THE

YOUNG MILL-WRIGHT'S

AND

MILLER'S GUIDE.

PART THE FIRST.

CHAPTER I.

MECHANICS.

Of the general Properties of Bodies, and the first Principles of Mechanics.

ARTICLE 1.

PRELIMINARY REMARKS.

ALTHOUGH there are many good, practical workmen who are entirely ignorant of the theory of mechanics as a science, it will be universally acknowledged that an acquaintance with the general properties of matter, and the laws of motion would not only be gratifying to every intelligent mind, but would introduce a certainty into many mechanical operations which would ensure their success: and this is a truth, with the importance of which the author of this work was so fully impressed, that he devoted a whole chapter to its consideration. The present editor has thought it best to alter and modify the original work, but he has been careful not only to relate all that appeared to him important in it, but to make such additions, and give such an arrangement to the whole, as have appeared to him calculated to place the subjects of which it treats in a more familiar light.

It is only, however, those properties of bodies, and those laws of motion, which most intimately concern the practical mechanician, that it is thought proper, here, to treat at any length, as any thing farther would be entirely foreign to the object of this work.

ARTICLE 2.

ON THE ESSENTIAL PROPERTIES OF BODIES.

There are certain properties of bodies which belong to matter in all its forms; these are called its essential properties, as they are those without which it cannot exist: these are *Extension*, *Figure*, *Impenetrability*, *Divisibility*, *Mobility*, *Inertia*, and *Attraction*.

Extension. We become acquainted with the existence of matter only by the space which it occupies. We cannot conceive of a body without length, breadth, and thickness, which are the three dimensions of extension. These vary greatly from each other in different bodies; and in some they are all equal to each other, as in the sphere and the cube.

Figure, or shape, is the necessary result of extension, and constitutes its limits. The business of the machinist is to give to various substances those figures, or shapes, which shall adapt them to his purpose.

Impenetrability is that property, by which a body occupies a certain space, which cannot, at the same time, be occupied by another body. If a nail be driven into a piece of wood, it removes a portion of the latter out of its way. Water and other fluids may be made to enter the pores of wood, but it is manifest that two distinct particles of matter cannot exist in the same space with each other.

Divisibility is the susceptibility of matter to be divided into any number of parts. If, in conceiving of the minuteness of the particles of matter, we carry the imagination to its utmost limits, we must confess that a single particle must contain as many halves, quarters, and eighths, as the largest masses. We are not to conclude

from this, however, that matter is actually infinitely divisible, although it is mathematically so. It is probable that the Creator has formed masses of matter of certain minute particles, which are infinitely hard, and incapable, from their nature, of mechanical division.

Mobility is one of those essential properties of matter, which form the very foundation of operative mechanics, as it is the capability of matter to be moved from the place, or space, which it now occupies. No mechanical operation, indeed, or any other change, can be effected in matter without motion.

Inertia, or inactivity, is that negative property of matter by which it resists every change of state, whether of rest or of motion. By this term we mean to express the fact that matter is powerless; that if at rest, it has nothing within itself tending to put it into motion; and if in motion, its own tendency is to continue to move, which it would consequently do perpetually, but for those extraneous resistances to which every thing upon the surface of the earth is subjected. The term *vis inertia*, or the power of inertia, is altogether objectionable, although it is very frequently employed. If inertia were a power existing in a body, it must be in some definite quantity, capable of being expressed in numbers, and of resisting a force less than itself; but it is a fact, that any force impressed, however small, will move any body, however great.

Attraction is that power which exists in particles or in masses, of matter, by which they tend to approach each other. It has been divided into five kinds: the attraction of *Gravitation*, of *Cohesion* or aggregation, of *Magnetism*, of *Electricity*, and *Chemical attraction*. It is the two former only of these attractions which claim particular attention in their relationship to mechanics.

The attraction of *cohesion* is that power by which particles of matter become united together and form masses. We could conceive of the existence of matter without attraction, but it must be in its original constituent particles only, unformed into masses; all matter, however, is manifestly endowed with this property, and its particles are, therefore, capable of being united together. In order that the attraction of cohesion may be exerted, it is ne-

cessary that the particles of matter be in contact with each other, as it does not take place at sensible distances. By sawing, filing, grinding, and many other mechanical operations, we destroy the attraction of cohesion; and this, indeed, is the great object of these processes. In those bodies which are capable of undergoing fusion, as the metals, we can readily restore this attraction, by subjecting the disentegrated particles to this process.

The attraction of *Gravitation* is manifested in masses as well as in particles of matter; by it all the bodies in nature tend to approach each other. The sun, the earth, the moon, and all the planets, notwithstanding their immense distances, are subjected to this universal law. A stone, or other substance, if unsupported, falls to the earth, in consequence of the attraction existing between it and the earth. What we call weight, results from this attraction, and is the measure of its force or power, in different bodies. The weight of a body is the sum of the attractive force exerted upon its individual particles. A piece of lead, weighing two pounds, contains twice as many particles as another weighing but one pound, and it is therefore drawn to the earth with double the force. It might be supposed that, in consequence of this double quantity of attraction, the piece of two pounds would fall with double the velocity of that of one pound; but, upon making the experiment, the time of their fall will be precisely the same in each. This arises from the inertia of matter, by which, when at rest, it tends to remain so; and, therefore, to move a double quantity with the same velocity, must require a double force. Gravitation must be considered as acting equally on each particle, and consequently, there exists no reason why a piece weighing two pounds should fall with any greater rapidity than would its two halves, were it divided. Light bodies, which expose a large surface to the air, are retarded in their fall by the resistance which it presents; were that removed, a feather would fall with the same velocity as a piece of lead.

This fact is of high importance in practical mechanics, as, in the greater number of instances, gravitation

is the active agent in moving machines; and in the construction of all, it is an element which must enter into the calculation of their power.

ARTICLE 3.

AXIOMS, OR LAWS, OF MOTION AND REST.

1. Every body in a state of rest, will remain so; and every body in motion, will continue to move in a right line, until a change is effected by the agency of some mechanical force.

2. The change from rest to motion, and from motion to rest, is always proportional to the force producing these changes.

3. Action and reaction are always equal, and in directions contrary to each other; or, when two bodies act upon each other, the forces are always equal, and directed towards contrary parts.

The first of these laws results, necessarily, from the inertia of matter. The assertion, however, that a body in motion would continue to move in a right line, may require some illustration. That motion when once communicated would never cease, is fairly inferred from the fact, that the motion is continued in the exact proportion in which the obstruction is diminished. A pendulum will vibrate longer in air than in water, and longer still in an exhausted receiver, and stops at last in consequence of the friction on its points of suspension, and the imperfection of the vacuum.

When a stone is thrown in a horizontal direction, as motion is constantly retarded, it also moves in a curve, and eventually falls to the ground. The retardation, in this case, is exactly proportioned to the density of the air, and the curve in which it moves is the consequence of the force of gravity, which is always drawing it towards the earth: the curve in which it moves is determined by this known force, and is precisely proportionate to it. It necessarily follows, that, if the cause of retardation, and of deflexion were both removed, that