

# Solenoid Operated Gear Shifting Mechanism for Two Wheeler

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**Abstract** - Solenoid operated gear shifting mechanism is mainly designed for the handicapped persons who unable to shift the gears by their foot. The technique used in this gear shifting mechanism consists of solenoid. Solenoid completes one up and down motion called as one stroke. This stroke time depend on supplied voltage and current. According to stroke length and voltage calculation, solenoids are mounted on both sides of gear shifting pedal at ends. By pressing that switch, person easily shifts the gear with the help of foot which is most efficient to handicapped persons.

**Keywords:** Solenoid, Gear Shifting, Permanent Magnet

## I. INTRODUCTION

Manual gear shifting or manual transmissions come in two basic types: simple unsynchronized systems, where gears are spinning freely. Whereas the other one is the synchronized systems, in which all gears are always in mesh but only one of these meshed pairs of gears is locked to the shaft on which it is mounted at any one time, the others being allowed to rotate freely; thus greatly reducing the skill required to shift gears.

## II. LITERATURE REVIEW

For easy gear shifting mechanism many researchers did theory and experiments. Muntaser Momani, Mohammed Abuzalata, Igried Al-Khawaldeh and Hisham Al-Mujafet had designed gear shifting mechanism and applied to make the shifting process faster and less destructible for the driver. They used many devices like pneumatic double acting cylinder; four pneumatic two positions five ways DCV, Programmable logical controller (PLC) were used [1].

Researcher beitaoguo, hongyiliu, zhonglou used Fuzzy logic and control which was applied in hydraulic pressure control of solenoid valve seal performance test. Hence the problem of supplying constant pressure requested by the test can be resolved [2].

## III. SOLENOID SELECTION

Actuators are defined as energy converter which converts one form of energy (electrical) into mechanical energy in a controlled form. Electromagnetic actuator which converts electrical to magnetic field is called "Solenoid" [3]. This system consists of an electromagnetic system which will work on the principle of British scientist William-

Sturgeon of electromagnet. An electric current flowing in a wire creates a magnetic field around the wire. To concentrate the magnetic field of a wire, in an electromagnet the wire is wound into a coil, with many turns of wire lying side by side. The magnetic field of all the turns of wire passes through the center of the coil, creating a strong magnetic field. Some simple mechanism is arranged with the electromagnet and will help us to change the gear as per the desired speed.

The proposed solenoid consists of a coil and a movable plunger as shown in fig.1. The electromagnetically inductive coil is wound around the plunger [4]. We used a permanent magnet (PM) as a plunger, rather than generally used metal rods, to generate a higher actuation force. Therefore, two kinds of forces are exerted in the solenoid. One is the electromagnetic force induced by the magnetic field inside the solenoid when a current flows into wound coils. The other is the magnetic force caused by a permanent magnet.

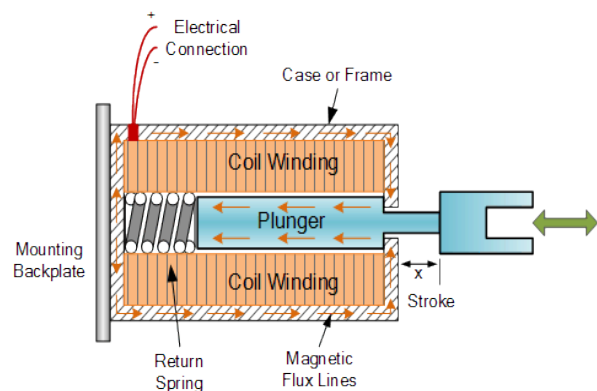


Fig.1 Working of Solenoid Actuator

This type of solenoid is generally called a Linear Solenoid, due to the linear directional movement and action of the plunger. Linear solenoids are available in two basic configurations called a "Pull-type" and "Push-type". Linear solenoids are useful in many applications that require an open or closed (in or out) type motion such as electronically activated door locks, pneumatic or hydraulic control valves, robotics, automotive engine management, irrigation valves to water the garden and even the "Ding-Dong" door bell has one. They are available as open frame, closed frame or sealed tubular types [5].

**A. Design and Calculations**

Calculation of pull torque required for solenoid as follows

**1. Force Developed by Electromagnet**

$$F_{max} = \frac{B^2 A}{2\mu}$$

Where,

F max= force in Newton

B=magnetic field in terlor

A=area of pole in meter

μ=permeability of space=  $4\pi * 10^{-7}$

Magnetic field

$$B = \frac{\mu NI}{L}$$

Where,

N= No. of turns = 4000 turns

I= current supplied in amp =5 amp

L=length of electromagnet in meter = 60mm =  $60 * 10^{-3}$

**2. Calculation of Required Electromagnetic Force for Passion Pro and Spender Plus Required Data**

N= No. of turns for coil = 4000 turns

I= current supplied in amp =5 amp

L=length of electromagnet in meter = 60mm =  $60 * 10^{-3}m$

$$B = \frac{\mu NI}{L}$$

$$B = \frac{1.256 * 10^{-6} * 4000 * 5}{60 * 10^{-3}}$$

$$B = 0.4186 \text{ Wb/m}^2 = \frac{\pi}{4} (D_o^2 - D_i^2)$$

Area = 7.85\*

$$F_{max} = \frac{B^2 A}{2\mu}$$

F max = 54.75 N

**3. Power Required for Operating Solenoids**

Required voltage = 12 v

Required ampere = 5 amp

Power required for one solenoid = V\*I= 12 \* 5= 60 watt

Total power required = 2 \* 60= 120 watts

**IV. ASSEMBLY OF ACTUATORS ON BIKE**

Solenoid completed one up and down motion called as one stroke. This stroke time depend on supplied voltage and current. According to stroke length and voltage calculation, mount solenoids on both sides of gear shifting pedal at ends. By providing appropriate voltage it pulls the plunger downward and by cutting off supply it retracts plunger upward.



Fig. 2 Mounting Top View



Fig.3 Mounting Side View

**V. ANALYSIS**

**A. Material Properties of the Component are as follows**

Material Properties		
Model Reference	Properties	Components
	Name: Beryllium Copper, UNS C19200 Model type: Linear, Elastic, Isotropic Default failure criterion: Max von Mises Stress Thermal conductivity: 118 W/(m.K) Mass density: 8250 kg/m <sup>3</sup>	SolBody: 1 (Body Extrude2, (axis=1))
Curve Data: N/A		
	Name: Ductile Iron Model type: Linear, Elastic, Isotropic Default failure criterion: Max von Mises Stress Thermal conductivity: 75 W/(m.K) Specific heat: 450 J/(kg.K) Mass density: 7130 kg/m <sup>3</sup>	SolBody: 2 (BoletoInductor -1)
Curve Data: N/A		
	Name: PVC Rigid Model type: Linear, Elastic, Isotropic, Inviscid Default failure criterion: Thermal Thermal conductivity: 0.147 W/(m.K) Specific heat: 1335 J/(kg.K) Mass density: 1300 kg/m <sup>3</sup>	SolBody: 1 (Body Extrude2, (upperplate-1))

Fig.4 Volumetric Properties

**B. The Thermal Analysis of the Model is done**

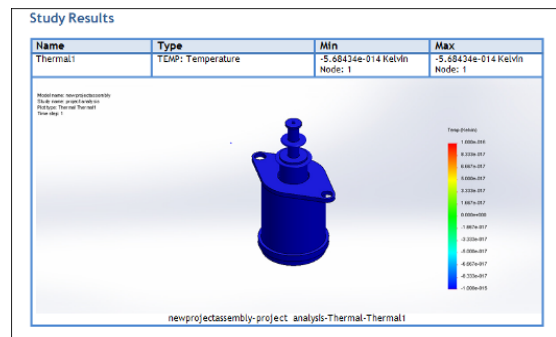


Fig. 5 Thermal analysis of model

TABLE I THERMAL RESULTS

Name	Type	Min	Max
Thermal1	Temperature	5.68434e-014 Kelvin Node: 1	5.68434e014 Kelvin Node: 1

## VI. DISCUSSION

The trial was taken on 3 types of bikes namely Hero Passion Pro model-2012, Hero Splendor Plus model-2011, Bajaj

boxer model-1999. After completing test we conclude that solenoid force required for new models bike is lower than force required for old model bikes. Also this force is affected by the type of gear box used. This mechanism is most suitable for asynchronies gear boxes. The total cost of equipment is Rs.10, 740/-

The test result is as follows. The comparative discussion chart is given below

TABLE II TEST RESULTS

S. No.	Parameters	Passion Pro	Splendor plus	Boxer
1.	Position of solenoid assembly	It's complicated to fix the assembly	It's difficult to fix the assembly	It's easy to fix the assembly
2.	Gear shifting motion	Smooth	Jerky	Smooth
3.	Solenoid force	6 kg	6 kg	3 kg
4.	Power required	120 watt	120 watt	72 watt
5.	No. of turn required for solenoid	4000 turns	4000 turns	1000 turns
6.	Costing of solenoid	9000 /-	9000 /-	7000 /-
7.	Thermal stability	Less	Less	More
8.	Actuation time	1.40 sec	1.50 sec	1.20 sec

## VII. RESULT

Power required for solenoid gear shifting mechanism is 72 watts in Boxer bike which is 48% less, as compared to passion pro and splendor plus and gives more thermal stability due to less current and voltage required for boxer. Solenoid force required in Boxer bike is half of the passion pro and splendor plus due to low current and voltage requirement. Also gives smooth Gear shifting motion.

## VIII. CONCLUSION

This project is most useful for handicap persons those who cannot drive the two wheelers because due to gear shifting problem. Hence the gear shifting mechanism is developed and modified according to their requirement. The application of this gear shifting mechanism leads to make the driving process for driver easier, reduces the risk of destabilizing, the chance of miss shifting. Due to this mechanism driver can concentrate on road rather giving

concentration of gear shifting and easily drive in traffic areas.

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