in the introductory portion of his work, we have such statements as these:—*Water is transformed into air by the action of fire. Far the vapours of boiling caldrons are nothing else than attenuated moisture expanding into air.* Indeed, by the four elements the ancients appear to have meant the same things which we now desig­nate by different terms. We comprehend all the mate rial agents with which we are acquainted under the four great designations, solid2, liquids, air, and ether. So exactly had the ancients their πυϑ and αηϑ, υδωϑ and γϑ, to which they assigned different regions according to their weight ; first, the solids or earth, then the liquids above, next the aerial covering, and finally the region of ether extending indefinitely beyond. The moderns have shown that all bodies are probably capable of assuming any of the three states and becoming solid, liquid, or fluid, according to the circumstances in which they are placed ; and we have every reason to believe that Timæus, of whom Plato speaks with so much reve rence, entertained the same idea, and believed that even the air might assume the state of a crystalline solid. It is not a little curious to find a mathematician of the pre­sent day giving it as a result of his calculus, that the air at a great distance from the earth is actually frozen into a crystalline solid by the extreme depression of temperature. He was probably not aware that his notion had been anticipated more than 2000 years. In this same work of Hero, we have descriptions and explanations of apparatus, in which the power of fire acting on moisture and air is made to produce phenomena of motion. He does not arrogate to himself the merit of these inven tions, but has given them as principally a collection from the works of those ancients who had long preceded him— *the ancient philosophers and mechanics.*

His *Pneumatics* commence with a lucid and excellent dissertation on the properties of air as a medium for the communication of pressure and motion, and especially upon the nature and effects of a vacuum, subjects to be thoroughly understood by all who would master the theory of the steam-engine. It is, indeed, as the means of producing a vacuum, that steam obtains much of its value as a mechanical power. The mode of raising water by a vacuum is thus described by him :—“ When they wish

to fill with water the round medical glasses which have slender long necks, they suck out the air which is con­tained in them, and, closing the orifice with the finger, they invert them in the water, and on removing the finger the water is drawn up into the vacuous space, in contradiction to the usual law of fluids.” He then proceeds to state that, “ in like manner, air may be rarefied by heat even as other substances are; for water is changed by fire into air, the vapours from boiling caldrons being nothing else than expanded water taking the form of air, and that mists and clouds are nothing else than water raised in the air by heat, which are partly afterwards converted into air, while portions again descend in rain.” He also attributes the origin of winds to the “ expansion and contraction of air and moisture by the alternate heating and cooling produced by the sun’s rays and illus­

trates the conversion of liquids into air or gas by the common observation, that, after a lamp has gone out. the vapour continues to rise up by the heat still left in it by the flame. Thus also, says he, a phial being filled with heated air and inserted in water, this air contracting will draw up water into the phial. Hence, he argues, that all airs consist of inconceivably small particles of matter, between which there are left wide vacuous spaces, so that, while the matter itself is incompressible, the volume occupied by the aggregate may be increased and diminished, and the air rarefied and condensed either by external force or the action of heat.

The following description of the manner in which the force of steam, issuing from a boiler, may be applied to supporting a weight, is given in the *Pneumatics.* “ A boiler, perforated on the top, is placed on the fire. From the perforation there proceeds a tube, on whose extremity is fixed a hollow hemisphere perforated in like manner.

If then we place a light hall in the hemispherical cup, it will follow that the vapour rising up from the boiler through the tube will sup port the sphere, and it will appear to dance.”

There is another apparatus in the *Pneumatics* for the purpose of producing a revolving motion by the action of steam—“ by a caldron placed on a fire to give motion to a sphere around its axis. Let a boiler be set on the fire, and nearly filled with water, and let its mouth be closed in by a cover, and let it be pierced with an opening through the bent tube, whose extremity exactly fits into the hollow sphere. But at the op­posite extremity of the diameter let there be an iron axis supported from the top of the cover; and let the sphere have two bent pipes at the ends of a diameter perforated along with it, and bent round in opposite direc­tions ; and let the hendings make right angles and he in the plane per­pendicular to the axis. Then it will follow that, on the boiler being heated, the vapour rushing through the tubes into the sphere will rush out through the reversed pipes of the ball, and whirl it round on its axis.”

The same apparatus, on similar principles, is next applied by Hero to the construction of a machine still more curious. The agent mentioned in this case is rarefied air, although the action is of precisely the same nature. Here the science of the philosopher appears to have been degraded to the base use of assisting an idolatrous priesthood in deceiving the populace by the resemblance of miraculous interference. “ A fire having been kindled upon an altar, living figures will appear to