The thermo-electric pile* possesses the requisite delicacy for indicating minute and rapid changes of temperature. Breathing for an instant on such an instrument, causes the needle of the attached galvanometer to be powerfully deflected in one direction; touching it for an instant with ice produces a prompt and energetic deflection in the opposite direction. Hence the thermo-electric pile is capable of indicating instantaneously, not only heat and cold, but their minutest variations.

As a general rule, whenever motion is arrested heat is produced, and *vice versa*, and the heat evolved in the measure of the force expended. It is a pretty and instructive experiment to fill a brass tube with water nearly to the brim, insert a cork tightly, and cause the tube to involve rapidly by means of a common whirling table. With a pair of wooden tongs the brass tube may be gently squeezed so as to produce friction, and thus generate heat by converting mechanical force into that agent. The water will soon boil, and in two minutes and a half the cork may be violently projected by the steam, with a report like that of a pistol. Opposite effects produced in an apparently similar manner can be beautifully explained by the "New Philosophy." Air expelled from a bellows strikes the face of the thermo-electric pile, and the vibrating needle shows instantly that heat is generated by the destruction of the motion. But the carbonic acid of a bottle of soda water driving out the cork produces cold when it strikes the face of the pile; the gas was compressed in the bottle, it performed mechanical work as it drove out the cork, and it consumed just as much heat as it performed work.

The dynamical or mechanical theory of heat discards the idea of materiality. The supporters of this theory do not believe heat to be matter, but a condition of matter, namely, a *motion* of its ultimate particles. When a sledge hammer strikes a piece of iron or lead, its descending motion is arrested and is transferred to the atoms of the lead or iron, and announces itself to our nerves as heat. Mr. Joule in his experiments agitated water, mercury, and sperm oil, in suitable vessels, and determined the amount of heat generated by the motion and labour or mechanical force expended in the operation. He varied his experiments in many different ways. He caused disks of iron to rub against one another, and measured the heat produced by their friction, and the force expended in overcoming it. The results at which he arrived leave no shadow of doubt upon the mind that, *under all circumstances, the quantity of heat generated by the same amount of force is fixed and invariable.* Turning to natural forces, we arrive at many important and unexpected conclusions of singular interest. The flow of rivers generate heat by the friction of the water against the bottom; the sea becomes warmer after a storm, by the clashing of the waves against one another, and the conversion of the mechanical force they exert into heat. May we not explain the sudden disappearance of the ice from our bays and lakes in the spring of the year, after a storm, in this manner? The extreme cold of the petroleum which issued from some of the spouting wells in Enniskillen may be explained in the same way as the cold produced by the exit of the gas from a bottle of soda water. No doubt at the depth of two hundred feet the petroleum is warmer than the mean temperature of the air above; but the vast mechanical force of compression employed in projecting it some thirty feet above the ground in a continuous stream is sustained by heat, and in accomodating itself to the new condition of pressure, its own heat is converted into mechanical force, and its temperature becomes much reduced. As the result of Mr. Joule's experiments, it was found that the quantity of heat which would raise one pound of water one degree of Fahrenheit in temperature, is exactly equal to what would be generated if a pound weight, after falling through a height of 772 feet, had its moving force destroyed by collision with the earth. Conversely, the amount of heat necessary to raise a pound of water one degree in temperature, would, if applied mechanically, be competent to raise a pound weight 772 feet high, or it would raise 772 pounds one foot high. The term "foot-pound" has been introduced to express the lifting of one pound to the height of one foot. And the quantity of heat necessary to raise the temperature of a pound of water one degree, being taken as the standard of measurement, 772 foot-pounds constitute what is termed the "*mechanical equivalent of heat.*"

Among the illustrations showing the conversion of mechanical force into heat, the following may be specified: A rifle bullet, when it strikes a target is intensely heated. Cannon balls striking the plates of an iron-clad produce a flash of light and

* The thermo-electric pile consists of a number of bars of antimony and bismuth, soldered together at alternate extremities When a hot body is applied to the points of junction a current of electricity is generated, the direction of the current being from the bismuth to the antimony. When a cold body is placed in contact with the points of contact with the points of junction, a current is generated in the opposite direction, or from the antimony to the bismuth. The existence and direction of the current are shown by its action on a freely suspended magnetic needle. Such an instrument is termed a galvanometer, and when the effect of the current is multiplied by passing it through a coil of wire, and the needle rendered independent of the magnetic force of the earth by a second needle placed above it, with reversed poles, the galvanometer becomes extremely sensible to variations of temperature, and indicates "heat" or "cold" by moving to the right hand or the eft hand, according to the direction of the current.