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RANDOM AND ARBITRARY CONTINGENCIES IN HISTORY OF SCIENCE AND TECHNOLOGY [5] – THE INVENTION OF THE STEAM ENGINE IN THE EARLY 18TH CENTURY

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ABSTRACT

Newtonian mechanics cannot be applicable for the invention of the steam engine. The laws of motion by Newton have nothing to do with the first principle of thermodynamics, the equivalence of heat and energy. Thus, Newtonian science at that time provided absolutely no guidance for the invention of the steam engine which was developed out of a pure luck. Despite the fact, the steam engine made possible the four major industries of locomotive, textile, steel, and coal. It was truly a central engine of the industrial revolution.

KEYWORDS: Industrial Revolution, Newton's laws of motion, Equivalence of heat and energy, air pump, steam engine, Newcomen, Calley

INTRODUCTION

In Newton's Principia (Newton, 2015) in 1687, originally developed from a letter to his friend, Halley, Newton proposed three laws of motion as well as the universal law of gravitation. The first law of motion is the law of inertia; a stationary object tends to be stationary and a moving object tends to move. The second law of motion is F = ma, where F is a force, m is a mass, and a is an acceleration. The third law of motion is the law of action and reaction; for every action, there is a reaction with an equal magnitude of an opposite direction. Finally, the universal law of gravitation states that the force of gravity is proportional to the product of two masses and inversely proportional to the square of the distance between them with the proportionality constant called the gravitational constant.

However, this Newtonian mechanics has absolutely nothing to do with the invention of the steam engine in the early 18^{th} century. The reason is rather obvious. In order to understand the steam engine, a clear

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connection between heat and mechanical work is required which is the central theme in thermodynamics of the late 19th century. In fact, for almost one hundred and eighty years, the steam engine did not have any theoretical support from Newtonian mechanics, although the steam engine was actively in use until thermodynamics was final established. Then, how was the steam engine developed without a help from physics in the first place.

The First Steam Engine

During the 17th century, the entire Europe, perhaps the entire world too, suffered from a severe weather. The world-wide era of low temperature might be qualified to be called a small ice age. An extensive low temperature was especially serious in England, where wood burning as a primary source of heating caused huge shortage of wood which again triggered a big economic trouble. Also, England demanded a constant high consumption of wooden material to construct a reliable sea going vessels, an absolute necessity for maintaining an essential every day supply to England.

In this situation, coal as a new source of heating material was finally found. However, a transition from wood to coal as a heating source was not easy due to a new emerging difficulty in coal mining. Underground water during coal mining became a major source of problem. It turned out that an air pump powered either by humans or by animals had a definite limit of application. It works properly only for a certain depth. However, once the depth becomes deeper, it no longer worked effectively anymore. So, a new kind of a pump was urgently needed for deeper mining.

Finally, in 1712, Newcomen and Calley invented the first steam engine for pumping out underground water during coal mining (McClellan and Dorn, 2006). They did not receive any proper science education for the invention. Even if they had a formal science education of the time, it was not going to help them anyhow because Newtonian science at the time had absolutely nothing to do with their invention. All Newtonian laws of motion including the universal law of gravitation were, in fact, designed to derive Kepler's third law. The laws of motion cannot handle anything related with the steam engine for which the equivalence of heat and energy should first be established. Today, this equivalence is known as the first law of thermodynamics which was announced at the end of 19th century, one hundred eighty years after the first steam engine.

Although the inventors did not have a proper formal science background, they had a practical insight to navigate all the possibilities for their actual prototypes. Once they have a working prototype, they could further develop it through trial and error. Their process of troubleshooting was literally lucky not to be harmed by their working prototype which was especially dangerous when heated enough to have a maximum pressure inside. All of their experimental paths for a working steam engine never grew out of

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their formal science education. Science of the time provided absolutely no guidance what so ever. Their success was deeply based on their pure luck. In other word, the first steam engine was developed from random and arbitrary contingencies of pure luck.

Later, some further development of a smaller high-pressure steam engine made the first steam locomotive possible, today known as Stevens' locomotive. The textile industry was also newly established by textile machines which was again powered by a steam engine. The establishment of the locomotive industry carrying coal and textile was supported by the steel industry. Therefore, the four industries of locomotive, textile, steel, and coal were all made possible through the invention of a steam engine which was truly a central engine behind this so-called industrial revolution.

CONCLUSION

The first steam engine invented by Newcomen and Calley in 1712 was not developed out of scientific knowledge available at the time. It was an outcome of not only trial and error, but also a pure luck. Newtonian Science provided absolutely no guidance what so ever for the successful invention of the first steam engine. Developed out of a random pure luck, however, the steam engine was truly a central figure of the industrial revolution.

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