INERTIAL ENERGY

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Abstract

This paper is prepared to show that as a consequence of induced inertial force over accelerated mass-body that have internal structure, an additional kind of energy will build up in that body beside the kinetic energy of it when it is accelerated in free space. The Lagrange of this body will acquire an additional term to represent this energy.

1. Theoretical Background

The encyclopaedia Britannica explain the inertial force as " any force invoked by an observer to maintain the validity of Isaac Newton's second law of motion in a reference frame that is rotating or otherwise accelerating at a constant rate.[1] " The inertial force is the main force behind the occurring of the inertial energy which we are going to derive here.

2. Analysis

Referring to Figure 1-(A), the frame of reference S' represents a body with internal structure of masses m_1 and m_2 which are bind together with a spring[1] of constant k. The S'-frame in Figure 1-(A) is at rest with respect to an observer O on an inertial frame of reference S. Both of the frames, S and S', are positioned in free space. In Figure 1-(B), the S'-frame accelerated uniformly from rest with acceleration a with respect to the S-frame and along its $+x$-axis. The S'-frame will invoke the inertial force, therefore the mass m_2 –which is a part of the S'-frame– will accelerate[2] with uniform acceleration a along the $-x'$-axis of the S'-frame, causing the spring to compress and hence charged it with an elastic[3] potential energy $\frac{1}{2}k(L-l)^2$. Meanwhile, the S'-frame with all of its constituents will also accelerate along the $+x$-axis with respect to the S-frame with uniform acceleration a –see Figure 1-(C). After accelerating for a time t the whole body will end up moving with velocity u along the $+x$-axis with respect to the S-frame and in addition to that the internal constituents of the body, m_1 and m_2, will vibrate[4] with respect to each other with energy $\frac{1}{2}k(L-l)^2$ –see Figure 1-(D). Therefore, one can write the Lagrange of this body

$$L = T - V + \Omega \tag{1}$$

where $T = \frac{1}{2}Mu^2$ is the total kinetic energy of the body. $M = m_1 + m_2$ is the total mass of the body. $u = at$ is the final velocity of the body with respect to the S-frame. V is the potential energy (here $V = 0$). Ω is the mentioned **inertial energy** and in this specific case its value is equivalent to $\frac{1}{2}k(L-l)^2$.

3. Conclusion

Throughout space there is energy that develop by non-inertial frames. This energy is caused by occurring of inertial forces.

[1] The mass of the spring is negligible.

[2] Under the influence of inertial force $F = m_2 a$.

[3] Inertial energy is need not always to be converted to elastic potential energy where in some specific cases it is possible to be directly convert to kinetic energy to the constituents of the body.

[4] This vibratory motion will add nothing to the total momentum of the body. The total momentum is conserved.

References

[1] *"inertial force", Encyclopaedia Britannica Online. 2017. Web. https://www.britannica.com/science/inertial-force.*

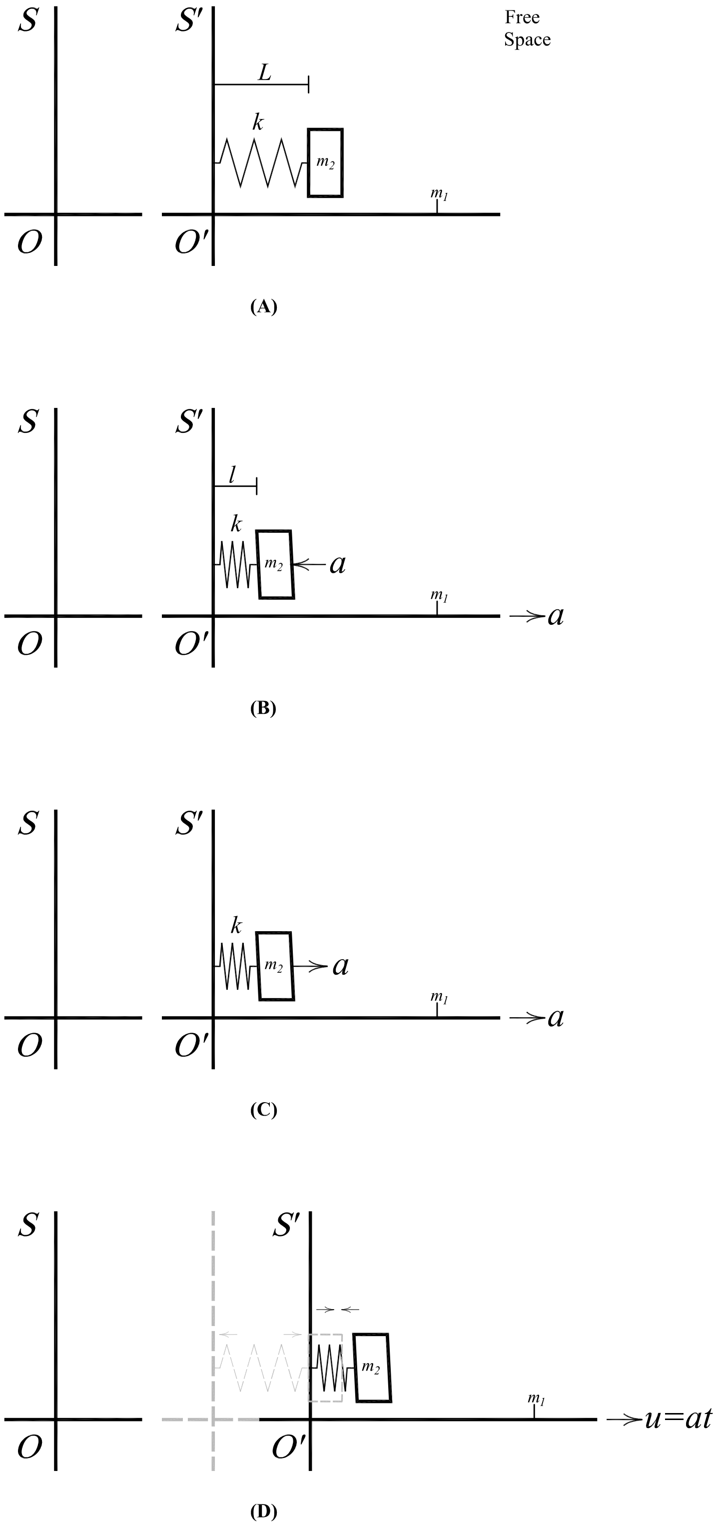

Figure 1: The build up of inertial energy.