of air themselves do not so travel. Accordingly Otto Guericke,[2] the inventor of the air-pump, asks, "How can sound be conveyed by the motion of the air? when we find that it is better conveyed through air that is still, than when there is a wind." We may observe, however, that he was partly misled by finding, as he thought, that a bell could be heard in the vacuum of his air-pump; a result which arose, probably, from some imperfection in his apparatus.

Attempts were made to determine, by experiment, the circumstances of the motion of sound; and especially its velocity. Gassendi[3] was one of the first who did this. He employed fire-arms for the purpose, and thus found the velocity to be 1473 Paris feet in a second. Roberval found a velocity so small (560 feet) that it threw uncertainty upon the rest, and affected Newton's reasonings subsequently.[4] Cassini, Huyghens, Picard, Römer, found a velocity of 1172 Paris feet, which is more accurate than the former. Gassendi had been surprised to find that the velocity with which sounds travel, is the same whether they are loud or gentle.

The explanation of this constant velocity of sound, and of its amount, was one of the problems of which a solution was given in the Great Charter of modern science, Newton's *Principia* (1687). There, for the first time, were explained the real nature of the motions and mutual action of the parts of the air through which sound is transmitted. It was shown[5] that a body vibrating in an elastic medium, will propagate *pulses* through the medium; that is, the parts of the medium will move forwards and backwards, and this motion will affect successively those parts which are at a greater and greater distance from the origin of motion. The parts, in going forwards, produce condensation; in returning to their first places, they allow extension; and the play of the elasticities developed by these expansions and contractions, supplies the forces which continue to propagate the motion.

The idea of such a motion as this, is, as we have said, far from easy to apprehend distinctly: but a distinct apprehension of it is a step essential to the physical part of the sciences now under notice; for it is by means of such *pulses*, or *undulations*, that not only sound, but light, and probably heat, are propagated. We constantly meet with evidence of the difficulty which men have in conceiving this undulatory motion, and in separating it from a local motion of the medium as a

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[2] *De Vac. Spat.* p. 138.
[3] Fischer, *Gesch. d. Physik.* vol. i. 171.
[4] Newt. *Prin.* B. ii. P. 50, Schol.
[5] Newt. *Prin.* B. ii. P. 43.