DESIGN AND FABRICATION OF MAGNETIC BEARING

A MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that mini project report **"DESIGN AND FABRICATION OF MAGNETIC BEARING"** is the bonafide work of **"M.GANAPATHY, S.JAGADESH, A.JAVED HUSSAIN, S.JEAN AUSTIN",** of final year (seventh semester) who carried out the mini project work under my supervision.

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EXTERNAL EXAMINER **INTERNALEXAMINER**

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ABSTRACT

Bearing is the major part for transmitting the rotary motion without any losses. The main purpose of bearing is to withstand axial and radial loads. There are various types of bearing used in rotary transmission such as ball bearing, roller bearing, jewel bearing, taper bearing, journal bearing and plain bearing. All these bearing are required lubrication.

In this project the magnetic bearing is designed and fabricated by using permanent magnets, Neodymium Iron Boron (NdFeB) magnet. Two magnets are been placed with same poles, one magnet is held inside another ring magnet, due to repulsive force of magnets.

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LIST OF SYMBOLS

SYMBOLS	DESCRIPTION	UNIT
R_a	Outer radius of frame magnet	mm
R_i	Inner radius of frame magnet	mm
r_a	Outer radius of shaft magnet	mm
r_i	Inner radius of shaft magnet	mm
D	Thickness of magnet	mm
L	Length of shaft	mm
D_x	Diameter of shaft	mm
Z	Distance between magnets	mm
B	Magnetic induction	Tesla
B_r	Remanance field	Tesla
F	Magnetic force	N
A_p	Area of magnet	mm^2
μ	Permeability of free space	$N.A^{-2}$

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CHAPTER 1

1.1 INTRODUCTION

A magnetic bearing is a bearing that supports a load using magnetic levitation. Magnetic bearings support moving parts without physical contact. For instance, they are able to levitate a rotating shaft and permit relative motion with very low friction and no mechanical wear. Magnetic bearings support the highest speeds of all kinds of bearing and have no maximum relative speed.

Passive magnetic bearings use permanent magnets and, therefore, do not require any input power but are difficult to design due to the limitations described by Earns haw's. As a result, most magnetic bearings are active magnetic bearings, using electromagnets which require continuous power input and an active control system to keep the load stable. Magnetic bearings are used in several industrial applications such as electrical power generation, petroleum refinement, machine tool operation and natural gas handling.

Permanent-magnet bearings generally have low damping and limited load carrying capacity. To add damping, the technology of hydrodynamic journal bearing can be incorporated. The high load carrying capacity at high rotational speed, soaring damping, and simple manufacturing of hydro-dynamic journal bearings make it admirably popular. The in-adequacy of the hydrodynamic journal bearing lies in its lack of film formation at lower speed that makes it vulnerable to wear.

1.2 OBJECTIVE OF THE PROJECT

To design and fabricate the magnetic bearing to reduce the friction between rotating parts.

CHAPTER 2

LITERATURE SURVEY

2.1 MAGNETISM

2.1.1 ACTIVE MAGNETIC BEARINGS

Active Magnetic Bearing (AMB) is a rather new concept in bearing technology. The AMBs are electromagnetic devices configured to suspend a shaft within a gap. The basic operating principles of AMBs are given in Allaire et al. They take radial loads or thrust loads by utilizing a magnetic field to support the shaft rather than a mechanical force as in fluid film or rolling element bearings.

2.1.2 THE CYCLOID PERMANENT MAGNETIC GEAR

Magnetic gears have gained some attention due to the following reasons: no mechanical fatigue, no lubrication, overload protection, reasonably high torque density, and potential for very high efficiency. Focus have been addressed to a kind of planetary magnetic gear, probably already invented before the strong NdFeB magnets came into the market in the early 1980s. An active torque density is in the range of 100 N·m/L, which is a very high torque density for a magnetic device. However, there is still a need for increased torque density and a better utilization of the permanent magnets. The torque density of a magnetic coupling is in the range of 400 N·m/l and this is, in principle, a magnetic gear with a 1:1 gearing ratio.

2.1.3 CONVERTED MAGNETIC GEARS

A particular type of the converted Magnetic gear is the magnetic torque coupler which can be used to transmit torque between the two coupling halves at the same speed. There are two types of magnetic torque couplers, namely axial and coaxial couplers. In parametric analysis of axial coupler is carried out with both FEA and torque formula established by Furlani, the coupling performances of the coaxial coupler are presented, which is useful for product design and analysis. With the advantages of high torque transmission capability and overload protection, these couplers can be used in seal-less pumps, process and chemical industries, and other applications where the driving and driven parts need to be separated.

Referencing to the structure of the mechanical planetary gear and the operating principle of parallel-axis MGs, a magnetic planetary gears. In addition to the advantages of the parallel-axis MGs, the MPG has the characteristics of three transmission modes, a high-speed reduction ratio, and a high torque density. Literature pointed out that the number of magnetic planet gears is the key to improve the MPG transmitted torque. By using the FEA, the MPG with six magnetic planet gears exhibits nearly 100kNm/m^3 of shear stress on the magnetic ring gear. Thus, there is an increasing interest in the MPG for various applications, such as wind power generation and electric propulsion.

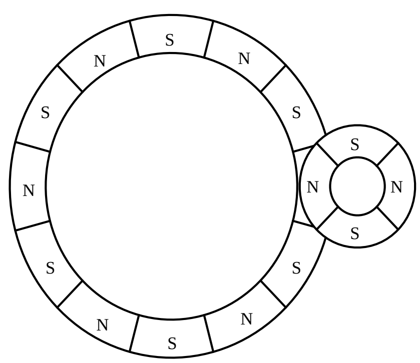


Figure 2.1

2.1.4 CO-AXIAL MAGNETIC GEAR

A Co-axial magnetic gear is a hypothetical elementary particle in particle physics that is an isolated magnet with only one magnetic pole (a north pole without a South Pole or vice-versa). In more technical terms, a magnetic monopole would have a net "magnetic charge".

Modern interest in the concept stems from particle theories, notably the grand unified and superstring theories, which predict their existence.

Magnetism in bar magnets and electromagnets does not arise from magnetic monopoles, and in fact there is no conclusive experimental evidence that magnetic monopoles exist at all in the universe. Some condensed matter systems contain effective (non-isolated) magnetic monopole quasi-particles or contain phenomena that are mathematically analogous to magnetic monopoles.

The torque transmission between the two separated rotors relies on the interaction of the magnetic fields. Starting from the analysis of magnetic fields in the two air gaps, this section will deduce how the proposed device functional gear transmitting stable torques when the rotors rotating at different speed.

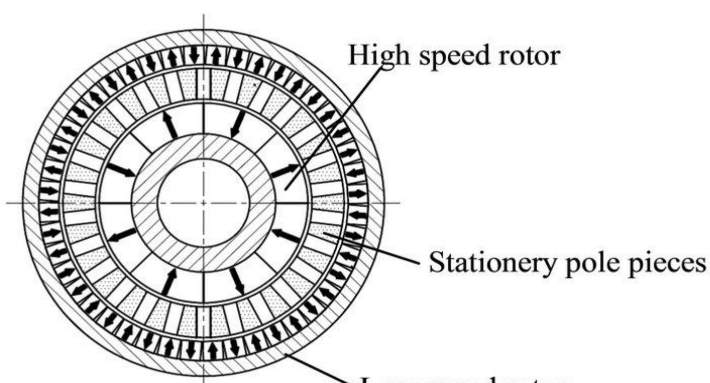


Figure 2.2

2.2 MAGNETIC LEVITATION SYSTEM

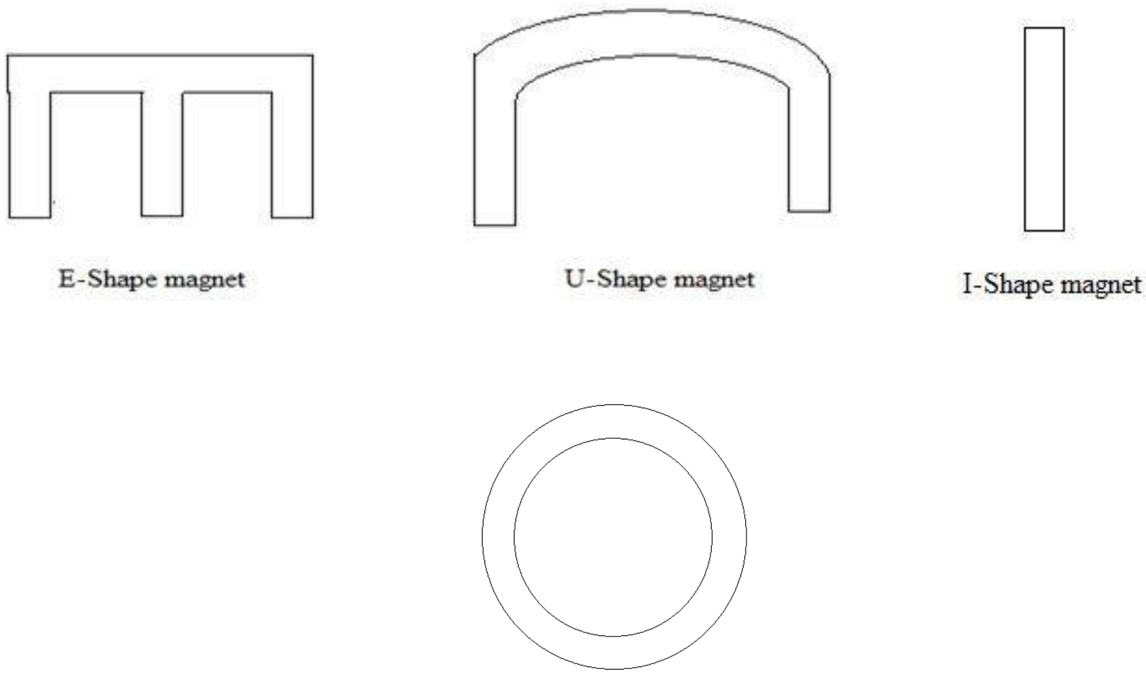
Magnetic levitation suspension is a method by which an object is suspended with no support other than magnetic field. Magnetic force is used to counteract the effects of the gravitational and any other accelerations.

The two primary issues involved in magnetic levitation are lifting force: providing an upward force sufficient to counteract gravity, and stability. Insuring that the system does not spontaneously slide or flip into a configuration where the lift is neutralized. Magnetic levitation is used for maglev trains, magnetic bearings and for product display purposes.

2.2.1 LIFTING POWER OF THE MAGNET

Computing the magnetic field and force exerted by ferromagnetic materials is difficult, because the magnetic field and force are non-linear function of the current, depending on the nonlinear relation between B and H for the particular core material used. However, in designing a DC electromagnet, in which the current is either on or off, the relations can be simplified. The main feature of ferromagnetic materials is that the B field saturated at a certain value, which is around 1.6T for most high permeability core steels. The B field increases quickly with increasing current up to that value, but above that value the field levels off, regardless of how much current is sent through the windings. So it is not possible to obtain a much stronger magnetic field from electromagnet than 1.6T. The maximum force (holding force) exerted by an electromagnet. So saturation set a limit on the maximum force per unit core area, or pressure, an electromagnet can exert.

Given core geometry, the B field needed for a given force can be calculated. If it comes out to much more than 1.6T, a larger core must be used. Once the B field needed is known, the magneto motive force the product of current and the number of turns in the winding can be calculated.



Ring shape magnet

Figure 2.3

The lifting power of an electromagnet is the ability of the magnet to lift a ferromagnetic material from a given distance. The lifting power or force for I-shape core of the electromagnet. For U-shape the force formula is divided by two, while for E-shape it’s divided by three, because the U-shape has 2 poles and E-shape has 3 poles respectively which will participate in lifting of the load.

2.3 MAGNETIC FLUX

The magnetic interaction is described in terms of a vector field, where each point in space (and time) is associated with a vector that determines what force a moving charge would experience at that point (see Lorentz force). Since a vector field is quite difficult to visualize at first, in elementary physics one may instead visualize this field with field lines. The magnetic flux through some surface, in this simplified picture, is proportional to the number of field lines passing through that surface (in some contexts, the flux may be defined to be precisely the number of field lines passing through that surface.

Although technically misleading, this distinction is not important). Note that the magnetic flux is the net number of field lines passing through that surface; that is, the number passing through in one direction minus the number passing through in the other direction (see below for deciding in which direction the field lines carry a positive sign and in which they carry a negative sign). In more advanced physics, the field line analogy is dropped and the magnetic flux is properly defined as the surface integral of the normal component of the magnetic field passing through a surface.

2.4 TYPES OF MAGNETIC FLUX

- Magnetic flux through a closed surface
- Magnetic flux through a opened surface

2.4.1 MAGNETIC FLUX THROUGH A CLOSED SURFACE

Gauss's law for magnetism, which is one of the four Maxwell's equations, States that the total magnetic flux through a closed surface is equal to zero. (A "closed surface" is a surface that completely encloses a volume(s) with no holes.) This law is a consequence of the empirical observation that magnetic monopoles have never been found.

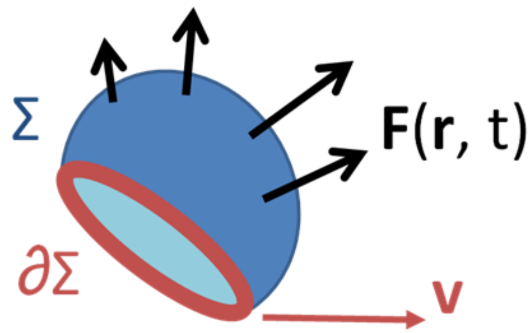


Figure 2.4

2.4.2 MAGNETIC FLUX THROUGH AN OPEN SURFACE

While the magnetic flux through a closed surface is always zero, the magnetic flux through an open surface need not be zero and is an important quantity in electromagnetism. For example, a change in the magnetic flux passing through a loop of conductive wire will cause an electromotive force, and therefore an electric current, in the loop.

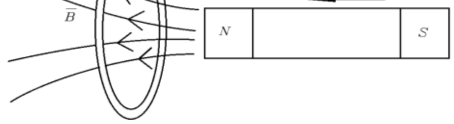


Figure 2.5

2.5 MAGNETIC RESONANT COUPLING

Wireless power transfer is essential for the spread of EVs as it provides a safe and convenient way to charge the vehicles. When wireless power transfer is achieved, the process the process of charging the devices will be made a lot more convenient as we do not have to plug the cord into the socket. Furthermore, as power can be constantly transferred to the vehicles,

The battery size can be reduced. Also, the danger of being electrocuted due to the wear and tear of an old cord, or rain will be avoided as the process of handling the power cord is unnecessary, thus making the charging process safer. To achieve wireless charging, the wireless power transfer system must satisfy these three conditions. high efficiency, large air gaps, and high power.

The most popular wireless transfer technologies are the electromagnetic induction and the microwave power transfer. However, the electromagnetic induction method has a short range, and the microwave power transfer has a low efficiency as it involves radiation of electromagnetic waves.

Recently, a highly efficient mid-range wireless power transfer technology using magnetic resonant coupling, WiTricity, was proposed. It is a system that transfers power in between two resonating antennas through magnetic coupling. It satisfies all three conditions to make wireless charging possible as it has a high efficiency at mid range.

2.6 ELECTROMAGNETIC POWER HARVESTER

As micro system technologies has been remarkably grown in recent years, advances in self-powering, micro power generation and energy micro harvesting technologies are necessary for the reliable and stable capacity of the micro systems. Various micro power generators use electrochemical, photovoltaic, electromechanical, thermoelectric, piezoelectric, or other exotic energy conversion mechanisms.

Likewise, energy harvesting has been explored actively from numerous resources such as solar power, electromagnetic fields, thermal gradients, fluid flow, energy produced by the human body, and the action of gravitational fields.

In addition, the micro energy scavengers would be potential power sources for many micro wireless devices that require self-supportive power to receive and transmit RF signal. Moreover, it is well known that piezoelectric materials are most competitive materials for harvesting power from ambient vibration sources due to the high conversion efficiency from mechanical strain to an electrical energy.

Various researches have been tried in the fundamental scaling various electromechanical effects in use of the magnetism. When a permanent magnet moves inside of winding, the change of magnetic flux induces electromotive force according to Faraday's law of induction.

If it has a connected load, the circuit starts to flow current so that electrical power is delivered to the load. In order to verify the power level that we can obtain from the inherent typing motions in a computer keyboard, the harvesting power from typing motions in a computer keyboard is theoretically derived and estimated based on the finger force exerted by each finger which is summarized in table 1. For example, on keyboard, if the thumb is used to type the key, the force is 16N to apply in order to depress a key and 5mm to move to register.

2.7 MAGNETIC MONOPOLE

A magnetic monopole is a hypothetical elementary particle in particle physics that is an isolated magnet with only one magnetic pole (a North

Pole without a South Pole or vice-versa).In more technical terms, a magnetic monopole would have a net "magnetic charge".

Modern interest in the concept stems from particle theories, notably the grand unified and superstring theories, which predict their existence.

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2.8 TYPES OF MAGNETS

- Permanent magnets
- Temporary magnets
- Electromagnets

2.8.1 PERMANENT MAGNETS

Permanent magnets are those we are most familiar with, such as the magnets hanging onto our refrigerator doors. They are permanent in the sense that once they are magnetized, they retain a level of magnetism. As we will see, different types of permanent magnets have different characteristics or properties concerning how easily they can be demagnetized, how strong they can be, how their strength varies with temperature, and so on.

2.8.2 TEMPORARY MAGNETS

Temporary magnets are those which act like a permanent magnet when they are within a strong magnetic field, but lose their magnetism when the magnetic field disappears. Examples would be paperclips and nails and other soft iron items.

2.8.3 ELECTROMAGNETS

An electromagnet is a tightly wound helical coil of wire, usually with an iron core, which acts like a permanent magnet when current is flowing in the wire. The strength and polarity of the magnetic field created by the electromagnet are adjustable by changing the magnitude of the current flowing through the wire and by changing the direction of the current flow.

2.9 MAGNETIC GRADES

The grade of the magnet directly refers to the maximum energy product of the material that composes the magnet. It is no way to refers to the physical properties of the magnet. Grade is generally used to describe the how strong a permanent magnet material is!

CHAPTER 3

PROJECT DESCRIPTION

3.1 BEARING

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Many bearings also facilitate the desired motion as much as possible, such as by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

The term "bearing" is derived from the verb "to bear"; a bearing being a machine element that allows one part to bear another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most demanding applications are very precise devices; their manufacture requires some of the highest standards of current technology.

Figure.3.1

3.2 VARIOUS TYPES OF BEARING

- Ball bearing
- Plain bearing
- Rolling-element bearing
- Jewel bearing
- Fluid bearing
- Flexure bearing
- **Magnetic bearing**

3.2.1 BALL BEARING

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Figure3.2

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

3.2.2 PLAIN BEARING

A plain bearing (in railroading sometimes called a solid bearing) is the simplest type of bearing, comprising just a bearing surface and no rolling elements. Therefore the journal (i.e., the part of the shaft in contact with the bearing) slides over the bearing surface. The simplest example of a plain bearing is a shaft rotating in a hole. A simple linear bearing can be a pair of flat surfaces designed to allow motion; e.g., a drawer and the slides it rests on or the ways on the bed of a lathe.

Figure.3.3

3.2.3 ROLLING ELEMENT BEARING

A rolling-element bearing, also known as a rolling bearing, is a bearing which carries a load by placing rolling elements (such as balls or rollers) between two bearing rings called races. The relative motion of the races causes the rolling elements to roll with very little rolling resistance and with little sliding.

One of the earliest and best-known rolling-element bearings are sets of logs lay on the ground with a large stone block on top. As the stone is pulled, the logs roll along the ground with little sliding friction. As each log comes out the back, it is moved to the front where the block then rolls on to it. It is possible to imitate such a bearing by placing several pens or pencils on a table and placing an item on top of them. See "bearings" for more on the historical development of bearings.

Figure.3.4

3.2.4 JEWEL BEARING

A jewel bearing is a plain bearing in which a metal spindle turns in a jewel-lined pivot hole. The hole is typically shaped like torus and is slightly larger than the shaft diameter. The jewel material is usually some form of synthetic corundum, such as ruby. Jewel bearings are used in precision instruments where low friction, long life, and dimensional accuracy are important, but their largest use is in mechanical watches.

Figure.3.5

3.2.5 FLUID BEARING

Fluid bearings are bearings that support their loads solely on a thin layer of liquid or gas. They can be broadly classified into two types: fluid dynamic bearings and hydrostatic bearings. Hydrostatic bearings are externally pressurized fluid bearings, where the fluid is usually oil, water or air, and the pressurization is done by a pump. Hydrodynamic bearings rely on the high speed of the journal (the part of the shaft resting on the fluid) to pressurize the fluid in a wedge between the faces.

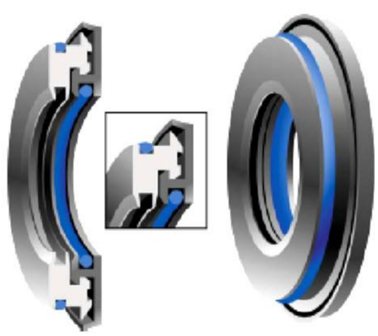

Figure.3.6

3.2.6 FLEXURE BEARING

A flexure bearing is a bearing which allows motion by bending a load element. A typical flexure bearing is just one part, joining two other parts. For example, a hinge may be made by attaching a long strip of a flexible element to a door and to the door frame. Another example is a rope swing, where the rope is tied to a tree branch.

Flexure bearings have the advantage over most other bearings that they are simple and thus inexpensive. They are also often compact, lightweight, have very low friction, and are easier to repair without specialized equipment. Flexure bearings have the disadvantages that the range of motion is limited, and often very limited for bearings that support high loads.

Figure.3.7

3.2.7 MAGNETIC BEARING

A magnetic bearing is a bearing that supports a load using magnetic levitation. Magnetic bearings support moving parts without physical contact. For instance, they are able to levitate a rotating shaft and permit relative motion with very low friction and no mechanical wear. Magnetic bearings support the highest speeds of all kinds of bearing and have no maximum relative speed.

Passive magnetic bearings use permanent magnets and, therefore, do not require any input power but are difficult to design due to the limitations described by Earns haw’s theorem. Techniques using diamagnetic materials are relatively undeveloped and strongly depend on material characteristics. As a result, most magnetic bearings are active magnetic bearings, using electromagnets which require continuous power input and an active control system to keep the load stable. In a combined design, permanent magnets are often used to carry the static load and the active magnetic bearing is used when the levitated object deviates from its optimum position. Magnetic bearings typically require a back-up bearing in the case of power or control system failure.

Magnetic bearings are used in several industrial applications such as electrical power generation, petroleum refinement, machine tool operation and natural gas handling. They are also used in the Zippe-type centrifuge, for uranium enrichment and in turbo molecular pumps, where oil-lubricated bearings would be a source of contamination.

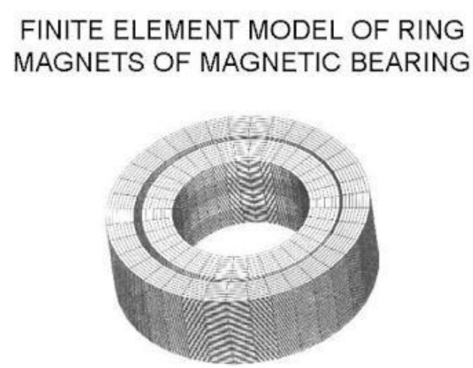

Figure 3.8

3.3 WORKING PRINCIPLE

Magnetic bearing is device that used for reduce rotational friction and support radial and axial loads. It works on the principle of repulsive forces of the magnetic flux Similar poles of the magnets repels with each other and also different poles of the magnets are attractive with each other. The repulsive forces of the magnets are used to rotate without any contact and with very less friction.

It is always more convenient to model the force between two magnets as being due to forces between magnetic poles having magnetic charges 'smeared' over them. Such a model fails to account for many important properties of magnetism such as the relationship between angular momentum and magnetic dipoles.

A very common source of magnetic field shown in nature is a dipole, with a South Pole and a North Pole, terms dating back to the use of magnets as compasses, interacting with the Earth's magnetic field to indicate North and South on the globe. Since opposite ends of magnets are attracted, the north pole of a magnet is attracted to the south pole of another magnet. The Earth's North Magnetic Pole (currently in the Arctic Ocean, north of Canada) is physically a south pole, as it attracts the north pole of a compass. A magnetic field contains energy, and physical systems move toward configurations with lower energy. When diamagnetic material is placed in a magnetic field, a magnetic dipole tends to align itself in opposed polarity to that field, thereby lowering the net field strength. When ferromagnetic material is placed within a magnetic field, the magnetic dipoles align to the applied field, thus expanding the domain walls of the magnetic domains.

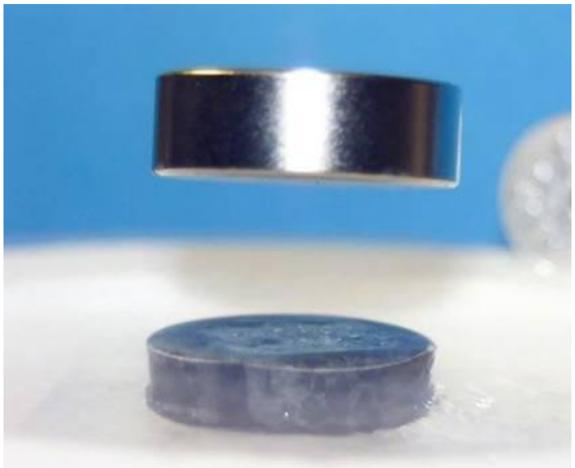

Figure 3.9

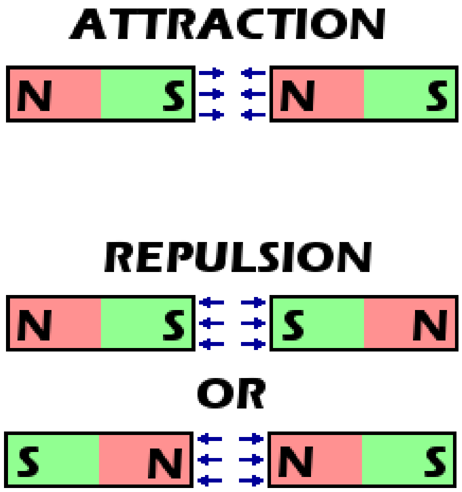

Figure.3.10

3.4 FABRICATION PROCEDURE

1. General procedure for fabricating a magnetic bearing is one magnet should be placed on the frame and be clamped.

2. The machining is done for the stainless steel shaft like turning, facing and threading.

3. Another magnet should be placed on the shaft with same poles which repulse each other.

4. Drilling is done in wood piece and frame magnet is clamped with nut and bolts.

5. Place the shaft in between the frame magnet.

3.5 REQUIRTMENTS OF GOOD BEARING

- It should have more stiffness while rotary motion.
- It should with stand radial and axial loads.
- Friction produced in bearing should be less while rotation.
- Life of bearing should be high.
- Speed distribution should be even all over the shaft.

3.6 DRAWBACKS OF OTHER BEARING

- Lubrication is required.
- Not having high temperature with stand
- Corrosion resistance

CHAPTER 4

DESIGN AND CALCULATION

Specifications

Frame magnet:

Outer radius (R_a) = 23mm

Inner radius (R_i) = 15mm

Shaft magnet:

Outer radius (r_a) = 10mm

Inner radius (r_i) = 5 mm

Thickness of magnets (D) = 16mm

Length of axle (L) = 250mm

Diameter of shaft (D_s) = 10mm

Distance between magnets (Z) = 10mm

MAGNETIC INDUCTION (frame):

$$B = \frac{B_r}{2}\left[\frac{D+z}{\sqrt{R_a^2+(D+z)^2}} - \frac{z}{\sqrt{R_a^2+z^2}} - \left(\frac{D+z}{\sqrt{R_i^2+(D+z)^2}} - \frac{z}{\sqrt{R_i^2+z^2}}\right)\right]$$

$$=1.11/2 \quad \frac{16+10}{\sqrt{23^2+(16+10)^2}} - \frac{10}{\sqrt{23^2+10^2}} - \left[\frac{16+10}{\sqrt{15^2+(16+10)^2}} - \frac{10}{\sqrt{15^2+10^2}}\right]$$

=0.1 Tesla

MAGNETIC INDUCTION (axle):

$$B = \frac{B_r}{2}\left[\frac{D+z}{\sqrt{R_a^2+(D+z)^2}} - \frac{z}{\sqrt{R_a^2+z^2}} - \left(\frac{D+z}{\sqrt{R_i^2+(D+z)^2}} - \frac{z}{\sqrt{R_i^2+z^2}}\right)\right]$$

$$=1.11/2 \quad \frac{16+10}{\sqrt{10^2+(16+10)^2}} - \frac{10}{\sqrt{10^2+10^2}} - \left[\frac{16+10}{\sqrt{5^2+(16+10)^2}} - \frac{10}{\sqrt{5^2+10^2}}\right]$$

=0.06 Tesla

MAGNETIC FORCE (F)

FRAME MAGNET

Magnetic Force (F) $= \frac{B^2 A_P}{2\mu_0}$

$= \frac{(0.1)^2\ (7.06X10^{-3})}{2X(4\pi X10^{-7})}$

Magnetic Force (F) = 10.11 N

Total Magnetic Force = Magnetic Force x No. of Magnet

= 10.11 x 2

= **20.22 N**

AXLE MAGNET

Magnetic Force (F) $= \dfrac{\boldsymbol{B^2 A_P}}{\boldsymbol{2\mu_0}}$

$= \dfrac{(0.06)^2\ (6.604X10^{-4})}{2X(4\pi X10^{-7})}$

Magnetic Force (F) **=** 0.946 N

Total Magnetic Force = Magnetic Force x No.of Magnet

= 0.946 x 2

= 1.892 N

Total Magnetic Force **=** Sum of magnetic forces in frame and axle magnet

= 22.112N

LOAD CARRYING CAPACITY

Load carrying capacity $= \dfrac{Total\ Magnetic\ Force}{9.81}$

= 22.112/9.81

Load carrying capacity = **2.25 kg**

4.1 2-D DIAGRAM

SIDE VIEW

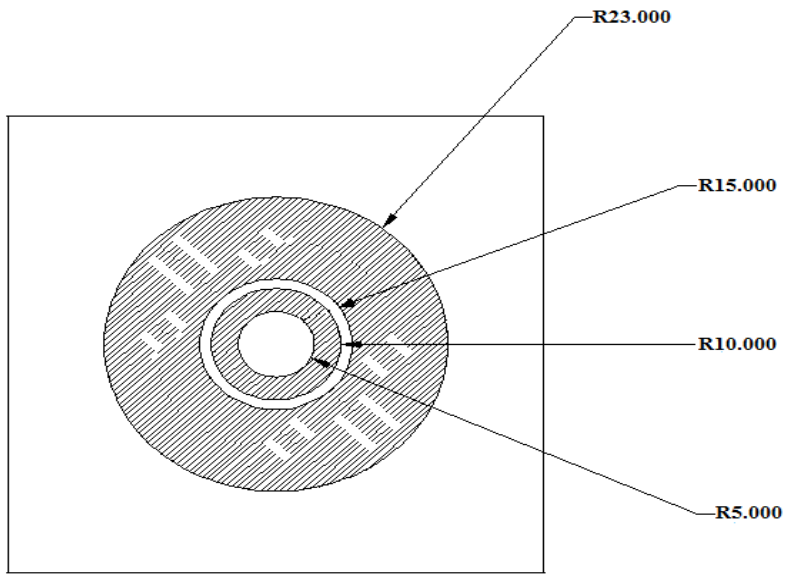

Figure 4.1

FRONT VIEW

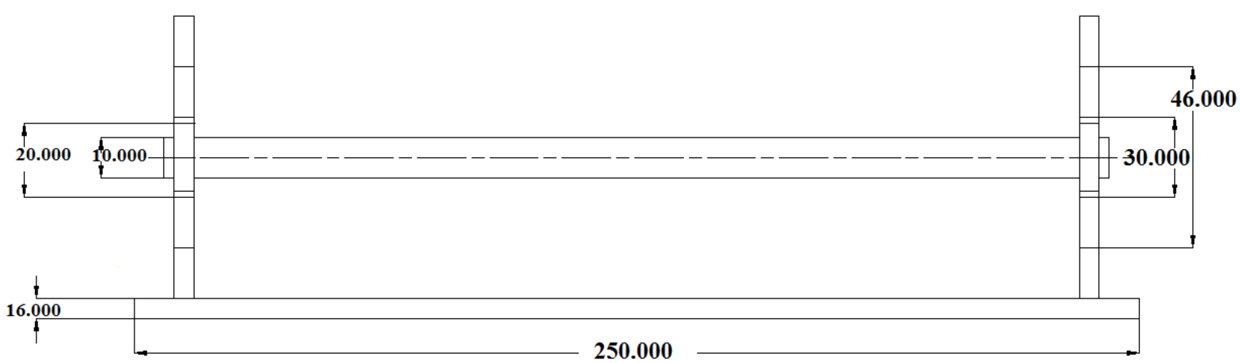

Figure 4.2

TOP VIEW

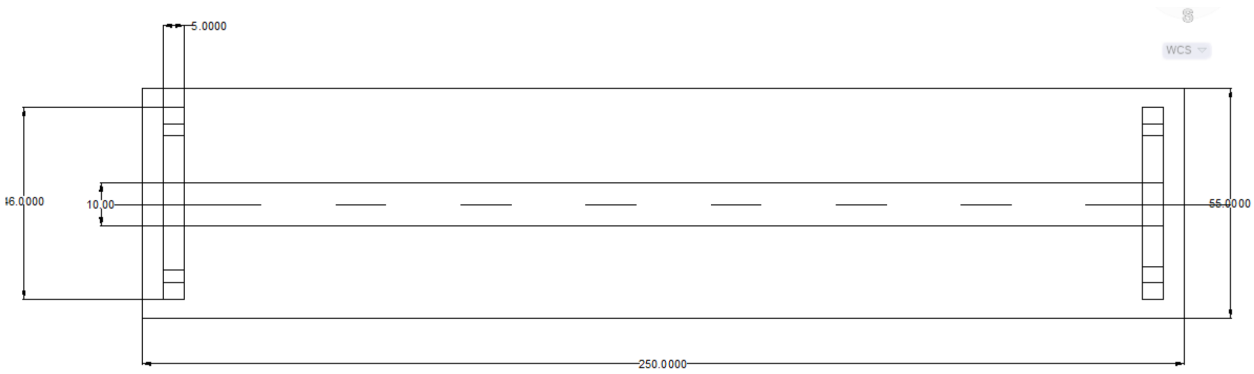

Figure 4.3

4.2 ASSEMBLY VIEW

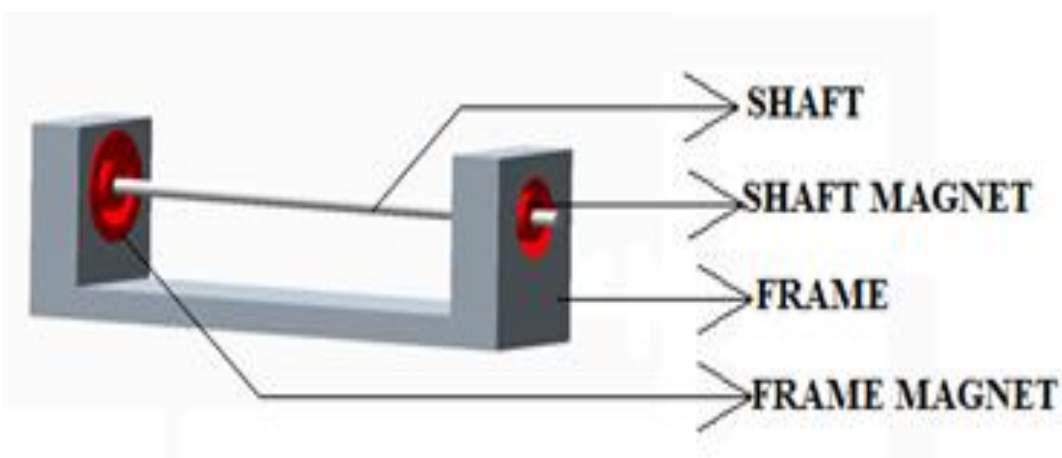

Figure 4.4

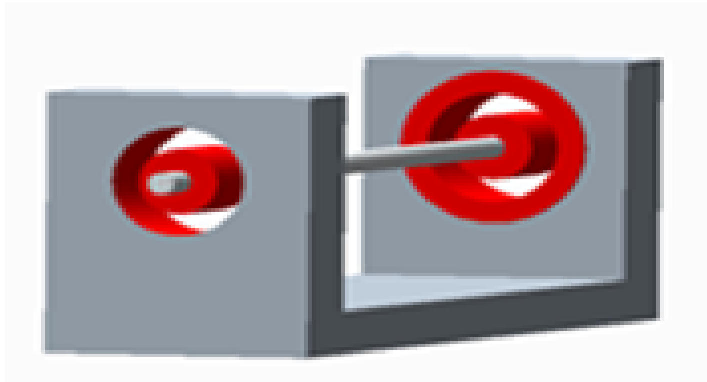

Figure 4.5

4.3 RESULT

The load carrying capacity of the designed magnetic bearing is up to **2.25kg.**

The load carrying capacity for various types of magnets are calculated as below,

TYPE OF MAGNET	GRADE	Br VALUE (Tesla)	MAGNETIC INDUCTION (Tesla)	LOAD CARRYING (kg)
NdFeB	**V-3300**	**1.11**	**0.16**	**2.25**
NdFeB	N-EECN52	1.42	0.397	18.79
Alnico	LNG52	1.3	0.363	15.60
NdFeB	EH-EECN35EH	1.2	0.334	13.33
Samarium cobalt	EEC2:17-33	1.17	0.3265	6.37
Alnico	FLNG34	1.1	0.307	11.22

Table 4.1

4.4 ADVANTAGES

- Very simple in design
- There is no need of lubrication in this coupling
- Smooth torque transmission occurs
- Low cost
- Very low and predictable friction

4.5 APPLICATION

- It can be used for al power transmission
- It is mostly Used in Automobile transmission
- It is used in the application for frictionless transmission
- Watt-hour meters
- Flywheel energy storage system
- Used in compressors, turbines, motors and generators

4.6 BILL OF MATERIALS

A bill of materials is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product. A BOM may be used for communication between manufacturing partners or confined to a single manufacturing plant and the bill of material for our project is shown in below table.

S.NO	PARTS	QUANTITY	DESCRIPTION
1	FRAME MAGNETS	2	Ring type Neodymium iron boron (NdFeB)
2	SHAFT MAGNETS	2	Ring type Neodymium iron boron (NdFeB)
3	SHAFT	1	Stainless steel
4	WOOD	1	200×450 mm plywood
5	CLAMPS	2	-
6	NUTS, BOLTS	4	-

Table 4.2

4.7 COST ESTIMATION

A cost estimate is the approximation of the cost of a program, project, or operation. The cost estimate is the product of the cost estimating process. A problem with a cost over run can be avoided with a credible, reliable, and accurate cost estimate and the cost estimation for our project is shown in below table.

S.NO	COMPONENTS	MATERIAL USED	OPERATIONS	COST(Rs)
1	Magnets	Neodymium iron boron (NdFeB)	-	500
2	Shaft	Stainless steel	Facing ,turning , threading	600
3	Frame	Wood	Cutting	200
4	Nuts, bolts, clams	Stainless steel	-	100

Table 4.3

Labour cost =600

Total cost =1400+600= Rs.2000

CHAPTER 5

CONCLUSION

In order to transfer power through bearing, lubrication is required to avoid friction between rotating parts hence magnetic bearing is used to avoid friction between rotating parts without lubricating parts.

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PHOTOGRAPH