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NEODYMIUM MAGNETS SUSPENSIONS FOR MECHANICAL SYSTEMS OF THE VEHICLE

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Abstract: Mechanical vibration on the human body they represent a very dangerous factor, in fact they have been / and are considered by many researchers in the field, using various methods to reduce their dangerous values. In the field of automotive, mechanical vibration are induced by the tread and their functional mechanisms, it is transmitted to the human body mostly through the chassis and seats. Thus, in order to reduce dangerous values on while driving, as well as increasing the comfort were achieved various systems such as: magneto-rheological dampers to the vehicle structure and seat with air suspension, but can undertake research for development of new elements for amortization of shocks and vibrations at their level
Keywords: magnets, neodymium, damper

INTRODUCTION

The present paper, makes reference to the study of reduction values of shock and vibration to the vehicle medium, heavy, tractors and special vehicles, at the level of seats.

Current, for seats are encountered these systems: the springs and torsion bars, air suspension or hydro-pneumatic. These existing systems have each one limitations specific to the construction and usage, reason for which the values dangerous for the body are reduced under a certain level only.

The conditions to operating of vehicles or the special machinery, in the building site area, in the rough terrain,a impose permanent new technical solutions. Thus, the achievement of some researches on the development new types of dampers for vibration, lead to increasing the comfort and reducing occupational diseases.

In order to accomplish of these goals, the present approach contemplates the use permanent magnets with high power, for the development of new components for amortization of shocks and vibrations, at the level of vehicles and the human body.

Interaction between two permanent magnets of the same polarity (Figure 1) creates a magnetic field which acts from a distance by the dynamic effect of rejection, so that the trajectory travel of the magnets will change accordingly.

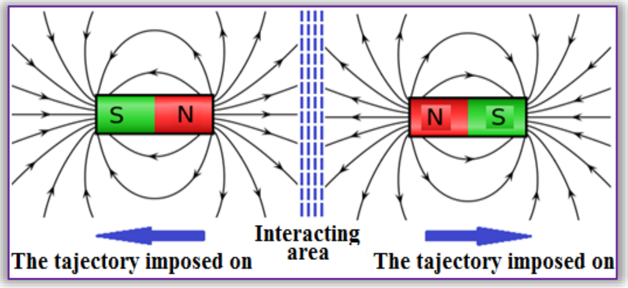

Figure 1. Interaction between two permanent magnets

In the mechanical applications, electromechanical are currently using various types of permanent magnets, composed of magnetic alloys with different properties, depending on the work requirements. Are encountered the magnets such as:

- Ferrite (ceramic) - strongest and breakable, has a intrinsic coercive force (Hci) high value, thing that creates a resistance to demagnetization fields.
- AlNiCo - have a high residual induction (Br), a high temperature stability, but have a low coercive force which causes them to be easily demagnetized.
- SmCo - are resistant to corrosion, have a high magnetism and an intrinsic coercive force (Hci) high, which makes them resistant to external demagnetization fields.
- NdFeB (neomagneţii) - the strongest type of magnets (rare earths) currently used.

The High Power magnets, constructed from rare earths (lanthanides) showed in the construction of trains with magnetic levitation(Maglev) it can give a surplus of comfort to people on while on the go, a major reduction ofmechanical stress and dynamic, and also a high durability thereof at the same times.

This paper aims at developing a system for vibration damping and shocks to seat level, usable for medium-large cars, tractors, but also for special purpose or military.

NEODYMIUM IRON BORON MAGNETS (NEO-MAGNETS) [1] [2] [5] [6]

Neo-magnets used are made most frequently by metallurgy technology of the powders. The powders of micron neodymium iron boron, into an atmosphere of inert gas are exposed to high temperatures close to the melting of the material, and then by pressure in the shapes rubber or steel is sintered. Under the influence of heat and pressure its forming a solid body with certain dimensions, with a much lower porosity.

Scheme of manufacturing process of these types of magnets is shown in the following figure (Figure 2).

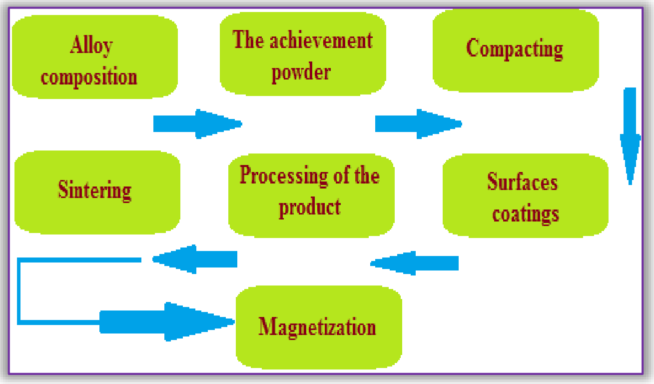

Figure 2. Scheme manufacturing process neodymium magnets

After pressing the alloy, alignment of anisotropic particles significantly favors the residual induction (Br).

The magnets obtained have high hardness (Rc58). Their processing can be done only in the state of non-magnetic, only with special equipment.

The chemical reaction that are frequently used in the manufacturing process, is given by:

$$57\ Fe + 8\ \underline{B} + 10\ Fe_2O_3 + 7.5\ Nd_2O_3 + 52.5\ Ca \rightarrow Nd_{15}Fe_{77}B_8 + 52.5\ CaO \qquad (1)$$

The alloy obtained by technological processes may have a chemical composition richer in Nd or B. Geometry of The Magnets(shape) is a very important factor of its performance. Also, the performance of NdFeB alloy is optimized after pressing operation, following application to saturation of a very high magnetic field, which it creates a certain magnetic orientation.

The disadvantages of using these types of magnets are given by sensitivity to high temperatures, humid environment, corrosive, which accelerates the process of demagnetization, so the loss of properties.

Due to this, the magnets are subjected to the process of coating with different compounds having different thicknesses.

The applications of the Neodymium magnets are very broad and include various industrial fields. Their use being performed primarily to machinery and equipment where is required the high power from a magnet as small as. Such magnets are used in:Energy = wind energy generators; transport =Maglev trains; Electrical = electric motors; Particle accelerators = CERN; Magnetic separators = recycling iron; for lifting very large tasks;Incinerators = extracting metal particles in the ash;

The following table (Table 1) shows the main types of coatings of neodymium of the magnets type and its properties.

Table 1: Type of coating of neodymium

Coverage	Thickness	Color	Resistance
Ni+Ni	10-20	Bright silver	Excellent against humidity
Ni+Cu+Ni			
Zn	8-20	Bright blue	Good against salt
Cu-Zn		Bright color	Excellent against salt
Ni+Cu+Sn	15-20	Silver	Good against humidity
Ni+Cu+Au	10-20	Golden	Good against humidity
Ni+Cu	10-20	Golden	Temporary protection
Epoxy	15-25	Black, red, gray	Excellent against humidity and salt
Ni+Cu+Epoxy			
Zn+Epoxy			

The following table (table 2) presents the main features and differences between neodymium-iron-boron magnet N48, chosen for the project and those of a magnet from Ferrite Y35.

Table 2: The diference of neodymium and iron magnets

Type	Remanence (Br)	Coercive Force (bHc)	Intrinsic coercive force (Hci)	Energy produced (BxH) max.	Maximum temperature (0C max.)
	N/Am (Tesla)	kA/m	kA/m	Kj/m3	0C
N48	1,37 – 1,42	10,8-12,5	> 12	358-382	< 80
Y35	0,40 - 0,41	2,20 - 2,45	2,26-2,51	30-32	< 250

In the project have been selected because of physical, properties the magnets N48, with the following specifications: N = maximum working temperature (80ºC); 48 = coefficient of power.

The power of the magnet is determined by a number of factors including: the size, the shape, the ratio of its sizes (width / thickness), the combination of different materials.

Next image (Figure 4) shows the shape, size and magnetic orientation for - N48.

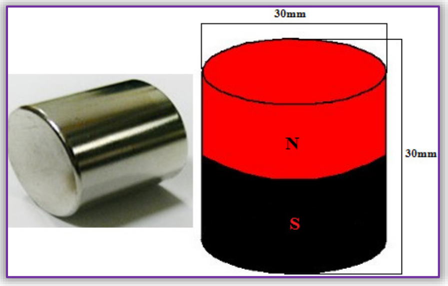

Figure 4. Magnet NdFeB - N48

The characteristics of this type of magnet are:- Shape: disc; size: 30mm x 30mm; weight: 159g; strength: approx. 60kg; coverage: Ni.

The magnetic flux density of the magnet cylinder used, can be calculated in an easy way, at a point located on the central axis of the poles, but a objective calculation must take into account the complexity of the three-dimensional field around the magnet.

NEODYMIUM PERMANENT MAGNET DAMPER

In the mechanical systems for vehicles, two components cand be found mainly for amortization of of mechanical oscillations with a particular importance: the suspension of vehicle and suspension of the seats.

The research foresees working towards a suspension system capable of being used in the construction of various types of vehicle seats. To achieving the damper have been taken into account specific conditions and factors that influence in a negative way desired results:

- » The isolation of magnets of the external environment to reduce the influence of temperature or corrosive environment upon them.
- » Isolating the magnetic field generated by magnets to not influence the equipment in the immediate area.
- » Fixing a minimum distance between the working group of the two polarities magnets.
- » a sufficient size for Inductors, to amplify the field created between the two groups of magnets.
- » Manufacturing The electronic system which generate a variety of voltages and currents, so it can be seen as eloquent the values damping factor.

Damper cylinder (Figure 4) was built on five structures made of polypropylene (PP-R).

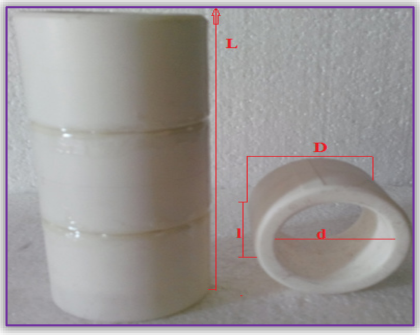

Figure 4. The dimensions of the cylindrical structure

The cylinder has the following dimensions:

- Outer diameter (D) = 66mm; Inner diameter (d) = 52mm;
- Length of section (l) = 50 mm; The total length of the cylinder (L) = 265mm.

Next image (Figure 5) shows the coil - N48 magnets inserted into the containment structures made of polypropylene (PP-R) this ensemble is subsequently inserted and fixed with an adhesive resin expohidic, inside the cylinder. The use of two different-sized structures, one for isolating and supporting the reel assembly - magnet, and the other to support in its entirety the the cylinder with the piston, performs a dual isolation of the magnetic field created by the external environment.

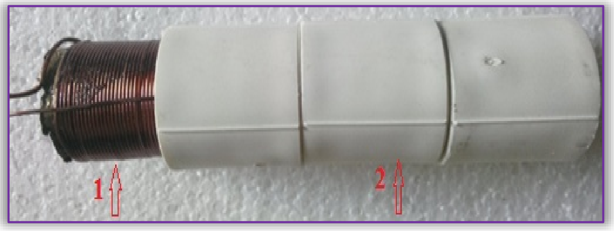

Figure 5. Assembly coil - magnets N48
and containment system PP-R

Composition:1 = inductor; 2 = fastening assembly and polypropylene isolation coil and magnet.

The dimensions of the containment structure (2) of the coil are:

- » Outer diameter section (D) = 44mm; section inner diameter (d) = 36mm;
- » Section length (l) = 43mm; The total length of the whole PP-R = 215mm.

The three magnets N48 are inserted inside the coil, with a total length of 90mm and representing 64.2% of

surface of the coils. The difference in area up to 100%, is useful for creating magnetic field concentrated in the presence of the other two magnets located on piston, under the influence of current / voltage witch circulating through the coil windings. The coil is achieved by a winding spiral after spiral, from CuEm wire of 0.7 mm in diameter, with a number of 200 windings, with a total length of 140mm, with an inner diameter of 30mm.

The magnetic field strength generated by the coil to a point of the field is described by Biot-Savart law:

$$dH= \int \left(\frac{\mu_0}{4\pi} \text{ x } \frac{I \text{ x } dl \text{ x } r}{r^3}\right) [A/m] \quad (2)$$

where: r = distance of the point considered to conductor element; I = current intensity; dl = length of the considered current browsing purposes; μ0 = permeability of the medium (4π x107).

The magnetic induction is influenced by the shape and geometry of the magnet and is calculated using the following equation:

$$B= \mu \text{ x } H \quad [T] \qquad (3)$$

where: μ = permeability of the medium; H = intensity of the magnetic field.

The electromagnetic force occurring in the coil during the passage of the electric current is described by:

$$F=|B| \quad [N] \qquad (4)$$

Where: I = current intensity; B = magnetic induction; l = length of the considered coil.

Repulsive force occurs between the two groups of magnets what interacting inside the coil is given by:

$$F=- \frac{\mu \text{ x } q_{m_1} \text{ x } q_{m_2} \text{ x }}{4\pi r^2} [N] \qquad (5)$$

where: μ = permeability of the medium; q_{m1}, q_{m2} = amperage at the two poles; r = the distance between the poles.

The piston (Figure 6) is provided at the free end with two magnet N48 and passing through inside the coil, fixed in the same sense of polarity with the other three, from inside the coil, to achieve the rejection.

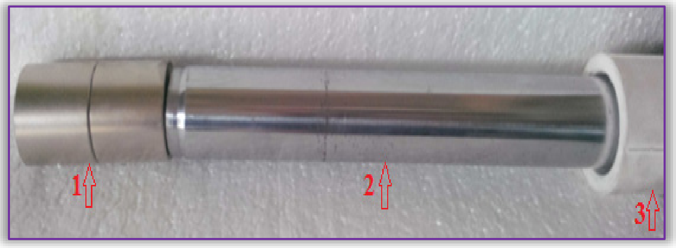

Figure 6. Piston with magnets N48 and limiter PP-R
Composition: 1 - magnets type N48; 2 -piston drive from steel; 3 - limiter PP-R

Composition of new system for research related of systems damping shocks and vibrations, is shown in the following figures (Figure 7 and Figure 8.

Functioning of the system is similar to a hydraulic shock absorber. The Piston, with two magnets mounted in the free end is moving through the inside coil crossed of electricity. The coil free space between the two magnetic structures creates a magnetic field is constant and variable intensity. In the event of an external force acting on the seat (vibrations caused by the road surface), the magnetic field created by the induction coil and the magnets, realize depreciation of shock created below a certain threshold,depending on the voltage and the current which circulating through the coil windings. The Electric coil supply system is equipped with a variable switch so that it can track and analyze way of operation to various voltages and currents: U = 0 - 24V; I = 0 - 5A.).

Figure 7. Assembly coil and insulation
1 = external insulation system and supportive of polypropylene (φint = 52mm); 2 = coil (140mm, d = 30mm, φ = 0.7 mm); 3 = insulator system and supportive coil and from polypropylene (φint = 32mm); 4 = base supportive and fixation outer cylinder from polypropylene; 5 = base star of support cylinder and assembly seat.

Figure 8. Assembly support of the magnetic cylinder
1 = grip and supportive seat system; 2 = limiter piston; 3 = spacer; 4 = cylinder with magnets N48; 5 = base star of support cylinder and assembly seat.

The control module (variator) to the experimental model is placed in the central area between the front seats and in the case serial fabrication of this type of seats suspension, it may be positioned as in the case others control commands, on the side of the seat support. Also, the electrical equipment to experimental module is provided with independent outputs for the voltmeter and ammeter, so they can independently monitor the current and operating voltage.

CONCLUSIONS

By point of view, of physical properties of magnets neodymium iron-boron (NdFeB) they have the strongest in value, in relation to size and performance. Because of high intrinsic coercive force has a very high resistance to external demagnetization fields, so are indicated for use in electro-mechanical applications.

Magnetic field strength generated between the poles of two magnets, facilitate shock absorption and mechanical oscillations occurring in the seat, to a higher value compared to other existing systems (hydraulic, pneumatic).

The suspensions achieved for the mechanical systems for motor vehicles based on neo-magnets, have a great advantage in reducing vibration caused by the roads, by vehicle structure, and also on persons wich are inside.

The advantages created by this type of damper are related to: reduce shock and vibration values transmitted to the vehicle and its staff, achieving higher stability of vehicles on travel time on rough roads, reducing stress and diseases of the spine, substantial increase seating comfort.

Bibliography

[1.] Jane Paju, Neodymium processing experiences through different eras by Molycorp Silmet As, The Conference of Magnetic Materials in Electrical Machine Applications 2012, PORI;
[2.] V. Panchanathan, Processing of neodymium-iron-boron alloys by rapid solidification technology,Journal of Materials Engineering March 1989, Volume 11, Issue 1, pp 51-60;
[3.] Mitroi,M.,Experimental research, Cernavodă, România, Mai, 2016.
[4.] Mitroi,M.,Arama,C., The implications of random vibrations generated by rough trails and hardly accessible on military body, AFASES, Brasov, Romania, 2016
[5.] http://www.reehandbook.com/neodymium.html;
[6.] http://www.eamagnetics.com/info_sintered_neodymium_process01.asp
[7.] http://www.hobber.ro/index.php?main_page=page&id=3&chapter=100&zenid=1235dbd6bdbf3c9414cd1cbab176e460.

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