



Electro - Mechanical Power Transmission System (Manual 5 Speed Gear Box)

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ABSTRACT

The world is advancing technically in the field of Engineering and Technology; it is never at a standstill. In recent time it has gained greater momentum than ever before. As demand for time increases, people require something less time consuming and fuel less as time is money, something more precise, something accurate, meaning something innovative which can serve the people comfortably. On this path, the science and engineering field is always under development and discoveries having come to the people and serves for their betterment and welfare. Electro-Mechanical power transmission or gearbox is a type of motor vehicle transmission that can run the vehicle using an external source instead of any fuel that can also change gear ratios as the vehicle moves. This change of gears takes place manually which are five speeds. In the coming intro it clearly explains about the vehicle that totally runs on electro-mechanical power. Generally electro-mechanical consists of BLDC motor powered by batteries which is an electrical part and a five speed gear box transmitting power via chain drive comes under mechanical. The mechanical gear box only consists of clutch shaft with two driving and driven gear shafts connecting to the rear wheel of the vehicle helps to run. This moving of the vehicle takes place using the power source coming from the solar arrays used to generate electric power and to start the BLDC motor. The output of the batteries is controlled by the controllers and the motor is connected to the driving shaft of the gear box via chain. The power is transmitted from the driving gear shaft to the main gear shaft which drives the rear wheel of the vehicle via chain again. These transfer of power or motion takes place under five speed gear ratios operated manually for different speeds. To reduce the fossil fuel there is a requirement to adopt any alternative technique which can overcome fuels to be utilized, thus the technique using of solar arrays and making the vehicle to run on batteries with the help of the innovational power transmission gear box captured the fuels.

Keywords: BLDC Motor, Batteries, Electro-Mechanical Gear Box, Power and Charge controllers, Solar..

1. INTRODUCTION

A transmission is a device or machine that consists of power source and power transmission system, which provides controlled application of the power. Often the term transmission refers simply to the gear box that uses

gears and gear trains to provide speed and torque conversion from a rotating power source to another machine devices. Often, a transmission has multiple gear ratios (or simply "gears") with the ability to switch between them as speed varies. This switching is done manually (by the operator). Directional (forward and reverse) control is also provided. Single-ratio transmissions also exist, which simply change the speed and torque (and sometimes direction) of motor output. The dynamics of a car vary with speed: at low speeds, acceleration is limited by the inertia of vehicular gross mass; while at cruising or maximum speeds wind resistance is the dominant barrier. Many transmissions and gears used in automotive and truck applications are contained in a cast case, though more frequently aluminum is used for lower weight especially in cars. There are usually three shafts: a main shaft, a countershaft and an idler shaft.

The arrangement is also sometimes known as a direct shift gearbox or power shift gearbox. It seeks to combine the advantages of a conventional manual shift with the qualities of a modern automatic transmission by providing different clutches for odd and even speed selector gears. When changing gear, the engine torque is transferred from one gear to the other continuously, so providing gentle, smooth gear changes without either losing power or jerking the vehicle. Gear selection may be manual, depending on throttle/speed sensors. Without a transmission, cars would be limited to one gear ratio, and that ratio would have to be selected to allow the car to travel at the desired top speed. If you wanted a top speed of 80 mph, then the gear ratio would be similar to third gear in most manual transmission cars. The transmission used is operated by both electrically and mechanically, in sense using the batteries the generation of power through the solar arrays helps the BLDC motor to drive. These BLDC motor is connected to the main shaft of the gear box which drives the driving shaft that it is connected to the rear wheel via chain sprocket system. By the generation of power from solar arrays, Electro– Mechanical system works to drive the vehicle. The gear shifts in the gear box is done by manually to achieve different speeds at different gear ratios.

1.1 Electro – Mechanical

Solar arrays are arranged to generate power which helps the BLDC Motor to drive controlled by the solar charge controller. By the generation of power through the solar source BLDC motor starts rotating and the main shaft of the motor is connected to the main shaft of the gear box via chain drive. The power is transmitted via chain and it follows to transmit on to the driving shaft of the gear box connecting to the rear wheel of the vehicle. The generation of power from the solar source and transferring it to the motor comes under Electrical part and the motor rotates helping gear box to run and runs the rear wheel comes under Mechanical part, named Electro – Mechanical system.

1.2 Manual Power Transmitting Gear Box

In this type of transmission system, the driver has to manually select and engage the gear ratios. The vehicle is operated at different gear speeds using the manual handling system which changes the gear ratios to run the vehicle at different speeds. As BLDC motor generates the power to run gear box changing the gears using manually. Manual system helps to operate easily and it can also be automatic. Using of manual system rather than the manual, the system is called Manual power transmitting gear box. Vehicles with manual transmission are usually cheaper and Manual transmission offers the driver more control on the vehicle.

2. EXPERIMENTATION

The electric motor in its simplest terms is a converter of electrical energy into useful mechanical energy. The electric motor has played a leading role in the high productivity of modern industries, and it is therefore directly responsible for the high standard of living being enjoyed throughout the industrialized world. An electric motor works on the principle of operation based on current carrying conductor when placed in a magnetic field. An electric motor of type BLDC used to generate the power of 3700rpm, 2kw to run the gear box via chain transmitting system. The electric motor is, of course, the very heart of any machine it drives. If the motor does not run, the machine or device will not function. The importance and scope of electric motor in modern life is attested to by the fact that electric motors, numbering countless millions in total, convert more energy than do all our passenger automobiles. Electric motors are much more efficient in energy conversion than automobile, but they are such a large factor in the total energy picture that renewed interest is being shown in motor performance. Today's industrial motors have energy conversion efficiency exceeding 96% in larger

horsepower's. This electric motor is made to run on the solar arrays which generate a power of 42 amps and 48 volts. The solar panel providing the power to the motor through the solar charge controller and to the batteries which helps the motor to run. There is a power controller between the batteries and the BLDC motor helping the vehicle to run with efficient power. The all set up is installed in aerodynamic designed car with three wheels covered with solar arrays. the car is covered fully with solar panels to generate more and more power to rotate the motor which runs the rear wheel of the vehicle or car. As the power transmission is done via motor to the gear box consist of driving and driven shafts rotates the wheel transmitting power via chain. To adopt this system there was a need to select a power full gear box providing a gear ratio with high torque and speeds. By neglecting Piston, connecting rod, Crank shaft, Clutches, Oil filters, Head and Bore, the remaining items in the gear box is just engaging and disengaging shaft with driving and driven gear shaft at five manual operating gears. The oil in the gear box was used as lubrication for gears inside and was used to work smooth with the gears. The operator also need to apply shifting of gears smoothly while in motion so the oil works as lubrication for the gear box. There is a small air outlet for the oil pressure to get exhaust, the pressure is created by the revolving of shafts inside the gear box. There is no oil filter placed because the oil need to be changed as usual within the standard limits of run of the vehicle, but the only thing is that the oil can remain and run for a long time. There no blur mixture of any type of fuel in the oil due to which the lifetime of oil used for lubrication extends and can be replaced after a long time. The all set up is placed under safe foundation and the safe design is shown in the picture below.

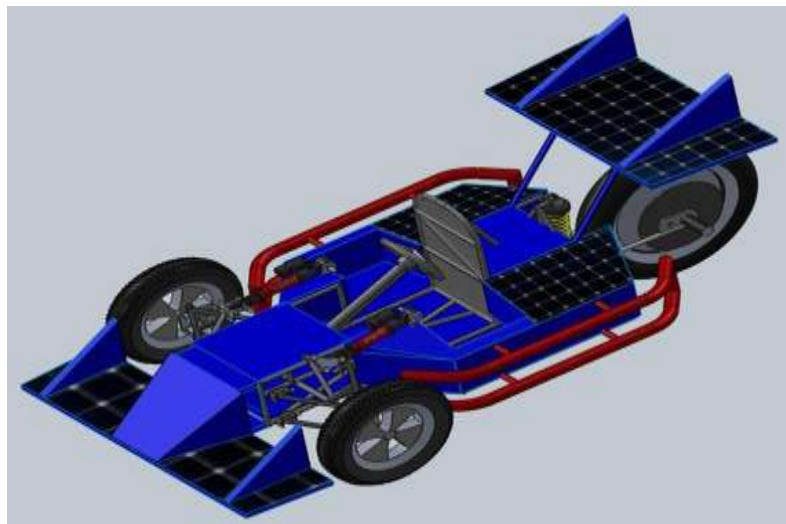


Fig – 1: Design on which Set up is installed

The above is the design picture on which the setup of Electro – Mechanical system is done on the rear wheel. The solar panels are used to generate power transferring the charges through the solar charge controller on to the batteries. The batteries are allowed to supply a required amount of charges following through the power controller and the BLDC motor starts to rotate. It is the unique design to hold the powerful gearbox at the base on the above motor is placed which on beside are placed batteries at the rear side of the vehicle or car. The solar arrays generating the power from the sun and batteries saves the power that is utilized by the BLDC motor and the made to run the rear wheel of the car. The below is the block diagram of the arrangement of the gear box and all setup of solar arrays, motor, batteries and rear wheel.

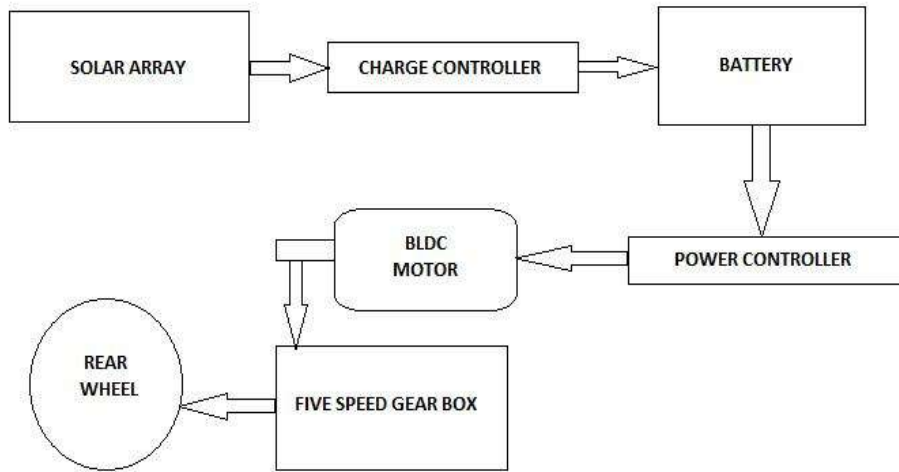


Fig-2: Block Diagram of Experiment Done

The main function of a transmission system is to ensure uninterrupted movement of the wheels with help of motor. The hope for the transmission system to be design was.....

- ☐ To achieve maximum possible speed using gears.
- ☐ To achieve maximum torque at the starting and continues.
- ☐ With a possible extent, to reduce the major and minor power losses.
- ☐ Selecting of components carefully to avoid the power losses and to overcome the above view.

In the below diagram there is a clear view describing power transmission from initial source to the final stage i.e., power transmission gearbox with diagrammatic view of gear shaft (driving and driven shaft). From the below shown diagram it clarifies that power is transmitting from electric motor i.e., small sprocket to the bigger sprocket connected to the main shaft or driving shaft of the gearbox. Now these driving shaft drives the shaft which is placed parallel to it consisting of different five gears to achieve different speeds. The engage and disengaged of gears are carried out by operating manually by the driver or operator.

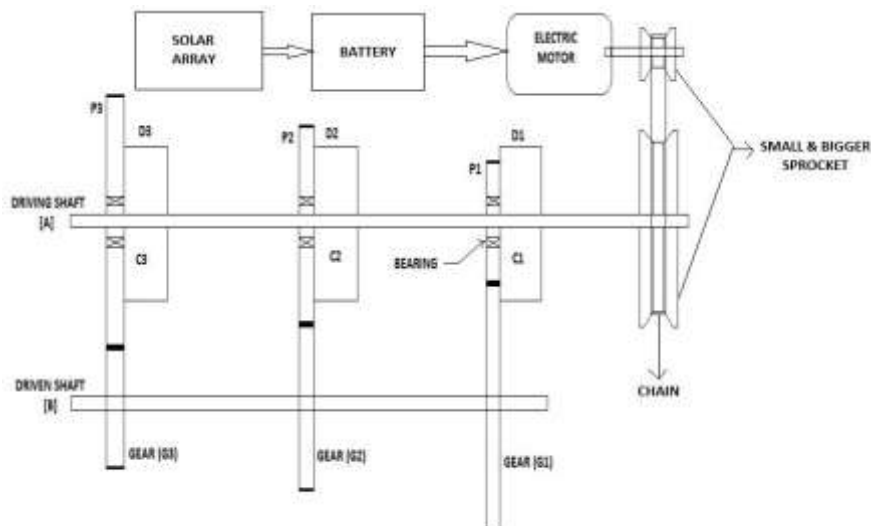


Fig- 3: Gear shafts connected with BLDC Motor

3. GEAR RATIOS AND ITS CALCULATIONS

Suppose the driving gear has 25 teeth and the driven gear has 50 teeth, Then the gearing ratio is defined by: $Gr = 25/50 = 0.5$. It means for every one complete rotation of the input gear the output gear turns by half a revolution.

Table – 1

Gears	Gear Ratios
1 st Gear	$36/13 = 2.76$
2 nd Gear	$32/17 = 1.88$
3 rd Gear	$29/21 = 1.38$
4 th Gear	$26/24 = 1.08$
5 th Gear	$24/27 = 0.88$
Final Drive Ratio	$36/13 = 2.76$

- Power generated by the solar panels all over the body, Power = 2KW
- Motor Speed placed above the gear box, $N_1 = 3700$ RPM (1st Shaft)
- At first gear shift the motor speed turns, $N_2 = 1123.44$ RPM
- Coefficient of Friction between road and tyres, $\mu = 0.3$
- Radius of the wheel where gear box is connected, $r = 0.6$ M
- Overall Weight of the vehicle, $W = 210$ KG
- Starting Torque of the motor, $T = \mu \times W/3 \times r$
- Torque=1, $T_1 = 0.3 \times 210/3 \times 0.6 = 12.6$ NM
- Torque=2, $T_2 = 1.3 \times T_1 = 1.3 \times 12.6 = 17$ NM
- Final driving ratio with high power = 2.76

4. EXPERIMENTAL EXPLANATION

To run the vehicle on solar arrays using the batteries with required power output was easier with the above calibration, now in this modern world it is essential to adopt such techniques which could save the mother earth by reducing fossil fuels. The arrangement of vehicle can be shown in the below picture, the motor is placed just parallel to the gear box in the bottom and the small sprocket is connected to the rear wheel as usual as standard. The rear wheel is adjusted with suitable suspension that can recover the weight of gear box especially. There is a big sprocket connected to the motor shaft and small sprocket to the main shaft of the gear box extended using a puller shaft. The puller is used to connect the main shaft and open the cover which made to mate with the main shaft to transmit the power coming from the motor via chain. This main shaft when receives power from the motor transfers to the driven shaft which again transfer power to the rear wheel and the vehicle runs. These experiment neglected piston, connecting rod, crank, oil filters, dynamo, head, bore, valves, spark plug, the only items or equipment's that used were driving and driven shaft, clutches, oil to run the gears smooth in the gear box. The head part of the gear box is hard pressed with aluminum plate of thickness 0.5mm and attached on four bolts by applying bond on the surface. Bond helps the plate to withstand the pressure created inside the gear box when motor is rotated. The speed maximum achieved was within the range of 70-80 kmph.



Fig- 4



Fig- 5



Fig- 6

Figure – 4: This is the image displaying motor of 2kw power and 3700 rpm with its shaft and one more shaft exactly parallel to the motor, the second shaft is of gear box helps to drive the rear wheel when transmitted motion. The motor is fixed with four bolts on the gear box and its foundation is on the chassis.

Figure - 5: To this motor shaft big sprocket is connected and to the gear box main shaft small sprocket via chain drive parallel, to the bottom part one more chain which is connected to the small sprocket is directly connected to the rear wheel. The both small sprockets belongs to the gear box made to transfer mechanical power.

Figure – 6: This figure shows the working of vehicle when power is given to the gear box from solar panels and motor, the power is easily transferred to the rear wheel via chain and the suspension that recovers the shocks as well as the weight.



Fig- 7: Clear view of the vehicle and transmission system without solar panels

5. CONCLUSION

The research was up to the mark and was successful to achieve a max speed of 70 kmph by utilizing the solar arrays and batteries with a unique design of car with three wheeled vehicle. It gave a great comfort with gear box helped to operate on different gear speeds. World can now know the useful technique that to be adopted by using the solar arrays generating power to run the BLDC motor through the help of the batteries. Using the motor electrical power is converted into mechanical in the gear box. The gear box transmitting power to the rear wheel makes the vehicle run on solar source and electro – mechanical system. The final view of the vehicle can be seen below clearly. The vehicle and the setup of the electro – mechanical system was unique and can be known as the innovation part in the mechanical industry. To make the mother earth green and save from fossil fuels the encircle need to adopt this type of technique because it is the well designed and tested experiment. The following benefits have been concluded from this project work:

- ☐ The Electro - Mechanical transmission gearbox with solar arrays is efficient and reliable. It provides ease for driving a three wheeler. Hence any one can easily drive the geared electro – mechanical vehicle.
- ☐ Time required for shifting gears is less; due to complicated gear shifting mechanism is not used.
- ☐ Positive engagement of gears during shifting is achieved.
- ☐ There is no jerkiness during shifting, no temporary loss of power and shifting can be known by manual gear shifting system.
- ☐ There are no belts, pulleys, fluid torque converter or any other parts associated with the gear box for

the transmission.

- ☐ Gear clashes are avoided because there is no pressure exerted on the driving shafts due to neglecting of piston, connecting rod, crank etc...
- ☐ Design of gearbox casing becomes simple by neglecting the head part along with bore and piston.
- ☐ There is a great future scope for the improvements in the present work and many more modifications can be carried out by proving button operated gear shifting, gear indicators i.e. visual representation of gear in digital indicators.



Fig – 8: Final output vehicle tested

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