⁷ *Acad. Berlin*, 1775.

⁸ *Acad. Berlin*, 1775.

⁹ *Camb. Trans.* vol. v. p. 234.