DEVELOPMENT OF CHARGING SYSTEM FOR ADVANCED VEHICLE

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ABSTRACT

Development of charging system for advanced vehicle becomes so much important nowadays. Every manufacturer is competing against each other to get the best design of the charging machine. In the development, the optimum design of the rotor and the control were considered. Most alternators for the charging system nowadays already upgraded into Integrated Alternator Starter, which combining the starter motor and alternator. This configuration has the best yield and after further researches, the technology has been implemented to manufacture better engines such as the hybrid engine. The technology is actually to improve the electric ability of most vehicles. Since the charging system was improved, the battery capacity was also expanded to store more power. Furthermore, hybrid vehicle can be more reliable same as the conventional vehicle which uses fuel as their main vitality.

ABSTRAK

Kemajuan dalam sistem pengecasan untuk kenderaan moden menjadi sangat penting ketika ini. Setiap pengilang dan pembuat saling berlumba untuk mendapatkan rekabentuk yang terbaik bagi sistem pengecasan kenderaan. Dalam usaha itu, rekabentuk untuk rotor dan kawalan motor adalah dititikberatkan. Kebanyakan alternator untuk sistem pengecasan pada hari ini telah ditambah nilai kepada *Integrated Alternator Starter* iaitu gabungan motor penghidup dan alternator. Konfigurasi ini mempunyai had yang terbaik dan selepas kajian yang lebih jauh dijalankan, teknologi ini diguna pakai untuk pembuatan enjin yang lebih baik seperti enjin hibrid. Teknologi seperti ini sebenarnya adalah untuk menambahbaik keupayaan elektrik untuk banyak kenderaan. Oleh kerana sistem pengecasan telah ditambah baik, kapasiti bateri juga boleh ditambah untuk menyimpan lebih tenaga. Lebih-lebih lagi, kenderaan hibrid boleh diharapkan sama seperti kenderaan konvensional yang menggunakan minyak sebagai bahan utama.

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$\wp_{ag}$	Air gap permeance
θ_p	Angular width of pole pitch
μ_0	Magnetic constant
l	Active length
L_d	Direct-axis Inductance
L_q	Quadrature-axis Inductance
i_d	Direct-axis current
i_q	Quadrature-axis Inductance
x_d	Direct-axis Per-unit Reactance
x_q	Quadrature-axis Per-unit Reactance

CHAPTER 1

INTRODUCTION

1.1 Background

Most manufacturers are making incremental improvements to existing technology. However, electronic control continues to be used in more areas of the vehicle. The main 'step change' in the near future will be the move to 42 V systems, which opens the door for other developments. Development of the Charging System for Advanced Vehicle is a process of producing new charging system for the advanced vehicle including electric and hybrid cars. This includes any transportation units that are wheeling on the road such as cars, trucks, buses and motorcycles. Modern transportation units nowadays require a better charging system so that they will work enhanced.

1.2 Problem statement

The need to improve the starting and charging system seems to increase nowadays because higher efficiency of these systems will reduce emission, reduce fuel consumption and adding ability to vehicle to bear higher loads. If the emission is reduce, the rate of pollution caused by vehicles will drop as well as peoples health. The major issue of fuel pricing will also drop because people are less depending to the fuel anymore. Thus, combining the starter and alternator will reduce the components in the engine in addition to reduce the complexity and weight of the whole engine system.

1.3 Objective of the project

1. To combine the starter and alternator for advance vehicle.
2. To extract the output data for the new design of Integrated Alternator Starter.

1.4 Project scopes

1. To understand the work of alternator and the starter motor.
2. To select the type of Alternator Starter machine for this project.
3. To design the Alternator Starter rotor and stator.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

2.1.1 Starting

An internal combustion engine has to fulfill criteria such as the combustible mixture, compression stroke, form of ignition and the minimum starting speed (about 100 rev/min) in order to start and continue running. In order to attain these, the minimum starting speed must be achieved. The ability to reach this minimum speed is again dependant on a numbers of factors.

- Rated voltage of the starting system
- Lowest possible temperature at which it must still be possible to start the engine. This is known as the starting limit temperature.
- Engine cranking resistance. In other words the torque required to crank the engine at its starting limit temperature (including the initial stalled torque).
- Battery characteristics
- Voltage drop between the battery and the starter.
- Minimum cranking speed of the engine at the starting limit temperature.

The typical starter motor can possibly be viewed as an isolated component within the vehicle electrical system. The battery in particular is of prime importance.

Another particularly important consideration in relation to engine starting requirements is the starting requirement is the starting limit temperature. Figure shows how, as temperature decreases, starter torque also decreases and the torque required cranking the engine to its minimum speed increases.

Typical starting limit temperatures are -18^{0}C to -25^{0}C for passenger cars and -15^{0}C to -20^{0}C for trucks and buses. Figures from starter manufacturers are normally quoted at both +20^{0}C and -20^{0}C.

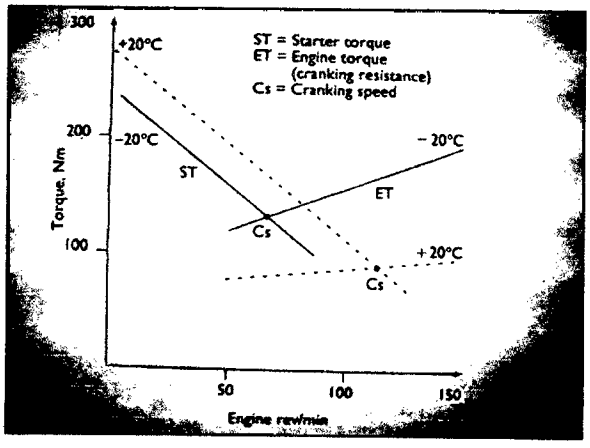


Figure 2.1: Motoring Characteristic [25]

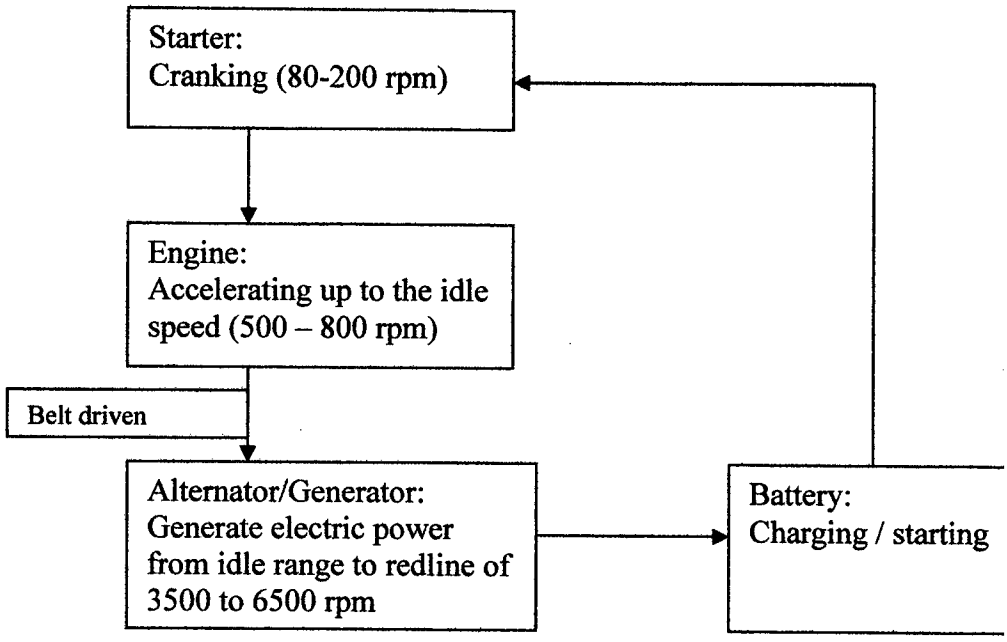


Figure 2.2 : Conventional Engine System

The conventional engine system can be simplified to Figure 2.2. It can be identified that the system used starter and alternator as different component.

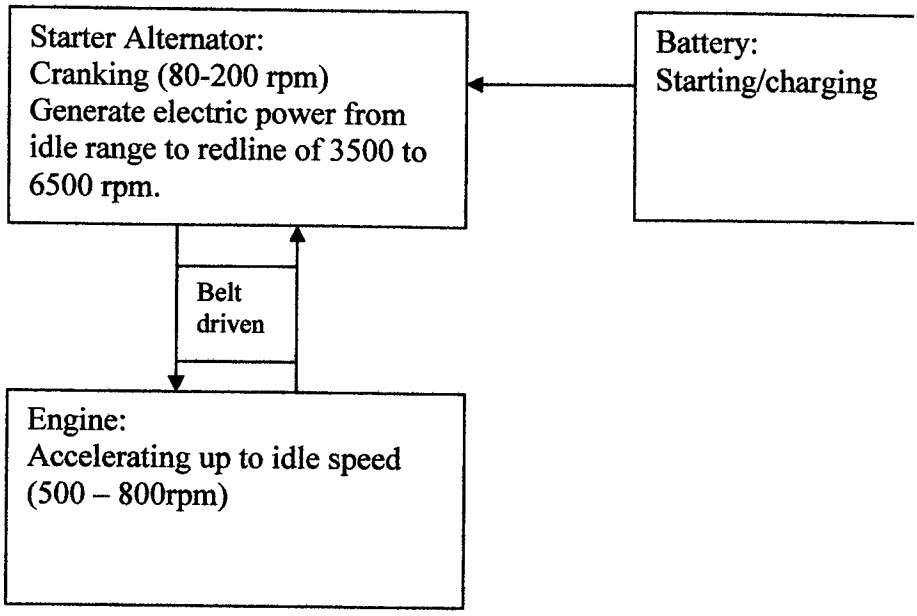


Figure 2.3 : Integrated Alternator Starter

In this project, to make sure the objective of combining the alternator and starter is achieved, the basic design of the engine system will be slightly modified. The proposed design for the Starter Alternator in the engine system is shown in the Figure 2.3.

2.1.2 Starter Alternator criteria

The criteria for this machine are that it has the ability of a starter and the ability of an alternator. The machine is belt driven and connected to the engine crankshaft same as the default conventional alternator. The next explanation will mention both the conventional type of starter and alternator used in the automotive these days. Considering the strength and weaknesses of different motors and alternators, this project could carry out the best type of starter will combine with the best type of alternator and will be renamed as Starter Alternator.

2.1.3 Conventional Starter motors and circuit

In comparison with most other circuits on the modern vehicle, the starter circuit is very simple. The problem to be overcome, however, is that of volt drop in the main supply wires. The starter is usually operated by a spring-loaded key switch, and the same switch also controls the ignition and accessories. The supply from the key switch, via a relay in many cases, causes the starter solenoid to operate, and this in turn, by as set of contacts, controls the heavy current. In some cases an extra terminal on the starter solenoid provides an output when cranking, which is usually used to bypass a dropping resistor on the ignition or fuel pump circuits. The basic circuit for starting system is shown in Figure 2.4

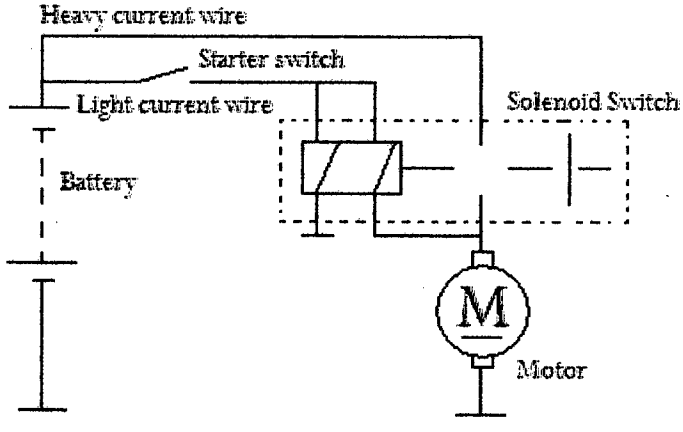


Figure 2.4 : Basic Circuit for starting system

2.1.4 Principle of operation

The simple definition of any motor is a machine to convert electrical energy into mechanical energy. The starter motor is no exception. When current flows through a conductor placed in a magnetic field, a force is created acting on the conductor relative to the field. The magnitude of this force is proportional to the field strength, the length of the conductor in the field and the current flowing in the conductor.

A conventional starter must also have some method of engaging with, and release from, the vehicle's flywheel ring gear. In the case of light vehicle starters, this is achieved either by an inertia-type engagement or a pre-engagement method. But in the development of combined starter alternator, this operation will not be employed because the machine will never released from the main engine crankshaft through the belt.

2.1.5 DC motor characteristics

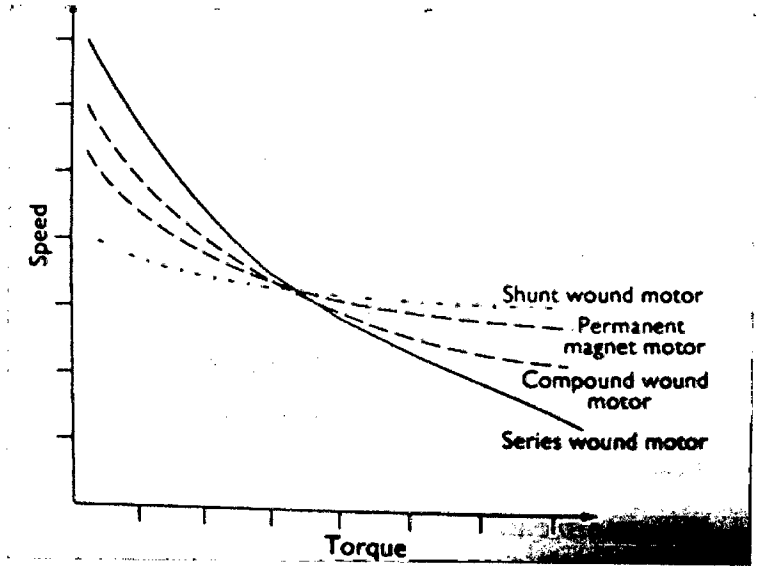


Figure 2.5: DC Motor Characteristics [25]

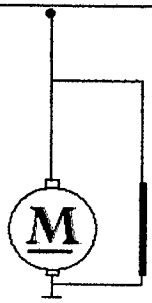
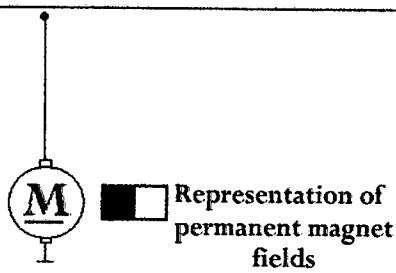
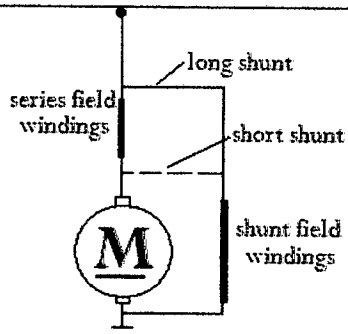
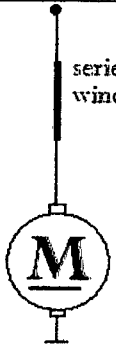
Name	Diagram	Description
Shunt wound motor		• Field winding is connected in parallel with the armature • Due to the constant excitation of the fields, the speed of this motor remains constant, virtually independent of torque
Permanent magnet motor		• The excitation will remain constant under all operating conditions. • Smaller and less weight
Compound wound motor		• Combination of shunt and series wound motor. • Characteristics can vary depending on how the field windings are connected.
Series wound motor		• The armature current passes through the fields making it necessary for the windings to consist usually of only a few turns of heavy wire. • When start under load the high initial current, generates a very strong initial torque.

Table 2.1: Descriptions of Motor [25]

2.1.6 Permanent Magnet Starters

The two main advantages of these motors, compared to the conventional types, are less weight and smaller size. This makes the permanent magnet starter a popular choice by vehicle manufacturers as, due to the lower lines of today's car, less space is now available for engine electrical system. The reduction in weight provides a contribution towards reducing fuel consumption.

The principle of operation is similar in most respects to the conventional pre-engaged starter motor. The reduction in weight is in the region of 15% and the diameter of the yoke can be reduced by a similar factor.

Permanent magnet provides constant excitation and it would be reasonable to expect the speed and torque characteristic to be constant. However, due to the fall in battery voltage under load and the low resistance of the armature windings, the characteristic is comparable to series wound motors. In some cases, fluxes concentrating pieces or interpoles are used between the main magnets. Due to the warping effect of the magnetic field, this tends to make the characteristic curve very similar to that of the series motor.

2.2 CHARGING SYSTEM

2.2.1 Overview

The current demands made by modern vehicles are considerable. The charging system must be able to meet these demands under all operating conditions and still 'fast charge' the battery.

The main component of the charging system is the alternator and on most modern vehicles – with the exception of its associated wiring – this is the only component in the charging system.

The charging system must meet the following criteria (when the engine is running)

1. Supply the current demands made by all loads
2. Supply whatever charge the battery demands
3. Operate at idle speed
4. Supply constant voltage under all conditions
5. Have an efficient power- to- weight ratio
6. Be reliable, quiet, and have resistance to contamination
7. Require low maintenance
8. Provide an indication of correct operation

2.2.2 Charging system principles

2.2.2.1 Basic principles

The basic vehicle charging systems are containing three sections, the alternator, battery, and vehicle loads. When the alternator voltage is less than the battery (engine slow or not running for example), the direction of the current flow is from the battery to the vehicles loads. The alternator diodes prevent current flowing into the alternator. When the alternator output is greater than the battery voltage, current will flow from the alternator to the vehicle loads and the battery.

2.2.2.2 Vehicle electrical loads

The loads placed on an alternator can be considered as falling under three separate headings: continuous, prolonged and intermittent. The charging system of a modern vehicle has to cope with demands under many varied conditions. To give some indication as to the output that may be required, consider the power used by each individual component and add this total to the power required to change the battery.

2.2.2.3 Charging voltages

The main consideration for the charging voltage is the battery terminal voltage when fully charged. If the charging system voltage is set to this value then there can be no risk of overcharging the battery. This is known as the constant voltage charging technique.

2.3 ALTERNATOR PRINCIPLES

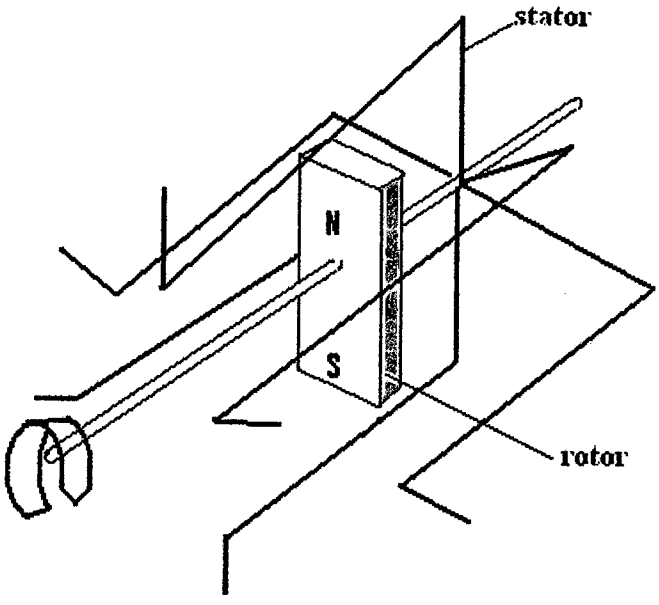


Figure 2.6 : Principle of a three-phase alternator

Figure 2.6 shows the basic principle of a three-phase alternator. Electromagnetic induction is caused by rotating magnet inside a stationary loop or loops of wire. In a practical alternator, the rotating magnet is an electromagnet that supplied via two slip rings.