Introduction to a New Approach for Producing Power using Neodymium Magnet

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Abstract: ***These Automobiles are well accepted and widely used for the means of transportation. The major applications are in the vehicle, railroad, marine, aircraft, home use and stationary areas. For many years, internal combustion engine research was aimed at improving thermal efficiency and reducing noise and vibration. As a consequence, the thermal efficiency has increased from about 10% to values as high as 50%. Since 1970, with recognition of the importance of air quality, there has also been a great deal of work devoted to reducing emissions from engines. Currently, emission control requirements are one of the major factors in the design and operation of internal combustion engines. The objective of the present work is to use magnets attraction and repulsion energy in comparison to the fossil fuels. Electromagnets do possess huge amount of power but subjected to electrical power source which restricts its mobility. Therefore, in order to attain mobility which adds colour to any power delivering source can be used in many places say in automobiles, in villages where electricity is still not available can be used for irrigation purposes, etc. Therefore, magnets will be non-polluting and time to time refilling of the fuel from now onwards will not be necessary. In this present work, neodymium magnet is used as the major power source in order to improve the efficiency.***

Keywords: Neodymium magnets, engine design, non conventional type, mobility**.**

1. Introduction

An internal combustion engine is defined as an engine in which the chemical energy of the fuel is released inside the engine and used directly for mechanical work, as opposed to an external combustion engine in which a separate combustor is used to burn the fuel.

The internal combustion engine was conceived and developed in the late 1800s. Internal combustion engines can deliver power in the range from 0.01 kW to 20x103 kW, depending on their displacement.

The adoption and continued use of the internal combustion engine in different application areas has resulted from its relatively low cost, favorable power to weight ratio, high efficiency, and relatively simple and robust operating characteristics.

The compact, well-toned, powerful and surprisingly quiet engine that seems to be purr under your vehicle's hood just wasn't the tame beast it seems to be now. It was loud, it used to roar and it used to be rather bulky. In fact, one of the very first engines that had been conceived wasn't even like the engine we know so well of today.

The vast majority of internal combustion engines are produced for vehicular applications, requiring a power output on the order of 102 kW. In 1900, steam engine was used to power ships and railroad locomotives; today two- and four-stoke diesel engines are used. Prior to 1950, aircraft relied almost exclusively on the pistons engines. Today gas turbines are the power plant used in large planes, and piston engines continue to dominate the market in small planes.

The components of a reciprocating internal combustion engine, block, piston, valves, crankshaft and connecting rod have remained basically unchanged since the late 1800s. The main differences between a modern day engine and one built 100 years ago are the thermal efficiency and the emission level. For many years, internal combustion engine research was aimed at improving thermal efficiency and reducing noise and vibration. As a consequence, the thermal efficiency has increased from about 10% to values as high as 50%. Since 1970, with recognition of the importance of air quality, there has also been a great deal of work devoted to reducing emissions from engines. Currently, emission control requirements are one of the major factors in the design and operation of internal combustion engines.

1.1. Types of engines

There are two major cycles used in internal combustion engines: Otto and Diesel. The Otto cycle is named after Nikolaus Otto (1832 – 1891) who developed a four-stroke engine in 1876. It is also called a spark ignition (**SI**) engine, since a spark is needed to ignite the fuel-air mixture. The Diesel cycle engine is also called a compression ignition (**CI**) engine, since the fuel will auto-ignite when injected into the combustion chamber. The Otto and Diesel cycles operate on either a four- or two-stroke cycle.

Since the invention of the internal combustion engine many pistons-cylinder geometries have been designed. The choice of given arrangement depends on a number of factors and constraints, such as engine balancing and available volume:

1. In line
2. Horizontally opposed
3. Radial
4. V

1.1.1. In Line

The inline-four engine or straight-four engine is an internal combustion engine with all four cylinders mounted in a straight line, or plane along the crankcase. The single bank of cylinders may be oriented in either a vertical or an inclined plane with all the pistons driving a common crankshaft. Where it is inclined, it is sometimes called a slant-four. In a specification chart or when an abbreviation is used, an inline-four engine is listed either as I4 or L4.

The inline-four layout is in perfect primary balance and confers a degree of mechanical simplicity which makes it popular for economy cars. However, despite its simplicity, it suffers from a secondary imbalance which causes minor vibrations in smaller engines. These vibrations become worse as engine size and power increase, so the more powerful engines used in larger cars generally are more complex designs with more than four cylinders.

Today almost all manufacturers of four cylinder engines for automobiles produce the inline-four layout, with Subaru's flat-four being a notable exception, and so four cylinder is synonymous with and a more widely used term than inline-four. The inline-four is the most common engine configuration in modern cars, while the V6 is the second most popular. In the late 2000s, with auto manufacturers making efforts to increase fuel efficiency and reduce emissions, due to the high price of oil and the economic recession, the proportion of new vehicles with four cylinder engines (largely of the inline-four type) has risen from 30 percent to 47 percent between 2005 and 2008, particularly in mid-size vehicles where a decreasing number of buyers have chosen the V6 performance option.

Usually found in four- and six-cylinder configurations, the straight engine, or inline engine is an internal combustion engine with all cylinders aligned in one row, with no offset.

A straight engine is considerably easier to build than an otherwise equivalent horizontally opposed or V-engine, because both the cylinder bank and crankshaft can be milled from a single metal casting, and it requires fewer cylinder heads and camshafts. In-line engines are also smaller in overall physical dimensions than designs such as the radial, and can be mounted in any direction. Straight configurations are simpler than their V-shaped counterparts. They have a support bearing between each piston as compared to "flat and V" engines which have support bearings between every two pistons. Although six-cylinder engines are inherently balanced, the four-cylinder models are inherently off balance and rough, unlike 90 degree V fours and horizontally opposed 'boxer' 4 cylinders.

An even-firing inline-four engine is in primary balance because the pistons are moving in pairs, and one pair of pistons is always moving up at the same time as the other pair is moving down. However, piston acceleration and deceleration are greater in the top half of the crankshaft rotation than in the bottom half, because the connecting rods are not infinitely long, resulting in a non-sinusoidal motion. As a result, two pistons are always accelerating faster in one direction, while the other two are accelerating more slowly in the other direction, which leads to a secondary dynamic imbalance that causes an up-and-down vibration at twice crankshaft speed. This imbalance is tolerable in a small, low-displacement, low-power configuration, but the vibrations get worse with increasing size and power.

The reason for the piston's higher speed during the 180° rotation from mid-stroke through top-dead-centre, and back to mid-stroke, is that the minor contribution to the piston's up/down movement from the connecting rod's change of angle here has the same direction as the major contribution to the piston's up/down movement from the up/down movement of the crank pin. By contrast, during the 180° rotation from mid-stroke through bottom-dead-centre and back to mid-stroke, the minor contribution to the piston's up/down movement from the connecting rod's change of angle has the opposite direction of the major contribution to the piston's up/down movement from the up/down movement of the crank pin.

Four cylinder engines also have a smoothness problem in that the power strokes of the pistons do not overlap. With four cylinders and four strokes to complete in the four-stroke cycle, each piston must complete its power stroke and come to a complete stop before the next piston can start a new power stroke, resulting in a pause between each power stroke and a pulsating delivery of power. In engines with more cylinders, the power strokes overlap, which gives them a smoother delivery of power and less vibration than a four can achieve. As a result, six- and eight- cylinder engines are generally used in more luxurious and expensive cars.

When a straight engine is mounted at an angle from the vertical it is called a slant engine. Chrysler's Slant 6 was used in many models in the 1960s and 1970s. Honda also often mounts its straight-4 and straight-5 engines at a slant, as on the Honda S2000 and Acura Vigor. SAAB first used an inline-4 tilted at 45 degrees for the Saab 99, but later versions of the engine were less tilted.

Two main factors have led to the recent decline of the straight-6 in automotive applications. First, Lanchester balance shafts, an old idea reintroduced by Mitsubishi in the 1980s to overcome the natural imbalance of the straight-4 engine and rapidly adopted by many other manufacturers, have made both straight-4 and V6-engine smoother-running; the greater smoothness of the straight-6 layout is no longer such an advantage. Second, fuel consumption became more important, as cars became smaller and more space-efficient. The engine bay of a modern small or medium car, typically designed for a straight-4, often does not have room for a straight-6, but can fit a V6 with only minor modifications.

Straight-6 engines are used in some models from BMW, Ford Australia, Chevrolet, GMC, Toyota, Suzuki and Volvo Cars.

Fig: 1 In *Line Engine*

1.1.2. Horizontally opposed

A horizontally opposed engine is an engine in which the two cylinder heads are on opposite side of the crankshaft, resulting in a flat profile. Subaru and Porsche are two automakers that use horizontally opposed engine in their vehicles.

Horizontally opposed engines offer a low centre of gravity and thereby may a drive configuration with better stability and control. They are also wider than other engine configurations, presenting complications with the fitment of the engine within the engine bay of a front-engine car. This kind of engine is wide spread in the aircraft production.

Typically, the layout has cylinders arranged in two banks on the either side of the single crankshaft and is generally known as boxer. Boxers got their name because each pair of piston moves simultaneously in and out, rather than alternately, like boxers showing they are ready by clashing their gloved fists against each other before a fight. Boxer engines of up to eight cylinders have proved highly successful in automobiles and up to six in motorcycles and continue to be popular for the light aircrafts engine.

Boxers are one of only three cylinder layouts that have a natural dynamic balance; the others being the straight-6 and the V12. These engines can run very smoothly and free of unbalanced forces with a four-stroke cycle and do not require a balance shaft or counterweights on the crankshaft to balance the weight of the reciprocating parts, which are required in other engine configurations. However, in the case of boxer engines with fewer than six cylinders, unbalanced moments (a reciprocating torque also known as a "rocking couple") are unavoidable due to the "opposite" cylinders being slightly out of line with each other.

Boxer engines (and flat engines in general) tend to be noisier than other common engines for both intrinsic and other reasons, valve clatter from under the hood is not damped by large air filters and other components. Boxers need no balance weights on the crankshaft, which should be lighter and fast-accelerating - but, in practice (e.g. in cars), they need a flywheel to run smoothly at low speeds and this negates the advantage. They have a characteristic smoothness throughout the rev range and offer a low centre of gravity.

1.1.3. Radial Engine

The radial engine is a reciprocating type internal combustion engine configuration in which the cylinders point outward from a central crankshaft like the spokes on a wheel. This configuration was very commonly used in large aircraft engines before most large aircraft started using turbine engines.

In a radial engine, the pistons are connected to the crankshaft with a master-and-articulating-rod assembly. One piston has a master rod with a direct attachment to the crankshaft. The remaining pistons pin their connecting rods` attachment to rings around the edge of the master rod. Four-stroke radials always have an odd number cylinders per row, so that a consistent every-other-piston firing order can be maintained, providing smooth operation. This achieved by the engine talking two revolution of the crankshaft to complete the four stokes (intake, compression, power, exhaust), which means the firing order is 1,3,5,2,4 and back to cylinder 1 again. This means that there is always a two-piston gap between the piston on its power stroke and the next piston on fire (piston compression). If an even number of cylinders was uses, the firing order would be something similar to 1,3,5,2,4,6 which leaves a three-piston gap between firing piston on the first crank shaft revolution and only one-piston gap on the second. This leads to an uneven firing order within the engine, and is not ideal.

Originally radial engines had one row of cylinders, but as engine sizes increased it become necessary to add extra rows. The first known radial-configuration engine using a twin-row was "Double Lambda" from 1912, designed as a 14 cylinder twin-row version.

While most radial engines have been produced for gasoline fuels, there have been instances of diesel fueled engines. The Bristol Phoenix of 1928-1932 was successfully tested in aircraft and the Nordberg Manufacturing Company of the US developed and produces series of large diesel engines from the 1940s.

1.1.4. V engine

V engine or Vee engine is a common configuration for an internal combustion engine. The cylinders and pistons are aligned in two separate planes or "banks", is that they appear to be in a "V" when viewed along the axis of the crankshaft. The Vee configuration generally reduces the overall engine length, height and weight compared to the equivalent inline configuration.

Various cylinder bank angles of Vee are used in different engines depending on the number of the cylinders; there may be angles that work better than others for stability. Very narrow angles of V combine some of the advantages of the straight and V engine.

The most common of V engines is V6. It is an engine with six cylinders mounted on the crankcase in two banks of three cylinders, usually set at either a right angle or an accurate angle to each other, with all six pistons driving a common crankshaft. It is second common engine configuration in modern cars after the inline-four.

It is becoming more common as the space allowed in modern cars is reduced at the time as power requirements increase, and has largely replaced the inline-6, which is too long to fit in the many modern engine compartments. Although it is more complicated than and not as smooth as the inline-6, the V6 is more rigid for a given weight, more compact and less prone to torsional vibrations in the crankshaft for a given displacement. The V6 engine has become widely adopted for medium-sized cars, often as an optional engine where a straight 4 is standard, or as a base engine where a V8 is a higher-cost performance.

The most efficient cylinder bank angle for V6 is 60 degrees, minimizing size and vibration. While 60 degrees V6 are not as well balanced as inline-6 and flat-6 engines, modern techniques for designing and mounting engines have largely disguised their vibrations. Unlike most others angles, 60 degree V6 engines can be made acceptably smooth without the need for balance shafts.

90° V6 engines are also produced, usually so they can use the same production-line tooling set up to produce V8 engines (which normally have a 90° V angle). Although it is easy to derive a 90° V6 from an existing V8 design by simply cutting cylinders off the engine, this tends to make it wider and more vibration-prone than a 60° V6.

120° might be described as the natural angle for a V6 since the cylinders fire every 120° of crankshaft rotation. Unlike the 60° or 90° configuration, it allows pairs of pistons to share crank pins in a three-throw crankshaft without requiring flying arms or split crankpins to be even-firing. The 120° layout also produces an engine which is too wide for most automobile engine compartments, so it is more often used in racing cars where the car is designed around the engine rather than vice-versa, and vibration is not as important.

1.2. Introduction of Magnets

A permanent magnet is an object made from a material that is magnetized and creates its own persistent magnetic field. Materials that can be magnetized, which are also the ones that are strongly attracted to a magnet, are called ferromagnetic (or ferromagnetic). These include iron, nickel, cobalt, some alloys of rare earth metals, and some naturally occurring minerals such as lodestone. Although ferromagnetic (and ferrimagnetic) materials are the only ones attracted to a magnet strongly enough to be commonly considered magnetic, all other substances respond weakly to a magnetic field, by one of several other types of magnetism. Ferromagnetic materials can be divided into magnetically "soft" materials like annealed iron, which can be magnetized but do not tend to stay magnetized, and magnetically "hard" materials, which do. Permanent magnets are made from "hard" ferromagnetic materials such as alnico and ferrite that are subjected to special processing in a powerful magnetic field during manufacture, to align their internal microcrystalline structure, making them very hard to demagnetize. To demagnetize a saturated magnet, a certain magnetic field must be applied, and this threshold depends on coercivity of the respective material. "Hard" materials have high coercivity, whereas "soft" materials have low coercivity.

An electromagnet is made from a coil of wire that acts as a magnet when an electric current passes through it but stops being a magnet when the current stops. Often, the coil is wrapped around a core of "soft" ferromagnetic material such as steel, which greatly enhances the magnetic field produced by the coil.

The overall strength of a magnet is measured by its magnetic moment or, alternatively, the total magnetic flux it produces.

1.2.1. Physical properties

Neodymium is a soft, malleable metal. Malleable means capable of being hammered into thin sheets. It can be cut and shaped fairly easily. It has a melting point of 1,024°C (1,875°F) and a boiling point of about 3,030°C (5,490°F). Neodymium has a density of 7.0 grams per cubic centimeter.

1.2.2. Chemical properties

Neodymium is somewhat reactive. For example, it combines with oxygen in the air to form a yellowish coating. To protect it from tarnishing, the metal is usually stored in mineral oil and wrapped in plastic.
Neodymium shows typical properties of an active metal. For example, it reacts with water and acids to release hydrogen gas.

1.2.3. Occurrence in nature

Neodymium is one of the most abundant of the rare earth elements. Its abundance in the Earth's crust is thought to be about 12 to 24 parts per million. That places it about 27th among the chemical elements. It is slightly less abundant than copper and zinc.

The most common ores of neodymium are monazite and bastnasite. These ores are the most common source for all the rare earth elements.

1.2.4. Isotopes

Seven naturally occurring isotopes of neodymium are known. These isotopes are neodymium-142, neodymium-143, neodymium-144, neodymium-145, neodymium-146, neodymium-148, and neodymium-150. Six of these isotopes are stable and one, neodymium-144, is radioactive. Isotopes are two or more forms of an element. Isotopes differ from each other according to their mass number. The number written to the right of the element's name is the mass number. The mass number represents the number of protons plus neutrons in the nucleus of an atom of the element. The number of protons determines the element, but the number of neutrons in the atom of any one element can vary. Each variation is an isotope.

1.2.5. Extraction

Neodymium occurs with other rare earth elements in monazite, bastnasite, and allanite. It must first be separated from these other elements. It is then obtained in a pure form by reacting neodymium fluoride ($NdF_{3)}$ with calcium:

1.2.6. Production

There are two principal neodymium magnet manufacturing methods:

- Classical powder metallurgy or sintered magnet process
- Rapid solidification or bonded magnet process

Sintered Nd-magnets are prepared by the raw materials being melted in a furnace, cast into a mold and cooled to form ingots. The ingots are pulverized and milled; the powder is then sintered into dense blocks. The blocks are then heat-treated, cut to shape, surface treated and magnetized.

As of 2012, 50,000 tons of neodymium magnets are produced officially each year in China, and 80,000 tons in a "company-by-company" build-up done in 2013.China produces more than 95% of rare earth elements, and produces about 76% of the world's total rare-earth magnets.

Bonded Nd-magnets are prepared by melt spinning a thin ribbon of the NdFeB alloy. The ribbon contains randomly oriented $Nd_2Fe_{14}B$ nano-scale grains. This ribbon is then pulverized into particles, mixed with a polymer, and either compression- or injection-molded into bonded magnets. Bonded magnets offer less flux intensity than sintered magnets, but can be net-shape formed into intricately shaped parts, as is typical with Halbach arrays or arcs, trapezoids and other shapes and assemblies (e.g. Pot Magnets, Separator Grids, etc.).There are approximately 5,500 tons of Neo bonded magnets produced each year. In addition, it is possible to hot-press the melt spun nano crystalline particles into fully dense isotropic magnets, and then upset-forge or back-extrude these into high-energy anisotropic magnets.

1.2.7. Grades

Neodymium magnets are graded according to their maximum energy product, which relates to the magnetic flux output per unit volume. Higher values indicate stronger magnets and range from N35 up to N52. Letters following the grade indicate maximum operating temperatures (often the Curie

temperature), which range from M (up to 100 degrees Celsius) to EH (200 degrees Celsius).
Grades of Neodymium magnets:

- N35-N52
- 33M-48M
- 30H-45H
- 30SH-42SH
- 30UH-35UH
- 28EH-35EH

1.2.8. Magnetic properties

Some important properties used to compare permanent magnets are:

remanence (B_r), which measures the strength of the magnetic field
coercivity (H_{ci}), the material's resistance to becoming demagnetized
energy product (BH_{max}), the density of magnetic energy
Curie temperature (T_C), the temperature at which the material loses its magnetism

Neodymium magnets have higher remanence, much higher coercivity and energy product, but often lower Curie temperature than other types. Neodymium is alloyed with terbium and dysprosium in order to preserve its magnetic properties at high temperatures. The table below compares the magnetic performance of neodymium magnets with other types of permanent magnets.

Magnet	B_r (T)	H_{ci}(kA/m)	BH_{max} (kJ/m³)	T_C (°C)	T_C (°F)
$Nd_2Fe_{14}B$ (sintered)	1.0–1.4	750–2000	200–440	310–400	590–752
$Nd_2Fe_{14}B$ (bonded)	0.6–0.7	600–1200	60–100	310–400	590–752
$SmCo_5$ (sintered)	0.8–1.1	600–2000	120–200	720	1328
$Sm(Co, Fe, Cu, Zr)_7$ (sintered)	0.9–1.15	450–1300	150–240	800	1472
Alnico (sintered)	0.6–1.4	275	10–88	700–860	1292–1580
Sr-ferrite (sintered)	0.2–0.4	100–300	10–40	450	842

1.2.8.Physical and mechanical properties

Comparison of physical properties of sintered neodymium and Sm-Co magnets

Property	Neodymium	Sm-Co
Remanence (T)	1–1.3	0.82–1.16
Coercivity (MA/m)	0.875–1.99	0.493–1.59
Relative permeability	1.05	1.05
Temperature coefficient of remanence (%/K)	−0.12	−0.03
Temperature coefficient of coercivity (%/K)	−0.55..–0.65	−0.15..–0.30
Curietemperature (°C)	320	800
Density (g/cm³)	7.3–7.5	8.2–8.4
CTE, magnetizing direction (1/K)	5.2×10^{-6}	5.2×10^{-6}
CTE, normal to magnetizing direction (1/K)	-0.8×10^{-6}	11×10^{-6}
Flexuralstrength (N/mm²)	250	150
Compressive strength (N/mm²)	1100	800
Tensile strength (N/mm²)	75	35
Vickers hardness(HV)	550–650	500–650
Electrical resistivity (Ω·cm)	$(110–170)\times10^{-6}$	86×10^{-6}

2. LITERATURE REVIEW

2.1. History and Development of engine

A brief outline of the history of the internal combustion engine includes the following highlights:

- **1680** - Dutch physicist, Christian Huygens designed (but never built) an internal combustion engine that was to be fueled with gunpowder.
- **1807** - Francois Isaac de Rivaz of Switzerland invented an internal combustion engine that used a mixture of hydrogen and oxygen for fuel. Rivaz designed a car for his engine - the first internal combustion powered automobile. However, his was a very unsuccessful design.
- **1824** - English engineer, Samuel Brown adapted an old Newcomen steam engine to burn gas, and he used it to briefly power a vehicle up Shooter's Hill in London.
- **1858** - Belgian-born engineer, Jean Joseph Étienne Lenoir invented and patented (1860) a double-acting, electric spark-ignition internal combustion engine fueled by coal gas. In 1863, Lenoir attached an improved engine (using petroleum and a primitive carburetor) to a three-wheeled wagon that managed to complete an historic fifty-mile road trip
- **1862** - Alphonse Beau de Rochas, a French civil engineer, patented but did not build a four-stroke engine (French patent #52,593, January 16, 1862).
- **1864** - Austrian engineer, Siegfried Marcus, built a one-cylinder engine with a crude carburetor, and attached his engine to a cart for a rocky 500-foot drive. Several years later, Marcus designed a vehicle that briefly ran at 10 mph that a few historians have considered as the forerunner of the modern automobile by being the world's first gasoline-powered vehicle
- **1873** - George Brayton, an American engineer, developed an unsuccessful two-stroke kerosene engine (it used two external pumping cylinders). However, it was considered the first safe and practical oil engine.
- **1866** - German engineers, EugenLangen and Nikolaus August Otto improved on Lenoir's and de Rochas' designs and invented a more efficient gas engine.

- **1876** - Nikolaus August Otto invented and later patented a successful four-stroke engine, known as the "Otto cycle".

- **1876** - The first successful two-stroke engine was invented by Sir Dougald Clerk.

- **1883 -** French engineer, EdouardDelamare-Deboutteville, built a single-cylinder four-stroke engine that ran on stove gas. It is not certain if he did indeed build a car, however, Delamare-Deboutteville's designs were very advanced for the time - ahead of both Daimler and Benz in some ways at least on paper.

- **1885** - Gottlieb Daimler invented what is often recognized as the prototype of the modern gas engine - with a vertical cylinder, and with gasoline injected through a carburetor (patented in 1887). Daimler first built a two-wheeled vehicle the "Reitwagen" (Riding Carriage) with this engine and a year later built the world's first four-wheeled motor vehicle.

- **1886** - On January 29, Karl Benz received the first patent (DRP No. 37435) for a gas-fueled car.

- **1889** - Daimler built an improved four-stroke engine with mushroom-shaped valves and two V-slant cylinders.

- **1890** - Wilhelm Maybach built the first four-cylinder, four-stroke engine.

2.2. History of Neodymium Magnets

Neodymium was discovered in 1885 by Austrian chemist Carl Auer (Baron von Welsbach; 1858-1929). Auer found the new element in a mineral called didymia. Didymia, in turn, had been found in another complicated mineral known as ceria, originally found in Sweden in 1803. It took chemists nearly a century to completely analyze ceria. When they had done so, they found that it contained seven new elements. Neodymium was one of these.

Neodymium is in Row 6 of the periodic table. The periodic table is a chart that shows how chemical elements are related to each other. The elements in Row 6 are sometimes called the rare earth elements. The term "rare earth" is inaccurate, however. These elements are not especially rare but are difficult to separate from each other. The rare earth elements are also called the lanthanides. That name comes from the third element in Row 6, lanthanum.

Neodymium has long been used in coloring glass and is now used in making lasers, very powerful magnets, and special alloys.

During the late 1700s, two important mineral discoveries were made in Sweden. One was made just outside the town of Ytterby. The mineral found there, yttria, was eventually found to contain nine new elements. The second discovery was made near the town of Bastnas. That mineral, called cerite, was later found to contain seven new elements.

In 1982, General Motors (GM) and Sumitomo Special Metals discovered the $Nd_2Fe_{14}B$ compound. The research was initially driven by the high raw materials cost of SmCo permanent magnets, which had been developed earlier. GM focused on the development of melt-spun nanocrystalline $Nd_2Fe_{14}B$ magnets, while Sumitomo developed full-density sintered $Nd_2Fe_{14}B$ magnets.

GM commercialized its inventions of isotropic Neo powder, bonded Neo magnets, and the related production processes by founding Magnequench in 1986 (Magnequench has since become part of Neo Materials Technology, Inc., which later merged into Molycorp). The company supplied melt-spun $Nd_2Fe_{14}B$ powder to bonded magnet manufacturers.

The Sumitomo facility became part of the Hitachi Corporation, and currently manufactures and licenses other companies to produce sintered $Nd_2Fe_{14}B$ magnets. Hitachi holds more than 600 patents covering neodymium magnets.

Chinese manufacturers have become a dominant force in neodymium magnet production, based on their control of much of the world's sources of rare earth ores.

The United States Department of Energy has identified a need to find substitutes for rare earth metals in permanent magnet technology, and has begun funding such research. The Advanced Research Projects Agency-Energy has sponsored a Rare Earth Alternatives in Critical Technologies (REACT) program, to develop alternative materials. In 2011, ARPA-E awarded 31.6 million dollars to fund Rare-Earth Substitute projects

Cerite was thoroughly studied by Swedish chemist Carl Gustav Mosander (1797-1858). In 1839, Mosander was able to separate cerite into two parts, which he called **cerium** and lanthanum. Mosander believed he had found two new elements. Two years later, however, he learned that lanthanum was not an element but a mixture of two parts. Mosander called these two new parts lanthanum and didymium. Mosander chose the name didymium because it means "twin." He said that didymium was like an identical twin to lanthanum. Chemists later confirmed that two of Mosander's discoveries were really new elements: cerium and lanthanum.

Mosander's didymium was not an element, however. In 1885, Auer found that didymium consisted of two simpler materials. The new elements were named neodymium and praseodymium.Auer chose the name neodymium because it means "new twin." Praseodymium, by comparison, means "green twin." Compounds of praseodymium are green.

So, after accomplishment of this engine it will no longer be required to refill the tank within a very short duration of time rather after long time using just like servicing it will be required to change the magnets. Thus it will be much more comfortable and convenient to use.

3. PROBLEM IDENTIFICATION

We have been relying on fossil fuels for the last 3 centuries. With the increase of population and more and more number of vehicles being introduced worldwide it has been a major contributor to pollution and also extinction of fossil fuels is also a major concern.

In order to get rid of this many new technologies have been brought about such as fuel cell electric vehicle, solar cell car, etc. Following the same legacy of getting nonpolluting, technologically improved engine which doesn't use the petroleum products.

My work focuses on using magnets attraction and repulsion energy. Electromagnets do possess huge amount of power but subjected to electrical power source which restricts its mobility. Therefore, in order to attain mobility which adds colour to any power delivering source can be used in many places say in automobiles, in villages where electricity is still not available can be used for irrigation purposes, etc.

By using neodymium magnet as the major power source I don't intend to achieve a perpetual motion machine, as when the magnets will be subjected to attraction and repulsion continuously they will lose their magnetic property slowly and therefore after sometime the power delivered by the engine will start reducing and after some time it will be required to change the magnets in order to regain its actual power. So, after accomplishment of this engine it will no longer be required to refill the tank within a very short duration of time rather after long time using just like servicing it will be required to change the magnets. Thus it will be much more comfortable and convenient to use.

4. COMPONENT DESIGN

4.1 Cylinder: Magnetic engine uses magnets for its operation. The cylinder must take care of unwanted magnetic field and other losses further cylinder material itself should not get attracted to the magnet and resist the movement of the piston. To take care of above issues, the cylinder must be only made up of non-magnetic materials such as stainless steel, titanium or similar materials of high resistivity and low electrical conductivity. The temperature within the magnetic engine cylinder is very low and so no fins are needed for heat transfer. This makes the cylinder easily manufacturable. Also the cylinder is made of aluminum, a non-magnetic material which limits the magnetic field within the boundaries of cylinder periphery. Usage of aluminum material makes the engine lighter unlike the cast-iron cylinder used in internal combustion engine.

4.2 Piston: The hollow piston casing is made up of non-magnetic stainless steel, titanium or similar materials of high resistivity non-metallic, thermal resistant materials as well or can be made by integrating both non-magnetic and non-metallic materials. The sides of the piston case connect to the piston rod that connects to the crankshaft. The crankshaft and the piston rod convert the linear reciprocating movement of the piston to the circular movement.

4.3 Connecting Rod: In a reciprocating engine, the connecting rod is used to connect the piston to the crankshaft. It converts the linear motion or reciprocating motion of the piston to the circular motion of the crankshaft. The connecting rod used in this engine is that of a power sprayer. For a single piston two connecting rods are used.

4.4 Flywheel: Flywheel is made up of mild steel and it is used to convert reciprocating energy into rotational energy. It regulates the engine's rotation, making it operate at a steady speed. Flywheels have a significant moment of inertia and thus resist changes its rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to the flywheel by applying torque to it. It is used to store the rotational kinetic energy.

5. WORKING PRINCIPLE: The working of the magnetic engine is based on the principle of magnetism. A magnet has two poles a north pole and a south pole. Magnetism is a class of physical phenomenon that includes forces exerted by magnets on other magnets. By principle of magnetism, when like poles of a magnet is brought together they repel each other. When unlike poles are brought near each other they attract.

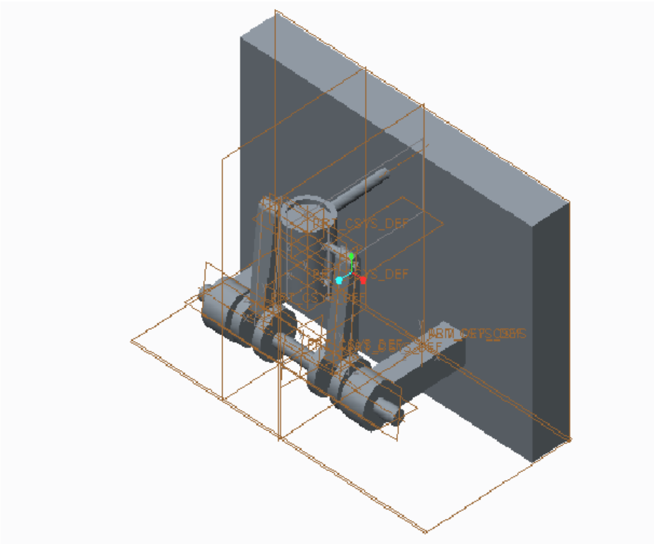

Fig-2 Creo model of proposed magnetic piston engine

5. CONCLUSION

The magnetic engine has various advantages over the internal combustion engines. The main advantage is, no fuel is being used in the engine. This results in no pollution which is very desirable in the present day situation. As there is no combustion taking place inside the cylinder there is only very little heat generation. This eliminates the need for a cooling system. As magnetic energy is being used the need for air filter, fuel tank, supply system, fuel filter, fuel injector, fuel pump, valves etc. are eliminated and the design of the engine is made simple. Also by the use of materials like aluminum, titanium etc. we can reduce the weight of the engine. Also existing transmission systems can be used in the magnetic engine. Less noise is produce during working. The disadvantage of the magnetic engine is its high initial cost. The permanent magnet can be very costly. Also the power of the permanent magnet will decrease during time and the permanent magnet has to be replaced during regular intervals. The engine is not as flexible as the internal combustion engine.

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