
A REVIEW ON STARTER MOTOR IN AUTOMOBILES

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ABSTRACT

Engine starting system is a system that has a function to crank the engine for the first time. Starter motor is an electrical device which is used to crank the engine when the vehicle is turned on. The pinion gear meshes with the flywheel and rotates it when the key is turned ON and disengages when the engine starts to run by itself. In this review paper we are going to discuss about the functions, construction working of starter motor, as well as some of its types and failures of starter motor.

Keywords: A Review Paper On Starter Motor In Automobiles, Starter Motor Of Cars, Starter Motors, Starting System Of A Vehicle.

I. INTRODUCTION

The starter motor is an electro-mechanical device which converts the electrical energy from battery into the mechanical energy in the motor ^[1]. A starter or starter motor is used to rotate (crank) internal combustion engines so as to initiate the engine's operation under its own power. As soon as the engine begins to run, it gets disconnected from the engine, which now relies on the combustion process. The component is mounted on the engine's gearbox housing, and the starter motor gear meets flywheel's teeth ^[2].

Internal combustion engines are feedback systems, which, once started, rely on the inertia from each cycle to initiate the next cycle. In a four-stroke engine, the third stroke releases energy from the fuel, powering the fourth (exhaust) stroke and also the first two (intake, compression) strokes of the next cycle, as well as powering the engine's external load. To start the first cycle at the beginning of any particular session, the first two strokes must be powered in some other way than from the engine itself. The starter motor is used for this purpose and it is not required once the engine starts running and its feedback loop becomes self-sustaining ^[3].

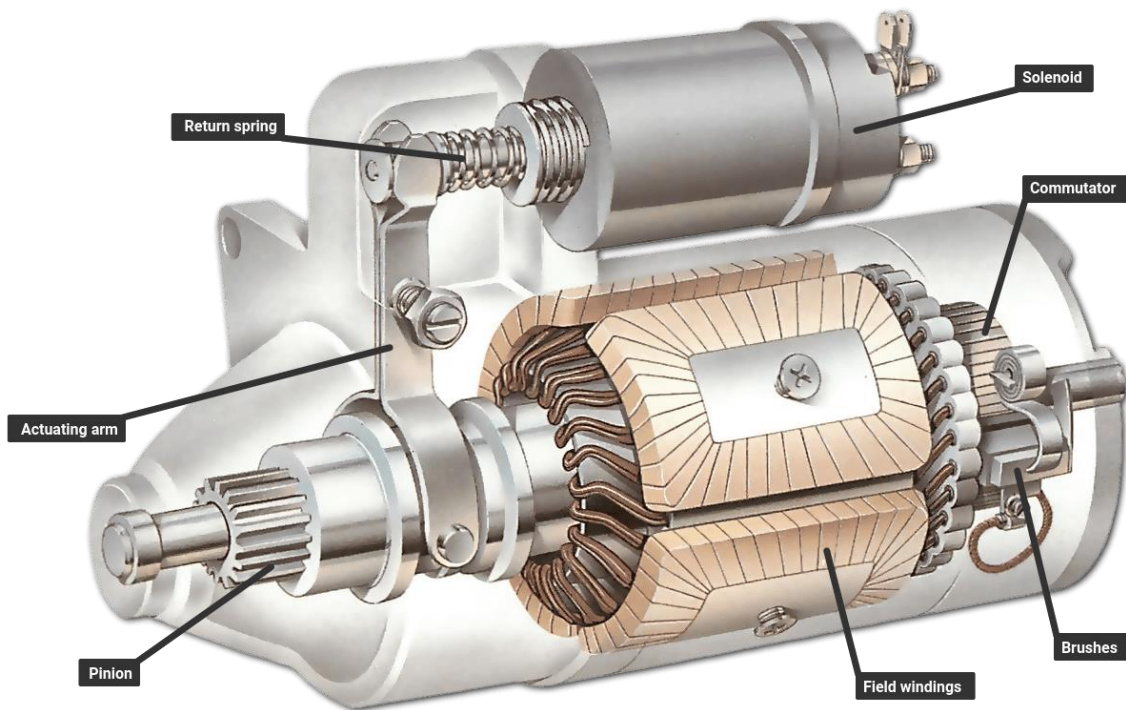
II. CONSTRUCTION

The armature of the motor consists of a stack of stamped soft iron pieces called laminations i.e. fitted on the armature shaft. Insulated wire is wound through the matching slots in the iron laminations i.e. to provide four electrical paths when four field poles are used.

Each complete winding loops form a commutator segment is completed at an adjustment commutator segment. This should be done all around the armature so that all the windings are interconnected.

The ends of two endings are soldered or welded to junction on each commutator segment bar. The commutator base is from the rest of the armature assembly. These are brushes supported by brush holders. They are held against the commutator by the brush spring.

The brushes are usually angled slightly to provide good contact minimum arcing and long service life. Two opposite brushes are insulated from the frame and other brushes are ground to the frame. One end of the armature shaft is much longer than other end to accommodate the drive assembly. This is opposite to the commutator end ^[4].



Parts of Starter Motor and their Functions:



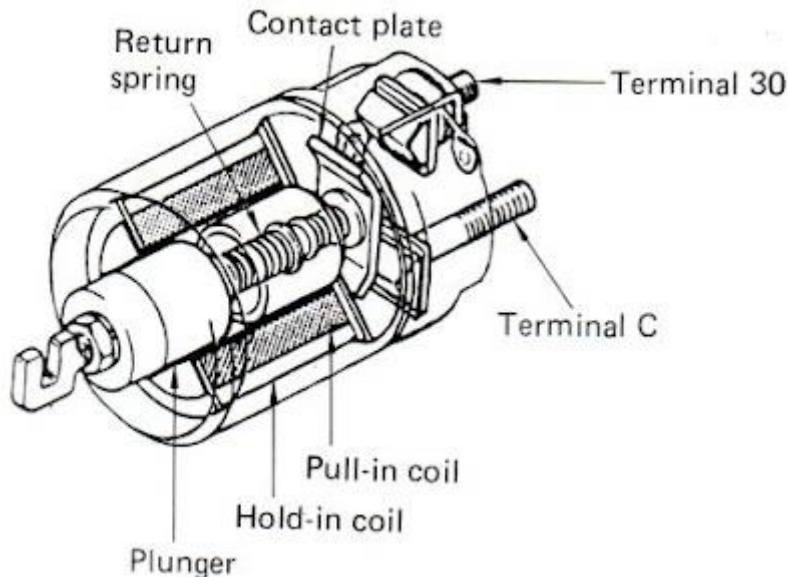
(img by jcrsupplies.co.uk)

1. Solenoid starter:

The first component you can see on the part that looks like a small tubular part on the main motor. This component is named solenoid starter because it contains two solenoid. The main function of Solenoid starter is to push the pinion drive gear and give voltage on main motor. The shape of the solenoid is like a coil, where an iron core is placed in the middle of a copper coil. But this winding has a large number and the dimensions are also larger so as to move the plunger with a strong and fast [5].

2. Solenoid plunger:

The plunger is located at the end of the pull in coil. Its function is only one that connects the movement of pull in coil to drive lever. In other words, this component only acts as a connecting rod. However, this plunger material is also strong because it will connect the pull in coil pull that have strong movement [5].



3. Solenoid cap:

The solenoid lid is a starter solenoid cover circuit located on the front of the starter. Not only as a cover, but this part is also used as a media liaison between the current from the system to the starter actuator. Actually there are 3 pieces of terminal on the starter motor i.e.

1. Terminal 50; is a terminal connected to the starter circuit of the ignition key. Through this terminal the starter motor gets the command to active or not. When terminal 50 gets current then the solenoid will work and the starter will react.
2. Terminal 30; the terminal which directly gets the electric current from the battery. In other words electric current is always available at this terminal when the motor is off or on.
3. Terminal C; the terminal used to channel the main currents from the solenoid to the starter motor in order to rotate. It will connect the current from terminal 30 when terminal 50 gets current [5].

4. Field Coil:

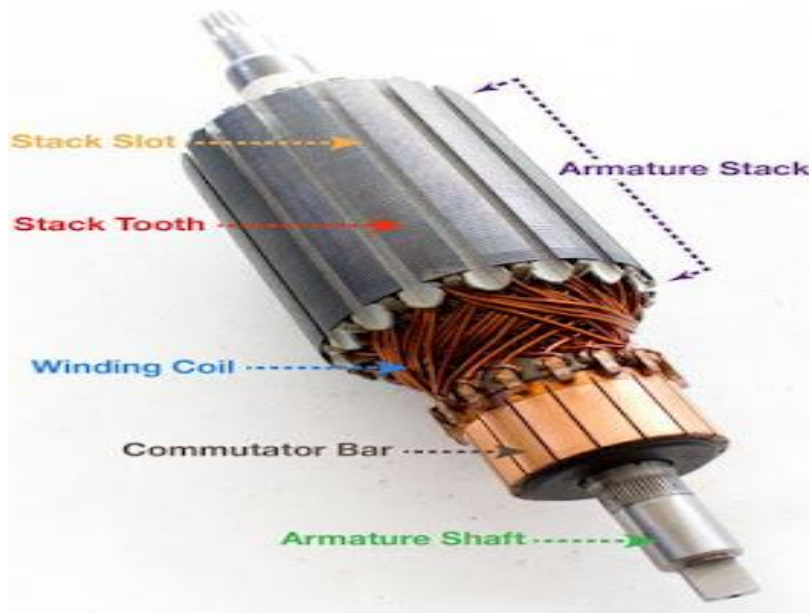
The field coils are held in housing with screws as it consists of two or more coils connected in series. These coils receive power from the battery that converts them into an electromagnet that turns the armature. This creates a magnetic field around the armature [2].

5. Armature coil:

The main function of the armature coil is also as a magnetic field generator that will be reacted with magnet field coil for the occurrence of movement. The shape of armature coil is such as rotor that has tubular shape. In general it is coated by copper; the difference with field coil can be find in its dimension and amount of coopers. Armature coil has a large number of windings and the amount of coopers also quite large, so the diameter of the coil is also larger [5].

6. Commutators:

The function of the commutator is to connect the electrical current from the brush to the armature coil. The segmented form of commutator prevents short circuiting of electric current because in the process the commutator will be connected to positive and negative currents directly [5].



(img by groschoop.com)

7. Drive lever / Actuator shaft:

The drive lever works with the principle of the lever, which will bring up the pinion gear when the other end is pushed in opposite directions. Pushing is a function of pull in the coil through plunger. While the other end will make the pinion gear pushed out and connected with flywheel [5].

8. Brushes:

A series of brushes used to connect the electrical current from a static conductor to a dynamic conductor. This brush will send an electric current from terminal 50 to the armature coil that moves around through the commutator. In a starter motor, there are usually about 4 or more brushes with two as a positive brush and the other two as negative brushes. The material of this brush is also made of copper but softer, to keep the commutator from wearing out. But, the impact brush become more quickly wears out. If this happens then the starter will be difficult to run [5].

9. Drive Pinion Clutch:

Drive pinion Clutch is a mechanical clutch that has function to connecting and disconnecting rotation from the starter shaft to the flywheel. The rotation needs to be disconnected because the starter motor is unlikely to keep working when the engine is running. So in a normal condition, the starter will be connected and when the starter system is turned on the round starter will be connected with flywheel [5].

10. Drive pinion gear:

Drive pinion gear is shaped like a gear in general that is located at the end of the drive pinion shaft. The function of this pinion gear is to connect the rotation of the generated electric motor to the engine crankshaft via flywheel. The pinion diameter is quite small compared to the flywheel so it will increase the gear ratio that makes the starter system capable to rotate high capacity engine [5].

11. Motor housing:

The last part is housing, which has the function as a protective part and as a place to put various components of starter. This housing is made of metal consisting of tubular main housing, pinion housing as pinion gear and stamped in front of the main housing as a starter chassis cover [5].

III. WORKING

Operating sequence of the starter motor is as follows:

1. ENGAGEMENT: When the ignition switch is in the starting position, it completes an electric circuit that energizes the starter-motor solenoid switch. The magnetic field created by the solenoid coil draws in the solenoid armature, thus operating the engagement lever so that the pinion gear is moved outwards and comes

into contact with the ring gear. As starter motors for commercial vehicles have to produce high levels of torque, appropriate meshing methods have to be adopted in order to prevent excessive stress on the teeth of the pinion and ring gear. They ensure that there is sufficient overlap of the teeth before the starter motor delivers its full power [1].

2. TURNING THE ENGINE: When the starter motor begins to rotate, the transmission ratio between the pinion and the ring gear produces a large amount of torque acting on the crankshaft of the engine. The frictional resistance is overcome and the engine starts to turn over [1].

3. STARTING AND OVERRUNNING: As soon as fuel is injected/ ignited, the internal combustion engine starts to generate its own torque and, therefore, to increase its speed of rotation. After only a few ignition strokes, it is revving so fast that the starter motor can no longer keep up. The starter motor is thus overrunning. At this point, it is essential that the one-way or overrunning clutch disengages the pinion from the starter-motor drive shaft. By doing so, it prevents excessive wear and protects the starter motor from damage [1].

4. PRECONDITIONS FOR STARTING: The resistance to rotation of an internal-combustion engine, i.e. the torque required to turn it over, depends primarily on the engine capacity and the viscosity of the engine. The design of the engine, the number of cylinders, the ratio of stroke to bore, the compression ratio, the mass of the moving engine components and the nature of their bearings, as well as the additional drag from clutch, transmission and auxiliary drive systems also has an effect [1].

Types of Starter Motors:

1. Direct Drive Starter Motor DD: Direct drive the most common and older types of starter motor available out there. It comes with different applications and construction design but it's solenoid operated unit. Well, the working remains plain like other types. The solenoid is energized by the car battery when the ignition switch or key is pressed. This pushes the plunger to shift the lever that directs the pinion gear. The pinion gear which then meshes with the engine flywheel. So, as the starter motor spin, the flywheel spin along which then begin the engine combustion to run on its own [2].

2. Planetary Gear PLGR: The existence of these types of starter motor has vastly replaced the direct-drive types. It is a permanent magnet that transmits power between the pinion shaft and the armature. The armature spins with more speed and torque. The essence of planetary gear is to reduce gear which further reduces the requirement of high current. There is a sun gear located at the end of the armature and three planetary carrier gears inside the ring gear held stationary. Planetary gears are able to attain a great amount of gear reduction as the ring gear is held and inputting the sun gear while outputting the carrier [2].

3. Permanent Magnet Gear Reduction PMGR: The permanent magnet gear reduction is designed to offer less weight, easy construction and less heat generation. It features four to six magnet field assemblies rather than field coil starters. It has three terminals on the 12V solenoid, and also heavy-duty making to require less current. Because there are no field coils, the commutator and brushes transfer current directly to the armature [2].

4. Permanent Magnet Direct Drive PMDD: The PMDD types of starter motors are similar to the direct drive in several ways. Their difference is that the field coil is replaced with permanent magnets in the permanent magnet direct drive type [2].

5. Off-Set Gear Reduction OSGR: These starter motor types work under high speed at low current. They are lighter and more compact which makes them easy to assemble. Off-set gear reduction starters are common among the four-wheel-drive vehicle as they increase cranking torque [2].

6. Inertial Starter: Inertial starters are the electric types that achieve the feature of all types of starter motors. It works perfectly fine during the cranking and even ensures the motor part safety. It starts the engine strong and very fast, making it the best option for cranking speed. The amount of weight associated with the torque capacity of the starter is extremely minimized [2].

Symptoms of Bad or Failing Starter Motor:

Below are the symptoms of bad starter motors:

1. Engine Won't Crank Or Start: This is one of the most common symptoms that occurs if a starter motor is bad. Well, failing battery, bad ignition switch, or engine mechanical problem can also be because. This is why the problem must be diagnosed by a professional in the field [2].

2. Slow-cranking: If you notice your engine crank slowly, then you should know the starter motor has an internal problem. Although a weak battery and internal engine problem can also cause this issue. So, seeing a good mechanic will help you determine and fix the problem [2].

3. Grinding Noise: You'll notice a grinding noise while starting the engine if the teeth on the starter pinion are damaged. If the starter fails to quickly retract soon enough once the engine starts running. The flywheel teeth can also be because of this problem [2].

4. Whirring Noise: A whirring noise occurs when the starter pinion gear freewheels during the engine cranking. This is because the pinion gear is not engaging the flywheel properly, which will also cause the engine to fail to start [2].

IV. CONCLUSION

Starter motor in Automobile is the very first and main component for starting the engine. The starter motor gives the first push to the engine for the start of combustion process and afterwards its shaft rotates on its own due continuous power generation in the combustion engine. In this above article we have studied the functions of starter motor, its construction, how it works and different types of starters. Also we have seen some of its Failures which give us a brief idea about the problems that occurs in the internal mechanism of the engine. By studying some of the failures we can work further on the development of starter motor.

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