We call every thing a *force* which we observe ever to be accompanied by a change of motion ; or, more strictly speak­ing, we infer the presence and agency of a force wherever we observe the state of things in respect of motion different from what we know to be the result of the action of all the forces which we know to act on the body. Thus when we observe a rope prevent a body from falling, we infer a mov­ing force inherent in the rope, with as much confidence as when we observe it drag the body along the ground. The *immediate action* of this force is undoubtedly exerted be­tween the immediately adjoining parts of the rope. The im­mediate effect is the keeping the particles of the rope to­gether. They ought to separate by any external force drawing the ends of the rope contrariwise ; and we ascribe their not doing so to a mechanical force really opposing this external force. When desired to give it a name, we name it from what we conceive to be its effect, and there­fore its characteristic, and we call it *cohesion.* This is merely a name for the fact ; but it is the same thing in all our denominations. We know nothing of the causes but in the effects ; and our name for the cause is in fact the name of the effect, which is *cohesion.* We mean nothing else by gravitation or magnetism. What do we mean when we say that Newton understood thoroughly the nature of gravitation, of the force of gravitation; or that Franklin understood the nature of the electric force ? Nothing but this ; Newton considered with patient sagacity the general facts of gravitation, and has described and classed them with the utmost precision. In like manner, we shall un­derstand the nature of cohesion when we have discovered with equal generality the laws of cohesion, or general facts which are observed in the appearances, and when we have described and classed them with equal accuracy.

Let us therefore attend to the more simple and obvious phenomena of cohesion, and mark with care every circum­stance of resemblance by which they may be classed. Let us receive these as the laws of cohesion, characteristic of its supposed cause, the force of cohesion. We cannot pre­tend to enter on this vast research. The modifications are innumerable ; and it would require the penetration of more than Newton to detect the circumstance of similarity amidst millions of discriminating circumstances. Yet this is the only way of discovering which are the primary facts cha­racteristic of the force, and which are the modifications. The study is immense, but it is by no means desperate ; and we entertain great hopes that it will ere long be suc­cessfully prosecuted ; but, in our particular predicament, we must content ourselves with selecting such general laws as seem to give us the most immediate information of the circumstances that must be attended to by the mecha­nician in his constructions, that he may unite strength with simplicity, economy, and energy.

1. Then, it is a matter of fact that all bodies are in a certain degree perfectly elastic ; that is, when their form or bulk is changed by certain moderate compressions or distractions, it requires the continuance of the changing force to continue the body in this new state; and when the force is removed, the body recovers its original form. We limit the assertion to *certain moderate* changes. For in­stance, take a lead wire of one fifteenth of an inch in dia­meter and ten feet long; fix one end firmly to the ceiling, and let the wire hang perpendicular ; affix to the lower end an index like the hand of a watch ; on some stand imme­diately below let there be a circle divided into degrees, with its centre corresponding to the lower point of the wire ; now turn this index twice round, and thus twist the wire. When the index is let go, it will turn backwards again, by the wire untwisting itself, and make almost four revolutions before it stops ; after which it twists and un­twists many times, the index going backwards and forwards round the circle, diminishing, however, its arch of twist

each time, till at last it settles precisely in its original po­sition. This may be repeated for ever. Now, in this mo­tion, every part of the wire partakes equally of the twist. The particles are stretched, require force to keep them in their state of extension, and recover completely their re­lative positions. These are all the characters of what the mechanician calls *perfect* elasticity. This is a quality quite familiar in many cases, as in glass, tempered steel, &c., but was thought incompetent to lead, which is generally considered as having little or no elasticity. But we make the assertion in the most general terms, with the limitation to moderate derangement of form. We have made the same experiment on a thread of pipe-clay, made by forcing soft clay through the small hole of a syringe by means of a screw, and we found it more elastic than the lead wire ; for a thread of one twentieth of an inch diameter and seven feet long allowed the index to make two turns, and yet completely recovered its first position.

2. But if we turn the index of the lead wire four times round, and let it go again, it untwists again in the same manner, but it makes little more than four turns back again ; and after many oscillations it finally stops in a position almost two revolutions removed from its original position. It has now acquired a new arrangement of parts, and this new arrangement is permanent like the former ; and, what is of particular moment, it is perfectly elastic. This change is familiarly known by the denomination of a *set.* The wire is said to have *taken a set.* When we attend mi­nutely to the procedure of nature in this phenomenon, we find that the particles have, as it were, slid on each other, still cohering, and have taken a new position, in which their connecting forces are in equilibrio ; nnd in this change of relative situation, it appears that the connecting forces which maintained the particles in their first situation were not in equilibrio in some position intermediate between that of the first and that of the last form. The force required for changing this first form augmented with the change, but only to a certain degree ; and during this process the connecting forces always tended to the recovery of this first form. But after the change of mutual position has passed a certain magnitude, the union has been partly destroyed, and the particles have been brought into new situations ; such, that the forces which now connect each with its neigh­bour tend, not to the recovery of the first arrangement, but to push them farther from it, into a new situation, to which they now verge, and require force to prevent them from ac­quiring. The wire is now in fact again perfectly elastic; that is, the forces which now connect the particles with their neighbours, augment to a certain degree as the de­rangement from this new position augments. This is not reasoning from any theory. It is narrating facts, on which a theory is to be founded. What we have been just now saying, is evidently a description of that sensible form of tangible matter which we call *ductility.* It has every gra­dation of variety, from the softness of butter to the firmness of gold. All these bodies have some elasticity ; but we say they are not perfectly elastic, because they do not com­pletely recover their original form when it has been greatly damaged. The whole gradation may be most distinctly ob­served in a piece of glass or hard sealing-wax. In the ordi­nary form glass is perhaps the most completely elastic body that we know, and may be bent till just ready to snap, and yet completely recovers its first form, and takes no set what­ever ; but when heated to such a degree as just to be visi­ble in the dark, it loses its brittleness, and becomes so tough that it cannot be broken by any blow ; but it is no longer elastic, it takes any set, and keeps it. When more heated, it becomes as plastic as clay ; but in this state is remarkably distinguished from clay by a quality which we may call *viscidity,* which is something like elasticity, of which clay and other bodies purely plastic exhibit no appearance. This