The Discovery of
An Extremely Inexpensive Source
Of Pollution-Free Energy

EDEN
PROJECT

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Harnessing Mechanical Energy
From Strong Electromagnetic Forces
Generated By The Spin Of Electrons

Over the past decade, extremely powerful “neodymium” (NdFeB) permanent magnets have been developed by Hitachi Metals (Tokyo). For example, a neodymium magnet measuring only 4” x 2” x ½“ and weighing 17 ounces has a pull-force of 641 pounds. The attracting and repelling electromagnetic forces of these and other permanent magnets are generated by the “intrinsic” spin of electrons in the magnets. A magnet generates mechanical energy or does work when for example it pulls toward another magnet or a piece of metal. The powerful magnetic forces of two neodymium magnets can do much more work than simply pull themselves together over a distance. They can be made to do other work such as turning an electric generator. To do this they have to repeatedly pull themselves together and be pulled apart. The amount of energy spent pulling them apart has to be significantly less than the amount derived when they come together thus leaving a useful net-yield of energy. Pulling two magnets apart along the same path they took to pull themselves together will of course require as much (or more) energy as the amount generated by the magnets when they come together. However, permanent magnets have at least one North and one South pole which gives polarity to their magnetic fields making the fields and the force in the field unevenly distributed. This makes it possible to pull magnets apart along a path that requires less energy (work) compared to the amount generated by the magnets when they pull themselves together along a different path. These paths, revealed by research, were a surprise and unintuitive. It has been discovered that cube-shaped and thin, rectangular magnets (magnetized through their thickness) generate significantly more mechanical energy when they pull themselves together “sideways” or horizontally (perpendicular to an axis between their poles) compared to the amount of mechanical energy required to pull them “straight” or vertically (parallel to an axis between their poles) apart. The remaining or net-yield of mechanical energy obtained in this manner from a volume of neodymium magnets less than the size of a car battery can generate electricity for one or more homes or generate an annual amount of mechanical energy equal to thousands of gallons of gasoline.

Harvesting energy from permanent magnets and using the energy to generate electricity does not require combustion or chemical reactions nor does it produce pollution. Powerful permanent magnets deliver clean, simple and very inexpensive mechanical energy derived from the spin of electrons and electromagnetic force. The vast amount of inexpensive, pollution-free energy available from this technology (which I aptly refer to as “The Eden Project”) can greatly improve the world not only by replacing petroleum as our primary fuel but also by affordably distilling ocean water into pure water for drinking and farming thereby greatly reducing world hunger. Our nation’s dependence on foreign oil and the incomprehensibly large amount of pollution created by the use of oil demands that we develop and implement as soon as possible this or another clean source of energy.

The premise and method behind this discovery is simple and straightforward although not intuitive. Validation is only a matter of verifying simple force measurements along prescribed pathways taken by a magnet as it moves toward a stationary magnet and as it is pulled away in a different direction. It appears that once again, an important discovery has been made in a garage. The inventor, Kenneth Kozeka earned his Ph.D. from the School of Medicine at the University of Pittsburgh in 1983 and has since spent most of his career in education serving as a college professor and administrator. Dr. Kozeka has claim to several important inventions in the fields of education, optics, electro-mechanics and medicine. Presently, he is launching his new company DermaCross which will develop, manufacture and sell transdermal patches based on a new proprietary patch technology. Kenneth is also launching a new 3-D image technology that he invented and has recently completed a manuscript titled “The Glucose Shift Theory on Weight-gain” that he hopes to have published soon. He lives with his wife in Fairview, Tennessee.

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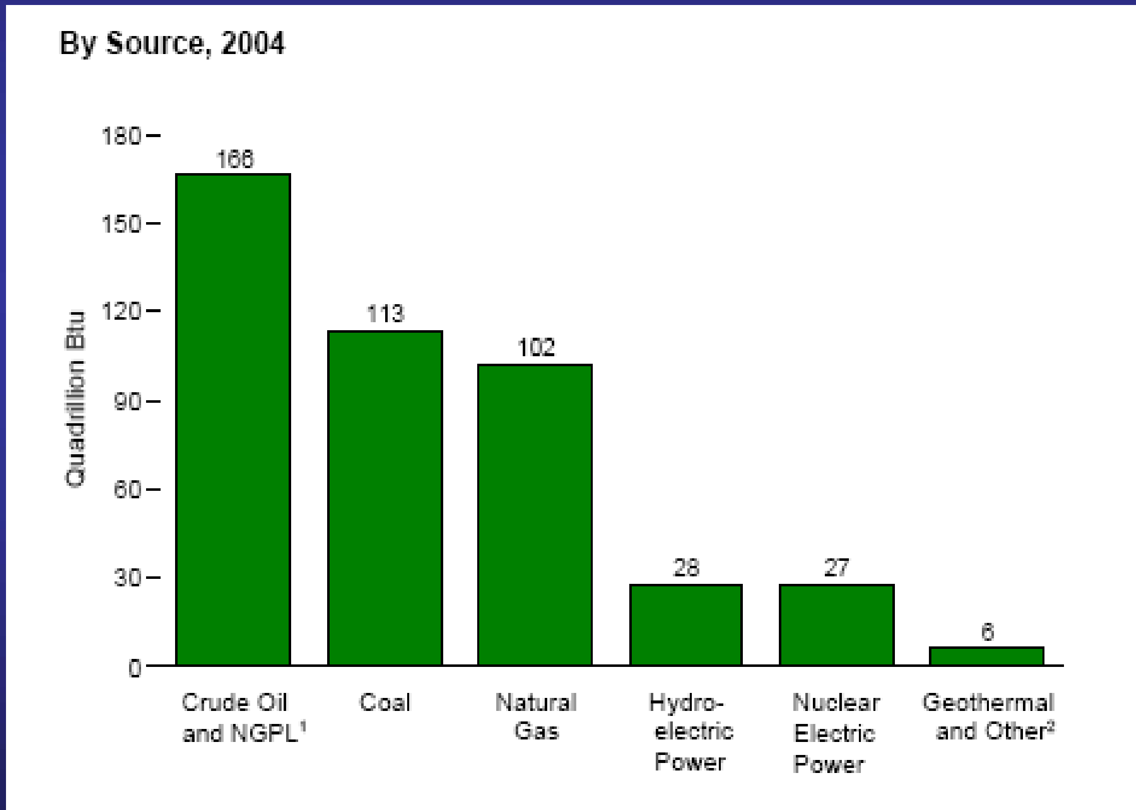
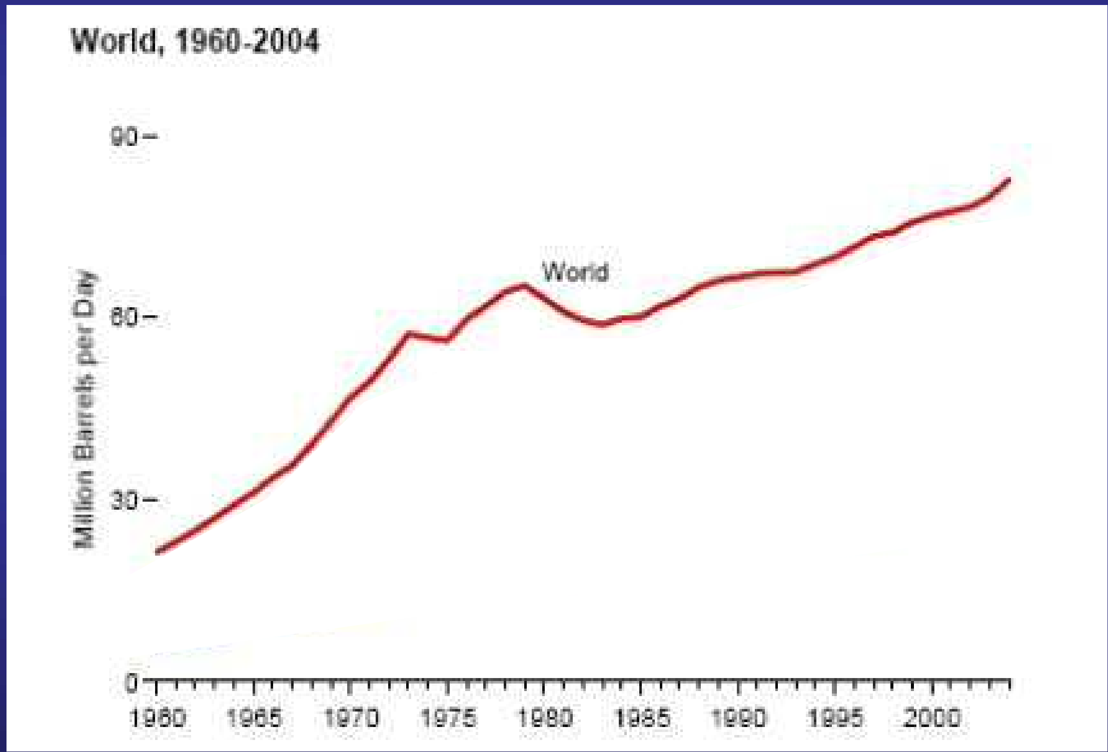
fossil fuels remain our primary source of energy

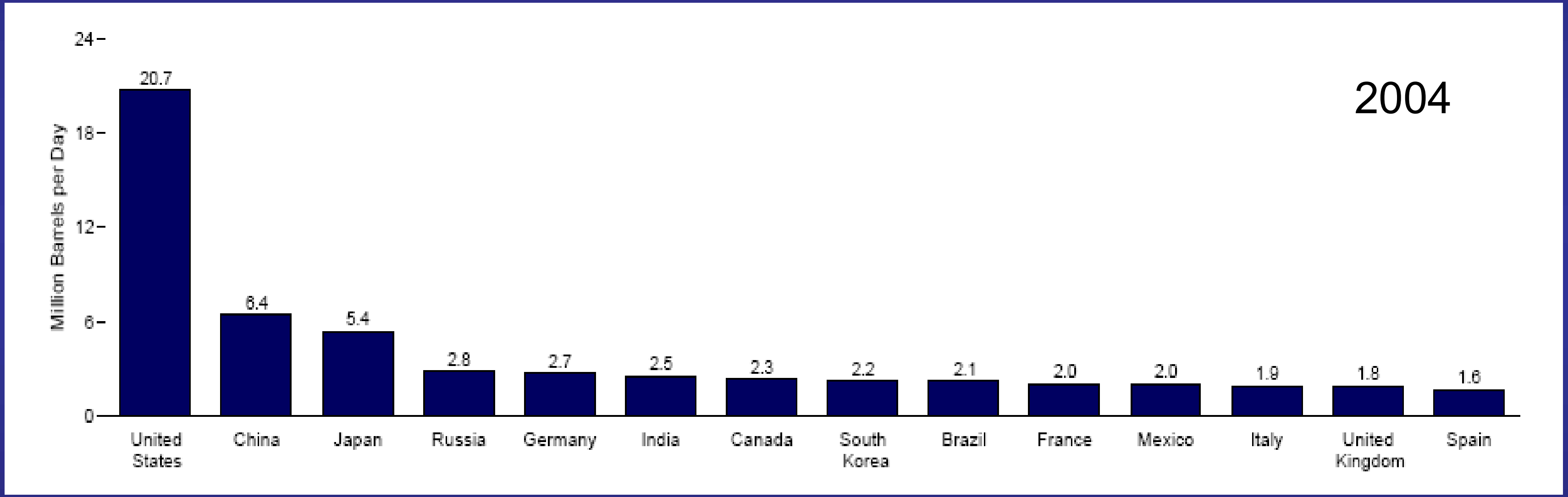
Today, we depend on an incredibly large amount of energy for a wide variety of uses.



world petroleum consumption is increasing at an alarming rate

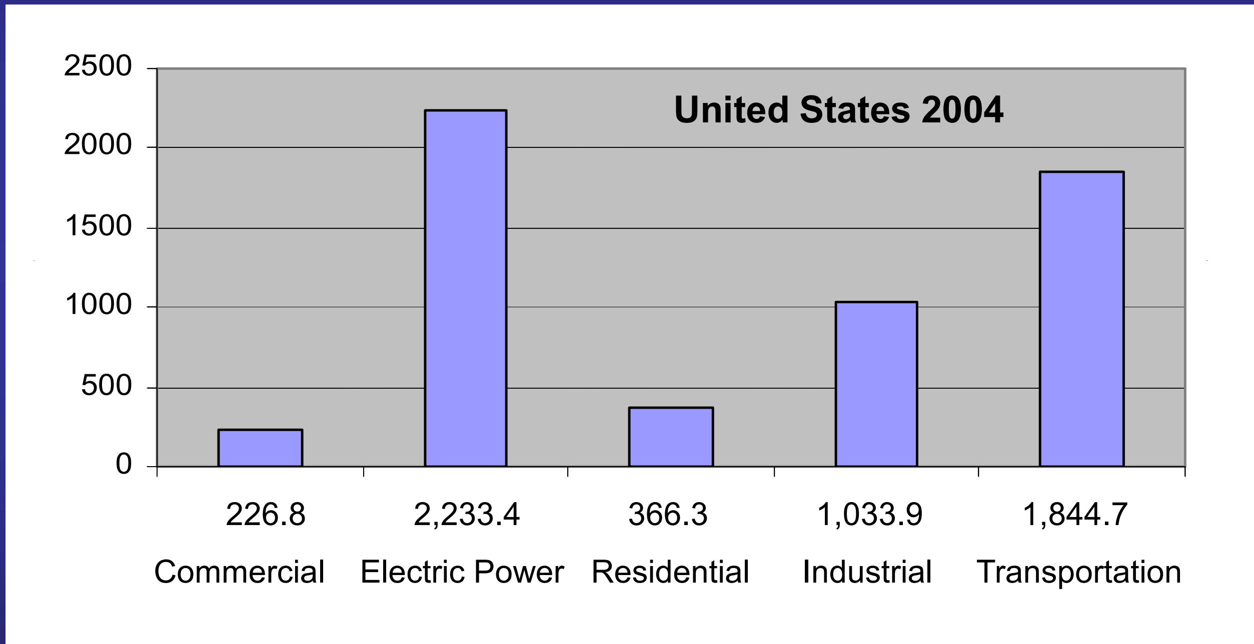


the United States uses far more petroleum than other countries



pollution generated in the United States from the use of fossil fuels

5,705 million metric tons of carbon dioxide



The use of electricity does not generate pollution; however, most electricity is produced from fossil fuels which create pollution.

BRIEF EXPLANATION OF HOW MECHANICAL ENERGY IS HARNESSED FROM ELECTROMAGNETIC FORCE

(There is <u>no claim</u> here of creating any amount of energy. As stated by the first law of thermodynamics, energy cannot be created or destroyed.)

Electromagnetic force is one of the four fundamental forces, the other three being gravity, weak nuclear and strong nuclear. Electromagnetic force is of order 10^{39} times stronger than gravity. It is the force which holds atoms together (and thereby prevents you from falling through the floor). The powerful electric motors we use today are other examples of electromagnetic force at work. Electromagnetic force (electromagnetism) arises when electrons move in an electric current whereas permanent magnets are believed to arise from the quantum-mechanical spin and orbital motion of electrons. Electron spin is believed to be the primary source of magnetic force. The “spin” of electrons is considered to be “intrinsic”. Electromagnetic interaction is mediated, or carried, by photons.

Extremely powerful permanent magnets are manufactured today which generate a tremendous amount of electromagnetic force. For example, one “neodymium” magnet (grade N42) measuring only 4” x 2” x ½” and weighing only 17 ounces generates a pull force of 640 pounds. Even more powerful neodymium magnets (grade N56 and the HILOP series) generate much larger forces per cubic-inch. The power of permanent magnets declines at a very slow rate, approximately 1% every 10 years. If you ever handled permanent magnets then you are familiar with how they attract and repel each other. The forces of powerful magnets today can do far more work than merely pull themselves together (or push themselves apart). However, to exploit this mechanical energy we must allow the magnets to repeatedly pull themselves together. This of course means that we must also repeatedly pull the magnets apart. If the magnets can be pulled apart in such a manner that the amount of work spent pulling them apart is less than the amount of work obtained when they came together, then the energy (work) left-over can be used for example, to turn an electric generator. The research and discovery presented here demonstrates that a useful amount of net mechanical energy can be obtained this way from powerful, permanent magnets. Again, the source of the energy is the intrinsic “spin” of the electron which generates magnetic forces that can do work (mechanical energy). Under proper conditions, the amount of work done by the magnets is more than sufficient to drive an electric generator as well as pull the magnets apart. Since the energy is harvested in the form of mechanical energy, it is clean and simple: there are no chemical reactions, no combustion, no byproducts and no pollution.

determining the amount of work performed

Work = Force X Distance

- The attractive force between two magnets increases as the magnets move closer together. Accordingly, force measurements (pounds) were taken at small (1/32”) intervals.

- To improve accuracy, the average force value between each 1/32” interval was calculated and used to compute the total work.

- Total work was then calculated by adding all average force values.

- This mathematical approach was compared to the integral method and found to be accurate.

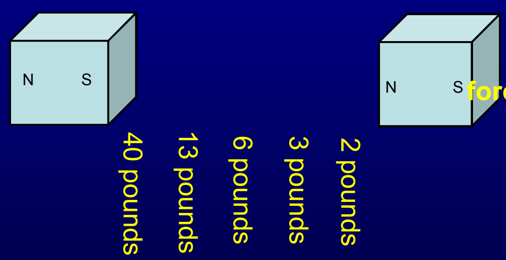
using magnetic force to do work

If you ever handled permanent magnets then you are familiar with how they attract and repel each other. As mentioned earlier, electromagnetic force is much (10^{39}) stronger than gravity. For example, a magnet defies gravity by holding itself on the refrigerator door. Likewise, two magnets placed in proximity will pull themselves together. In this case they have done ***work*** by applying a ***force*** over a ***distance***.

Powerful magnets can do far more work than merely pull themselves together. For example, consider two ¾" square, neodymium magnets each weighing 1.83 ounces. When (opposite poles of) these two (grade N38) magnets are in contact, they have a pull force of 43 pounds. Of course this pull force decreases as the distance between the magnets increases.

The total amount of work that these two magnets are capable of doing as they come together in this manner can be determined by measuring the pull force between these two magnets when the magnets are separated by various distances. The total amount of work that these two magnets are capable of doing when they pull themselves together along the horizontal path shown below is 9.5 inch-pounds. In other words, these two small magnets weighing (each) only 1.83 ounces are capable of lifting (the equivalent of) 9.5 pounds one inch.

click here to start animation



force X distance = work = 9.5 inch-pounds

repeating the work cycle

We have seen from the previous slide that even small magnets are capable of doing a considerable amount of work when they are drawn together by their magnetic forces. If this event were made to occur repeatedly, the work (mechanical energy) could be used to drive a generator producing electricity. However, that is easier said than done. To allow the magnets to repeatedly draw themselves together, they will have to be pulled apart repeatedly. As we would imagine, pulling the magnets "straight" apart along the same path taken when they came together will require as much (or more) energy (work) compared to the amount of work done when they came together. Accordingly, no energy will be left-over to use for driving a generator. To produce a *net* yield of mechanical energy (work) that we can use, the amount of energy spent separating the magnets must be less than the amount of energy obtained when they came together. The invention described here explains exactly how this can be done.

If you have handled permanent magnets, you might think that this can be achieved simply by pulling the magnets apart "sideways". It is "easier" to pull magnets apart in this manner and the instructions that come with magnets often suggest this approach. However, as illustrated below, careful measurements reveal that the amount of *work* required to pull the magnets apart "sideways" is actually larger than the amount of work required to pull them "straight" apart.

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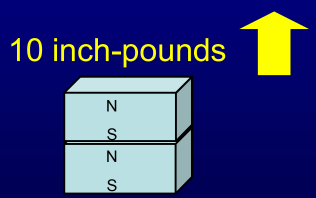
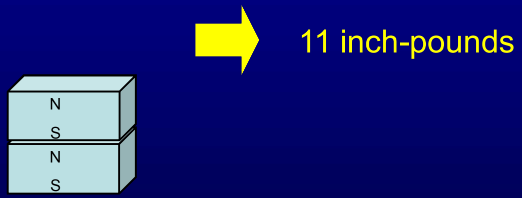




an example of how to obtain a net yield

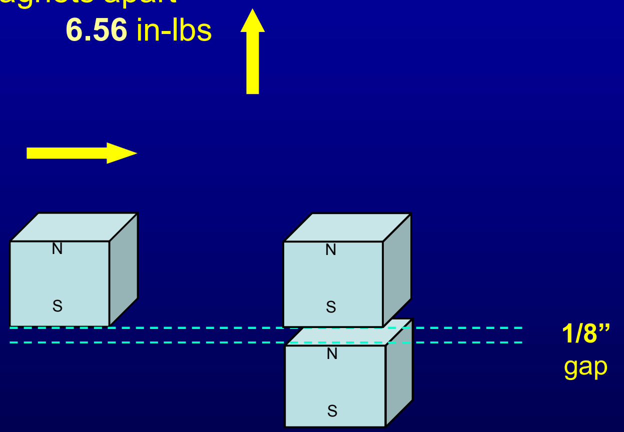
The method illustrated in the below animation produces a substantial net yield of mechanical energy or work. Less energy (work) is required to pull the magnets “straight” apart along the prescribed (vertical) path compared to the amount of energy (work) available when the magnets come together sideways (horizontally). This leaves a net amount of energy available for turning a generator or doing other work .

Other combinations of paths, magnet shapes and positions exist that also produce useful yields. Tedious testing and unconventional thinking is necessary to discover the design and paths that will produce the greatest yield. The yield of .90 inch-pounds shown in this animation may seem small; however, it is actually a very large and practical yield considering that the magnets weight only 1.83 ounces and measure only ¾” x ¾” x ¾”. Furthermore, the magnets used in this particular study were a low grade N38 which is much weaker than the most powerful grade of N56. To learn more about yield go to the section titled “yield assessment”.

click here to start animation

work spent pulling magnets apart = **6.56** in-lbs

work output = **7.46** in-lbs



7.46 inch-pounds produced

- **6.56** inch-pounds spent

.90 inch-pounds left-over

the first law of thermodynamics

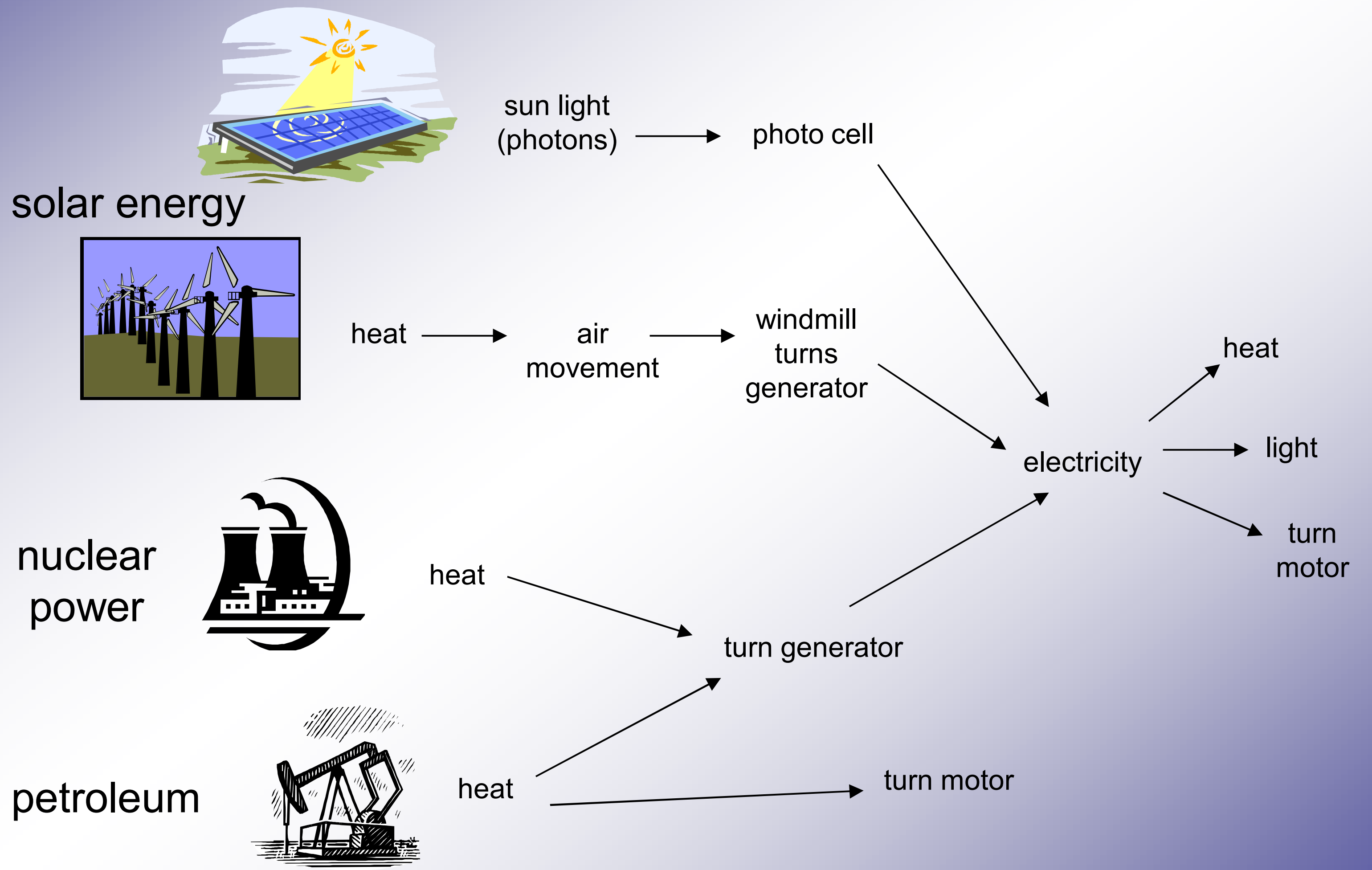
There is no claim here of creating any amount of energy. As stated by the *first law of thermodynamics,* energy cannot be created or destroyed.

Electromagnetic forces believed to be generated by the spin of electrons is transferred into mechanical energy (work) which can be used to turn a generator producing electricity.

"The amount of energy lost in a steady state process cannot be greater than the amount of energy gained. This is the statement of conservation of energy for a thermodynamic system. It refers to the two ways that a closed system transfers energy to and from its surroundings - by the process of heating (or cooling) and the process of mechanical work. The rate of gain or loss in the stored energy of a system is determined by the rates of these two processes. In open systems, the flow of matter is another energy transfer mechanism, and extra terms must be included in the expression of the first law. The First Law clarifies the nature of energy. It is a stored quantity which is independent of any particular process path, i.e., it is independent of the system history. If a system undergoes a thermodynamic cycle, whether it becomes warmer, cooler, larger, or smaller, then it will have the same amount of energy each time it returns to a particular state."

<u>Energy is not created by windmills, solar cells, nuclear reactors or petroleum.</u>

Instead, it is merely *transformed* and *transferred*.

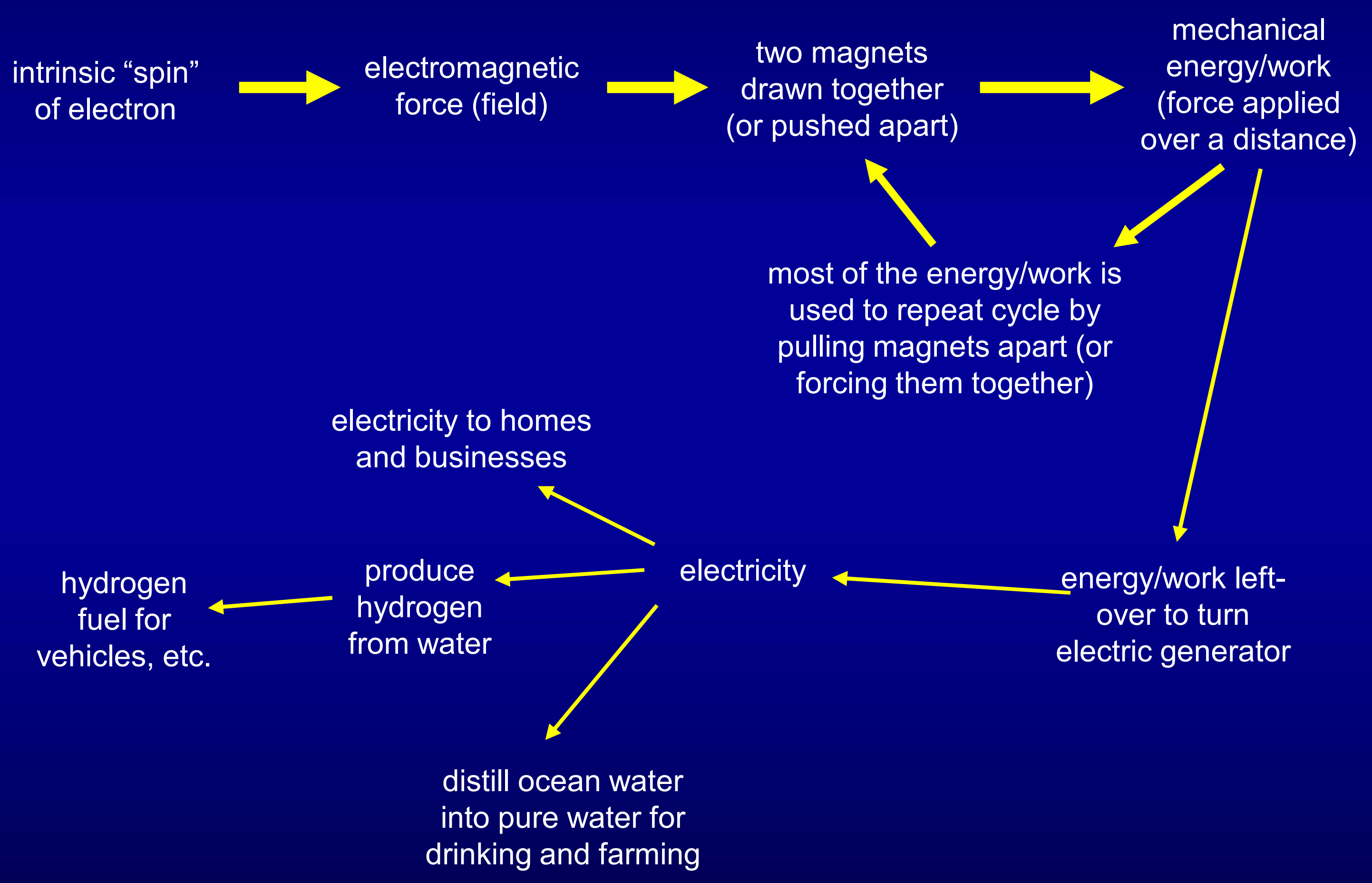


defining electromagnetic force

The electromagnetic force is one of the four fundamental forces, the other three being gravity, weak nuclear and strong nuclear. The electromagnetic force is a long-range force that involves the electric and magnetic properties of elementary particles. It is responsible for the repulsion of like electric charges and the attraction of unlike electric charges. Electromagnetic force explains atomic structure and the properties of light and other forms of electromagnetic radiation. Electromagnetic force is of order 10^{39} times stronger than gravity. It is the force which holds atoms together (and thereby prevents you from falling through the floor).

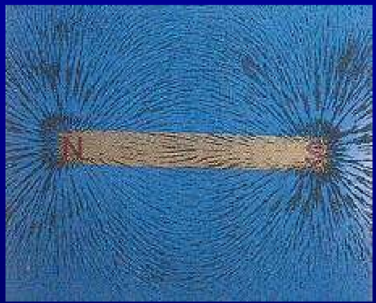
Electromagnetic force arises from the movement of electrical charge. Accordingly, magnetic forces exist when electrically charged particles are in motion. Electromagnetism arises when electrons move in an electric current whereas permanent magnets are believed to arise from the quantum-mechanical spin and orbital motion of electrons. Electron spin is believed to be the primary source of magnetic force. (However, it is noted here that the current quantum theory states that electrons neither physically spin nor orbit the nucleus.) The electromagnetic interaction is mediated, or carried, by photons.

the source and use of electromagnetic force

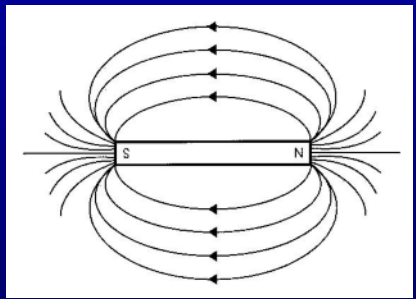


magnetic fields

The area around the magnet where magnetic forces exist is the “magnetic field” or “vector field”. Magnetic fields contain energy. Normally, magnetic fields are seen as dipoles, having a “South pole” and a “North pole”. Iron filings in a magnetic field of a permanent magnet reveal the “field lines” or directions of electromagnetic force (vectors). The electromagnetic force is responsible for the repulsion and attraction. Field lines travel from the North pole to the South pole. The interactions between the poles involve the exchange of photons. Photons are believed to be the “carier particles” of electromagnetic interactions. The highest surface intensity of the field occurs at the poles. Since the magnets are di-poles, their field lines (and force vectors) are not symetrically distributed. For example, the field lines that travel in the magnet from the North to the South pole travel a shorter and straighter path than those that travel outside of the magnet. Thereby the field is not uniform and has field lines (force vectors) of differing direction and magnitude. This makes it possible to find a path in which the two magnets can be pulled apart (or pushed together) with less energy than the energy obtained when they pulled themselves together (or pushed themselves apart).

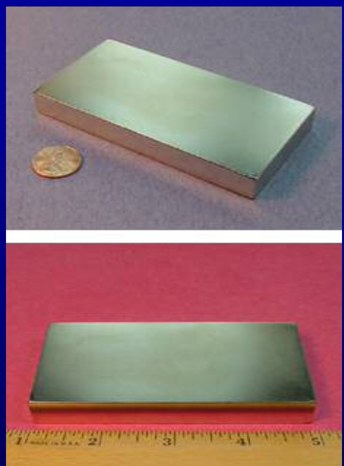


Iron filings in a magnetic field generated by a bar magnet



powerful permanent magnets

Permanent magnets are used today in a wide variety of consumer products. Over the past couple decades, the strength of permanent magnets has grown far beyond what most of us are familiar with. Today, our most powerful permanent magnets are the "neodymium" magnets. The NdFeB ("neodymium") system permanent magnet was developed in 1995 and a U.S. patent (5,472,525) was issued to Hitachi Metals, Ltd. (Tokyo). These permanent magnets made of neodymium, iron and boron generate an astonishing amount of force. For example, one magnet measuring only 4" x 2" x ½" and weighing only 17 ounces generates a pull force of 640 pounds. The magnets shown here are "grade" N42. More powerful grades exist up to grade N56 and the "HILOP series" which generate much greater pull forces. Other permanent magnets are made of alnico, ceramic, plastic, and samarium-cobalt. This invention demonstrates the use of magnetic forces from neodymium permanent magnets since they are the most powerful available today. However, this invention is not limited to any particular type of permanent magnet.



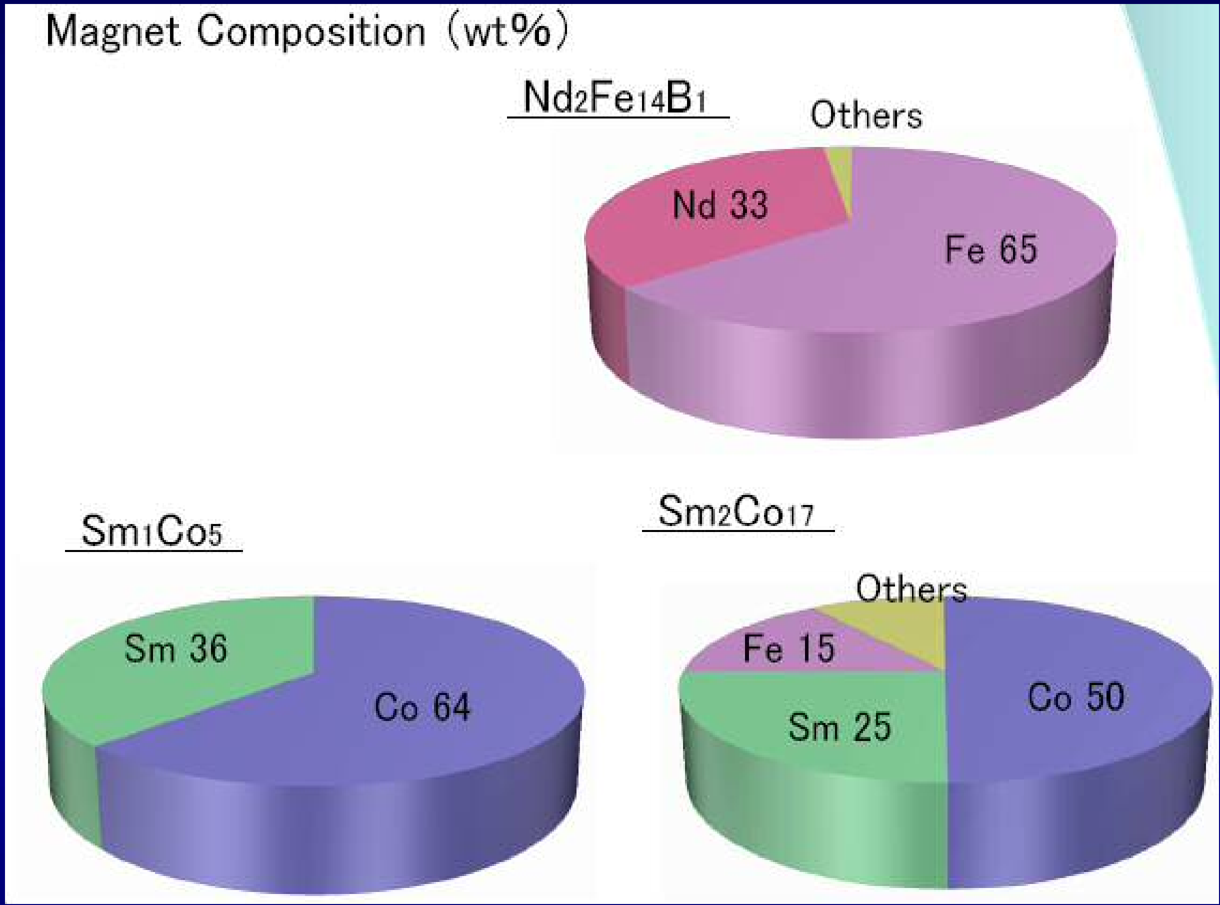
Dimensions: 4" x 2" x 1/2" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: thru thickness
Weight: 17.34 oz. (491.7 g)
Pull Force: 640.50 lbs
Surface Field: 5120 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe

Dimensions: 1" x 1" x 1" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 4.34 oz. (122.9 g)
Pull Force: 88 - 101 lbs
Surface Field: 6835 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe

powerful permanent magnets

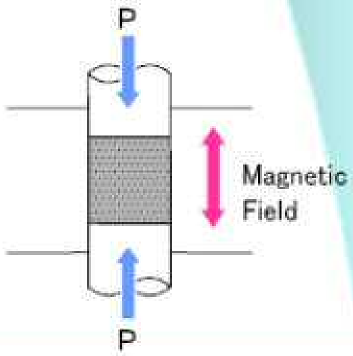
The table below provides examples of neodymium magnets and the tremendous force they generate.

height	width	thick	cubic-in	wt oz	pull-force lbs	pull-force/cubic in	pull-force/oz	grade	Bhmax	Brmax
1.00	1.00	0.50	0.5000	2.17	58	116.00	26.76	N50	50 MGOe	14,700 Gauss
4.00	0.50	0.50	1.0000	4.34	83	83.00	19.15	N50	50 MGOe	14,700 Gauss
2.00	1.00	0.50	1.0000	4.34	82	82.00	18.92	N50	50 MGOe	14,700 Gauss
2.00	2.00	1.00	4.0000	17.34	250	62.50	14.42	N50	50 MGOe	14,700 Gauss
2.00	1.00	0.75	1.5000	6.50	142	94.67	21.84	N48	48 MGOe	14,100 Gauss
0.75	0.75	0.375	0.2109	0.91	28	132.74	30.62	N45	45 MGOe	13,300 Gauss
2.00	1.00	0.50	1.0000	4.34	73	73.00	16.84	N45	45 MGOe	13,300 Gauss
2.00	2.00	1.00	4.0000	17.34	210	52.50	12.11	N45	45 MGOe	13,300 Gauss
0.25	0.25	0.25	0.0156	0.07	6	384.00	88.58	N42	42 MGOe	12,900 Gauss
0.50	0.50	0.50	0.1250	0.54	25	200.00	46.14	N42	42 MGOe	13,200 Gauss
0.75	0.75	0.75	0.4219	1.83	59	139.85	32.26	N42	42 MGOe	13,200 Gauss
1.00	1.00	0.1875	0.1875	0.81	21	112.00	25.84	N42	42 MGOe	13,200 Gauss
1.00	1.00	0.125	0.1250	0.54	13	104.00	23.99	N42	42 MGOe	13,200 Gauss
1.00	1.00	0.50	0.5000	2.17	51	102.00	23.53	N42	42 MGOe	13,200 Gauss
1.00	1.00	1.00	1.0000	4.34	101	101.00	23.30	N42	42 MGOe	13,200 Gauss
4.00	1.00	0.50	2.0000	8.67	110	55.00	12.69	N42	42 MGOe	13700 Gauss
4.00	2.00	2.00	16.0000	69.36	571	35.69	8.23	N42	42 MGOe	13,200 Gauss
4.00	2.00	1.00	8.0000	34.68	285	35.63	8.22	N42	42 MGOe	13,200 Gauss
4.00	3.00	1.00	12.0000	52.02	350	29.17	6.73	N42	42 MGOe	13,200 Gauss
6.00	3.00	0.50	9.0000	39.02	214	23.78	5.49	N42	42 MGOe	13,200 Gauss
6.00	4.00	1.00	24.0000	104.04	495	20.63	4.76	N42	42 MGOe	13,200 Gauss
4.00	4.00	1.00	16.0000	69.36	325	20.31	4.69	N42	42 MGOe	13,200 Gauss

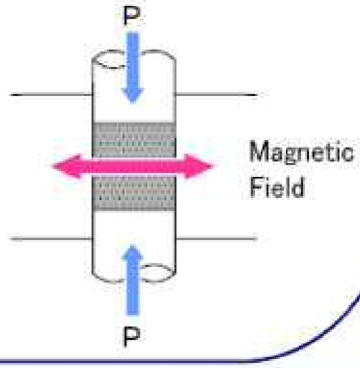

Magnet Composition (wt%)
$Nd_2Fe_{14}B_1$
Others
Nd 33
Fe 65
Sm_1Co_5
Sm 36
Co 64
Sm_2Co_{17}
Others
Fe 15
Sm 25
Co 50

Note：1. The above characteristics may not be attainable depending on sharp and dimensional conditions. Assured characteristics are to be determined through consultation and agreement.

2. V indicates vertical field pressing (press direction and magnetic field direction are parallel).



H indicates horizontal field pressing (Press direction and magnetic field direction are cross at right angles).



Measurement Systems

Unit	cgs System	SI System	English System
Length (L)	centimeter (cm)	meter (m)	inch (in)
Flux (ø)	Maxwell	Weber (Wb)	Maxwell
Flux Density (B)	Gauss (G)	Tesla (T)	lines/in^2
Magnetizing Force (H)	Oersted (Oe)	Ampere turns/m (At/m)	Ampere turns/in (At/in)
Magnetomotive Force (mmf or F)	Gilbert (Gb)	Ampere turn (At)	Ampere turn (At)

Conversion Between Systems

cgs System to SI system
1 Oe = 79.62 At/m
10,000 G = 1 T
1 Gb = 0.79577 At
1 Maxwell = 1 Line = 10^{-8} Wb
1 G = 0.155 lines/in^2

Glossary

Anisotropic Magnet: A magnet having a preferred direction of magnetic orientation, so that the magnetic characteristics are optimum in that direction.

Coercive force, Hc: The demagnetizing force, measured in Oersted, necessary to reduce observed induction, B to zero after the magnet has previously been brought to saturation.

Curie temperature: The temperature at which the parallel alignment of elementary magnetic moments completely disappears, and the materials is no longer able to hold magnetization.

Flux: The condition existing in a medium subjected to a magnetizing force. This quantity is characterized by the fact that an electromotive force is induced in a conductor surrounding the flux at any time the flux changes in magnitude. The unit of flux in the GCS system is Maxwell. One Maxwell equals one volt x seconds.

Gauss, Gs: A unit of magnetic flux density in the GCS system; the lines of magnetic flux per square inch. 1 Gauss equals 0.0001 Tesla in the SI system.

Hysteresis Loop: A closed curve obtained for a material by plotting corresponding values off magnetic induction, B (on the abscissa), against magnetizing force, H (on the ordinate).

Induction, B: The magnetic flux per unit area of a section normal to the direction of flux. The unit of induction is Gauss in the GCS system

Intrinsic Coercive Force, Hci: An intrinsic ability of a material to resist demagnetization. Its value is measured in Oersted and corresponds to zero intrinsic induction in the material after saturation. Permanent magnets with high intrinsic coercive force are referred as "Hard" permanent magnets, which usually associated with high temperature stability.

Irreversible Loss: Defined as the partial demagnetization of a magnet caused by external fields or other factors. These losses are only recoverable by remagnetization. Magnets can be stabilized to prevent the variation of performance caused by irreversible losses.

Isotropic Magnets: A magnet material whose magnetic properties are the same in any direction, and which can therefore be magnetized in any direction without loss of magnetic characteristics.

Magnetic Flex: The total magnetic induction over a given area.

Magnetizing Force: the magnetomotive force per unit length at any point in a magnetic circuit. The unit of the magnetizing force is Oersted in the GCS system

Maximum Energy Product, (BH)max.: There is a point at the Hysteresis Loop at which the product of magnetizing force H and induction B reaches a maximum. The maximum value is called the Maximum Energy Product. At this point, the volume of magnet material required to project a given energy into its surrounding is a minimum. This parameter is generally used to describe how "strong" this permanent magnet material is. Its unit is Gauss Oersted. One MGOe means 1,000,000 Gauss Oersted.

Oersted, Oe: A unit of magnetizing force in GCS system. 1 Oersted equals 79.58 A/m in SI system.

Permeability, Recoil: The Average slope of the minor hysteresis loop.

Polymer-Bonding: Magnet powders are mixed with a polymer carrier matrix, such as epoxy. The magnets are formed in a certain shape, when the carrier is solidified.

Rare Earths: A family of elements with an atomic number from 57 to 71 plus 21 and 39. They are lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, scandium, and yttrium.

Remenance, Bd: The magnetic induction which remains in a magnetic circuit after the removal of an applied magnetizing force. If there is an air gap in the circuit, the remenance will be less than the residual induction, Br.

Reversible Temperature Coefficient: A measure of the reversible changes in flux caused by temperature variations.

Residual Induction, Br: A value of induction at the point at Hysteresis Loop, at which Hysteresis loop crosses the B axis at zero magnetizing force. The Br represents the maximum magnetic flux density output of this material without an external magnetic field.

Saturation: A condition under which induction of a ferromagnetic material has reach its maximum value with the increase of applied magnetizing force. All elementary magnetic moments have become oriented in one direction at the saturation status.

Sintering: The bonding of powder compacts by the application of heat to enable one or more of several mechanisms of atom movement into the particle contact interfaces to occur; the mechanisms are: viscous flow, liquid phase solution-precipitation, surface diffusion, bulk diffusion, and evaporation-condensation. Densification is a usual result of sintering.

Surface Coatings: Unlike Samarium Cobalt, Alnico and ceramic materials, which are corrosion resistant, Neodymium Iron Boron magnets are susceptible to corrosion. Base upon of magnets' applications, following coatings can be chosen to apply on surfaces of Neodymium Iron Boron magnets.

Neodymium Magnets

Magnetic Characteristics

Material Type	Residual Flux Density (Br)	Coercive Force (Hc)	Intrinsic Coercive Force (Hci)	Max.Energy Product (BH)max
N35	11.7-12.1 KGs	>10.8 KOe	>12 KOe	33-35 MGOe
N38	12.2-12.6 KGs	>10.8 KOe	>12 KOe	36-38 MGOe
N40	12.6-12.9 KGs	>10.5 KOe	>12 KOe	38-40 MGOe
N42	13.0-13.2 KGs	>10.5 KOe	>12 KOe	40-42 MGOe
N45	13.3-13.7 KGs	>10.5 KOe	>12 KOe	43-45 MGOe
N46	13.4-13.8 KGs	>10.5 KOe	>11 KOe	43-46 MGOe
N48	13.8-14.2 KGs	>10.5 KOe	>11 KOe	46-48 MGOe
N50	14.1-14.7 KGs	>10.5 KOe	>11 KOe	48-50 MGOe
N35M	11.7-12.1 KGs	>10.8 KOe	>14 KOe	33-35 MGOe
N38M	12.2-12.6 KGs	>10.8 KOe	>14 KOe	36-38 MGOe
N40M	12.6-12.9 KGs	>10.8 KOe	>14 KOe	38-40 MGOe
N42M	12.9-13.2 KGs	>10.8 KOe	>14 KOe	40-43 MGOe
N35H	11.7-12.1 KGs	>10.8 KOe	>17 KOe	33-35 MGOe
N37H	12.1-12.6 KGs	>11.5 KOe	>17 KOe	35-37 MGOe
N41H	12.5-13.3 KGs	>11.9 KOe	>16 KOe	38-42 MGOe
N33SH	11.4-11.7 KGs	>10.3 KOe	>20 KOe	31-33 MGOe
N35SH	11.7-12.1 KGs	>10.8 KOe	>20 KOe	33-35 MGOe
N38SH	12.2-12.9 KGs	>11.6 KOe	>21 KOe	36-40 MGOe
N28UH	10.4-11.0 KGs	>9.8 KOe	>25 KOe	26-30 MGOe
N33UH	11.1-11.9 KGs	>10.5 KOe	>25 KOe	30-34 MGOe
N32EH	11.1-11.9 KGs	>10.5 KOe	>27 KOe	30-34 MGOe
N28Z	10.4-10.8 KGs	>10.0 KOe	>30 KOe	26-28 MGOe

Neodymium Magnets

Thermal Characteristics

Neodymium Material Type	Temp. Coefficient (αBr)	Maximum Operating Temp	Curie Temp	Thermal Conductivity
	%/°C	ºC (ºF)	ºC (ºF)	kcal/m-h-°C
N	-0.12	80ºC (176ºF)	310ºC (590ºF)	7.7
NM	-0.12	100ºC (212ºF)	340ºC (644ºF)	7.7
NH	-0.11	120ºC (248ºF)	340ºC (644ºF)	7.7
NSH	-0.10	150ºC (302ºF)	340ºC (644ºF)	7.7
NUH	-0.10	180ºC (356ºF)	350ºC (662ºF)	7.7
NEH	-0.10	200ºC (392ºF)	350ºC (662ºF)	7.7
NZ	-0.10	200ºC (392ºF)	350ºC (662ºF)	7.7

Neodymium Magnets

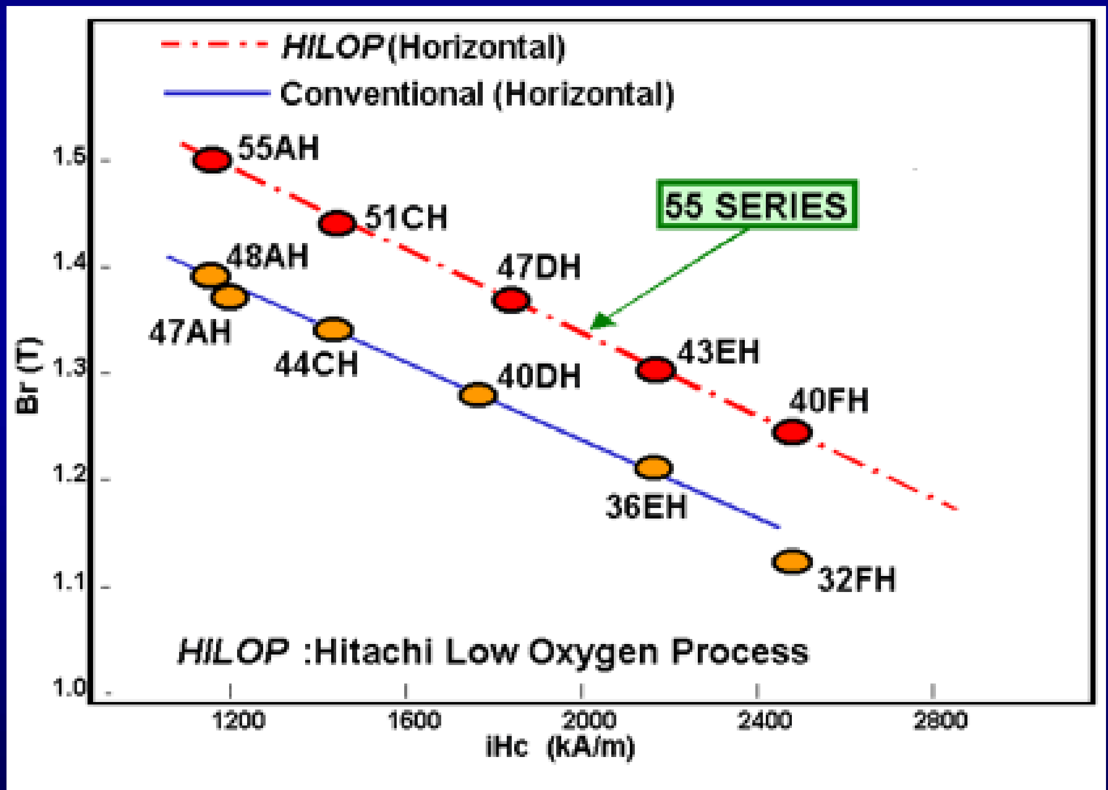
Physical and Mechanical Characteristics

Density	7.4-7.5 g/cm^3
Compression Strength	110 kg/mm^2
Bending Strength	25 kg/mm^2
Vickers Hardness (Hv)	500 - 600
Tensile Strength	7.5kg/mm^2
Young's Modulus	1.7 x 104 kg/mm^2
Recoil Permeability	1.05 μrec
Electrical Resistance (R)	160 μ-ohm-cm
Thermal Expansion Coefficient (0 to 100°C) parallel to magnetization direction	5.2×10^{-6} /°C
Thermal Expansion Coefficient (0 to 100°C) perpendicular to magnetization direction	-0.8×10^{-6} /°C

NEOMAX Co., Ltd.

HIGH-PERFORMANCE Nd-Fe-B SINTERED MAGNET (HILOP™)

HICOREX-SUPER High Energy Series
Magnetic Properties of High Energy Series



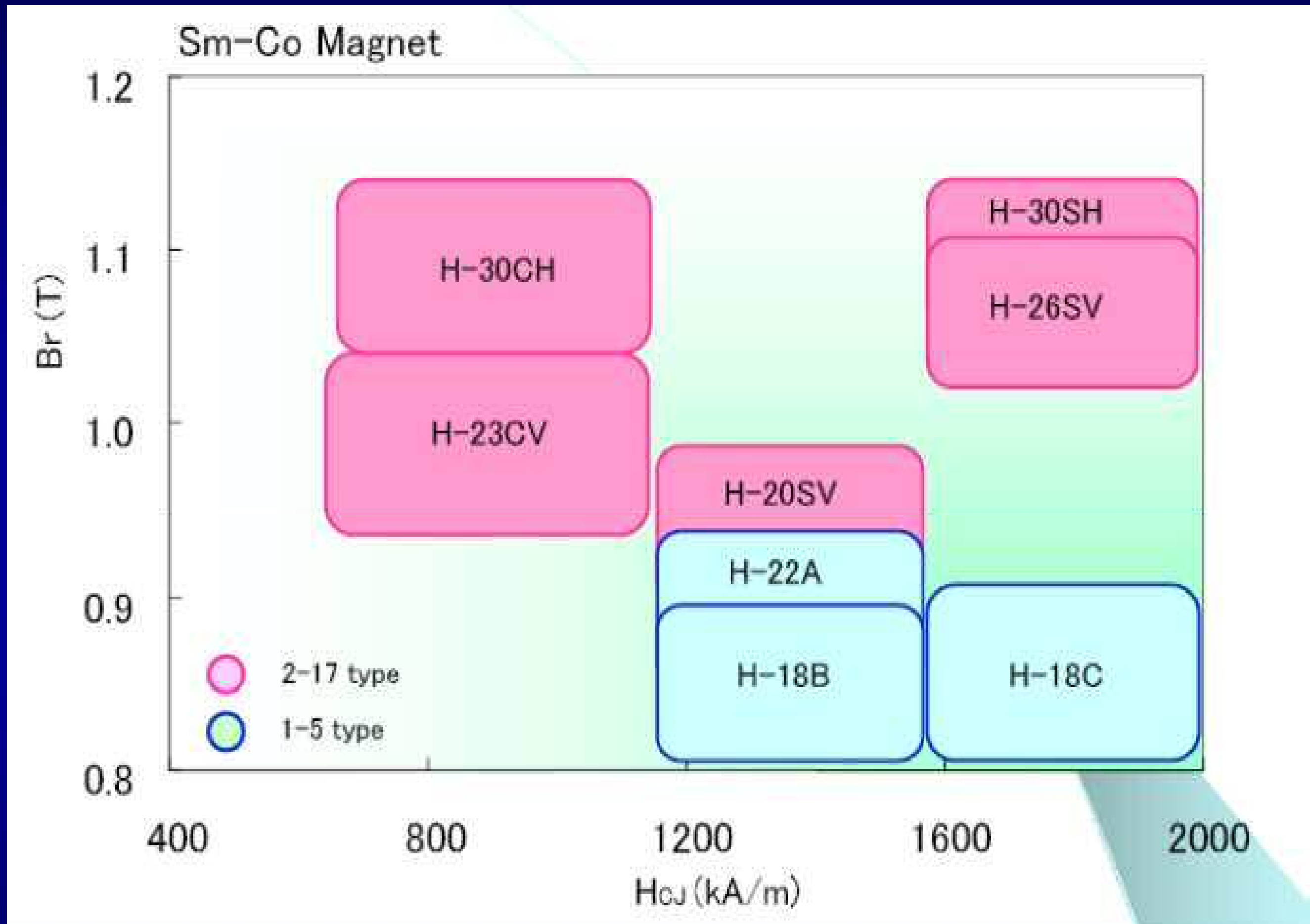
NEOMAX Co., Ltd.

HIGH-PERFORMANCE Nd-Fe-B SINTERED MAGNET (HILOP™)

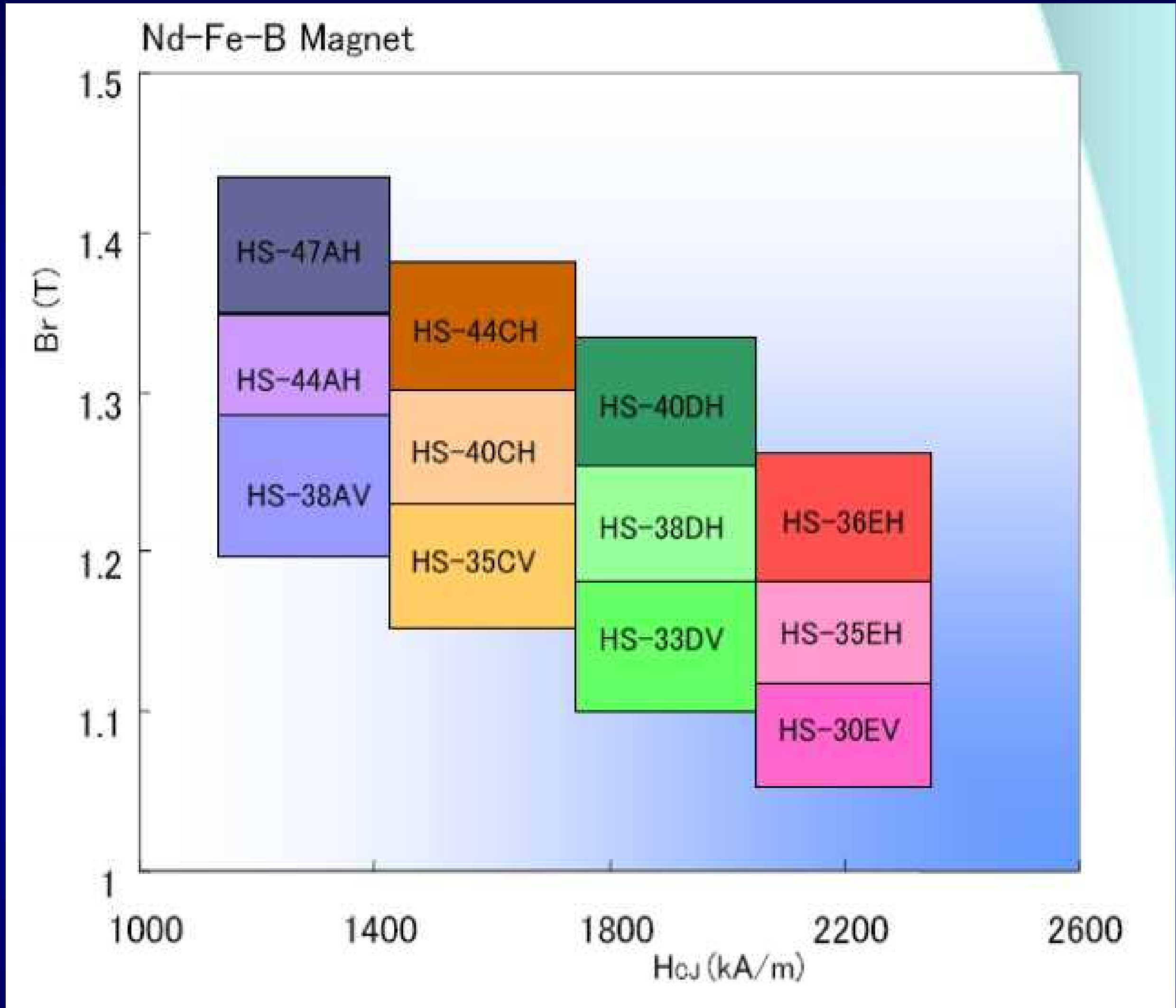
Magnetic Properties of High Energy Series

Material	Brand Name	Residual Flux Density Br (T)	Coercive Force bHc (kA/m)	Coercive Force iHc (kA/m)	Maximum Energy Product BHmax (kJ/m^3)
HILOP	HS-55AH	1.47—1.52	994—1178	1034 Min.	413—446
	HS-51CH	1.39—1.45	1050—1130	1352 Min.	366—406
	HS-47DH	1.33—1.39	1002—1083	1671 Min.	334—375
	HS-43EH	1.26—1.34	946—1043	1989 Min.	302—343
	HS-40FH	1.21—1.29	907—1003	2387 Min.	278—319
Conven tional	HS-48AH	1.36—1.43	1026—1114	1034 Min.	351—390
	HS-44CH	1.30—1.38	978—1083	1352 Min.	318—385
	HS-40DH	1.25—1.33	939—1043	1671 Min.	295—334
	HS-36EH	1.18—1.26	883—987	1989 Min.	262—302
	HS-32FH	1.10—1.17	819—908	2387 Min.	230—271

Characteristic	Symbol	Unit	Sm-Co(1-5)	Sm-Co(2-17)		Nd-Fe-B
			H-18B, 18C, 22A	H-23B, 23CV	H-20SV	HS
Temperature Coefficient	α	%/℃	-0.04	-0.035	-0.02	-0.13～-0.11
Curie Point	TC	℃	710	770	820	310
Density	ρ	gr/cm^3	8.3	8.5	8.5	7.5
Vickers Hardness	HV	D.P.N.	600	600	500	600
Bending Strength	B.S	N/mm^2	100	100	100	250
Tensile Strength	T.S	N/mm^2	40	40	40	80
Compression Strength	C.S	N/mm^2	850	850	850	1050
Young's Modulus	E	N/mm^2	1.5×10^5	1.1×10^5	1.1×10^5	1.6×10^5
Electrical Resistance	R	$\mu \Omega \cdot cm$	50	50	50	150
Thermal Expansion Coefficient	C//	10^{-6}/℃	7	8	10	5
	C⊥		13	11	13	-1.5
Thermal Conductivity	λ	W/m·℃	10	10	10	9
Specific Heat	C	J/kg·℃	420	380	380	460

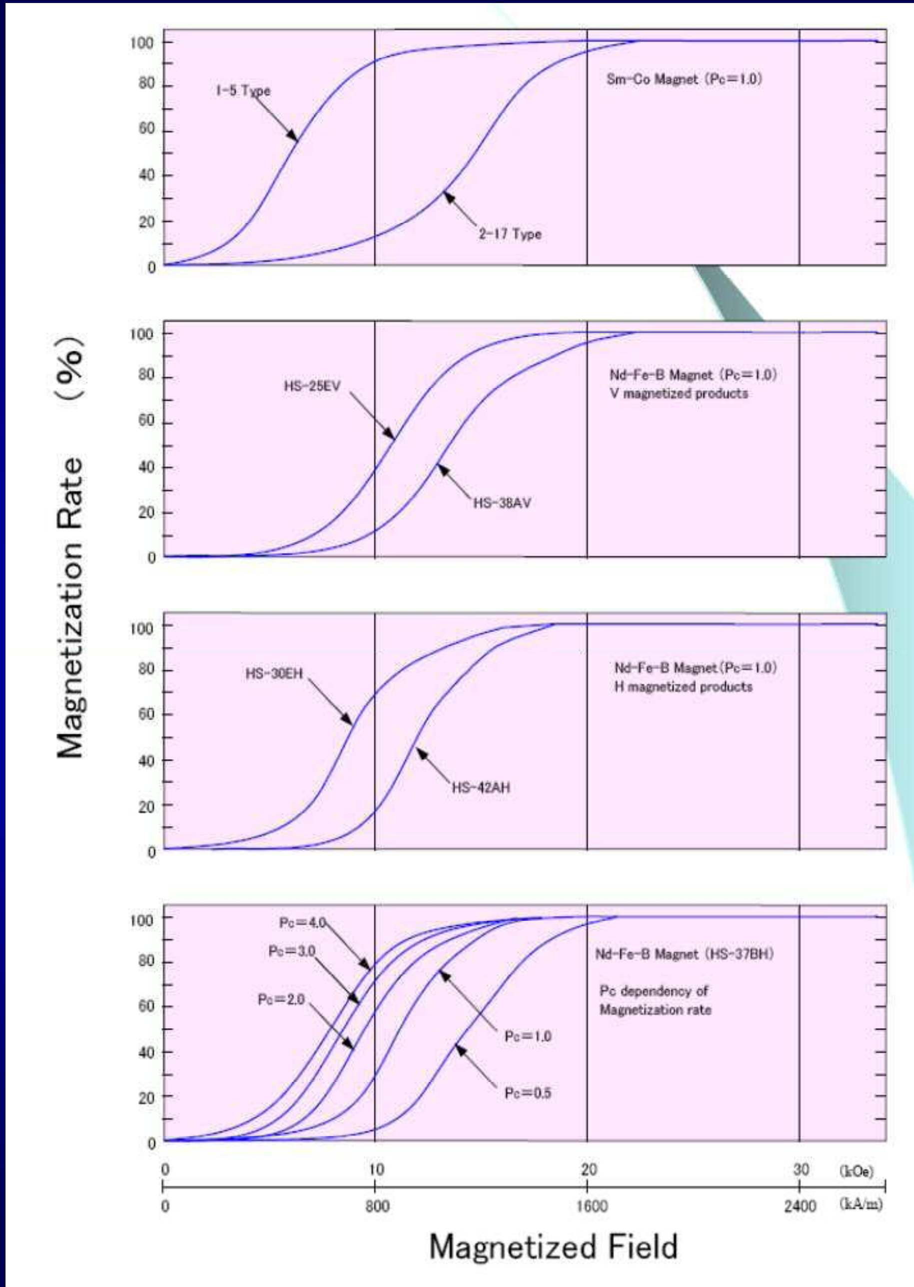


Sm-Co Magnet
Br (T)
1.2
1.1
1.0
0.9
0.8
400
800
1200
1600
2000
HcJ (kA/m)
H-30CH
H-23CV
H-30SH
H-26SV
H-20SV
H-22A
H-18B
H-18C
2-17 type
1-5 type


Nd-Fe-B Magnet
Br (T)
1.5
1.4
1.3
1.2
1.1
1
1000
1400
1800
2200
2600
HcJ (kA/m)
HS-47AH
HS-44AH
HS-38AV
HS-44CH
HS-40CH
HS-35CV
HS-40DH
HS-38DH
HS-33DV
HS-36EH
HS-35EH
HS-30EV

Material	Code	Residual Induction Br T / kG	Coercive Force H_{CB} kA/m / kOe	Coercive Force H_{CJ} kA/m / kOe	Maximum Energy Product (BH)max. kJ/m^3 / MG·Oe	Pressing Methods ※2
Sm-Co (1-5)	H-22A	0.85～0.95 8.5～9.5	636～756 8.0～9.5	1193min 15.0min	143～176 18～22	H
	H-18B	0.80～0.90 8.0～9.0	620～717 7.8～9.0	1193min 15.0min	127～152 16～19	V
	H-18C	0.80～0.90 8.0～9.0	620～717 7.8～9.0	1591min 20.0min	127～152 16～19	
Sm-Co (2-17)	H-30SH	1.04～1.14 10.4～11.4	732～852 9.2～10.7	1591min 20.0min	198～247 25～31	H
	H-30CH	1.04～1.14 10.4～11.4	636～796 8.0～10.0	676min 8.5min	198～247 25～31	
	H-26SV	1.02～1.12 10.2～11.2	716～836 9.0～10.5	1591min 20.0min	190～231 24～29	V
	H-23CV	0.95～1.05 9.5～10.5	596～796 7.5～10.0	636min 8.0min	159～207 20～26	
	H-20SV	0.88～0.98 8.8～9.8	636～756 8.0～9.5	1114min 14.0min	143～176 18～22	

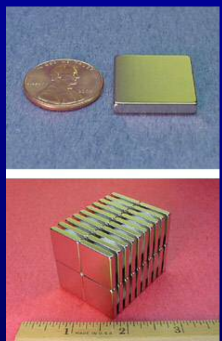
Material	Code	Residual Induction	Coercive Force		Maximum Energy Product	Pressing Methods ※2
		Br	H_{CB}	H_{CJ}	(BH)max.	
		T kG	kA/m kOe	kA/m kOe	kJ/m^3 MG·Oe	
Nd-Fe-B	HS-47AH	1.35～1.43 13.5～14.3	1018～1123 12.8～14.1	1114min 14.0min	342～390 43～49	H
	HS-44CH	1.30～1.38 13.0～13.8	978～1083 12.3～13.6	1352min 17.0min	318～359 40～45	
	HS-40DH	1.25～1.33 12.5～13.3	939～1043 11.8～13.1	1671min 21.0min	294～335 37～42	
	HS-36EH	1.18～1.26 11.8～12.6	883～987 11.1～12.4	1989min 25.0min	262～303 33～38	
	HS-44AH	1.31～1.39 13.1～13.9	986～1091 12.4～13.7	1114min 14.0min	326～367 41～46	
	HS-40CH	1.23～1.31 12.3～13.1	915～1027 11.5～12.9	1352min 17.0min	286～327 36～41	
	HS-38DH	1.18～1.30 11.8～13.0	875～1035 11.0～13.0	1671min 21.0min	278～319 35～40	
	HS-35EH	1.13～1.21 11.3～12.1	835～947 10.5～11.9	1989min 25.0min	238～279 30～35	
	HS-42AH	1.28～1.35 12.8～13.5	954～1075 12.0～13.5	1114min 14.0min	318～359 40～45	
	HS-37BH	1.21～1.31 12.1～13.1	883～1027 11.1～12.9	1193min 15.0min	278～319 35～40	
	HS-35CH	1.18～1.28 11.8～12.8	875～1003 11.0～12.6	1273min 16.0min	262～311 33～39	
	HS-33DH	1.13～1.23 11.3～12.3	835～963 10.5～12.1	1671min 21.0min	238～287 30～36	
	HS-30EH	1.08～1.18 10.8～11.8	795～924 10.0～11.6	1989min 25.0min	222～263 28～33	
	HS-40AV	1.24～1.32 12.4～13.2	923～1035 11.6～13.0	1114min 14.0min	286～327 36～41	V
	HS-35CV	1.15～1.25 11.5～12.5	859～979 10.8～12.3	1352min 17.0min	246～295 31～37	
	HS-33DV	1.10～1.20 11.0～12.0	795～955 10.0～12.0	1671min 21.0min	230～279 29～35	
	HS-30EV	1.05～1.13 10.5～11.3	771～884 9.7～11.1	1989min 25.0min	206～239 26～30	
	HS-38AV	1.20～1.30 12.0～13.0	875～1035 11.0～13.0	1114min 14.0min	278～319 35～40	
	HS-32BV	1.13～1.23 11.3～12.3	819～963 10.3～12.1	1193min 15.0min	238～287 30～36	
	HS-30CV	1.08～1.18 10.8～11.8	795～924 10.0～11.6	1273min 16.0min	222～263 28～33	
	HS-28DV	1.03～1.13 10.3～11.3	755～884 9.5～11.1	1671min 21.0min	198～239 25～30	
	HS-25EV	0.98～1.08 9.8～10.8	716～844 9.0～10.6	1989min 25.0min	183～223 23～28	



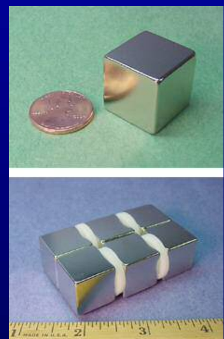
Magnetization Rate (%)
Sm-Co Magnet (Pc=1.0)
1-5 Type
2-17 Type
Nd-Fe-B Magnet (Pc=1.0)
V magnetized products
HS-25EV
HS-38AV
Nd-Fe-B Magnet (Pc=1.0)
H magnetized products
HS-30EH
HS-42AH
Nd-Fe-B Magnet (HS-37BH)
Pc dependency of
Magnetization rate
Pc=4.0
Pc=3.0
Pc=2.0
Pc=1.0
Pc=0.5
0
10
20
30
(kOe)
0
800
1600
2400
(kA/m)
Magnetized Field

methods

An apparatus was constructed to measure the magnetic (attract and repel) forces exerted between two magnets in different directions. Neodymium permanent magnets were used. Very small magnets (see photographs below) with a pull force of approximately 43 to 45 pounds were used so that the measuring apparatus would not have to withstand large forces. The apparatus (shown in the following slides) included a cart that moved along two metal rails. One magnet was fixed to the movable cart and the other stationary magnet was fixed to the platform. The metal rails and other metal parts were made of non-magnetic materials such as stainless steel and brass to avoid their interfering with the magnetic forces being measures. Bushings between the cart and the metal rails kept friction to a minimum. Silicone was applied on the steel rails to further reduce friction. A digital scale accurate within .05 pounds was used to measure force. The scale was attached to the cart as shown in the following photographs. The cart and attached magnet was moved at 1/32” intervals using a worm gear box that allowed precise and fixed movement. The distance between the fixed and stationary magnets was constantly monitored for accuracy. Each experiment was repeated 3 to 7 times to assure accuracy and consistency. The average force between two values measured at 1/32” intervals was calculated and used to compute total work output in inch-pounds. This simple method of computing work was compared to the integral method and found to be accurate.



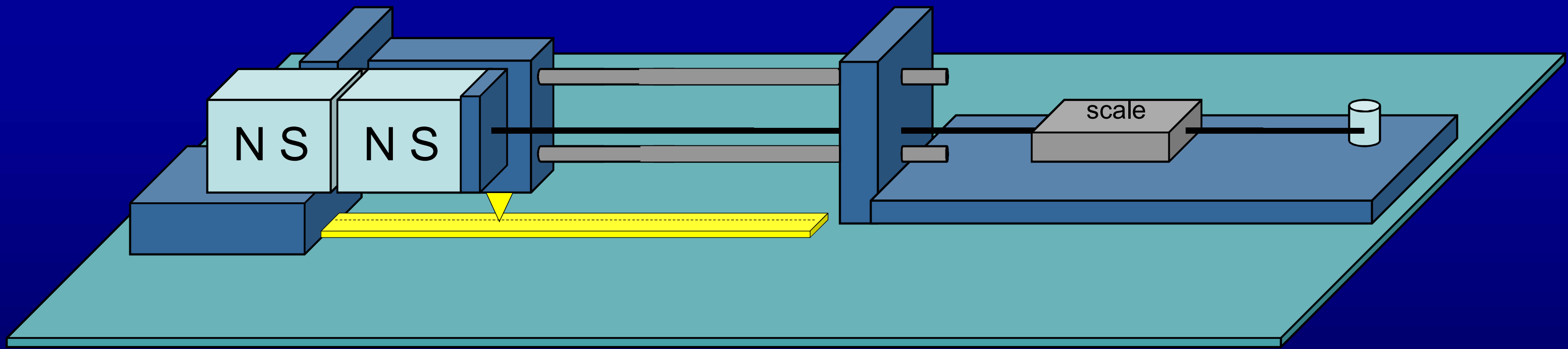
Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18.00 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe



Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 1.83 oz. (51.86 g)
Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss
BHmax: 38 MGOe

measuring magnetic force

Measuring the attractive force between the two magnets was done with one magnet held stationary. The second magnet was fixed to a platform comprised of non-magnetic material. Sleeve bearings in the platform allowed it to move along two stainless steel rods with minimum friction. **Frictional force was determined and deducted** from magnetic force values. A digital force meter was attached to the cart by a cable. The scale (with cart and moving magnet attached) was pulled along at 1/32” intervals using a worm gear box. Force (in pounds) was read from the force meter (+/- .05) and recorded. Accuracy and consistency was determined by repeating the experiment on different days.

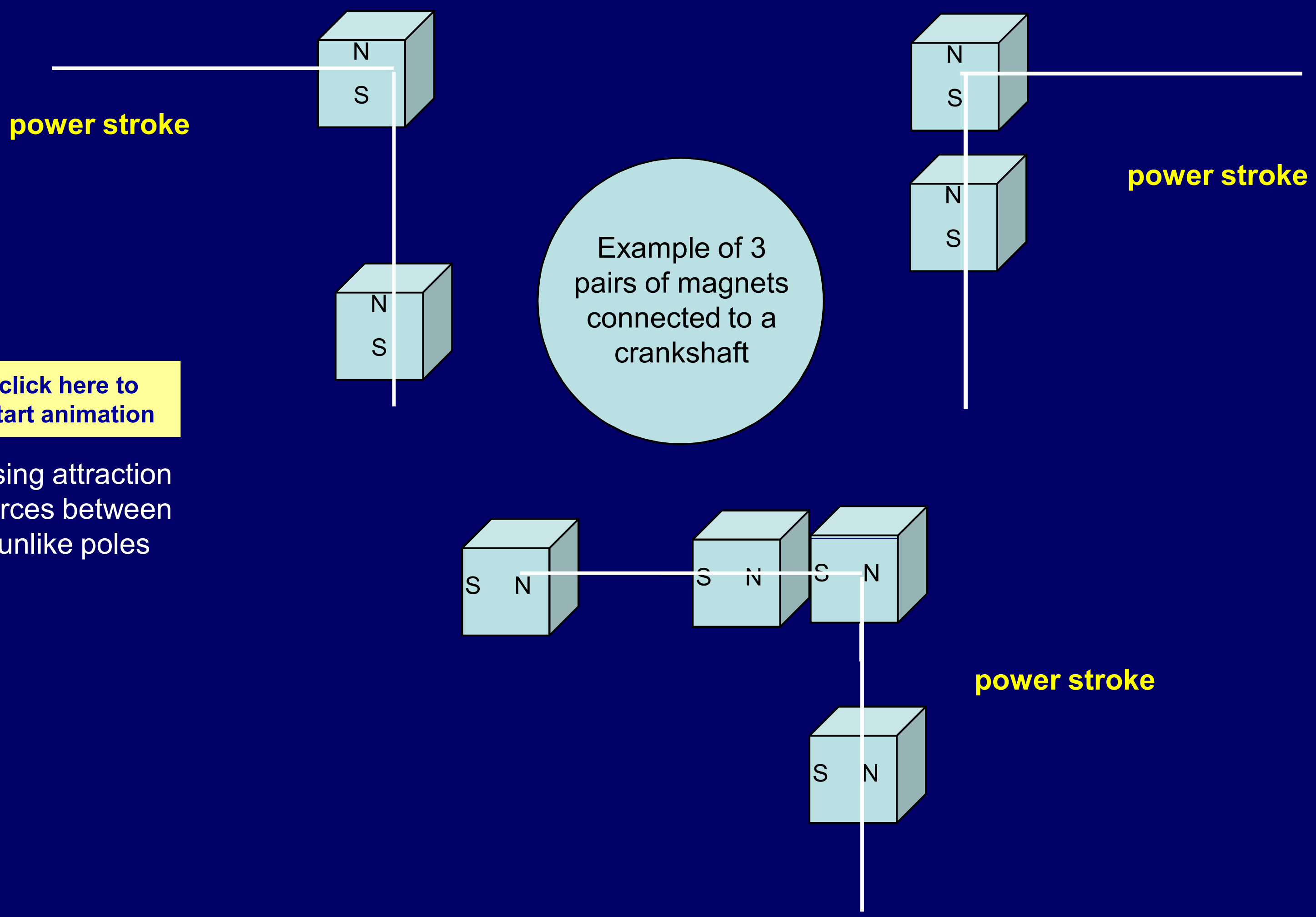


click here to start animation

Designing an EMF (electromagnetic force) engine to drive an electric generator

Transferring the mechanical energy (work) produced by the electromagnetic force of permanent magnets into electricity is a matter of mechanical engineering. There are no chemical reactions and no combustion, just clean and simple mechanical energy. The energy harnessed from the permanent magnets is already in the form of mechanical energy. The linear motion of the magnets as they do work need only be converted into rotational motion necessary for turning a generator. However, there are a few engineering challenges since the linear movements of the magnets follow more than one path and the paths are perpendicular to one another. The forces generated by the magnets are not constant over distance. This condition is similar to the force generated in the cylinder of a combustion engine and can be treated likewise by having multiple "cylinders" firing at different times. The distribution of force generated when the magnets "do work" with attract forces is (low to high force output) the opposite of the distribution of force (high to low) needed to pull the magnets apart. This can also be addressed fairly easily in a variety of ways, for example by using a flywheel. The animations on the next slide illustrates how the EMF MACHINE might be designed when using attracting forces.

click here to view animation

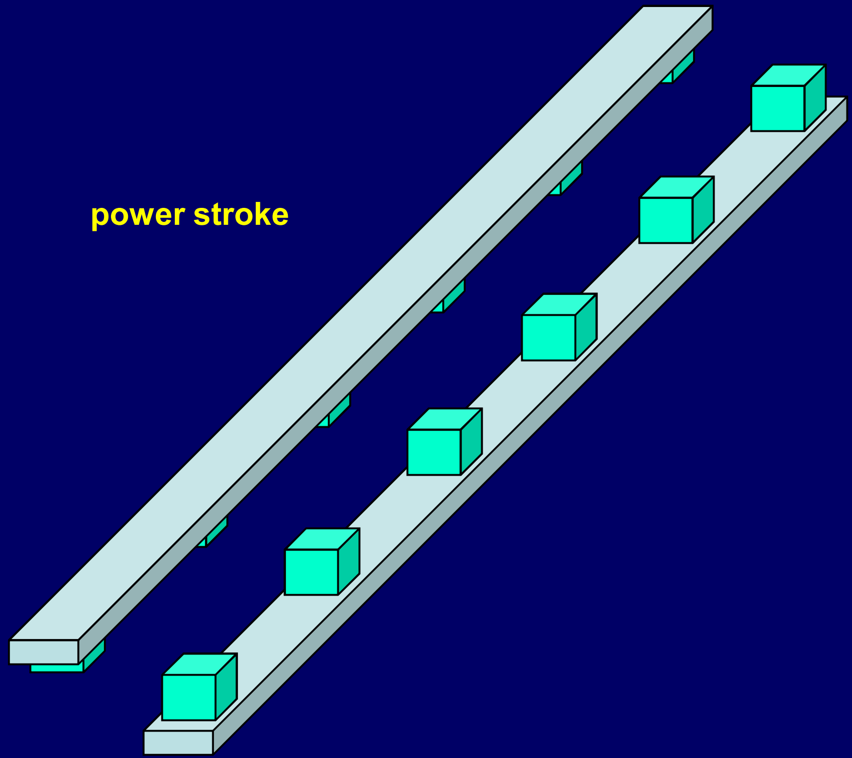


click here to start animation

using attraction forces between unlike poles

Smaller neodymium magnets generate more pull-force compared to larger magnets. Accordingly, each "cylinder head" could contain many smaller magnets imbedded into the surface as shown in the next slide instead of using one larger magnet as shown here.

Many pairs of magnets can work together in a “bay” and one “engine” will contain many bays of magnets. The “power stroke” of each bay will occur in a manner as illustrated in the previous slide.



click here to start animation

more testing and implementation

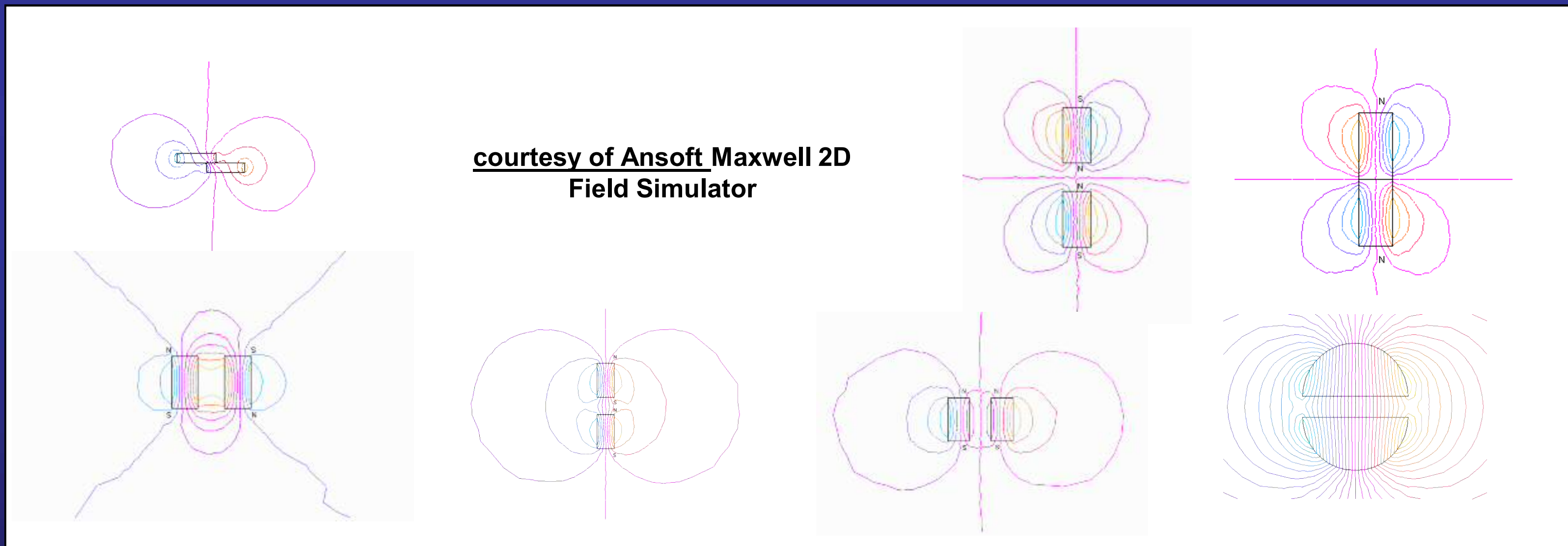
The preliminary testing presented here reveals a yield sufficient to put this technology into immediate use (see “yield assessment” section of this report). A machine that transfers the mechanical force generated by the magnets as linear motion into the rotary motion needed to turn a generator can be built immediately for individual homes and power-plants. However, it is highly probable that designs not tested here will produce greater net yields. Further testing should begin immediately along with producing a prototype engine that will demonstrate this new technology. See the “EMF ENGINE” section of this report for an example of engine design.

Hitachi Metals appears to be the leader in the development of powerful permanent magnets. They continually improve the strength and material properties of their neodymium magnets. Their best product should be used as the energy source. Recently, Hitachi has produced a new, more powerful line of high-performance, sintered neodymium magnets which they refer to as HILOP (Hitachi’s Low Oxygen Production).

Data and results presented here represent the most promising model to date. The reasons this model provides the best yield is explained in the earlier section titled “why a net yield”. Several models have been tested. There remains much room for improvement.

searching for the best yield

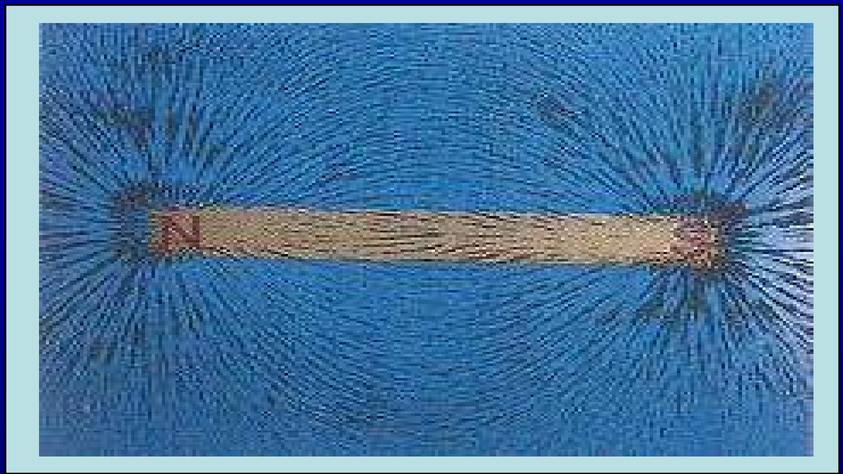
Further testing is required to determine which combination of magnet size, shape, configuration and paths will produce the best yield of energy. A mathematical model can be developed to predict the best model. Presently, we do not understand precisely how field lines physically interact with each other. The illustrations below are examples of how magnetic fields are altered when two magnets are in proximity.



courtesy of Ansoft Maxwell 2D Field Simulator

why a net yield can be harnessed (i.e., why this works)

An understanding of force vectors would be helpful but is not necessary. As mentioned earlier in this report, permanent magnets have (at least) two poles (one North and one South). This dipole structure gives the magnet and its field “polarity” in its form or shape as well as its charge. The magnetic fields (magnetic forces) generated by permanent magnets are unevenly distributed (see photograph). Accordingly, it should not be difficult to imagine two magnets generating different amounts of mechanical energy (work) when they pull themselves together (or push themselves apart) along different paths (in different directions or planes).

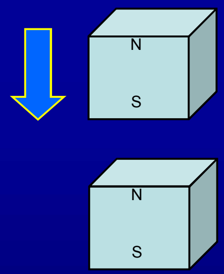


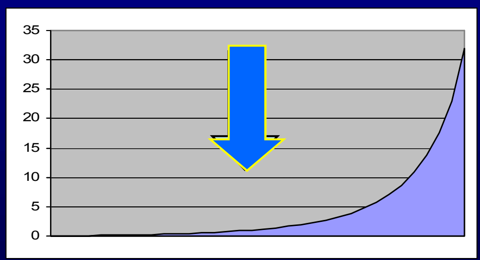
iron filings in a magnetic field
generated by a bar magnet

why a net yield can be harnessed (i.e., why this works)

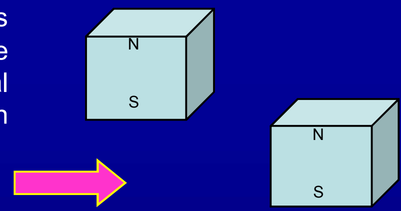
The uneven distribution in the magnetic field is easily and commonly experienced when handling two magnets. Often the instructions that come with the purchase of powerful magnets suggests separating them by pulling them apart "sideways". It is easier to separate magnets this way compared to pulling them "straight" apart because the maximum force between the magnets is much less in the horizontal (sideways) direction. This is easily validated by measuring the magnetic forces between the two magnets in the horizontal (sideways) and vertical (straight apart) directions. For example, we see that two ¾ inch square, neodymium magnets generate 7.46 inch-pounds (work) when pulling themselves together horizontally and 6.56 inch-pounds when pulling themselves together vertically. Therefore it takes more work to pull these magnets apart horizontally (sideways) than it does to pull them straight (vertical) apart. So why then is it easier to pull them apart sideways? It is "easier" to pull them apart sideways because the *maximum* force exerted between the two magnets in the horizontal plane is only 14.9 pounds, less than half the maximum force of 31.9 exerted in the vertical plane. The graphs below show that the distribution of force over distance also differs dramatically in the vertical and horizontal planes.

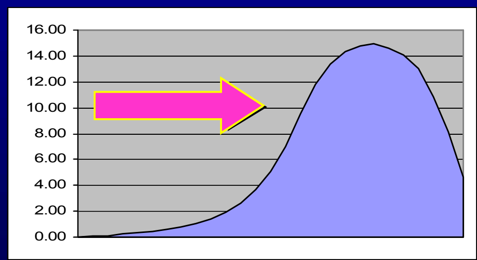
6.56 in-lbs generated in the vertical direction





7.46 in-lbs generated in the horizontal direction

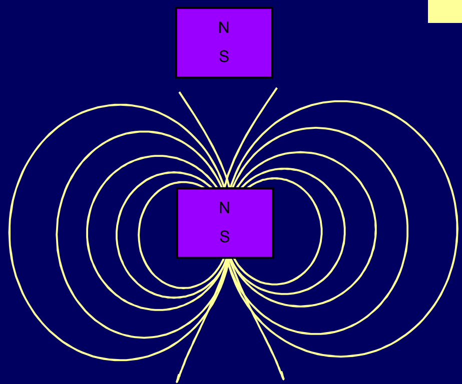


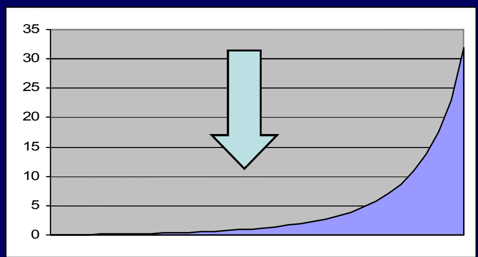


why a net yield can be harnessed (i.e., why this works)

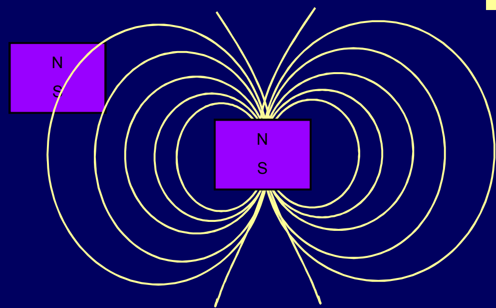
The animations below illustrate the magnetic fields that are traveled by a magnet as it is drawn toward another stationary magnet in the vertical or “straight-on” direction compared to the horizontal or “sideways” direction. The density and direction of field lines along each path correspond to the forces generated over distance and also clearly reveal why more total energy (work) is available in the horizontal direction. For example, notice that the field lines in the horizontal path follow closely the direction taken by the moving magnet as it moves inward horizontally whereas the field lines in the vertical path run more oblique or perpendicular. Accordingly, the vector components of the respective forces favor the horizontal direction compared to the vertical direction. More total attracting force is therefore exerted in the horizontal plane. Also notice that the magnet moving vertically initially approaches the stationary magnet in a sparse field which becomes dense abruptly and near the end of travel. This accounts for the distribution (see curve) of force in the vertical direction. On the other hand, the magnet moving horizontally travels in a dense field over a greater distance. These differences in field shape and density are responsible for different amounts of work that are done by the magnets in the vertical and horizontal planes As illustrated in the next slide, the total horizontal force increases as the shape of the magnet “flattens”.

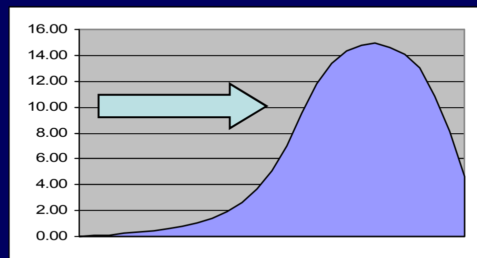
click to start animation





Click to start animation

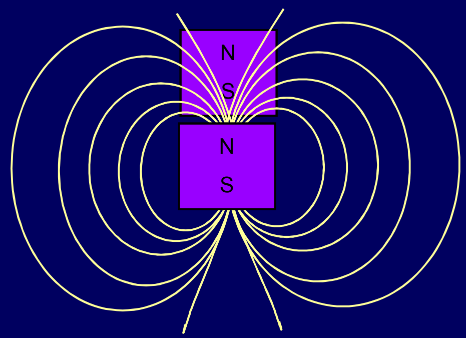




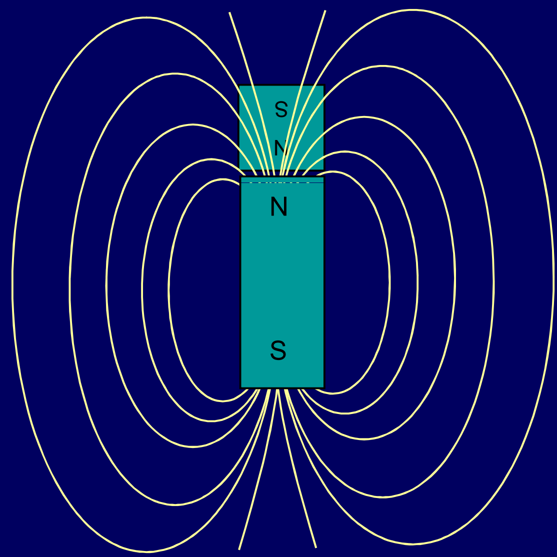
why a net yield can be harnessed (i.e., why this works)

Magnet shapes as illustrated in figure A produced the least yield. The work produced in the horizontal and vertical directions were nearly equal. Square magnets as illustrated in figure B and rectangular magnets as illustrated in figure C produce the greatest yield. Such magnets magnetized through the thickness (and not along the long axis) are common today and produce the largest pull forces. Observe from the animation that the moving magnet travels horizontally through a dense field with lines traveling largely parallel to the direction of motion. On the other hand, the magnet travels through much less field in the vertical direction where the field lines are oblique or nearly perpendicular to the direction of (vertical) motion. Consequently, the amount work that can be generated in the horizontal plane is greater than in the vertical plane.

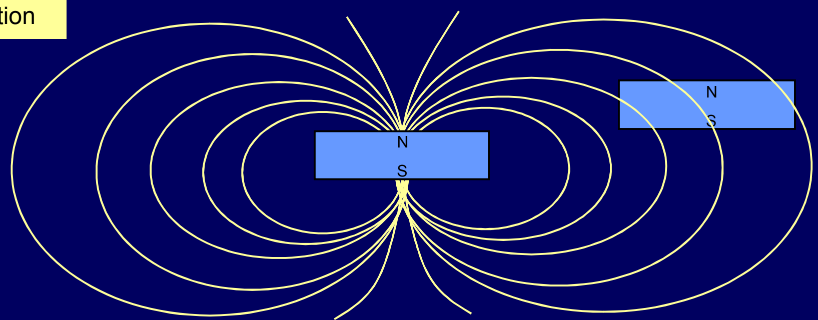
B



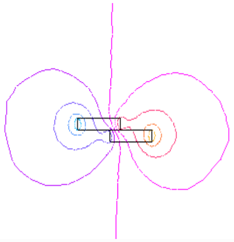
A



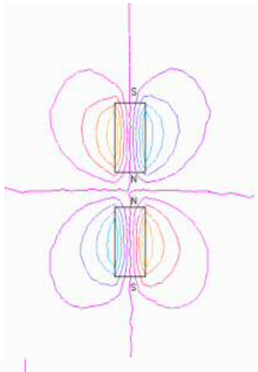
click to start animation

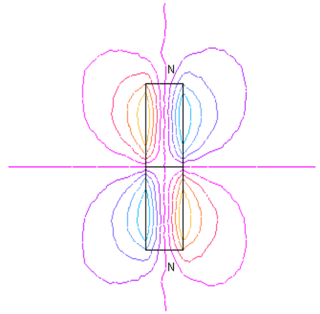


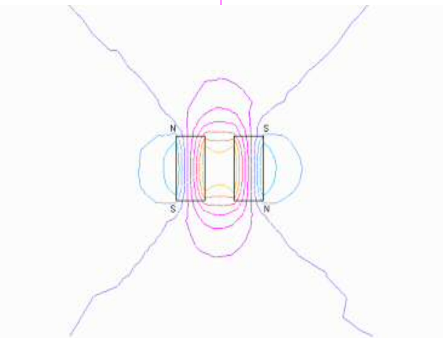
C

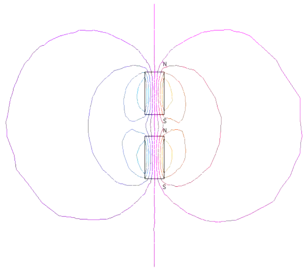


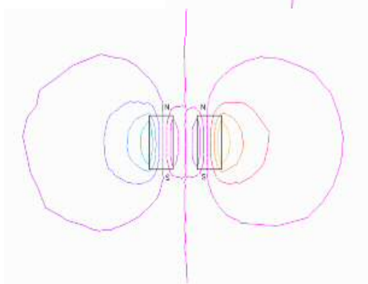
courtesy of Ansoft Maxwell 2D
Field Simulator

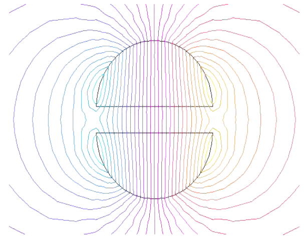










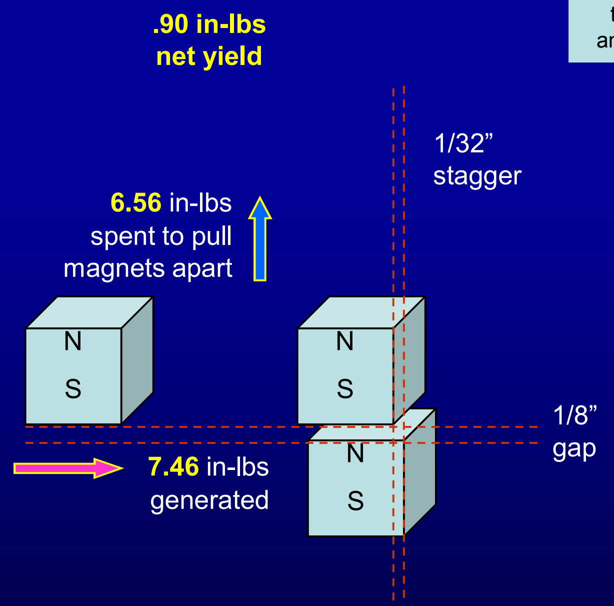


yield for attract forces using ¾"cubes (data and results)

Today's powerful permanent magnets can do far more work than merely pull themselves together. To put magnets to work, for example turning an electric generator, the magnets must come together and be pulled apart repeatedly. The amount of work (energy) required to pull them apart must be less than the amount of work produced by the magnets when they come together so that a net yield of work is available to turn a generator. When magnets of a particular shape are made to follow specific paths a useful net yield is available. Several models have been tested and the ones (to date) that produce the largest yields are presented here. Measurements have been made repeatedly to assure accuracy. Frictional forces were measured and deducted where appropriate from the measured magnetic forces. The amount of energy harnessed here is more than sufficient for practical use and can produce without pollution, very inexpensive electricity. The following section of this report provides an assessment of yield and practicality.

The attractive forces between the unlike-poles of two ¾ " square magnets pulls the magnets together in the horizontal plane (for a distance of approximately one-and-a-half inches) until they come to rest. The horizontal path traveled by the moving magnet is 1/8" above the surface of the stationary magnet. Force measurements reveal that the magnets are capable of generating 7.60 inch-pounds of work over the horizontal distance traveled. It is noted here that the magnets naturally come to rest 1/32" out of vertical alignment ("stagger"). Force measurements reveal that only 6.21 inch-pounds are required to pull the magnets "straight" apart along a perpendicular path leaving a net yield of .90 inch-pounds.

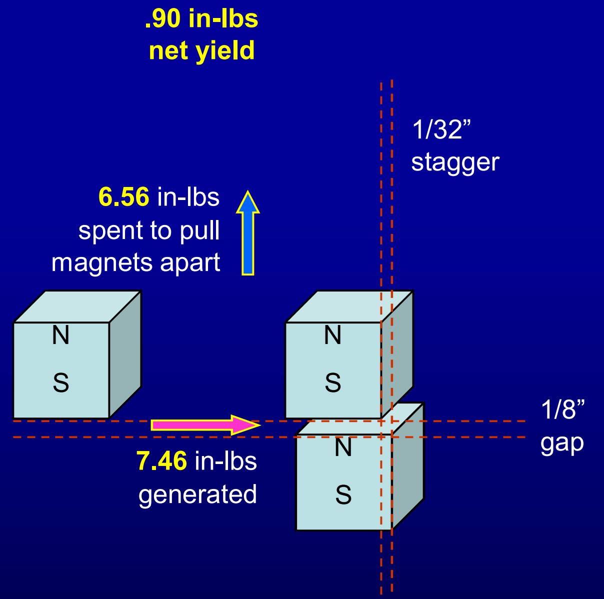
click here to start animation

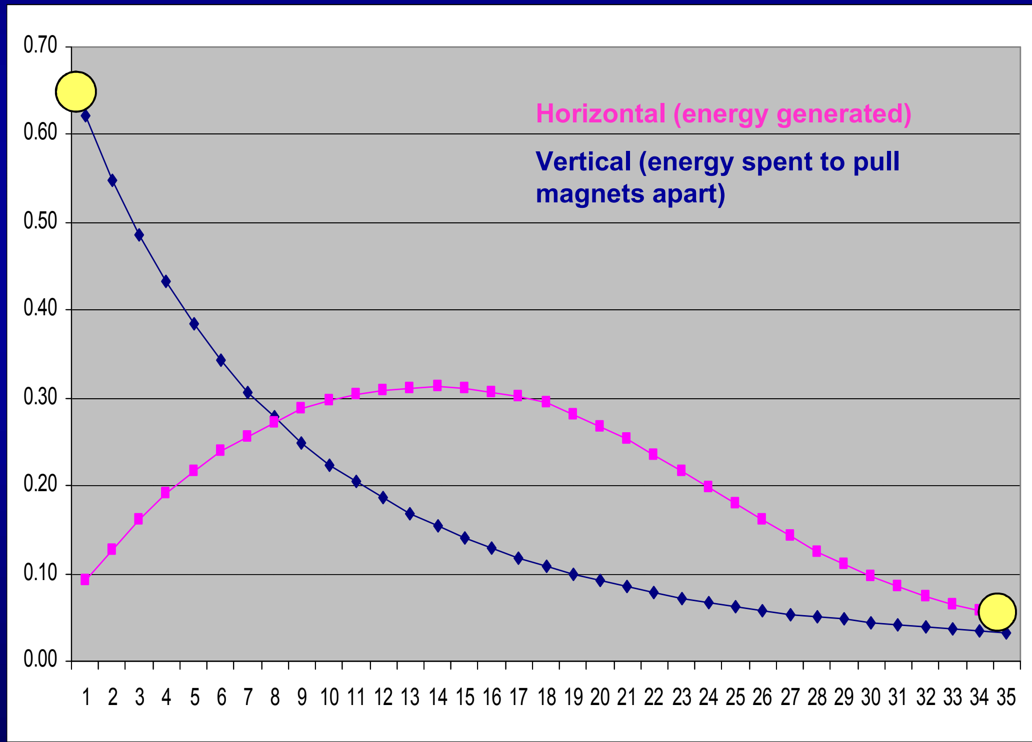


yield for attract forces using ¾” cubes (contd.)

The graph below shows the work (inch-pounds) generated by the magnets as they pull themselves together horizontally and the work required to separate the magnets in the perpendicular direction (vertically).

click here to start animation





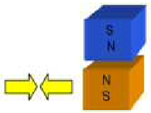
yield for attract forces using ¾” cubes (contd.)

The chart below shows the force measurements taken along the horizontal path of the moving magnet as it was pulled away from the stationary magnet at 1/32 inch intervals in three separate trials. To increase accuracy, average values for three trials were used as well as averaging the force measurements taken at 1/32” intervals.

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: April 2, 2007
FORCES: ATTRACT
DIRECTION: HORIZONTAL

MATERIAL:

Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 1.83 oz. (51.86 g)
Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss
BHmax: 38 MGOe



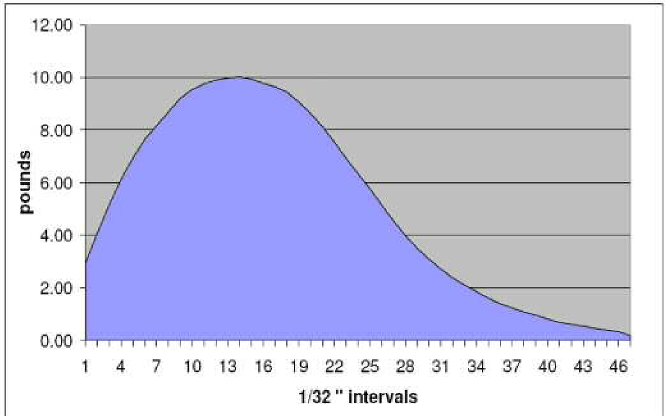
GAP: 2/16"
STAGGER: 1/32”
TEMP: 76-78°F
MEASUREMENTS: forces measured at rest at 1/16" intervals

8.47
INCH-POUNDS

FRICTION

15.1-20 lbs	8.97%
12.51-15 lbs	10.14%
10-12.5 lbs	11.31%
5.1-9.9 lbs	12.26%
0 - 5 lbs	13.20%

7.46
INCH-POUNDS minus friction



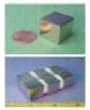
inches	trial one	trial two	trial three	average of three force in pounds at 1/32" intervals	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.	minus drag	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.
0											
1/32	2.68	2.82	2.74	2.75	0.09	3.41	0.11	2.38	0.07	2.96	0.09
1/16	4.04	4.12	4.04	4.07	0.13	4.68	0.15	3.53	0.11	4.08	0.13
3/32	5.28	5.28	5.30	5.29	0.17	5.88	0.18	4.64	0.14	5.15	0.16
1/8	6.38	6.50	6.52	6.47	0.20	6.98	0.22	5.67	0.18	6.12	0.19
5/32	7.46	7.52	7.48	7.49	0.23	7.92	0.25	6.57	0.21	6.95	0.22
3/16	8.30	8.34	8.42	8.35	0.26	8.72	0.27	7.33	0.23	7.65	0.24
7/32	9.06	9.08	9.14	9.09	0.28	9.31	0.29	7.97	0.25	8.16	0.26
1/4	9.58	9.34	9.66	9.53	0.30	9.84	0.31	8.35	0.26	8.68	0.27
9/32	10.08	10.18	10.20	10.15	0.32	10.36	0.32	9.01	0.28	9.19	0.29
5/16	10.50	10.58	10.64	10.57	0.33	10.74	0.34	9.38	0.29	9.53	0.30
11/32	10.90	10.90	10.92	10.91	0.34	10.99	0.34	9.67	0.30	9.75	0.30
3/8	11.10	11.06	11.08	11.08	0.35	11.14	0.35	9.83	0.31	9.88	0.31
13/32	11.14	11.24	11.22	11.20	0.35	11.24	0.35	9.93	0.31	9.97	0.31
7/16	11.24	11.30	11.30	11.28	0.35	11.28	0.35	10.01	0.31	10.01	0.31
15/32	11.26	11.30	11.28	11.28	0.35	11.20	0.35	10.01	0.31	9.93	0.31
1/2	11.12	11.10	11.14	11.12	0.35	11.02	0.34	9.86	0.31	9.77	0.31
17/32	10.92	10.86	10.96	10.91	0.34	10.87	0.34	9.68	0.30	9.64	0.30
9/16	10.74	10.86	10.86	10.82	0.34	10.63	0.33	9.60	0.30	9.43	0.29
19/32	10.40	10.46	10.48	10.45	0.33	10.21	0.32	9.27	0.29	9.05	0.28
5/8	9.94	9.96	10.00	9.97	0.31	9.78	0.31	8.84	0.28	8.63	0.27
21/32	9.58	9.62	9.60	9.60	0.30	9.27	0.29	8.42	0.26	8.13	0.25
11/16	8.92	8.96	8.92	8.93	0.28	8.61	0.27	7.83	0.24	7.55	0.24
23/32	8.24	8.32	8.28	8.28	0.26	7.88	0.25	7.26	0.23	6.91	0.22
3/4	7.48	7.50	7.48	7.49	0.23	7.21	0.23	6.57	0.21	6.33	0.20
25/32	6.90	6.94	6.98	6.94	0.22	6.56	0.21	6.09	0.19	5.76	0.18
13/16	6.18	6.18	6.20	6.19	0.19	5.85	0.18	5.43	0.17	5.13	0.16
27/32	5.50	5.54	5.50	5.51	0.17	5.20	0.16	4.84	0.15	4.54	0.14
7/8	4.90	4.88	4.88	4.89	0.15	4.59	0.14	4.24	0.13	3.99	0.12
29/32	4.28	4.34	4.28	4.30	0.13	4.04	0.13	3.73	0.12	3.50	0.11
15/16	3.76	3.78	3.78	3.77	0.12	3.56	0.11	3.28	0.10	3.09	0.10
31/32	3.34	3.34	3.34	3.34	0.10	3.14	0.10	2.90	0.09	2.72	0.09
1	2.92	2.92	2.96	2.93	0.09	2.75	0.09	2.55	0.08	2.38	0.07
1 1/32	2.54	2.54	2.60	2.56	0.08	2.40	0.08	2.22	0.07	2.09	0.07
1 1/16	2.24	2.24	2.26	2.25	0.07	2.11	0.07	1.95	0.06	1.83	0.06
1 3/32	1.98	1.98	1.98	1.98	0.06	1.84	0.06	1.72	0.05	1.60	0.05
1 1/8	1.70	1.70	1.70	1.70	0.05	1.60	0.05	1.48	0.05	1.39	0.04
1 5/32	1.52	1.46	1.52	1.50	0.05	1.41	0.04	1.30	0.04	1.22	0.04
1 3/16	1.30	1.32	1.32	1.31	0.04	1.24	0.04	1.14	0.04	1.08	0.03
1 7/32	1.16	1.18	1.18	1.17	0.04	1.09	0.03	1.02	0.03	0.95	0.03
1 1/4	1.00	1.02	1.02	1.01	0.03	0.94	0.03	0.88	0.03	0.82	0.03
1 9/32	0.84	0.88	0.88	0.87	0.03	0.80	0.02	0.75	0.02	0.69	0.02
1 5/16	0.72	0.74	0.72	0.73	0.02	0.69	0.02	0.63	0.02	0.60	0.02
1 11/32	0.66	0.66	0.66	0.66	0.02	0.61	0.02	0.57	0.02	0.53	0.02
1 3/8	0.50	0.58	0.60	0.56	0.02	0.52	0.02	0.49	0.02	0.45	0.01
1 13/32	0.46	0.50	0.50	0.49	0.02	0.45	0.01	0.42	0.01	0.39	0.01
1 7/16	0.34	0.44	0.44	0.41	0.01	0.38	0.01	0.35	0.01	0.33	0.01
1 15/32	0.32	0.38	0.38	0.36	0.01	0.18	0.01	0.31	0.01	0.16	0.00

yield for attract forces using ¾"cubes (contd.)

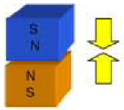
The chart below shows the force measurements taken along the vertical path of the moving magnet as it was pulled away from the stationary magnet at 1/32 inch intervals in three separate trials. To increase accuracy, average values for three trials were used as well as averaging the force measurements taken at 1/32" intervals.

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: April 2, 2007
FORCES: ATTRACT
DIRECTION: VERTICAL

MATERIAL:



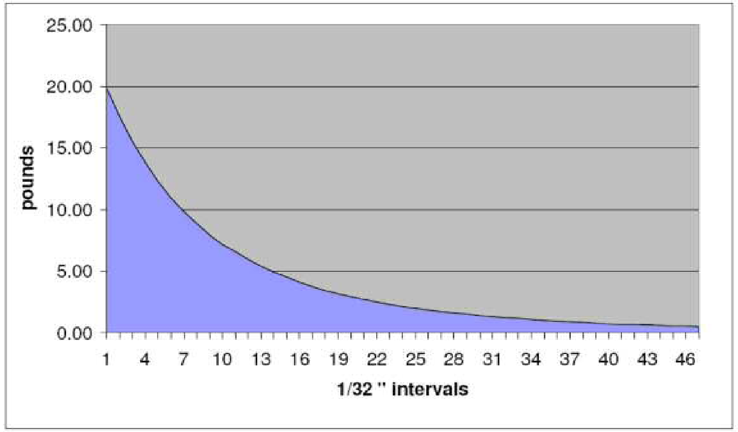
Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 1.83 oz. (51.86 g)
Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss
BHmax: 38 MGOe



GAP: 1/8"
STAGGER: 1/32"

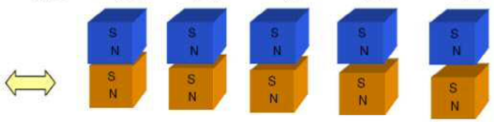
MEASUREMENTS: forces measured at rest at 1/16" intervals

6.71	0.06	6.56
INCH-POUNDS	**FRICTION**	**INCH-POUNDS minus friction**



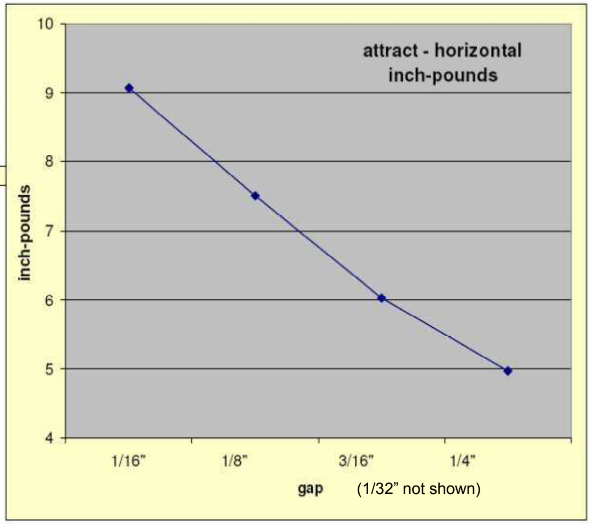
inches	trial one	trial two	trial three	average of three force in pounds at 1/32" intervals	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.	minus .06 drag	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.
0											
1/32											
1/16											
3/32											
1/8	21.28	21.24	21.18	21.23	0.66	19.94	0.62	21.17	0.66	19.88	0.62
5/32	18.62	18.68	18.66	18.65	0.58	17.59	0.55	18.59	0.58	17.53	0.55
3/16	16.52	16.54	16.52	16.53	0.52	15.61	0.49	16.47	0.51	15.55	0.49
7/32	14.72	14.76	14.58	14.69	0.46	13.89	0.43	14.63	0.46	13.83	0.43
1/4	13.16	13.08	13.02	13.09	0.41	12.35	0.39	13.03	0.41	12.29	0.38
9/32	11.60	11.68	11.58	11.62	0.36	11.00	0.34	11.56	0.36	10.94	0.34
5/16	10.38	10.40	10.38	10.39	0.32	9.89	0.31	10.33	0.32	9.83	0.31
11/32	9.40	9.42	9.38	9.40	0.29	8.94	0.28	9.34	0.29	8.88	0.28
3/8	8.46	8.48	8.50	8.48	0.27	8.01	0.25	8.42	0.26	7.95	0.25
13/32	7.26	7.66	7.68	7.53	0.24	7.24	0.23	7.47	0.23	7.18	0.22
7/16	6.98	6.94	6.94	6.95	0.22	6.64	0.21	6.89	0.22	6.58	0.21
15/32	6.32	6.30	6.34	6.32	0.20	6.02	0.19	6.26	0.20	5.96	0.19
1/2	5.72	5.70	5.72	5.71	0.18	5.46	0.17	5.65	0.18	5.40	0.17
17/32	5.22	5.22	5.18	5.21	0.16	4.99	0.16	5.15	0.16	4.93	0.15
9/16	4.78	4.78	4.76	4.77	0.15	4.57	0.14	4.71	0.15	4.51	0.14
19/32	4.36	4.34	4.38	4.36	0.14	4.17	0.13	4.30	0.13	4.11	0.13
5/8	3.98	3.98	3.98	3.98	0.12	3.81	0.12	3.92	0.12	3.75	0.12
21/32	3.64	3.64	3.64	3.64	0.11	3.49	0.11	3.58	0.11	3.43	0.11
11/16	3.34	3.34	3.36	3.35	0.10	3.22	0.10	3.29	0.10	3.16	0.10
23/32	3.08	3.14	3.08	3.10	0.10	2.98	0.09	3.04	0.10	2.92	0.09
3/4	2.82	2.90	2.88	2.87	0.09	2.76	0.09	2.81	0.09	2.70	0.08
25/32	2.62	2.68	2.66	2.65	0.08	2.55	0.08	2.59	0.08	2.49	0.08
13/16	2.42	2.50	2.44	2.45	0.08	2.36	0.07	2.39	0.07	2.30	0.07
27/32	2.22	2.30	2.26	2.26	0.07	2.19	0.07	2.20	0.07	2.13	0.07
7/8	2.08	2.16	2.10	2.11	0.07	2.04	0.06	2.05	0.06	1.98	0.06
29/32	1.94	2.02	1.96	1.97	0.06	1.90	0.06	1.91	0.06	1.84	0.06
15/16	1.78	1.86	1.86	1.83	0.06	1.79	0.06	1.77	0.06	1.73	0.05
31/32	1.74	1.76	1.74	1.75	0.05	1.69	0.05	1.69	0.05	1.63	0.05
1	1.64	1.62	1.62	1.63	0.05	1.58	0.05	1.57	0.05	1.52	0.05
1 1/32	1.54	1.54	1.50	1.53	0.05	1.47	0.05	1.47	0.05	1.41	0.04
1 1/16	1.42	1.42	1.38	1.41	0.04	1.37	0.04	1.35	0.04	1.31	0.04
1 3/32	1.36	1.34	1.32	1.34	0.04	1.29	0.04	1.28	0.04	1.23	0.04
1 1/8	1.26	1.24	1.24	1.25	0.04	1.21	0.04	1.19	0.04	1.15	0.04
1 5/32	1.18	1.18	1.18	1.18	0.04	1.14	0.04	1.12	0.04	1.08	0.03
1 3/16	1.10	1.12	1.10	1.11	0.03	1.07	0.03	1.05	0.03	1.01	0.03
1 7/32	1.04	1.04	1.00	1.03	0.03	1.00	0.03	0.97	0.03	0.94	0.03
1 1/4	0.98	0.98	0.96	0.97	0.03	0.95	0.03	0.91	0.03	0.89	0.03
1 9/32	0.92	0.94	0.90	0.92	0.03	0.90	0.03	0.86	0.03	0.84	0.03
1 5/16	0.84	0.90	0.88	0.87	0.03	0.84	0.03	0.81	0.03	0.78	0.02
1 11/32	0.82	0.82	0.80	0.81	0.03	0.79	0.02	0.75	0.02	0.73	0.02
1 3/8	0.78	0.78	0.76	0.77	0.02	0.76	0.02	0.71	0.02	0.70	0.02
1 13/32	0.74	0.74	0.74	0.74	0.02	0.72	0.02	0.68	0.02	0.66	0.02
1 7/16	0.70	0.70	0.68	0.69	0.02	0.68	0.02	0.63	0.02	0.62	0.02
1 15/32	0.66	0.68	0.66	0.67	0.02	0.65	0.02	0.61	0.02	0.59	0.02
1 1/2	0.62	0.66	0.62	0.63	0.02	0.61	0.02	0.57	0.02	0.55	0.02

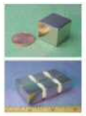
ATTRACT FORCES - HORIZONTAL



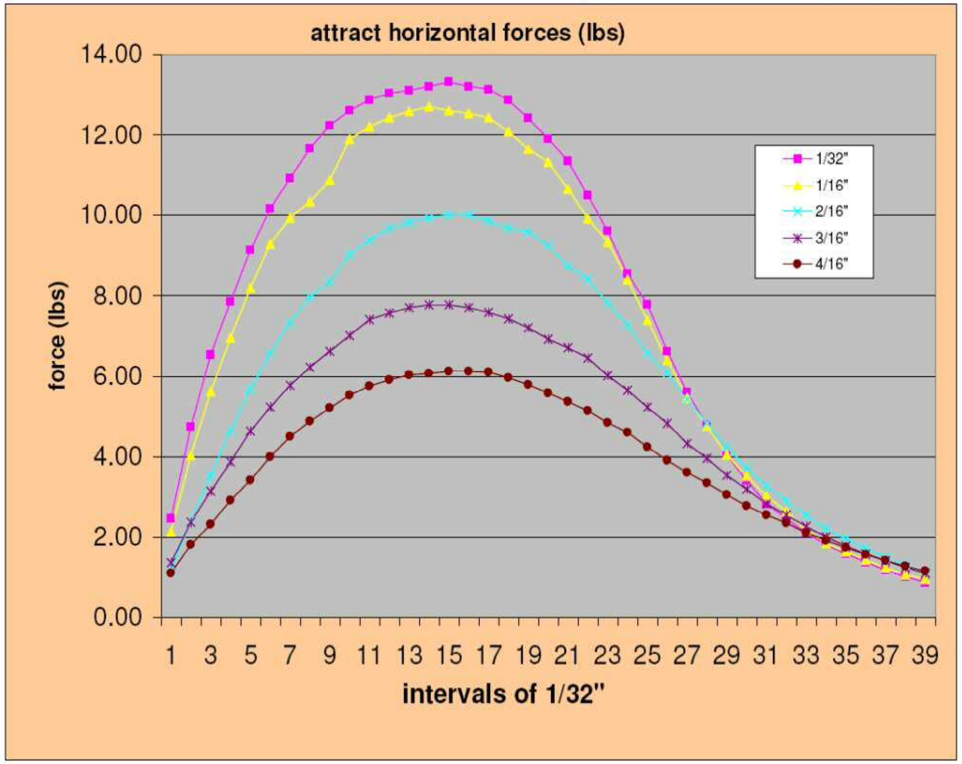
gaps	1/32"	1/16"	1/8"	3/16"	1/4"
inch-lbs.	9.60	9.07	7.51	6.03	4.97

intervals inches	force (average)	force (average)	force (average)	force (average)	force (average)
0	2.45	2.12	1.16	1.35	1.09
1/32	4.74	4.03	2.38	2.37	1.81
1/16	6.53	5.61	3.53	3.13	2.31
3/32	7.86	6.96	4.64	3.87	2.92
1/8	9.13	8.20	5.67	4.63	3.43
5/32	10.16	9.30	6.57	5.24	4.00
3/16	10.93	9.94	7.33	5.78	4.49
7/32	11.67	10.34	7.97	6.22	4.89
1/4	12.24	10.89	8.35	6.63	5.22
9/32	12.61	11.88	9.01	7.00	5.53
5/16	12.89	12.20	9.38	7.40	5.75
11/32	13.05	12.43	9.67	7.57	5.91
3/8	13.11	12.59	9.83	7.71	6.03
13/32	13.22	12.71	9.93	7.78	6.06
7/16	13.32	12.60	10.01	7.77	6.12
15/32	13.22	12.54	10.01	7.71	6.12
1/2	13.14	12.43	9.86	7.58	6.11
17/32	12.87	12.08	9.68	7.42	5.96
9/16	12.41	11.64	9.60	7.20	5.79
19/32	11.90	11.33	9.27	6.92	5.58
5/8	11.35	10.64	8.74	6.71	5.37
21/32	10.50	9.92	8.42	6.44	5.14
11/16	9.61	9.34	7.83	6.02	4.85
23/32	8.54	8.41	7.26	5.64	4.60
3/4	7.79	7.40	6.57	5.24	4.24
25/32	6.63	6.40	6.09	4.82	3.91
13/16	5.60	5.45	5.43	4.33	3.61
27/32	4.79	4.75	4.84	3.95	3.34
7/8	4.03	4.04	4.24	3.54	3.06
29/32	3.42	3.52	3.73	3.18	2.77
15/16	2.82	3.02	3.28	2.82	2.54
31/32	2.46	2.64	2.90	2.55	2.36
1	2.11	2.18	2.55	2.27	2.12
1 1/32	1.81	1.85	2.22	2.00	1.92
1 1/16	1.58	1.64	1.95	1.78	1.74
1 3/32	1.37	1.43	1.72	1.58	1.57
1 1/8	1.17	1.23	1.48	1.41	1.41
1 5/32	1.01	1.06	1.30	1.24	1.27
1 3/16	0.87	0.95	1.14	1.09	1.15
1 7/32	0.77	0.80	1.02	0.99	1.04
1 1/4	0.65	0.69	0.88	0.87	0.94
1 9/32	0.60	0.57	0.75	0.74	0.82
1 5/16	0.49	0.50	0.63	0.67	0.75
1 11/32	0.43	0.43	0.57	0.58	0.67
1 3/8	0.37	0.38	0.49	0.52	0.60
1 13/32	0.30	0.31	0.42	0.45	0.52
1 7/16	0.00	0.00	0.35	0.38	0.47
1 15/32	0.00	0.00	0.31	0.33	0.40
1 1/2	0.00	0.00	0.00	0.29	0.38
1 17/32	0.00	0.00	0.00	0.00	0.35
1 9/16	0.00	0.00	0.00	0.00	0.30
1 19/32	0.00	0.00	0.00	0.00	0.23
1 5/8	0.00	0.00	0.00	0.00	0.00
1 21/32	0.00	0.00	0.00	0.00	0.00





Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 1.83 oz. (51.86 g)
Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss
BHmax: 38 MGOe

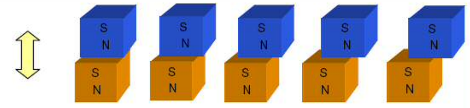


yield for attract forces using ¾" cubes (contd.)

The chart and graphs show the forces generated at 1/32" intervals between the two magnets along the various horizontal paths taken by the moving magnet. As expected, mechanical energy (work measured in inch-pounds) decreases proportionally to an increase in the horizontal "gap".

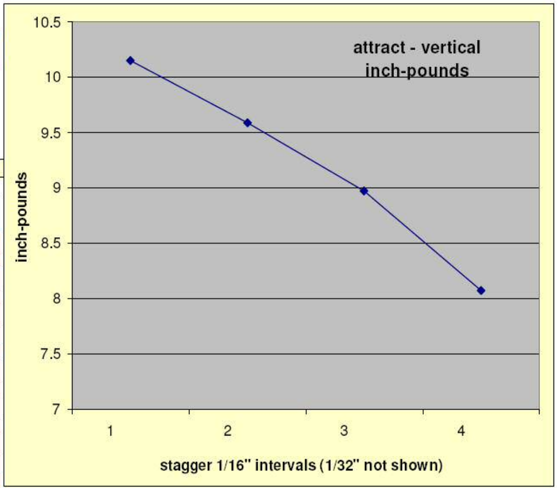
ATTRACT FORCES - VERTICAL

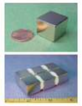
stagger	1/32	1/16	1/8	3/16	1/4



inch-lbs.	10.23	10.15	9.59	8.97	8.07

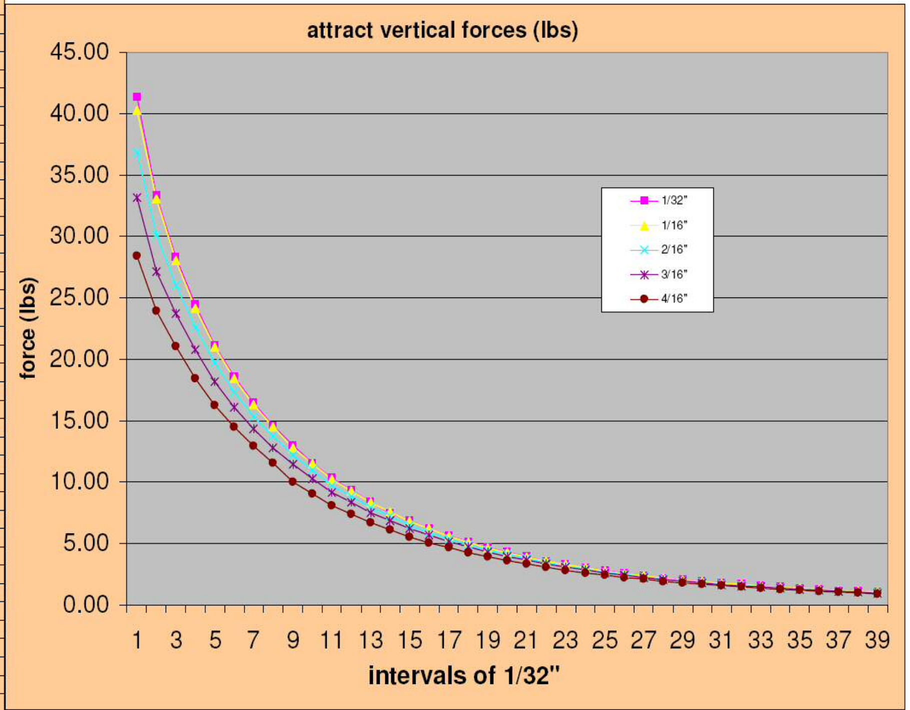
intervals inches	force (average)	force (average)	force (average)	force (average)	force (average)
0	41.37	40.25	36.82	33.14	28.42
1/32	33.31	33.05	30.13	27.15	23.93
1/16	28.30	28.03	26.01	23.70	21.04
3/32	24.48	24.17	22.61	20.82	18.44
1/8	21.17	20.99	19.73	18.19	16.28
5/32	18.59	18.43	17.35	16.11	14.50
3/16	16.47	16.30	15.38	14.34	12.93
7/32	14.63	14.52	13.78	12.77	11.57
1/4	13.03	12.81	12.21	11.44	10.03
9/32	11.56	11.50	10.97	10.28	9.04
5/16	10.33	10.23	9.72	9.18	8.13
11/32	9.34	9.28	8.83	8.37	7.41
3/8	8.42	8.35	7.97	7.53	6.74
13/32	7.47	7.55	7.23	6.87	6.14
7/16	6.89	6.80	6.52	6.23	5.57
15/32	6.26	6.23	5.92	5.69	5.09
1/2	5.65	5.62	5.39	5.19	4.67
17/32	5.15	5.09	4.91	4.73	4.27
9/16	4.71	4.65	4.50	4.33	3.93
19/32	4.30	4.28	4.13	3.97	3.61
5/8	3.92	3.90	3.78	3.66	3.34
21/32	3.58	3.59	3.47	3.36	3.07
11/16	3.29	3.29	3.17	3.09	2.82
23/32	3.04	3.03	2.93	2.85	2.63
3/4	2.81	2.79	2.69	2.63	2.43
25/32	2.59	2.57	2.50	2.45	2.25
13/16	2.39	2.37	2.31	2.25	2.11
27/32	2.20	2.20	2.15	2.09	1.94
7/8	2.05	2.05	1.99	1.95	1.80
29/32	1.91	1.91	1.84	1.80	1.70
15/16	1.77	1.76	1.71	1.67	1.58
31/32	1.69	1.69	1.61	1.57	1.47
1	1.57	1.56	1.51	1.47	1.36
1 1/32	1.47	1.45	1.39	1.38	1.27
1 1/16	1.35	1.36	1.30	1.30	1.20
1 3/32	1.28	1.28	1.22	1.20	1.13
1 1/8	1.19	1.19	1.13	1.12	1.07
1 5/32	1.12	1.12	1.07	1.06	1.01
1 3/16	1.05	1.05	1.00	0.98	0.93
1 7/32	0.97	0.98	0.94	0.93	0.89
1 1/4	0.91	0.93	0.89	0.88	0.82
1 9/32	0.86	0.87	0.86	0.83	0.77
1 5/16	0.81	0.83	0.80	0.76	0.72
1 11/32	0.75	0.77	0.76	0.73	0.69
1 3/8	0.71	0.72	0.72	0.68	0.66
1 13/32	0.68	0.68	0.68	0.66	0.63
1 7/16	0.63	0.65	0.66	0.62	0.58
1 15/32	0.61	0.62	0.62	0.60	0.55
1 1/2	0.57	0.59	0.60	0.54	0.52
1 17/32	0.53	0.54	0.55	0.52	0.50
1 9/16	0.51	0.52	0.50	0.50	0.48
1 19/32	0.49	0.50	0.46	0.46	0.46
1 5/8	0.48	0.47	0.44	0.46	0.44
1 21/32	0.44	0.45	0.42	0.44	0.42
1 11/16	0.42	0.43	0.40	0.40	0.41
1 23/32	0.40	0.40	0.39	0.40	0.39
1 3/4	0.38	0.38	0.34	0.38	0.38
1 25/32	0.34	0.34	0.34	0.32	0.34
1 13/16	0.32	0.34	0.32	0.32	0.32





Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness

Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss
BHmax: 38 MGOe



yield for attract forces using ¾" cubes (contd.)

The chart and graphs show the forces generated at 1/32" intervals between the two magnets along the various vertical paths taken by the moving magnet. As expected, mechanical energy (work measured in inch-pounds) decreases proportionately to an increase in the vertical "stagger".

The smooth, evenly spaced curves indicate that the measurements are consistent and strongly suggest that they are accurate.

yield for attract forces using ¾" cubes (contd.)

The chart below compares the various energy yields (inch-pounds) in the horizontal (yellow) and vertical (green) directions. The difference in yield ("net yield") for each set of horizontal and vertical yields are also shown (orange). The largest net yields occur when the horizontal path of the moving magnet is 1/16" - 1/8" away from the surface of the fixed magnet. This occurs because vertical yield decreases disproportionately compared to horizontal yield as the "gap" between the magnets increases. The distribution of force between magnets moving together along a horizontal path is very different compared to the distribution of force along a vertical path (see previous slides).

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: April , 2007
FORCES: ATTRACT
DIRECTION: VERTICAL and HORIZONTAL
MEASUREMENTS: forces measured at rest at 1/32" intervals

MATERIAL:

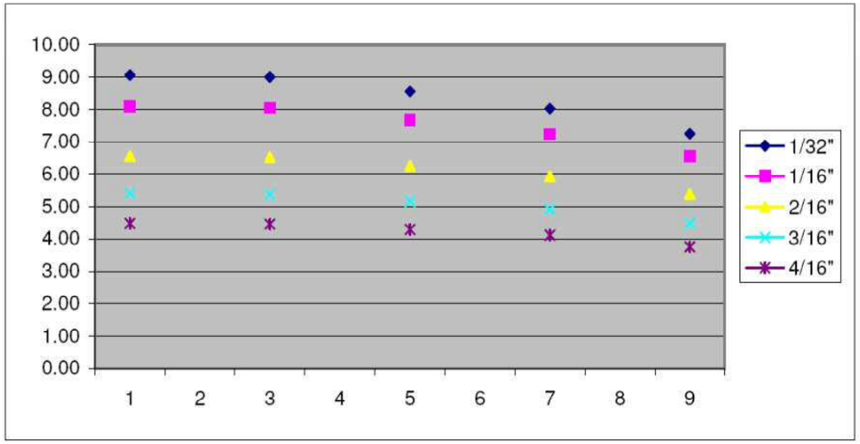

Dimensions: 3/4" x 3/4" x 3/4" thick
Material: NdFeB, Grade N38
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru thickness
Weight: 1.83 oz. (51.86 g)
Pull Force: 43.40 lbs
Surface Field: 5860 Gauss
Brmax: 12,600 Gauss

ATTRACT MATRIX - COMPARES IN-LB VALUES
FOR HORIZONTAL AND VERTICAL

orange boxes contain net-yields for adjacent values

	stagger 1/32	stagger 1/16	stagger 1/8	stagger 3/16	stagger 1/4
	9.07	9.00	8.55	8.03	7.25
gap 1/32	9.49	9.31	8.82	8.19	7.47
	0.42	0.31	0.27	0.16	0.22
	8.10	8.05	7.67	7.24	6.55
gap 1/16	8.98	8.83	8.39	7.82	7.17
	0.88	0.78	0.72	0.58	0.62
	6.56	**6.53**	6.25	5.93	5.39
gap 1/8	7.46	7.36	7.07	6.67	6.17
	0.90	0.83	0.82	0.74	0.78
	5.40	5.37	5.16	4.92	4.48
gap 3/16	5.97	5.89	5.65	5.32	4.93
	0.57	0.52	0.49	0.40	0.45
	4.48	4.46	4.29	4.12	3.76
gap 1/4	4.92	4.86	4.68	4.43	4.12
	0.44	0.40	0.39	0.31	0.36

9.07	9.00	8.55	8.03	7.25
8.10	8.05	7.67	7.24	6.55
6.56	6.53	6.25	5.93	5.39
5.40	5.37	5.16	4.92	4.48
4.48	4.46	4.29	4.12	3.76



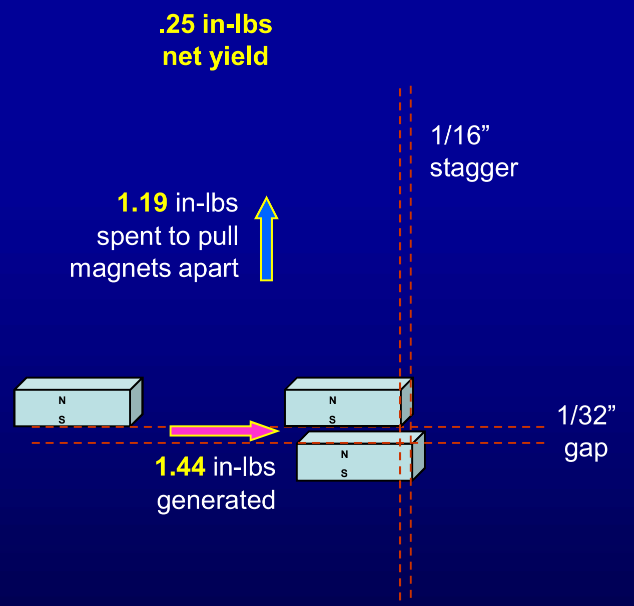
The above chart and graph compares the magnetic forces (inch-pounds) generated by the two magnets as the pull together along different vertical paths.

yield for attract forces using thin (1/8” x ¾” x ¾”) magnets (data and results)

Today’s powerful permanent magnets can do far more work than merely pull themselves together. To put magnets to work, for example turning an electric generator, the magnets must come together and be pulled apart repeatedly. The amount of work (energy) required to pull them apart must be less than the amount of work produced by the magnets when they come together so that a net yield of work is available to turn a generator. When magnets of a particular shape are made to follow specific paths a useful net yield is available. Several models have been tested and the ones (to date) that produce the largest yields are presented here. Measurements have been made repeatedly to assure accuracy. Frictional forces were measured and deducted where appropriate from the measured magnetic forces. The amount of energy harnessed here is more than sufficient for practical use and can produce without pollution, very inexpensive electricity. The following section of this report provides an assessment of yield and practicality.

The attractive forces between two thin magnets measuring 1/8” x ¾“ x ¾” pull them together in the horizontal plane until they come to rest. The horizontal path traveled by the moving magnet is 1/32” (gap) above the surface of the stationary magnet. The vertical plane traveled by the moving magnet is 1/16” staggered. (It is noted here that the magnets naturally come to rest 1/32” out of vertical alignment).

Force measurements reveal that the magnets are capable of generating 7.60 inch-pounds of work over the horizontal distance traveled and only 6.21 inch-pounds over the vertical distance traveled. Accordingly, less work is required to pull the magnets straight (vertically) apart compared to the amount of work generated horizontally.

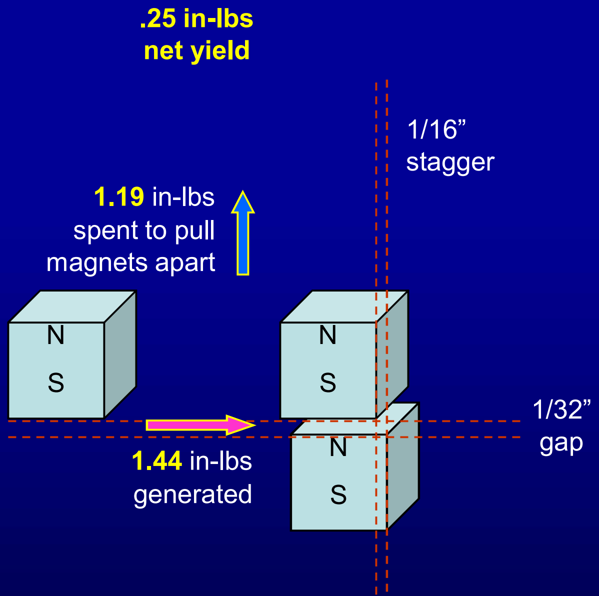


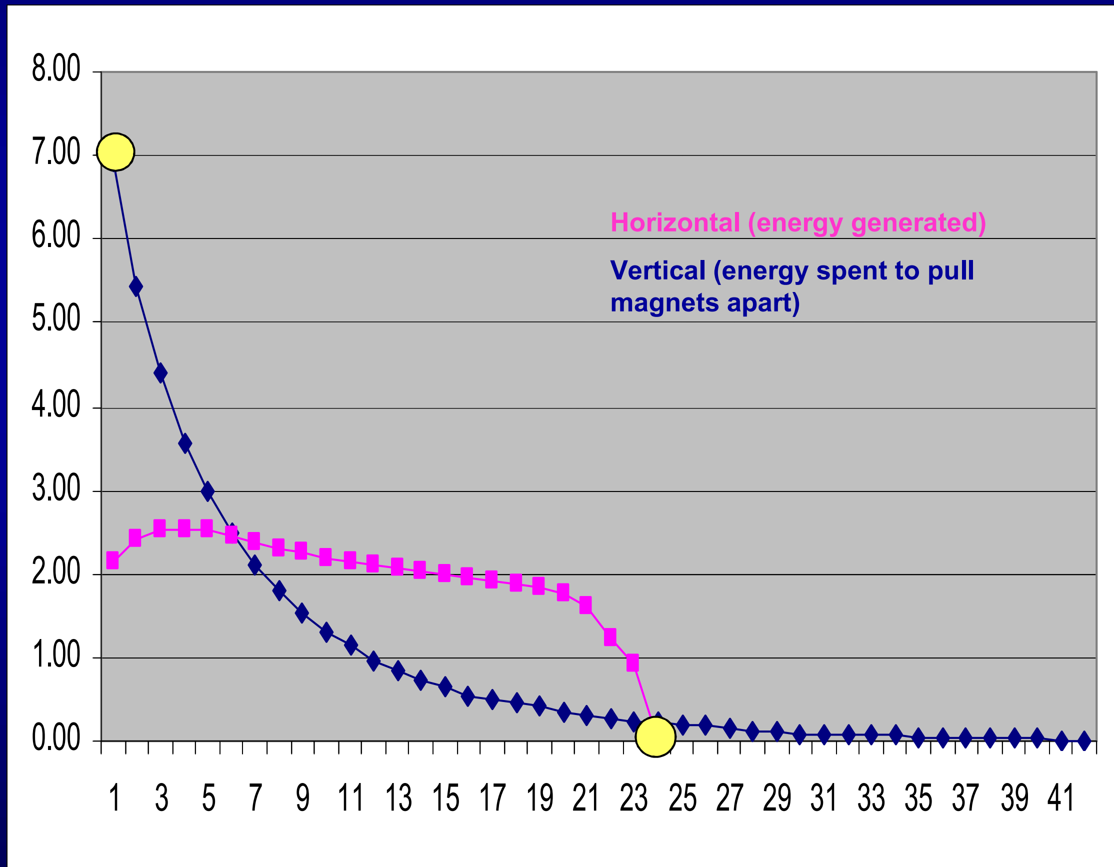
click here to start animation

yield for attract forces using thin (1/8" x ¾" x ¾") magnets (contd.)

The animated graph below shows the work (inch-pounds) generated by the magnets as they pull themselves together horizontally and the work required to separate the magnets in the perpendicular direction (vertically).

click here to start animation



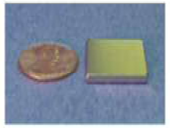


yield for attract forces using thin (1/8" x ¾" x ¾") magnets (contd.)

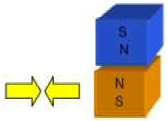
The chart below shows the force measurements taken along the horizontal path of the moving magnet as it was pulled away from the stationary magnet at 1/32 inch intervals in three separate trials. To increase accuracy, average values for three trials were used as well as averaging the force measurements taken at 1/32" intervals. The attractive force between these thin magnets in the horizontal plane ended short and abruptly (compared to square magnets) by becoming a repelling force.

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: May 1, 2007
FORCES: ATTRACT
DIRECTION: HORIZONTAL

MATERIAL:



Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru Thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe



GAP: 1/32"
STAGGER: 1/16"
TEMP: 77°F

MEASUREMENTS: forces measured at rest at 1/32" intervals

1.66

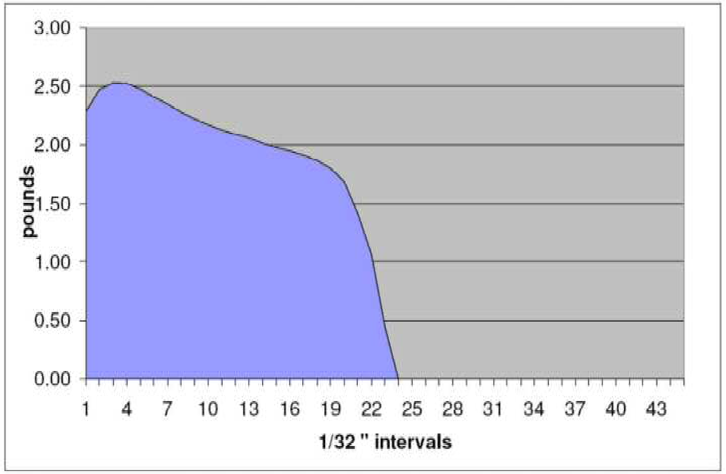
INCH-POUNDS

FRICTION

15.1-20 lbs	9.0%
12.51-15 lbs	10.1%
10-12.5 lbs	11.3%
5.1-9.9 lbs	12.3%
0 - 5 lbs	13.2%

1.44

INCH-POUNDS minus friction



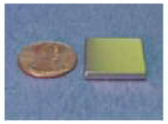
at 1/64 inches	1.44 trial one	1.42 trial two	1.42 trial three	average of three force in pounds at 1/32" intervals	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.	minus drag	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.
0											
1/32											
1/16	2.44	2.50	2.50	2.48	0.08	2.63	0.08	2.15	0.07	2.28	0.07
3/32	2.74	2.82	2.78	2.78	0.09	2.84	0.09	2.41	0.08	2.47	0.08
1/8	2.92	2.90	2.90	2.91	0.09	2.92	0.09	2.52	0.08	2.53	0.08
5/32	2.92	2.94	2.92	2.93	0.09	2.91	0.09	2.54	0.08	2.53	0.08
3/16	2.94	2.86	2.88	2.89	0.09	2.85	0.09	2.51	0.08	2.47	0.08
7/32	2.82	2.78	2.82	2.81	0.09	2.78	0.09	2.44	0.08	2.41	0.08
1/4	2.72	2.76	2.76	2.75	0.09	2.70	0.08	2.38	0.07	2.35	0.07
9/32	2.66	2.66	2.66	2.66	0.08	2.62	0.08	2.31	0.07	2.28	0.07
5/16	2.60	2.56	2.60	2.59	0.08	2.56	0.08	2.25	0.07	2.22	0.07
11/32	2.52	2.52	2.54	2.53	0.08	2.50	0.08	2.19	0.07	2.17	0.07
3/8	2.48	2.48	2.46	2.47	0.08	2.45	0.08	2.15	0.07	2.12	0.07
13/32	2.42	2.42	2.42	2.42	0.08	2.41	0.08	2.10	0.07	2.09	0.07
7/16	2.40	2.40	2.38	2.39	0.07	2.37	0.07	2.08	0.06	2.06	0.06
15/32	2.34	2.38	2.32	2.35	0.07	2.32	0.07	2.04	0.06	2.01	0.06
1/2	2.30	2.32	2.26	2.29	0.07	2.28	0.07	1.99	0.06	1.98	0.06
17/32	2.26	2.28	2.24	2.26	0.07	2.24	0.07	1.96	0.06	1.95	0.06
9/16	2.22	2.24	2.22	2.23	0.07	2.20	0.07	1.93	0.06	1.91	0.06
19/32	2.18	2.18	2.18	2.18	0.07	2.15	0.07	1.89	0.06	1.87	0.06
5/8	2.10	2.10	2.16	2.12	0.07	2.07	0.06	1.84	0.06	1.80	0.06
21/32	2.02	2.02	2.04	2.03	0.06	1.94	0.06	1.76	0.05	1.68	0.05
11/16	1.84	1.86	1.86	1.85	0.06	1.63	0.05	1.61	0.05	1.42	0.04
23/32	1.40	1.42	1.42	1.41	0.04	1.23	0.04	1.23	0.04	1.06	0.03
3/4	1.04	1.04	1.04	1.04	0.03	0.52	0.02	0.90	0.03	0.45	0.01
25/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13/16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/8				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15/16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 1/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 1/16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 3/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 1/8				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 5/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 3/16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 7/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 1/4				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 9/32				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 5/16				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

yield for attract forces using thin (1/8" x ¾" x ¾") magnets (contd.)

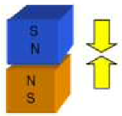
The chart below shows the force measurements taken along the vertical path of the moving magnet as it was pulled away from the stationary magnet at 1/32 inch intervals in three separate trials. To increase accuracy, average values for three trials were used as well as averaging the force measurements taken at 1/32" intervals.

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: May 1, 2007
FORCES: ATTRACT
DIRECTION: VERTICAL

MATERIAL:

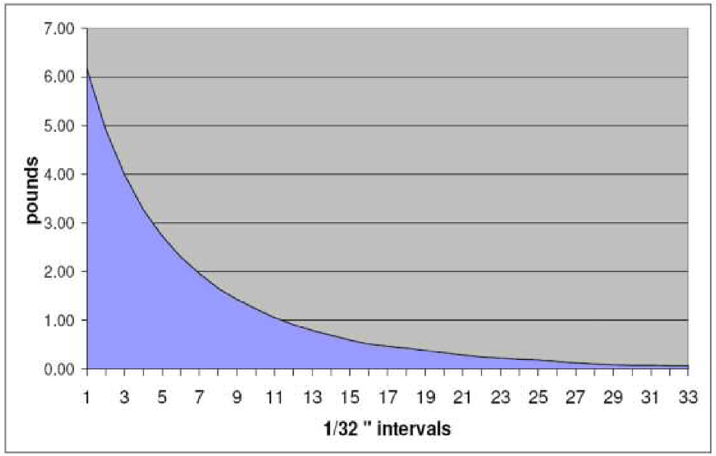


Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru Thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe



GAP: 1/32"
STAGGER: 1/16"
MEASUREMENTS: forces measured at rest at 1/16" intervals

1.27	0.06	1.19
INCH-POUNDS	FRICTION	INCH-POUNDS minus friction

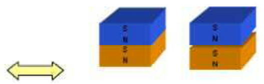


inches	trial one	trial two	trial three	average of three force in pounds at 1/32" intervals	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.	minus .06 drag	force X .03125" = lbs X in.	force averages	average force X .03125" = lbs X in.
0											
1/32	7.06	6.90	7.00	6.99	0.22	6.24	0.19	6.93	0.22	6.18	0.19
1/16	5.48	5.56	5.42	5.49	0.17	4.98	0.16	5.43	0.17	4.92	0.15
3/32	4.46	4.50	4.46	4.47	0.14	4.05	0.13	4.41	0.14	3.99	0.12
1/8	3.64	3.64	3.62	3.63	0.11	3.34	0.10	3.57	0.11	3.28	0.10
5/32	3.04	3.08	3.04	3.05	0.10	2.80	0.09	2.99	0.09	2.74	0.09
3/16	2.54	2.54	2.54	2.54	0.08	2.36	0.07	2.48	0.08	2.30	0.07
7/32	2.16	2.18	2.20	2.18	0.07	2.01	0.06	2.12	0.07	1.95	0.06
1/4	1.84	1.84	1.86	1.85	0.06	1.72	0.05	1.79	0.06	1.66	0.05
9/32	1.58	1.58	1.62	1.59	0.05	1.49	0.05	1.53	0.05	1.43	0.04
5/16	1.36	1.38	1.40	1.38	0.04	1.29	0.04	1.32	0.04	1.23	0.04
11/32	1.20	1.20	1.22	1.21	0.04	1.12	0.04	1.15	0.04	1.06	0.03
3/8	1.02	1.04	1.04	1.03	0.03	0.97	0.03	0.97	0.03	0.91	0.03
13/32	0.90	0.92	0.92	0.91	0.03	0.85	0.03	0.85	0.03	0.79	0.02
7/16	0.78	0.80	0.80	0.79	0.02	0.75	0.02	0.73	0.02	0.69	0.02
15/32	0.70	0.72	0.72	0.71	0.02	0.66	0.02	0.65	0.02	0.60	0.02
1/2	0.60	0.62	0.62	0.61	0.02	0.58	0.02	0.55	0.02	0.52	0.02
17/32	0.52	0.56	0.56	0.55	0.02	0.53	0.02	0.49	0.02	0.47	0.01
9/16	0.48	0.54	0.54	0.52	0.02	0.50	0.02	0.46	0.01	0.44	0.01
19/32	0.44	0.48	0.50	0.47	0.01	0.45	0.01	0.41	0.01	0.39	0.01
5/8	0.38	0.44	0.44	0.42	0.01	0.40	0.01	0.36	0.01	0.34	0.01
21/32	0.34	0.38	0.40	0.37	0.01	0.35	0.01	0.31	0.01	0.29	0.01
11/16	0.30	0.34	0.36	0.33	0.01	0.32	0.01	0.27	0.01	0.26	0.01
23/32	0.26	0.32	0.32	0.30	0.01	0.29	0.01	0.24	0.01	0.23	0.01
3/4	0.26	0.28	0.30	0.28	0.01	0.27	0.01	0.22	0.01	0.21	0.01
25/32	0.24	0.26	0.28	0.26	0.01	0.25	0.01	0.20	0.01	0.19	0.01
13/16	0.22	0.24	0.24	0.23	0.01	0.22	0.01	0.17	0.01	0.16	0.01
27/32	0.18	0.22	0.22	0.21	0.01	0.19	0.01	0.15	0.00	0.13	0.00
7/8	0.16	0.18	0.20	0.18	0.01	0.17	0.01	0.12	0.00	0.11	0.00
29/32	0.14	0.18	0.18	0.17	0.01	0.16	0.01	0.11	0.00	0.10	0.00
15/16	0.14	0.16	0.16	0.15	0.00	0.15	0.00	0.09	0.00	0.09	0.00
31/32	0.14	0.14	0.16	0.15	0.00	0.14	0.00	0.09	0.00	0.08	0.00
1	0.12	0.14	0.16	0.14	0.00	0.13	0.00	0.08	0.00	0.07	0.00
1 1/32	0.12	0.12	0.14	0.13	0.00	0.13	0.00	0.07	0.00	0.07	0.00
1 1/16	0.12	0.12	0.14	0.13	0.00	0.12	0.00	0.07	0.00	0.06	0.00
1 3/32	0.10	0.12	0.12	0.11	0.00	0.11	0.00	0.05	0.00	0.05	0.00
1 1/8	0.10	0.10	0.12	0.11	0.00	0.10	0.00	0.05	0.00	0.04	0.00
1 5/32	0.10	0.10	0.10	0.10	0.00	0.10	0.00	0.04	0.00	0.04	0.00
1 3/16	0.08	0.10	0.10	0.09	0.00	0.09	0.00	0.03	0.00	0.03	0.00
1 7/32	0.08	0.08	0.10	0.09	0.00	0.08	0.00	0.03	0.00	0.02	0.00
1 1/4	0.08	0.08	0.08	0.08	0.00	0.08	0.00	0.02	0.00	0.02	0.00
1 9/32	0.06	0.08	0.08	0.07	0.00	0.07	0.00	0.01	0.00	0.01	0.00
1 5/16	0.06	0.06	0.06	0.06	0.00	0.03	0.00	0.00	0.00	0.00	0.00

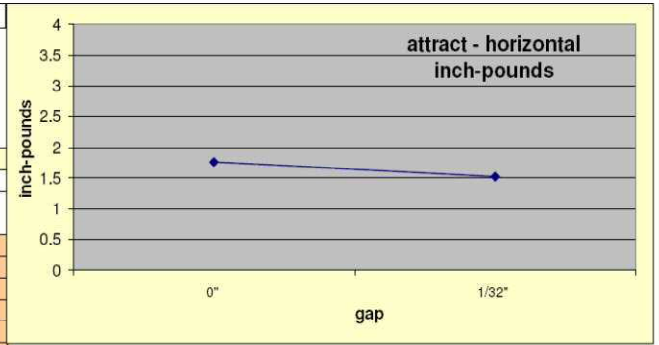
yield for attract forces using thin (1/8” x ¾” x ¾”) magnets (contd.)

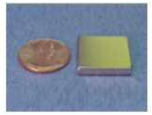
The chart and graphs below show the forces generated at 1/32” intervals between the two magnets along two horizontal paths taken by the moving magnet. The attractive force between these thin magnets in the horizontal plane ended short and abruptly (compared to square magnets) by becoming a repelling force.

ATTRACT FORCES - HORIZONTAL



gaps	none	1/32			
inch-lbs.	1.76	1.52			
intervals inches	force (average)	force (average)	force (average)	force (average)	force (average)
0	0.00	0.00			
1/32	2.25	1.61			
1/16	2.82	2.15			
3/32	3.02	2.41			
1/8	3.03	2.52			
5/32	2.96	2.54			
3/16	2.88	2.51			
7/32	2.77	2.44			
1/4	2.67	2.38			
9/32	2.57	2.31			
5/16	2.50	2.25			
11/32	2.40	2.19			
3/8	2.35	2.15			
13/32	2.31	2.10			
7/16	2.27	2.08			
15/32	2.25	2.04			
1/2	2.22	1.99			
17/32	2.20	1.96			
9/16	2.20	1.93			
19/32	2.18	1.89			
5/8	2.16	1.84			
21/32	2.09	1.76			
11/16	1.94	1.61			
23/32	1.46	1.23			
3/4	0.74	0.90			
25/32	0.00	0.00			
13/16					
27/32					
7/8					
29/32					
15/16					
31/32					
1					



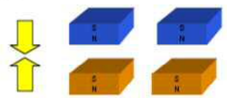


Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru Thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe

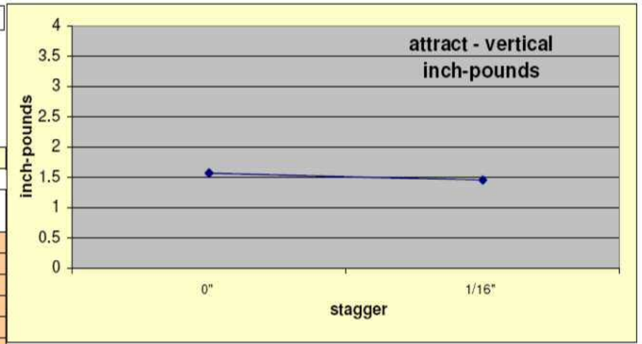
yield for attract forces using thin (1/8” x ¾” x ¾”) magnets (contd.)

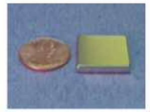
The chart and graphs below show the forces generated at 1/32” intervals between the two magnets along two vertical paths taken by the moving magnet.

ATTRACT FORCES - VERTICAL

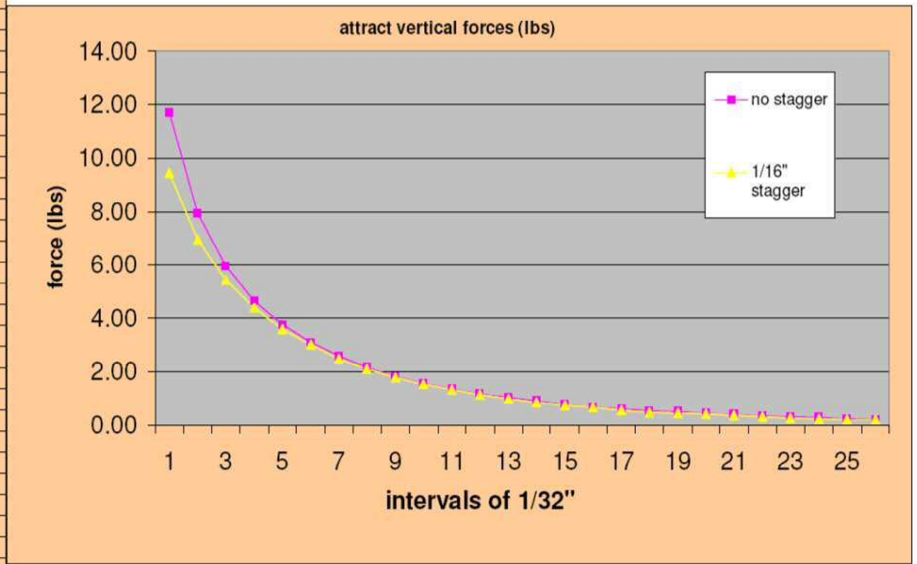


stagger	none	1/16			
inch-lbs.	1.57	1.45			
intervals inches	force (average)	force (average)	force (average)	force (average)	force (average)
0	11.70	9.45			
1/32	7.90	6.93			
1/16	5.95	5.43			
3/32	4.65	4.41			
1/8	3.77	3.57			
5/32	3.09	2.99			
3/16	2.58	2.48			
7/32	2.17	2.12			
1/4	1.82	1.79			
9/32	1.55	1.53			
5/16	1.34	1.32			
11/32	1.16	1.15			
3/8	1.03	0.97			
13/32	0.89	0.85			
7/16	0.77	0.73			
15/32	0.67	0.65			
1/2	0.61	0.55			
17/32	0.54	0.49			
9/16	0.50	0.46			
19/32	0.45	0.41			
5/8	0.40	0.36			
21/32	0.35	0.31			
11/16	0.31	0.27			
23/32	0.28	0.24			
3/4	0.24	0.22			
25/32	0.22	0.20			
13/16	0.20	0.17			
27/32	0.17	0.15			
7/8	0.15	0.12			
29/32	0.11	0.11			
15/16	0.10	0.09			
31/32	0.09	0.09			
1	0.07	0.08			





Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru Thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe

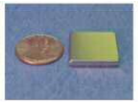


yield for attract forces using thin (1/8” x ¾” x ¾”) magnets (contd.)

The chart below compares the various energy yields (inch-pounds) in the horizontal (yellow) and vertical (green) directions. The difference in yield (“net yield”) for each set of horizontal and vertical yields are also shown (orange). The largest net yields occur when the horizontal path of the moving magnet is 1/32” away (gap) from the surface of the fixed magnet. This occurs because vertical yield decreases disproportionately compared to horizontal yield as the “gap” between the magnets increases. The distribution of force between magnets moving together along a horizontal path is very different compared to the distribution of force along a vertical path (see previous slides). It is noted again that when the magnets pull themselves together horizontally they come to rest shortly before reaching vertical alignment. Accordingly, a “staggered” vertical path of at least 1/32” must be used. The best net yield from the measurements taken below is between .28 and .25 inch-pounds.

EDEN PROJECT: Kenneth Kozeka, Ph.D.
DATE: April , 2007
FORCES: ATTRACT
DIRECTION: VERTICAL and HORIZONTAL
MEASUREMENTS: forces measured at rest at 1/32" intervals

MATERIAL:
Dimensions: 3/4" x 3/4" x 1/8" thick
Material: NdFeB, Grade N42
Plating/Coating: Ni-Cu-Ni (Nickel)
Magnetization Direction: Thru Thickness
Weight: 0.305 oz. (8.64 g)
Pull Force: 18 lbs
Surface Field: 3170 Gauss
Brmax: 13,200 Gauss
BHmax: 42 MGOe

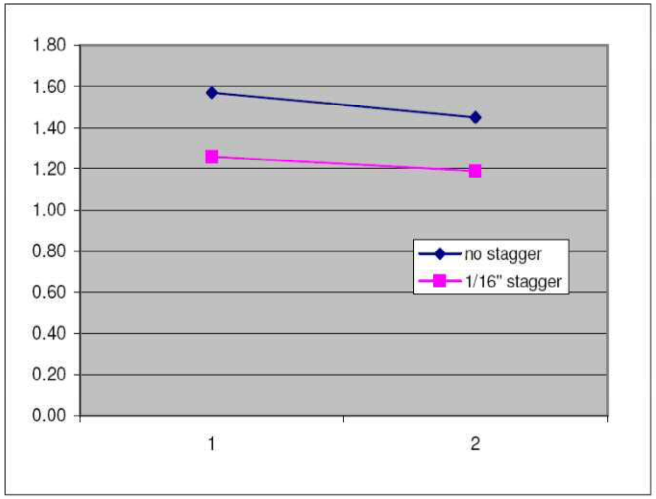


ATTRACT MATRIX - COMPARES IN-LB VALUES
FOR HORIZONTAL AND VERTICAL

orange boxes contain net-yields for adjacent values

	stagger none	stagger 1/16	stagger	stagger	stagger
	1.57	1.45			
gap none	1.76	1.64			
	0.19	0.19	0.00	0.00	0.00
	1.26	1.19			
gap 1/32	1.54	1.44			
	0.28	0.25	0.00	0.00	0.00

1.57	1.45
1.26	1.19



yield assessment

Assessing energy output and practicality

Based on the research conducted to date, the ratio of net-yield (expressed in inch-pounds) to pull-force (expressed in pounds) is 1:46. For example, two ¾" cube magnets, grade N38, with a pull force of 41.3 pounds produced a net-yield of .90 inch-pounds. More powerful magnets (e.g., grade N55) are available and will produce much larger net-yields. The following calculations are based on commercially available, grade N42 magnets that measure 4"x2"x ½", have a pull-force of 640.5 pounds and accordingly will generate a net-yield of 13.75 in-lbs or 1.15 ft-lbs. Estimates are made also for grade N50 magnets of the same size. Higher grades such as N55 are available but not assessed here. Net-yield is also a product of the speed at which the magnets pull themselves together and are pulled apart ("cycle"). It is not known at this time how fast they can cycle and if higher cycle speeds will hinder output. Electric generators and combustion engines typically operate at several thousand revolutions per minute (rpm). It is highly reasonable to assume that the magnets will be able to cycle 8-16 times per second or 480 – 960 rpm.

As shown in the table below, a quantity of magnets that would fit in a 10.8" cube and that operate at 16 or less cycles per second can generate a net-yield of mechanical energy equal to 5 KWH (kilowatt-hour) or 6.8 horsepower; more than enough to meet the energy needs of an average household. This net-yield of energy equates approximately to the energy available from 3.3 gallons of gasoline a day or 1,196 gallons per year. Considering that 74% of the energy in gasoline is lost as heat, a combustion engine would actually have to burn approximately 4,598 gallons of gasoline each year to match the net-yield from the magnets.

	cycles/ second	RPM	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr
grade N42	4	240	4.60	0.01	0.01	184	0.25	0.33	368	0.50	0.67	736	1.00	1.34
	8	480	9.20	0.01	0.02	368	0.50	0.67	736	1.00	1.34	1472	2.00	2.68
	16	960	18.40	0.02	0.03	736	1.00	1.34	1472	2.00	2.68	2944	3.99	5.35
total volume of magnets			2" cube			6.8" cube			8.6" cube			10.8" cube		
	cycles/ second	RPM	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr	net-yield ft-lbs	net-yield KWH	net-yield horsepwr
grade N50	4	240	5.80	0.01	0.01	232	0.31	0.42	464	0.63	0.84	928	1.26	1.69
	8	480	11.60	0.02	0.02	464	0.63	0.84	928	1.26	1.69	1856	2.52	3.37
	16	960	23.20	0.03	0.04	928	1.26	1.69	1856	2.52	3.37	3712	5.03	6.75
total volume of magnets			2" cube			6.8" cube			8.6" cube			10.8" cube		

yield assessment (contd.)

The discovery described here is a way to harness energy from magnetic force generated by permanent magnets thereby providing a new source of inexpensive, pollution-free energy. Designing an engine or machine that can transfer magnetic force into mechanical energy and convert the linear motion into rotary motion is fairly simple. Such an engine that uses electromagnetic force (EMF) will require only a small fraction of the complexity and parts that comprise a combustion engine . This report includes an illustration (animation) of how such an engine might be designed.

Much of the energy we use today is transformed into mechanical energy. Combustion engines convert the heat produced from burning fuel into mechanical energy that turns electric generators and turns the wheels on our vehicles. Most of the “heat” energy is lost during the process of transferring it to mechanical energy. For example, gasoline engines waste about 74% of the energy (in gasoline) as heat lost to the cooling system and through the exhaust. The mechanical energy generated by the magnetic forces of permanent magnets is far more efficient since there is no combustion: heat losses will occur only through friction of the moving engine parts. Comparing the energy available from petroleum and permanent magnets should bear this in mind.

yield assessment (contd.)

The "neodymium" permanent magnet developed by Hitachi Metals is truly a marvel of science. The large amount of force generated by such small magnets is astounding. For example, a gradeN42 magnet measuring 4"x 2"x ½" and weighing only 17 ounces generates a pull force of 641 pounds. Higher grades such as N55 and the new HILOP series generate even greater force. The research presented here was conducted using relatively small and weak magnets. Smaller pull forces of 40 pounds or less were easier to handle and to measure accurately.

Pull-force values should not be mistaken for "work" values. The pull-force of a magnet is the magnetic force (often expressed as pounds) generated by the magnet at its surface. This is typically measured by placing the magnet between two plates of metal and measuring the force required to separate one of the plates from the magnet. As already mentioned, pull-force can be very large. However, magnetic force (pull-force) decreases as distance from the magnet increases. Consequently, the amount of work that can be done by magnetic force will be a number that is smaller than the magnet's (maximum) pull-force. This is because "work" is a measure of force exerted over a distance. For example, a magnet having a pull-force of 40 pounds may be capable of generating 10 inch-pounds of work in one particular direction. In other words, the magnet generates an amount of force sufficient to move 10 pounds a distance of one inch (or 1 pound a distance of 10 inches). The "net yield" of work described in this report is yet a smaller number, for example 1 inch-pound. Nonetheless, the net-yield presented here demonstrates high feasibility and practicality for permanent magnets as a major source of inexpensive, pollution-free energy that could free our nation's dependence on foreign oil. As with any new technology, it is highly likely that further research and development will produce vast improvements.

As stated earlier in this report, permanent magnets lose their strength at a rate of only 1% every 10 years. This slow decline in the magnet's strength is attributed primarily to a change in the physical properties of the material and not a decline in electron spin, the source of magnetic force in permanent magnets. Electron spin is considered to be "intrinsic". I have not been able to determine if any other long-term changes may occur in electron spin and magnetic force when permanent magnets are used in the prescribed manner. Our common use of permanent magnets in motors and generators shows that the magnetic force does not diminish rapidly.

yield assessment (contd.)

Ratio of net-yield to maximum pull-force

To date, the largest net-yields were found using “attract” forces (between unlike poles of two magnets) compared to “repel” forces (between like poles). Larger yields were also found using square (cube) magnets and rectangular magnets (for example 1” x 1” x .5” thick) magnetized through their thickness. The two best yields were obtained from two ¾” square magnets and from two magnets measuring ¾” x ¾” x 1/8”. Although these magnets were rated as having pull-forces of 43 and 18 pounds respectively, the maximum pull-forces measured were 41.32 and 11.80. The ¾” square magnets produced a net-yield of .90 inch-pounds and the 1/8” thin magnets produced a net-yield of .25 inch-pounds. The net-yield relative to the strength of the magnet (maximum pull-force) was essentially the same for both the square and thin magnets. The ratio of net-yield to pull-force is 46:1 for the square magnets and 47:1 for the thin magnets.

The strongest permanent magnets

Neodymium magnets vary in strength ranging from grade N32 to N55 (HILOP series). For example, N42 is 20% stronger than N35 and N50 is 26% stronger than N42. Furthermore, smaller magnets are more powerful (per volume) than larger ones of the same grade. Consider for example the three N42 grade, square magnets listed below. The ½” square magnet has a pull-force per cubic-inch that is twice as large as the 1” square magnet. The last section of this report titled “The EMF Engine” provides an example of how many small magnets can work together. Assessment of yield presented in the earlier slide was made using larger (4”x2”x1/2”) magnets. Although smaller magnets are more powerful (per volume), their use may be impractical.

cube size	pull-force	pull-force/cu-inch
½”	25 lbs	200
¾”	59 lbs	140
1”	101 lbs	101

Why hasn't this been discovered long ago?

There are many plausible explanations (speculations) for why this discovery has not been made earlier. Here are some of them. I believe that the primary reason pertains to the conventional shape of magnets (#5 below).

1. No doubt "paradigm paralysis" played a role as it so often does in science as well as all other aspects of our thinking. The use of permanent magnets as a source of energy fell into the realm of perpetual motion machines. Our intuition and experiences with magnets led us to believe that the amount of energy (work) spent pulling magnets apart must be equal to (or greater) than the amount obtained when they drew themselves together.
2. The fact that it is easier to pull magnets apart sideways (horizontally) compared to "straight" apart may have led us astray. While the maximum force between two magnets is less in the horizontal direction, force measurements and work calculations reveal that more work is required. The results of such calculations may have been interpreted incorrectly as evidence that a positive net yield is not achievable.
3. For various reasons, earlier research might have been conducted with magnets repelling one another. To date, my findings indicate that repelling forces do not produce a sufficient net-yield. Similar findings made earlier by other investigators may have stopped them from testing attractive forces believing that the results would be the same.
4. Until recently (past ten years), permanent magnets did not produce the tremendous forces that they generate today. The weaker magnets of the past might not have been able to produce practical yields.
5. In the past, it was common to equate stronger magnets with longer magnets. Long, rectangular (bar) magnets with poles at either end (along the long axis) were considered to be the stronger magnets. Such a shape does not produce nearly the net yield generated by square magnets or rectangular magnets magnetized through their thickness ("flat magnet"). The shape of the field (lines) from a square or flat magnet is ideally suited to generate more work in the "horizontal" direction compared to the "vertical" direction.
6. An incorrect understanding of "conservation of energy" might also have stopped some scientists from pursuing this discovery. Quantum physics has led us to a better understanding of electron spin and electromagnetic force. Electron spin, which is the source of electromagnetic force, is considered to be "intrinsic". Without fully understanding the source of the spin, I cannot say for certain how much (and for how long) energy can be harnessed from a given permanent magnet. A long history of using permanent magnets shows us that their magnetic force does not diminish rapidly.

VITA

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EDUCATION

1972 - 1976	**UNIVERSITY OF PITTSBURGH** Pittsburgh, PA 15261	B.S.	1976	Psychology, Anatomy and Physiology
1976 - 1983	**SCHOOL OF MEDICINE** University of Pittsburgh Pittsburgh, PA 15261	Ph.D.	1983	Neurobiology, Anatomy and Cell Science
1986 - 1987	**UNIV. OF SOUTHERN CALIFORNIA** Department of Higher & Postsecondary Education Los Angeles, CA 90089			Administration of Higher Education

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EMPLOYMENT

1987 - present **PRESIDENT**
KEDRON CORPORATION and DERMACROSS
7640 Sleepy Summit Lane
Fairview, TN 37062

2004 – 2006 **ASSOCIATE PROFESSOR OF ANATOMY & PHYSIOLOGY**
DEAN, SCIENCE AND MATHEMATICS
NASHVILLE STATE COMMUNITY COLLEGE
120 White Bridge Road
Nashville, TN 37209

1999 - 2004 **CHAIR, DEPARTMENT OF BIOLOGY, HEALTH & WELLNESS**
MIAMI-DADE COLLEGE
11380 NW 27th Avenue
Miami, FL 33167

1996 - 1999 **CHAIR, DEPARTMENT OF SCIENCE & WELLNESS**
BROWARD COMMUNITY COLLEGE
7200 Hollywood Pines Boulevard
Pembroke Pines, FL 33024

1984 - 1987 **ASSISTANT PROFESSOR OF ANATOMY & KINESIOLOGY**
UNIVERSITY OF SOUTHERN CALIFORNIA
Graduate School of Biokinesiology and Physical Therapy
2025 Zonal Avenue, CSA-280
Los Angeles, CA 90033

COURSES TAUGHT

Anatomy & Physiology I & II
General Biology
Medical Histology
Cell Biology
Medical Gross Anatomy and Embryology
Psychobiology
Applied Anatomy and Kinesiology
Applied Physiology
Human Dissection
Human Anatomy and Kinesiology
Graduate Seminar Series
Personal and Community Health
Nutrition
Introduction to Psychology
Learning Skills

MEMBERSHIP IN PROFESSIONAL SOCIETIES

American Association of Anatomists
American Society for Cell Biology
Florida Association of Community Colleges
Alabama Association for Sickle Cell Disease
Academic Leadership Program of Florida

GRANTS

USC Collaborative Faculty Research and Innovation Fund

Project: Equipment for an anatomy research laboratory
Amount requested: $75,000
Submitted: 10/84, approved, not funded

USC Department of Physical Therapy

Project: The construction of an anatomy/electron microscopy research laboratory
Amount requested: $50,000
Submitted: 2/85, approved, funded

National Science Foundation

Project: Microcomputer-based physics and engineering laboratory
Amount requested: $54,234
Submitted: 11/88, approved, funded

BCC Foundation Grant

Project: Digital cameras for biological and physical science programs
Amount requested: $1,200
Submitted: 1998, approved, funded

BCC Technology Enhancement Fund

Project: 48 student microscopes
Amount requested: $54,000
Submitted: 1997, 1998, approved, funded

National Science Foundation - Students With Disabilities

Project: Develop teaching/learning methods for science and mathematics students with disabilities
Amount requested: $484,000
Submitted: 1/99

Staff and Professional Development Fund

Project: Supplemental Instruction Program for science courses
Amount requested: $18,000
Submitted: 1997, 1998, approved, funded

United States Department of Agriculture, Agriculture Research Service (USDA-ARS)

Project: Enhance Student Development and Career Opportunities in Agriculture Research
Agency: SDA, ARS, Headquarters, Extramural Agreements Division
Agreement Number: 58-0101-2-113
Amount requested: $106,000
Submitted: 2002, approved, funded
Submitted: 2003 renewal, approved, funded

AWARDS

Full tuition scholarship, School of Medicine

Two Year Teaching Fellowship Award, School of Medicine

Electron Microscopic Society of America: Presidential Scholarship (1981)

Mechanical Musculoskeletal Model: U.S. patent application (1985)

Three Dimensional Image Generator, U.S. patent allowed (1991)

Three Dimensional Image Generator, U.S. patent application (2006)

Transdermal patch ("wrap") for the administration of large quantities of fatty acids, amino acids, vitamins and minerals to subjects suffering from gastro-intenstinal malabsorption such as those inflicted with AIDS, cancer, anorexia, old age and following bariatric surgery, U.S. patent application (2006)

Transdermal wrap for the administration of large quantities of peptides to facilitate sustained, elevated levels of growth hormone and promote anabolism, U.S. patent application (2006)

RESEARCH

Topics:

Prenatal and early postnatal development of skeletal muscle cells

Prenatal and early postnatal development of muscle spindles

Prenatal development of peripheral nerves

Techniques:

Light and electron microscopy

Serial sectioning and electron microscopic reconstructions

Light and electron microscopic autoradiography

Computer assisted morphometry

DIRECTED GRADUATE RESEARCH

University of Southern California, Biokinesiology and Physical Therapy:

Master's Program Research Sponsor

Knee motion in slow velocity gait.

Maximum isometric hip and knee extension torque and plantar flexion strength in normal men.

Maximum isometric hip and knee extension torque and plantar flexor strength in normal women.

Doctoral Program Committee Member

Adaptations during the stance phase of gait for simulated flexion contractures at the knee.

PUBLICATIONS

ARTICLES

Kozeka, K. (1981) Prenatal development of muscle spindles in the mouse. Proc. Electron Microscopy Soc. Amer., 39:510-511.

Kozeka, K. and Ontell, M. (1981) Three dimensional cytoarchitecture of developing muscle spindles. Dev. Biol., 87:133-147.

Ontell, M. and Kozeka, K. (1984) Organogenesis of striated muscle: A cytoarchitectural study. Am. J. Anat., 171:133-148.

Ontell, M. and Kozeka, K. (1984) Organogenesis of the mouse extensor digitorum longus muscle: A quantitative study. Am. J. Anat., 171:149-161.

Kozeka, K. (1986) Learning the musculoskeletal system: A mechanical musculoskeletal model. Physical Therapy.

Perry, J., Locke, T.M., Lowe, R., Barto, P.S., Torburn, L. and Kozeka, K. (1987) Knee motion during slow gait. Journal of Orthopedic Research.

ABSTRACTS

Kozeka, K. and Ontell, M. (1980) Ultrastructural evidence of the establishment of polyneuronal innervation in the hindlimb musculature of fetal mice. Anat. Rec., 196:103a.

Kozeka, K. and Ontell, M. (1981) Three dimensional cytoarchitecture of developing muscle spindles. J. Cell Biol., 87:257a.

Kozeka, K. and Ontell, M. (1981) The cytodifferentiation of skeletal muscle fibers in prenatal mice. Anat. Rec., 199:146a.

Kozeka, K. and Ontell M. (1982) In vivo myogenesis. J. Cell Biol., 95:369a.

PRESENTATIONS

Kozeka, K. and Ontell M. (1980) Ultrastructural evidence of the establishment of polyneuronal innervation in hindlimb musculature of fetal mice. Anat. Rec., 196:103a. American Association of Anatomists Ninety-third Annual Session (Platform Presentation).

Kozeka, K. and Ontell, M. (1980) Three dimensional cytoarchitecture of developing muscle spindles. J. Cell. Biol., 87:257a. American Society for Cell biology, Twentieth Annual Meeting (poster session).

Kozeka, K. and Ontell M. (1982) In vivo myogenesis. J. Cell. Biol., 95:369a. Amer. Society for Cell Biology, Twenty-second Annual Meeting (Poster Session).

Kozeka, K. (1986) A Mechanical Musculoskeletal Model. American Association of Anatomists Ninety-ninth Annual Session (Platform Presentation).