New elements of relativistic electrodynamics for generating useful work from permanent magnets: A review

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Resumen— Este artículo presenta una revisión acerca de nuevos elementos encontrados en la electrodinámica relativista orientados a la generación de trabajo útil a partir de imanes permanentes. En este sentido, se expone el estado del arte sobre Máquinas de Movimiento Perpetuo y Motores Magnéticos, como los dos tipos de sistemas que por sus similitudes sirven de punto de partida para la elaboración de una metodología orientada a inferir la dinámica de los torques que se pueden obtener en sistemas rotacionales que emplean interacciones magnetostáticas.

Palabras clave— Máquinas de movimiento perpetuo, motores magnéticos, imanes permanentes, máquinas eléctricas rotativas.

Abstract— This document a review of new topics in relativistic electrodynamics oriented towards useful work by using permanent magnets. In this sense, we sought to establish the state of the art of Perpetual Motion Machines and Magnetic Motors as two types of systems that, given their similarities, serve as a starting point for elaborating of a methodology aimed at inferring the dynamic behavior of the torques in rotational systems based on magnetostatics interactions.

Keywords— Perpetual motion machine, magnetic motor, permanent magnets, rotating electrical machines.

I. INTRODUCTION

Rotating electrical machines can be engines or generators; to develop mechanical torque, engines use 100% electric power, while generators use gravitational potential energy [1].

The study of the effects of torque generated in permanent magnet arrangements connected externally to rotation axles in rotating electrical machines, is of interest when there is the possibility of replacing a fraction of the energy consumed in these machines by using the potential magnetic energy stored in permanent magnets as an alternate source for reinforcing the mechanical torque [2]. In relation to the study of torque produced by the force due to the magnetic interaction between permanent magnet arrangements coupled to rotation axles , the information identified is dispersed and does not concretely document the topic, although some publications deal with the magnetic effects in cylindrical geometries [3], [4], [5].

The main objective of this review is to establish whether the available information is sufficient for advancing a theoretical study, on the effects of torque pr

oduced from the magnetic interaction generated between permanent magnet arrangements coupled to rotation axles, and to determine the viability of replacing part of the traditionally used energy with potential magnetic energy. Thus, new elements of Relativistic Electrodynamics are reviewed with the aim of analyzing the possibility of using the energy of permanent magnets for performing useful work.

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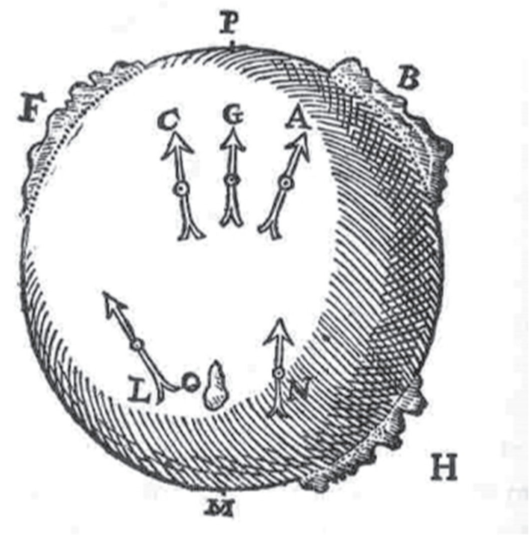
II. BACKGROUND

Magnetism, as an invisible force, has provided the puzzled humanity for thousands of years. The Greeks, in the Western world, were the first to describe the properties of natural magnets, as they knew of the magnet stone, found in a region known as Magnesia in western Greece. This mineral is scientifically known as magnetite (lodestone) (Fe_3O_4) and its first practical use was in the compass, a revolutionary instrument of navigation, since it allowed geographic orientation without requiring the stars to be visible [6].

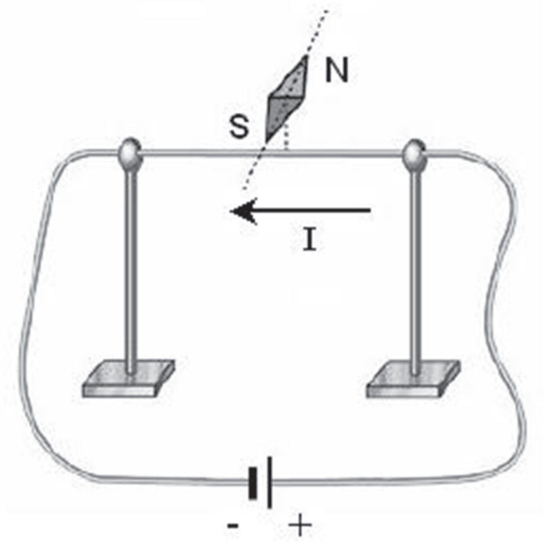
Notwithstanding, magnets and magnetism only began to be studied in the 17th century, when Englishman William Gilbert published his work *De Magnete* [7], in which he declared that the earth behaved like a *Magno Magnete* or giant magnet (see Fig. 1). During the following two hundred years there was much speculation, until in 1819, in Denmark, Hans Christian Oersted [8] demonstrated that the circulation of a current across a wire conductor produces a magnetic field (see Fig. 2), proving that magnetism can be generated from electricity. An opposite effect was discovered, in England, by Michel Faraday, who by means of a variable magnetic field managed to induce electrical current on a conductor [9].

FIG. 1. GILBERT´S MAGNO MAGNETE, 17TH CENTURY



Source: W. Gilbert, *De Magnete*, United States: Dover Publications, 1958, p. 238.

FIG. 2. OERSTED´S EXPERIMENT, 1819



Source: R. Wood, *Magnetismo*, Mexico: McGraw Hill 1991, p.37

But it was James Clerk Maxwell, the Scot mathematician and physicist, who by 1873 provided the theoretical basis to the observations by Oersted, Faraday, and others, and presented the equations that describe the previously mentioned phenomena [10] and that represent the foundation of our knowledge on electromagnetism. Maxwell's original publication of 1865, A Dynamical Theory of the Electromagnetic Field [11], contained many expressions, but all of them can be deducted from four general differential equations:

Gauss's electrical law:

$$\nabla \bullet D(r,t) = \rho(r,t) \qquad (1)$$

Gauss's law for magnetism:

$$\nabla \bullet B(r,t) = 0 \qquad (2)$$

Faraday's law:

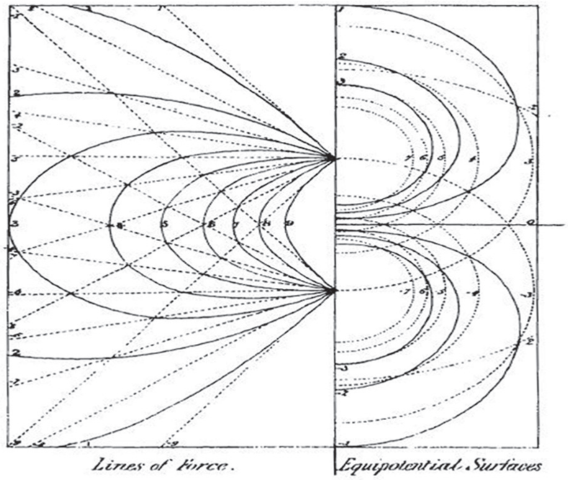
$$\nabla \times E(r,t) + \frac{\partial}{\partial t} B(r,t) = 0 \qquad (3)$$

Ampère-Maxwell's law:

$$\nabla \times H(r,t) - \frac{\partial}{\partial t} D(r,t) = J(r,t) \qquad (4)$$

Expressions (1), (2), (3), and (4), are the laws that govern electromagnetism, which in their differential form are known as Maxwell's equations and although they were not deduced in principle by him, they take his name as he verified their validity by using his vortex model of lines of force [12] (see Fig. 3) and as he included some modifications in the equations.

FIG. 3. LINES OF FORCE AND EQUIPOTENTIALS SURFACES, 1861



Source: J. C. Maxwell, *A Treatise on Electricity & Magnetism*, vol. 1. New York: Dover Publications, 1954, p.149

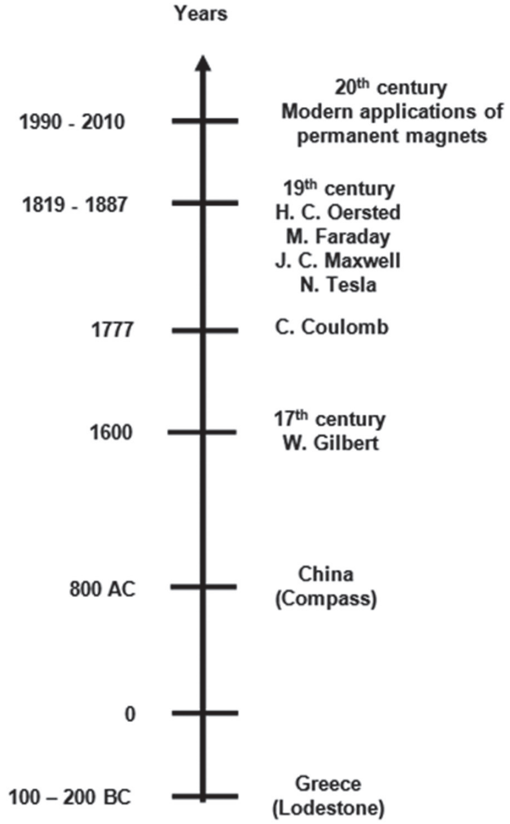
Thus, Maxwell's most important contribution was the inclusion of the temporary derivative of an electrical field or displacement current in Ampère's law, which is the product of the existence of electromagnetic waves propagating according to the material; this last element led to unifying optics with electromagnetism [13].

Subsequently, the technological application of all this new knowledge on permanent magnets and electromagnetism would be triggered during the 19th and 20th centuries by the Industrial Revolution [14], which generated growth of the socioeconomic middle class, encouraged a market in need of innovations, and after several centuries of using magnets in compasses, they were used in new applications like the telegraph and, later, the telephone. But the most important use of magnets and electromagnets was in achieving the movement of rotation stemming from electricity (Nikola Tesla - 1887), which contributed to the development of conventional engines and electrical generators and those applications derived from such [15].

In general, Fig. 4 presents a chronological summary of the most relevant events pertaining to magnetism and permanent magnets.

Finally, through contributions of material science to the improvement of magnetic properties [16], new application fields have been found for artificial permanent magnets. Permanent magnets, as the most representative elements of magnetostatic interaction, and have been in use during the last decade in highly specialized applications such as transport systems by magnetic levitation, MAGLEV, [17] [18] [19] [20], which uses the repulsion force and valves [21] in magneto-resistant devices [22] [23], in magnetic refrigeration equipment [24] [25], in the detection and characterization of subatomic particles [26], and in diamagnetic levitation systems [27] that simulate variable gravity force.

FIG. 4. MAGNETISM AND PERMANENT MAGNETS



III. STATE OF THE ART

The bibliographical references available do not document the effects that torque may have on a permanent magnet device (magnetic impeller) coupled externally to a rotation axle. Nevertheless, historically we know two types of systems that given their characteristics and similarities deserve further study. They are, Perpetual Motion Machines and Magnetic Motors.

A. Perpetual motion machines [28]

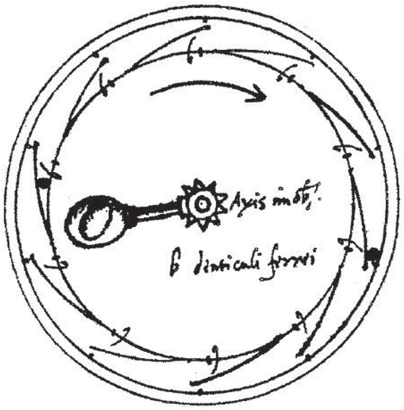
Prior to having a clear idea of what energy is – as we know it today – many knew that it was not possible to generate energy out of nothing. In 1586, Simon Stevin, a Dutch mathematician and physicist, stated the principle of the impossibility of creating forces [29]. In 1686, Gottfried Wilhelm Leibnitz introduced the concept of kinetic energy (*vis viva*) [30], and, around 1826, French physicists Gustav Coriolis and Jean Victor Poncelet defined mechanical work as the product of force by displacement [31]. In 1842, Robert Julius von Mayer proposed the concept of *Kind* [32], to characterize the Perpetual Motion Machines:

1) Perpetual motion machines of the first kind [33]

They are those that perform work indefinitely without receiving additional energy to the impulse required for conquering the resting inertia [34], that is to say, they work without an equivalent consumption of energy, which is impossible in light of the Energy Conservation law. Although such machines were not successful, wheels, axles, fluids, or permanent magnets were used in their manufacture. These types of machines were macroscopical mechanical systems.

The first kind of perpetual motion devices of the Middle Ages that are greatly similar to the *Magnetic Impeller* are those of Petrus Peregrinus (1296) and Athanasius Kircher (1640); these were characterized by using permanent magnet arrangements placed in front of each other in concentric cylindrical geometries [35], as illustrated in Fig. 5 and Fig. 6.

FIG. 5. PETRUS PEREGRINUS DE MARICOURT, 1269

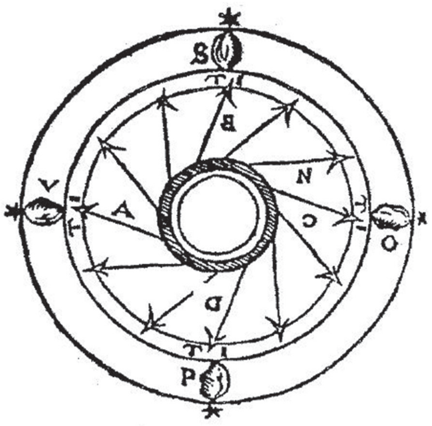


Source: A. Klienert, “Wie funktionierte das Perpetuum mobile des Petrus Peregrinus,” *NTM*, vol. 11, pp. 155-170, 2003

2) Perpetual motion machines of the second kind

The functioning of perpetual motion machines of the second kind was based on the supposition that they might indefinitely exchange heat with their surroundings by means of Carnot’s cycle [36], which goes against the Second Thermodynamic law [37], since at some stage every system must reach thermal equilibrium [38], [39]. These types of machines were associated to the exchange of internal energy, U, in microscopic systems. After the first and second laws of thermodynamics were formulated, *circa* 1850, the idea of developing perpetual motion devices was abandoned.

FIG. 6. ATHANASIUS KIRCHER, 1643



Source: A. Klienert, “Wie funktionierte das Perpetuum mobile des Petrus Peregrinus,” *NTM*, vol. 11, pp. 155-170, 2003

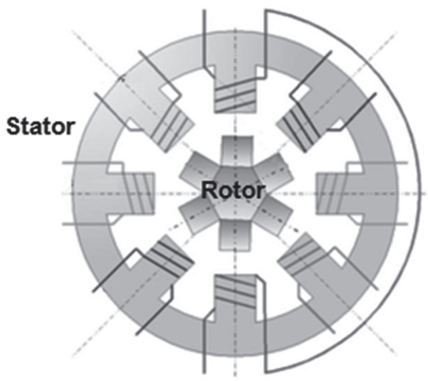
A. Magnetic motors

Currently in the literature, the magnetic motors of which there are references are the switched reluctance (SR) motor, Howard Johnson’s motor of permanent magnets – patented in 1979 – and Perendev motor, patented in 2006. These machines use magnetostatic interaction as the principle of operation.

1) Switched reluctance (SR) motor [40]

It is formed by a rotor of permanent magnets of several poles and a stator constituted by electromagnets that operate in a switched manner (see Fig. 7) according to current pulses that are sent to every coil by means of an electronic-type control. It is not strictly a magnetic motor, because in spite of benefiting from the magnetostatic interaction, it consumes electricity to produce the magnetism in the stator poles.

FIG. 7. MODIFICATION OF A SWITCHED RELUCTANCE (SR) MOTOR.

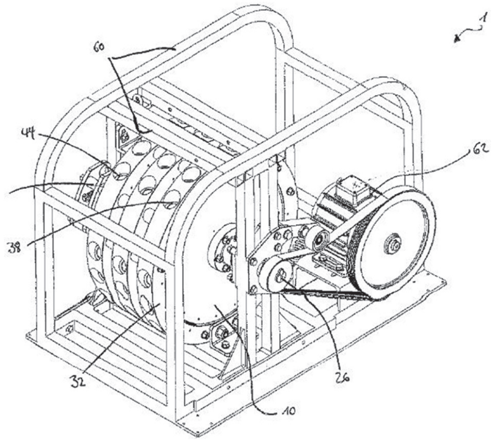


Source: J. Faiz *et al*, 1995

2) Perendev motor [41]

It is made up of a rotor and a stator, both from permanent magnets. Nevertheless, in its invention patent (the only reference document available until now) its operation is guaranteed by the geometry used (see Fig. 8).

FIG. 8. ILLUSTRATION OF A PERENDEV MOTOR



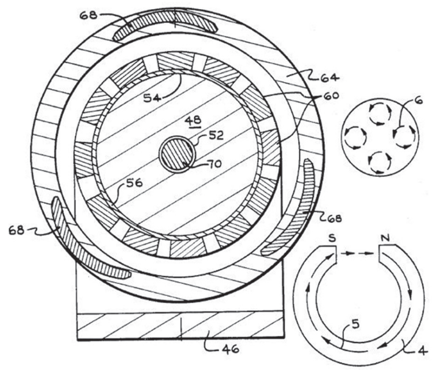
Source: Patent Cooperation Treaty No.: WIPO 2006/045333 A1 – May. 2006.

Moreover, there are no details to substantiate the functioning of this device and, by what can be observed in the patent graphs, it is not clear how to control the start up and stop of this motor.

3) Johnson motor [42]

The design of this motor considers rotor and stator from permanent magnets (see Fig. 9). Its operation is sustained in an attraction-repulsion magnetostatic interaction obtained from the geometry and the magnetic characteristics of the materials used [43].

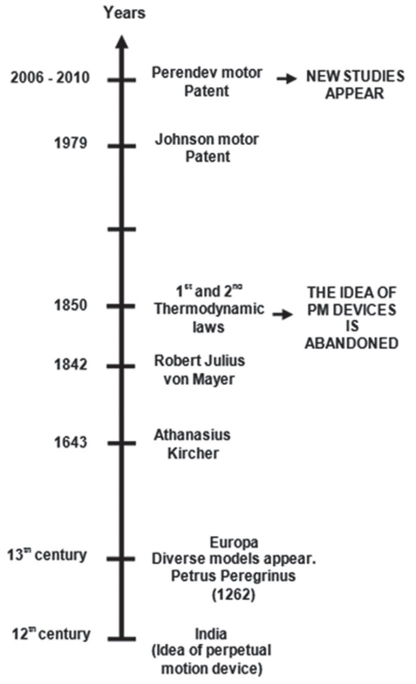
FIG. 9. JOHNSON MOTOR



Source: United States Patent No.: 4.151.431 – Apr. 1979

It is important to note that there is no reference to the practical utilization of the Johnson and Perendev motors in domestic or industrial environments, which is strange, specially as the Johnson's motor patent has been available for approximately 30 years. This leads to doubts about of the real functioning of these motors, or at least, of the possibility of implementing them in a practical manner; given that, according to the principles of Classic Electrodynamics, its continuous operation is not viable if we consider the torque generated in the magnetostatic interaction. Fig. 10 shows the chronological relationship of the concepts of perpetual motion devices and magnetic motors.

FIG. 10. PERPETUAL MOTION (PM) DEVICES AND MAGNETIC MOTORS IN HISTORY



IV. A PRESENT AND FUTURE OF PERPETUAL MOTION MACHINES AND MAGNETIC MOTORS

Currently, there is no mention of Perpetual Motion Machines as such, due to their physical impossibility. Nevertheless, this term is used to refer to phenomena that present anomalous behaviors in terms of the fulfilment of the First and Second laws of Thermodynamics at cosmological scale [44] like the spontaneous breaking of the Lorentz invariance in the proximities of black holes [45], or the possible extraction of energy from the *Dark Matter* in Space [46], [47], [48], both effects of the gravitation - magnetism interaction at a large scale.

Recent studies in the area of Relativist Electrodynamics propose the viability of magnetic motors capable of generating useful work, not as Perpetual Motion Machines but as devices that take advantage of the *Energy of the Vacuum* [49], [50] from space-time relativist considerations [51].
The possibility of this new energy source arises from the reciprocal interaction between gravitation and electromagnetism; according to Classic Electrodynamics, this interaction is impossible [52], [53]. Nevertheless, the Einstein-Cartan-Evans (ECE) theory predicts that a gravitational field is connected to an electric field and vice versa [54]. The effect produced by this relationship was observed for the first time in the *Unipolar Generator*, invented by Faraday in 1831 [55].

The most interesting technological application, stemming from the ECE theory, refers to the direct extraction of energy from space-time from a resonance effect [56]. In the first place, the equations of the ECE theory indicate that matter can convert energy from the surrounding space-time, also known as the vacuum, by means of some type of device whose configuration must be such that it can provoke a resonant excitation of the material. It is probable that many inventions in the field of alternative energy, as is the case of the Johnson motor, function in this manner, although the discovery of the resonance mechanism was a product of trial and error. For this reason, without the corresponding documentation, the experiment is not easily reproduced, since there is no clarity in the fundamental mechanism or critical parameters of the system that led to the desired result.

The Einstein-Cartan-Evans Unified Field theory suggests implications in several areas of science and technology, particularly, in predicting the possibility of new energy sources. Hence, nowadays there are initiatives [57], though without conclusive results, to prove the existence of the $B^{(3)}$ field, which is the basis for generating the connection between the spin and space-time where it is possible to harness the energy of the vacuum although there is no experimental evidence in the literature. Finally, given the relevancy of this theory, it is estimated that efforts to prove this purpose will continue into the future.

V. CONCLUSIONS

Historical trends in perpetual motion and magnetic motors show that the initiative of taking advantage of the energy stored in permanent magnets is not new. However, it is clear that until now the proposed solutions in most cases have been constructed in an empirical manner, ignoring current fundamental scientific knowledge.

At present, new Relativistic Electrodynamic elements point towards the possibility of using energy of permanent magnets to perform useful work without opposing the law of energy conservation.

Although the information available, with regard to the object of study, does not fully document the possible effects of the coupling arrangement of permanent magnets connected to the rotation axle of a rotating electrical machine, there is sufficient documentation to conduct a study as is proposed.

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Appendix: Symbols Used in this Document*

$\boldsymbol{B}$	Flux density or induction (T)
$\boldsymbol{D}$	Electric displacement ($C\times m^{-2}$)
$\boldsymbol{E}$	Electric field ($V\times m^{-1}$)
$\boldsymbol{J}$	Charge flow ($A\times m^{-2}$)
$\boldsymbol{H}$	Magnetic field ($A\times m^{-1}$)
$\boldsymbol{r}$	Position vector (m)
$\boldsymbol{t}$	Time (s)
∇	Nabla differential operator
ρ	Volume density of charge ($C\times m^{-3}$)

* Every symbol presented in bold lettering corresponds to a vectoral magnitude.

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