A tangential motion between two surfaces is impossible, if the surfaces are in contact, since the matter would be continuous in passing from one side of the surface to the other, and continuous matter is rigid by our assumption. Tangential motion can only take place between two surfaces when they are really divided, that is, when there is a vacuum space, no matter how thin, between them.

Suppose a smooth rigid particle falling down a smooth curved tube under the action of gravity, what is the nature of the reaction of the tube, which is supposed to consist of continuous matter, and consequently to be rigid?

The motion conferred by gravity on the particle may be resolved into a component at right angles to the tube, and one tangential to it. The reaction is due to the rapid impacts which arise from the former motion, and the velocity is due to the latter motion. The particle never remains in contact with the tube. Its contacts are instantaneous, that is to say, occupy no time. It is always in the air, so to speak.

Thus no forces can be exerted between the parts of a rigid body, simply because no motion can take place between them. It will be observed that our definition of force is based upon rectilinear motion; but there is another kind of motion which gives rise to actions between the parts of bodies. This is angular motion. If a body be set spinning about an axis, we know that a strain takes place in it, and if the angular motion is very great, the body may fly to pieces.

Is there no strain between the parts of a rigid body when thus set spinning? We answer, No. We can explain all strains in ordinary bodies by our definition of force, but the idea of rigidity is utterly incompatible with the idea of forces acting between the parts of the rigid body. We are thus relieved from the necessity of attempting to pursue the idea of force through a never-ending division of matter, to which those are subjected who hold the idea that the conservation of relative motion depends upon resilience.

Rigidity is an elementary idea, which can be defined but is incapable of being analyzed or accounted for.

It will be observed that we do not assert that a body necessarily moves when forces act on it. Thus a rigid body, struck by equal blows on opposite sides at the same instant, will not move. The whole motion in this case will be confined to the striking bodies.