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DESIGN AND FABRICATION OF AUTOMATIC ELECTROMAGNETIC CLUTCH SYSTEM IN AUTOMOBILE & ALTERNATIVE POWER GENERATION

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Abstract*- The goal of the invention of clutch system was obtaining enhanced breaking distribution in vehicle breaking system and also upgraded speed control system. Clutch is a device used to make and brake contact from the transmission. When it engages, power is transferred from engine to transmission and when it disengage, power flow will stop, which is called free running of engine. Electromagnetic clutches are operated electrically, but transmit torque mechanically. The clutch system was built on the theory of magnetism. When DC current passed through the system, it activated the electromagnet which disengaged the clutch and when DC current supply was stopped, due to spring reaction force clutch got engaged automatically. Using the rotary motion of the driven shaft alternative power can be generated for further use.*

Keywords: Electromagnet, Engagement time, Force on current carrying conductor, Brake coil.

1. INTRODUCTION

The automotive drive train or power train carries power from the engine to drive wheels. This power flows through the clutch from the engine to the transmission system.

A clutch is that system of automobile which engages or disengages power from the engine crankshaft to transmission. This is a mechanism by which we change the gears. In simple words, it turns on or off power to rear wheel. A clutch is made of clutch assembly which includes clutch plate, clutch basket, clutch hub, pressure plates, clutch springs, lever and clutch cable.

In air conditioning system, the clutch device engages or disengages the compressor shaft from its continuously rotating drive-belt pulley.

In vehicles clutch is usually operated by the driver's foot. But some clutches have power assist device to reduce driving effort. Various electronic devices can be used so that clutch can be operated automatically.

Electromagnetic clutches operate electrically, but transmit torque mechanically. This is why they used to be referred to as electro-mechanical clutches. Since the clutches started becoming popular over 60 years ago, the variety of applications and clutch designs has increased dramatically, but the basic operation remains the same.
The clutch [1] has four basic functions:

1. It can be disengaged. This allows the engine cranking and permits the engine to run quickly without delivering power to the transmission.
2. While disengaged, the clutch permits the driver to shift the transmission into various gears. This allows the driver to select the proper gear (1st, 2nd, and 3rd, reverse or neutral) for the operating condition.
3. During engagement the clutch sleeps momentarily. This provides smooth engagement and reduces shock on gears, shafts and other driving parts. As the engine develops enough torque to overcome the inertia of the vehicle, the drive wheels turn and the vehicle begins to move.
4. When engaged the clutch transmits power from engine to the transmission. All slipping has stopped.

Advantages of Electromagnetic Clutch [2]:

1. The electromagnetic clutch is most suitable for remote operation since no linkages are required to control its engagement.
2. It can act faster and has smooth operation so that, the gear shifting operation in automobiles will be lot more easy
3. It is much more efficient than manual clutch system user friendly. Less slip occurs and user friendly.

4. In ordinary clutch system, there is a clearance in the clutch pedal called clutch pedal play and due to which, proper disengagement of clutch is not achieved. As a result, clutch got slipped or dragged. But in case of electromagnetic clutch this problem can be avoided.
5. During shifting gear of electromagnetic clutch, the clutch disengages automatically. Hence, the driver will require less effort to engage as well as disengage the clutch.

2 BASIC TEMINOLOGIES

2.1 Electromagnet

An electromagnet [3] is a type of magnet in which the magnetic field is produced by a flow of electric current. The magnetic field disappears when the current ceases. The simplest type of electromagnet is a coiled piece of wire. A coil forming the shape of a straight tube (similar to a corkscrew) is called a solenoid; a solenoid that is bent so that the ends meet is a toroid. Much stronger magnetic fields can be produced if a "core" of paramagnetic or ferromagnetic material (commonly iron) is placed inside the coil. The core concentrates the magnetic field that can then be much stronger than that of the coil itself. Current (I) flowing through a wire produces a magnetic field (B) around the wire.

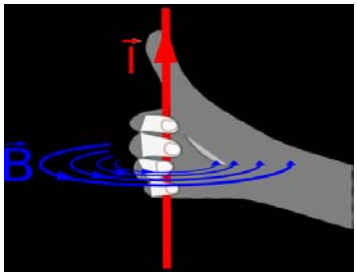

Figure1: Magnetic field around the wire [4]

2.2 Left Hand Rule for Conductors

A definite relationship exists between the direction of current flow and the direction of the magnetic field. The left-hand rule [4] for conductors demonstrates this relationship. If a current carrying conductor is grasped with the left hand with the thumb pointing in the direction of electron flow, the fingers will point in the direction of the magnetic lines of flux.

2.3 Engagement Time

There are actually two engagement times to consider in an electromagnetic clutch. The first one is the time it takes for a coil to develop a magnetic field, strong enough to pull in an armature. Within this, there are two factors to consider. The first one is the amount of ampere turns in a coil, which will determine the strength of a magnetic field.
The second one is air gap, which is the space between the armature and the rotor. Magnetic lines of flux diminish quickly in the air. The further away the attractive piece from the coil, the longer it takes that piece to actually develop enough magnetic force to be attracted and pull in to overcome the air gap.

2.1.3 Force on current carrying conductor

If a current carrying conductor is placed in a magnetic field produced by permanent magnets, then the field due to current carrying conductor and the permanent magnets interact and cause a force to be exerted on the conductor. The force on the current carrying conductor [4] in a magnetic field depends on:-
a) The flux density of the field, B Tesla
b) The strength of current, I Ampere
c) The length of the conductor perpendicular to the magnetic field.
The direction of the field and current
When the magnetic field, the current and the conductor are mutually perpendicular to each other then, force exerted:

F=IBL Newton (N)

When the conductor and magnetic field are at an angle, then the force exerted:

F= IBL x Sinα

Where;
I=current, B magnetic field, L=Length of conductor
α= angle between conductor and magnetic field.

2.1.5 Brake Coil

The brake coil is a device act like a solenoid system which is used for the engagement and disengagement of the clutch system.

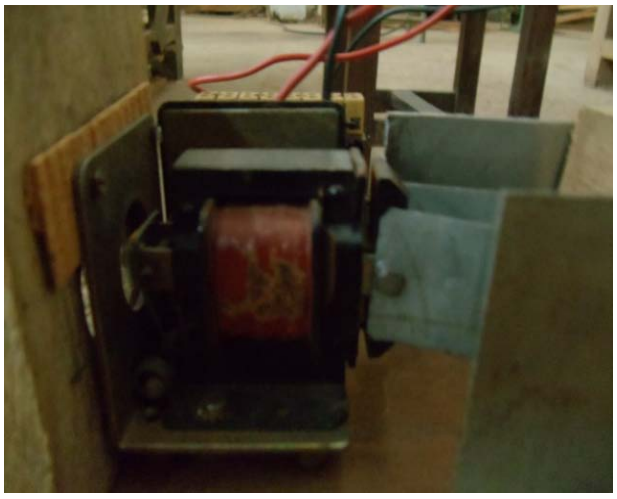

Figure 2: Brake coil

It consists of a ferromagnetic material [5] or iron which is surrounded by a coil piece of wire turns. When high voltage is supplied through the coil, a strong electromagnetic field produces around the iron core. For which the iron will be attracted by the magnetic field. When current stops passing, the magnetic field also got stopped. After that, the spring pushes the iron bar towards forward and then goes back to its previous position.

2.2 Flow Chart

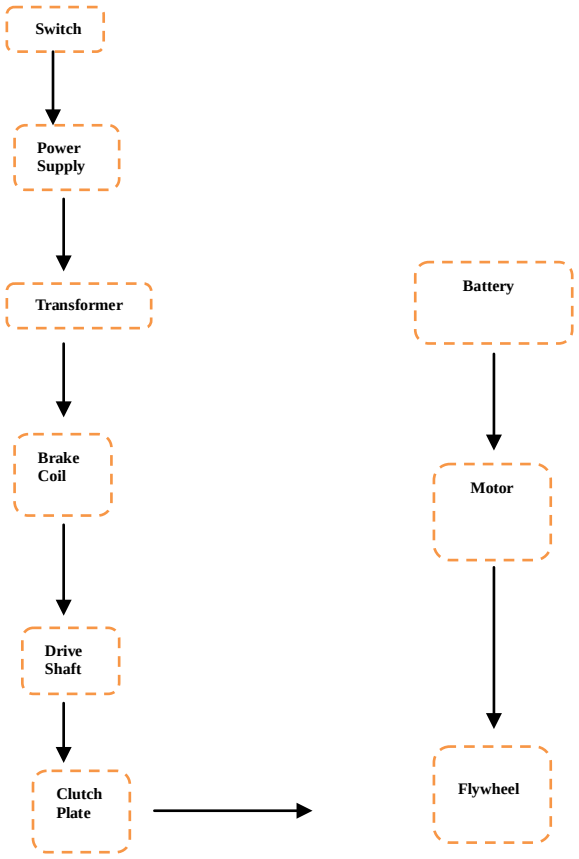

Figure 3: Flow chart of electromagnetic clutch system

3 DESIGNING AND IMPLEMENTATION

3.1 Necessary Equipment

To complete the experiment following equipments are used: a) A DC Motor. b) Transformer. c) Brake coil d) Shaft e) Two metal disk f) Battery g) Guide h) Bearing i) Switch and wire j) Frame (wood)

3.2 Construction

In this work a DC motor was used, which has 200 rpm, voltage rating was 12V and power rating was 40Watt.Here, the motor represented the engine. Two metal disc were also used which were acting as flywheel and clutch plate.

The motor was connected with the flywheel by a bearing and a shaft. The clutch plate was connected with the one end of the driven shaft, which were supported by another bearing. The bearings were mounted on squire wooden casings. The wooden casings were fixed with the base frame with pins and L shaped metal fittings which were also made by wood.

The other end of the shaft was connected with the braking coil by another bearing and wood casing. Hence, the drive shaft could rotate freely. The bearing casing was guided by two steel plates so that, the alignment of the shaft could be maintained perfectly and also to avoid axial vibration.

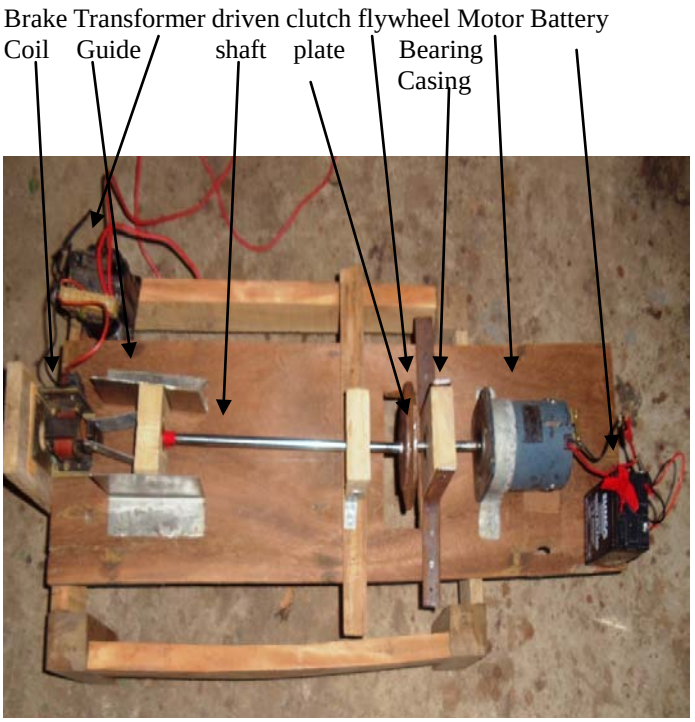

Figure 4: Structure of electromagnetic clutch system

The braking coil was connected with a step up transformer, which has multiple output (220 V, 240 V, 380 V, 415 V, 440 V) for 220 V input. Here, we need 380 V to 440 V output to energize the brake coil. The transformer was connected with 220V ac main by wire and switch.

The power required to run the motor was supplied from a 6V battery.

3.3 Working Principle

In this system a DC motor is used which acted as an actuator. For this reason a battery is used to run the motor. The battery supplied 6V DC to the DC motor and the motor l start to rotate. As a result, the flywheel and clutch disk also rotate.

At the engagement position, the brake coil is not energized. Hence flywheel and disk rotate with the rotation of the motor.

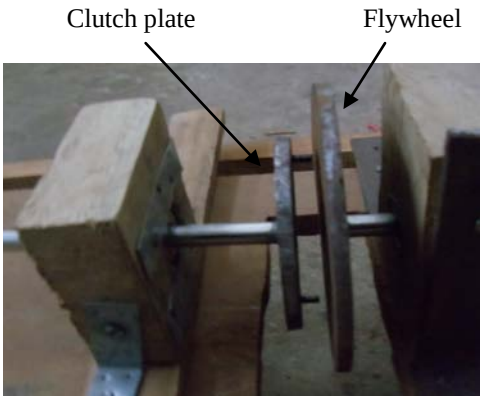

Figure 5: The clutch plate is disengaged.

Figure 6: The brake coil is energized

In case of disengagement, at first 220V input is given to the step up transformer, this transformer convert 220V into 380V and supply to the brake coil to energize it. This high voltage supply through the coil induces a strong stationery electromagnetic field. For which the iron core is attracted by the magnetic field. Then the driven shaft is pulled backward with the armature since it is fitted with bearing and casing. Hence, the clutch disk is disengaged from the flywheel and stopped rotating eventually. But the flywheel rotates continuously.

When the power input is switched off, the high voltage supply as well as, the electromagnetic field also stops working. Then the spring mounted on the rear side of the brake coil push the iron core towards forward. Thus, the shaft and the clutch disk move forward. Then the clutch disk meshes with the flywheel and after a little slip the clutch disk is rotated with the flywheel at same speed.

Figure 7: The clutch disk is engaged.

The rotary motion of the shaft can be used to produce alternative electrical energy by fitting an alternator with it. This electrical energy can be supplied to the brake coil through transformer to produce electromagnetic field.

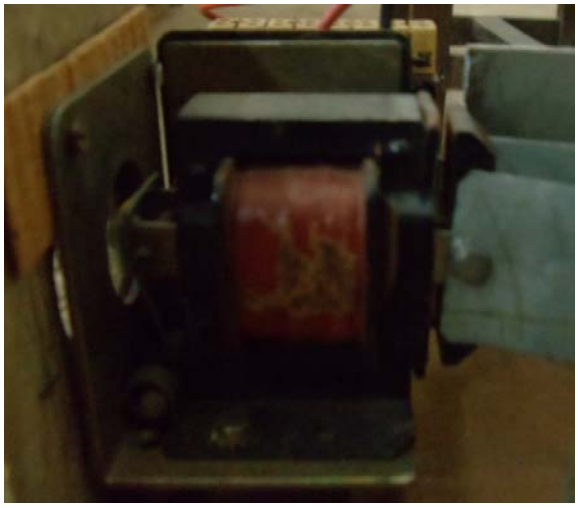

Figure 8: The brake coil is not energized

4. CONCLUSION

In this work it has been found that, an electromagnetic clutch would be very advantageous, as it has great braking efficiency and makes gear shifting operation easier. The engagement control requires no linkage. Hence, it is more efficient than other braking system. It acts faster than normal clutch since, it has less slip. It also has smooth operation and maintenance cost is low. Moreover, electromagnetic clutch can reduce brake wear which is a common problem of automobile.

When the motor is running, the driven shaft will be in rotary motion as long as it is connected by the clutch plate with the flywheel. So, we can utilize this motion and convert it into electrical energy by using an alternator. It can be connected with the driving shaft by belt system. The electrical energy can be used to supply power to the brake coil of the clutch, or we can charge the battery for further usage.

To complete the project some difficulties have been faced to maintain the alignment of the shaft and clutch plates. But at last it was successfully completed.

5. REFERENCES

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