IMPROVEMENT DESIGN FOR POWER WNDOW MECHANISM OF CABLE TYPE

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Automotive Engineering.

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Date: 20 NOVEMBER 2009

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurently submitted for award of other degree.

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My beloved father, Mr. Mohd Pilus Bin Jaafar,
My loving mother Mrs. Hashimah Binti Md Abu,
Brothers and sisters,
All my friends

May Allah bless all of you

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ABSTRACT

Power windows system or electric windows is divided in two types. They are cable type power window system and scissor type power window system. The main function of the power windows is to raise and lower automobile windows by depressing a button or switch, as opposed to using a hand-turned crank handle. The system have five components which are the window, the frame and guide rails, the electric motors and the door frame. In the cable type, the electric motors that are provided consist of the motor and a cable driven track that raises and lowers the window. The motor assembly will need to be fastened to the door frame. These components were reviewed for differences in shape and construction prior to being assembled to the vehicles. There are difference specifications for different manufacturers. For this project, power window system of Proton Gen-2 car was chosen to be benchmarking. Then the parts that always failed will be defined. The parts will be redesign and the material will be changed. The current and new parts were design by using SOLIDWORK software in dimensional of Proton Gen-2 car power window system. By using FEA tools that is ALGOR software, the design was analyzed using constant force. Improvement of power window parts design was compared based on material used, analysis on Stress Von Mises and displacement, buying and repairing cost, and others. The new design that will give the lowest value of Stress Von Mises and displacement will be selected as the improvement part. The material that will be selected also deal with the value of stress and displacement. The important result is to improve power window parts in order to enhance the life time of the system and to give advantages to the car users such as reducing the maintenance cost.

ABSTRAK

Tingkap automatik atau tingkap elektrik terbahagi kepada dua jenis iaitu tingkap automatik jenis kabel dan tingkap automatik jenis gunting. Fungsi utama tingkap automatik adalah untuk menurun dan menaikkan cermin tingkap kereta dengan menekan butang atau suis, sebagai tukaran menggunakan pemutar pegangan engkol. Terdapat lima komponen dalam sistem tingkap automatik iaitu cermin tingkap, bingkai dan rel pembimbing, motor elektrik dan bingkai pintu. Pada tingkap automatik jenis kabel, motor elektrik yang disediakan terdiri daripada motor dan trek pembimbing kabel yang menaik dan menurunkan cermin tingkap. Motor yang dihimpunkan dengan bingkai pintu perlu diketatkan. Sebelum dipasang kepada kenderaan, komponen-komponen ini diterima dalam bentuk yang berbeza-beza. Pengeluar berbeza akan mengeluarkan spesifikasi yang berbeza. Untuk projek ini, sistem tingkap automotik Proton Gen-2 telah dipilih untuk dijadikan tanda aras. Kemudian bahagian-bahagian yang selalu rosak akan ditakrifkan. Bahagian-bahagian tersebut akan direka bentuk semula dan penggunaan bahan akan ditukar. Reka bentuk bahagian lama dan baru direka menggunakan perisian SOLIDWORK berdasarkan ukuran sistem tingkap automatik Proton Gen-2. Dengan menggunakan perisian FEA iaitu perisian ALGOR, reka bentuk bahagian dianalisa menggunakan daya yang kekal. Penambahbaikan bentuk bahagian tingkap automatik dibandingkan dengan berdasarkan pada penggunaan bahan, analisa pada Stress Von Mises dan regangan, pemasangan, kos pembelian dan pembaikian, dan lain-lain. Penambahbaikan bentuk yang akan menghasilkan nilai Stress Von Mises dan regangan yang paling rendah akan dipilih sebagai bentuk yang baru untuk komponen. Pemilihan bahan juga akan bergantung kepada nilai Stress Von Mises dan regangan yang dihasilkan. Kepentingan keputusan adalah untuk menambahbaikan bahagian tingkap automatik kereta dengan menambahkan jangka hayat dan untuk memberi lebih keuntungan kepada penguna-penguna kereta seperti mengurangkan kos penyelenggaraan.

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LIST OF ABBREVIATIONS

3D	Three dimension
AISI	America Iron and Steel Institute
CAE	Computer-aided engineering
FEA	Finite element analysis
FYP	Final year project
UMP	Universiti Malaysia Pahang
UTS	Ultimate tensile strength

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Power window or electric window system is a part of an automotive element which locates at the door of vehicle. The purpose of power window system is to raise and lower door glass by depressing a switch in order to replace the use of hand-turned crank handle. Power window system is made up of driver motor, electronic power and control system.

Power window system is divided in two types. They are cable type power window system and scissors type power window system. The main functions for both of them are for raising and lowering the automobile windows using a dc motor. For this project, the focus is to the cable type power window system. The cable type has four components consisted of electric motor, railing, cable, and switch. The mechanism works by using the cable to raise and lower the glass. The window glass is attached at the carrier plate and the cable is located on the railing surface. Motor is use to rotate the cable in order to move the window up and down using a gear attached to the motor and the cable.

This design project covers the improvement of the cable type system. The improvement is based on the parts design, material used and load testing. The load testing is using Algor, a Finite Element Analysis (Fea) software. Analysis using software to test the design on this project.

1.2 PROBLEM STATEMENT

Power window system is one of the common components that are built in a car. It is not a compulsory component but more to accessory component which can help user. The current power window system in Proton Gen-2 rear door is the cable type system. The common complaints from the customers are:

(i) Frequent problem cause by window jammed.

(ii) Glass drops during down operation.

(iii) Cable that be use is easier to snap.

(iv) The slider hook easy to break causes the cable cannot move smoothly.

(v) Rough sound when glass reaches top position.

(vi) All above issues cause premature failure of power window and reflects high repair cost.

The problems arise from components that are easy to damage or broken. For example, the pulley that is used is easy to cracks or broken. This makes the cable get out from the pulley. The pulley is also only mounted on the railing by using one riveting pin and causes the pulley easy to disengage from the railing. The riveting cable guide cracks or broken causes the cable not able to move smoothly. The slider hook is easy to break, this makes the window detaches from the railing. So, the window cannot be pulled up or down. These entire causes make the power window cannot be used in a longer than normal period. So, the users have to spend some money in order to replace the power window system after a couple of years.

1.3 OBJECTIVE

The main objective of this project is to improve the design of cable type system. It will be designed using Solidwork and Catia Software. Another main objective is to analyze the current and improvement design using Finite Element Analysis Software. The design will be analyzed in ALGOR software. Another objective is to make the design simpler and to increase the life time of the system.

1.4 PROJECT SCOPE

Study the current design of mechanical parts for cable type power window system. Proton Gen-2 rear door power window is selected as the benchmark design. Design and improve the current design using Solidwork. Make the analysis using CAE (ALGOR) software.

1.5 SIGNIFICANCE OF PROJECT

The significance of this project is to reduce the problem that user of Proton Gen-2 faced. The new parts design will help reducing the maintenance cost of the user in order to maintain their power window system in a good condition. The planning is to make a new part which can be used for a long time without any failure. So, the user can use the system in their Proton Gen-2 without faced any problem and can spend their money for other usage.

1.6 LIMITATION

During this project, some limitations occurred. One of them is not many references about the cable type power window system. This gave difficulty for me to research the background. However, another alternative is by using the books from University Malaysia Pahang (UMP) library. Other limitation is, three dimensional (3D) scanner was under maintenance. In order to continue with the project, normal measurement was implemented.

CHAPTER 2

LITERATURE REVIEW

2.1 POWER WINDOWS SYSTEM

The purpose of power windows system is to raise and lower windows. The systems do not vary significantly from one model to another. The major components of a typical system are the master control switch, individual window control switches, and the window drive motors (Erjavec 2005).

They can be operated by both a master control switch located beside the driver and additional independent switches for each electric window. Some power window systems use a lockout switch located on the driver's control to prevent operation of the power windows from the independent switches. Power window are designed to operate only with the ignition switch in the "on" (run) position. This safety feature of power windows should never be defeated. Some manufacturers use a time delay for accessory power after the ignition switch is turned off. This feature permits the driver and passengers an opportunity to close all windows or operate other accessories for about 10 minutes or until a vehicle door is opened after the ignition has been turned off (Halderman and Mitchell, 2003).

Most power window systems use permanent magnet electric motors. It is possible to run a PM motor in reverse direction simply by reversing the polarity of the two wires going to the motor. Most power windows motors do not require that the motor be grounded to the body (door) of the vehicle. The ground for all the power windows is most often centralized near the driver's master control switch. The up-and-down motion of the individual window motors is controlled by double-people, double-

throw (DPDT) switches. These DPDT switches have five contacts and permit battery voltage to be applied to the power window motor and to reverse the polarity and direction of the motor (Halderman and Mitchell, 2003).

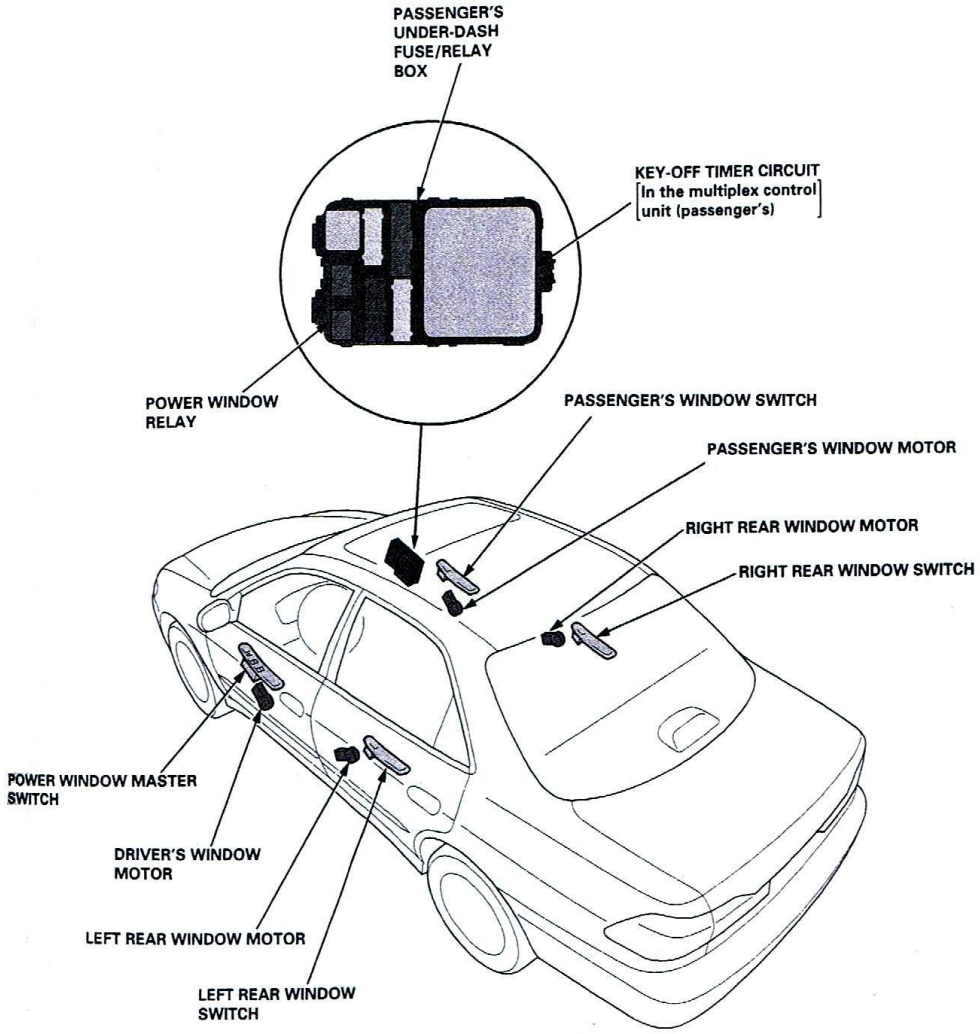

Figure 2.1: A power window system

2.2 POWER WINDOW CONTROL

The window is controlled manually by means of a rocker switch. For a greater convenience, power window can be linked to a central or decentralized closing system which, when the vehicle is locked, closes the windows automatically or sets them to a predefined partially open position for a ventilation purposes when the windows are

closed, a force limitation device comes into effect. The device serves to prevent human limbs from being caught by the closing window. In Germany, paragraph 30 of the St V20 (Road traffic Licensing Regulations) stipulates that the force limitation device must be effective when the window is moving upwards within a range of 200 to 4mm from the upper edge of the window aperture (Gilles and Barbara, 2002).

The power window drive units include integral Hall-effect sensors to monitor motor speed during operation. If a reduction in speed is detected, the motor's direction of rotation is immediately reversed. The window closing force must not exceed 100N at a spring rate of 10N/mm. The unit automatically overdrives the force limitation function immediately before the window enters the door seal, allowing the motor to run to its end position and permitting complete closure of the window. The window position is monitored over its entire range of movement. Electronic control may be dispersed among the individual power window motors in order to reduce the complexity of the wiring. Future decentralized electronics will be networked via bus interfaces (LIN bus/ CAN bus). The advantages offered are fault diagnosis for the electronics and further reduction of the amount of wiring (Robert Bosch Gmbh 2006).

2.3 CIRCUIT OPERATION

Typically a permanent magnet motor operates each power window. Each motor raises or lowers the glass when voltage is applied to it. The direction that the motor moves the glass is determined by the polarity of the supply voltage. Voltage is applied to a motor when any UP switch in the master switch assembly is activated. The motor is grounded through the DOWN contact. Battery voltage is applied to the motor in the opposite direction when any DOWN switch in the master switch assembly is activated. The motor is then grounded through the master switches UP contact (Schwaller 1999).

The operation of the individual window switches is much the same. When the UP switch is activated, voltage is applied to the window's motor. The motor is grounded through the DOWN contact at the switch and the DOWN contact at the master switch.

When the DOWN switch in the window switch is activated, voltage is applied to the motor in the opposite direction. The motor is grounded through the UP contact at the window switch and the UP contact in the master switch. This runs the motor in the opposite direction (Erjavec 2005).

Each motor is protected by an internal circuit breaker. If the window switch is held too long with the window obstructed or after the window is fully up or down, the circuit breaker opens the circuit (Erjavec 2005).

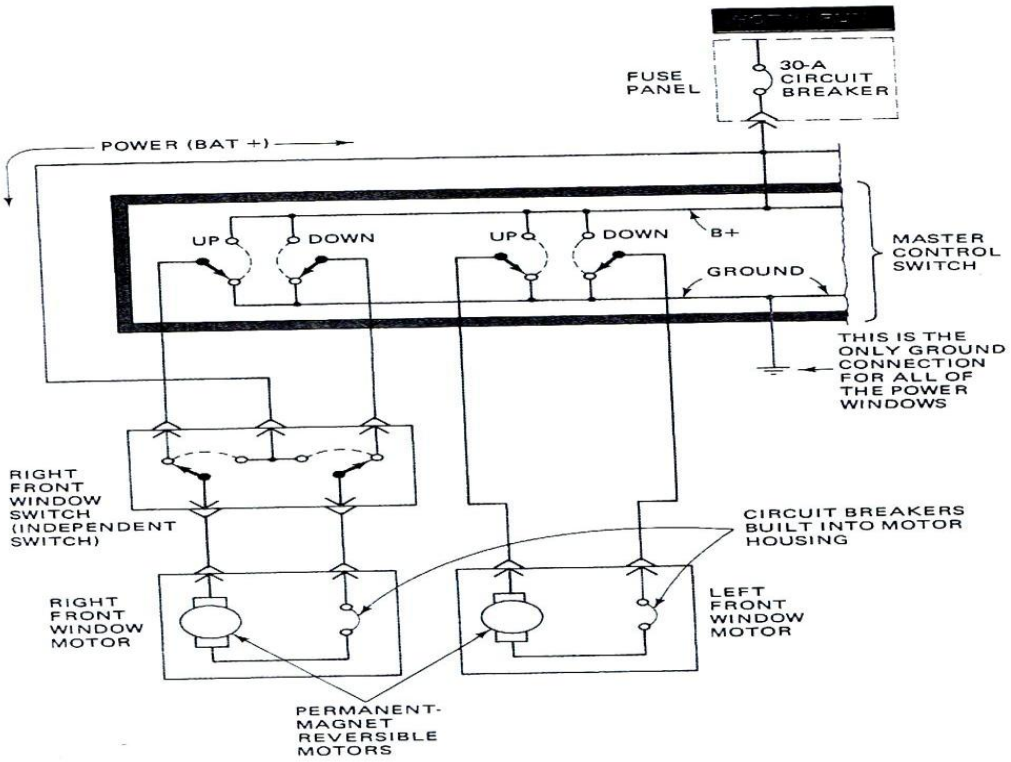

Figure 2.2: Typical power window circuit

2.3.1 OBSTACLE-SENSING WINDOWS

This feature is available on some vehicles and prevents the window from closing if something is in the way, such as fingers. On some systems, if the window is closing and contacts something, the window will reverse and open fully. Other systems do not require direct contact with an obstacle. Rather, they rely on infrared sensors. When the

light beams are broken by the presence of an obstacle, the window will reverse and go down (Schwaller 1999).

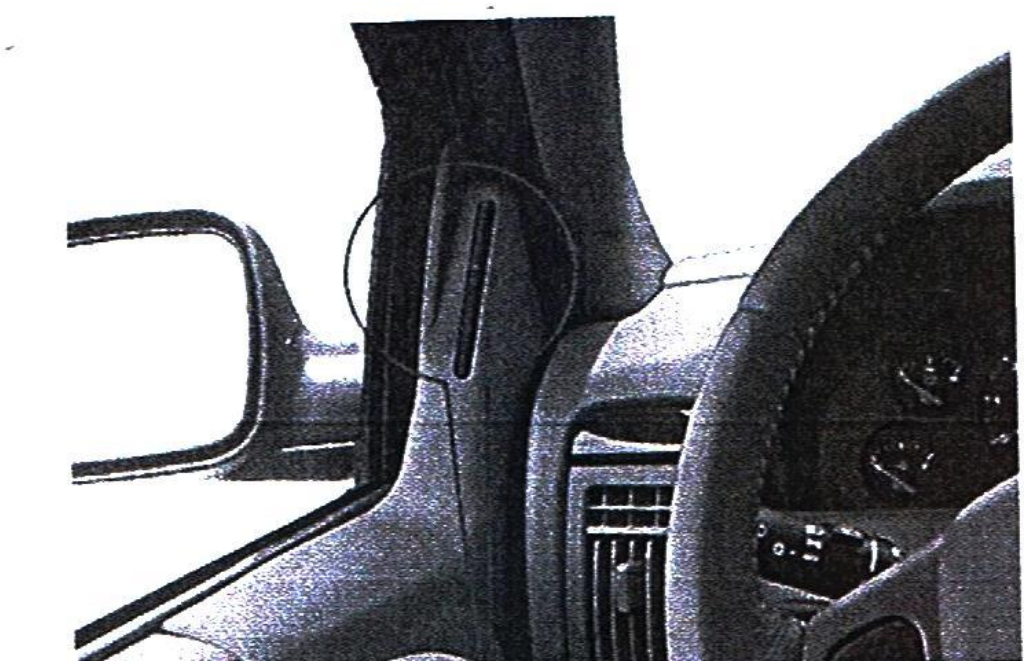

Figure 2.3: The infrared sensor for a smart window system

2.4 POWER WINDOW MOTOR

Power window have a mechanism that are driven by electric motor. There are two types of system in use. The available installation space assumes a prominent place among the criteria applied in determining which system to install. The types of power window that always be use are rod linkage regulator mechanism and flexible cable mechanism. For a rod linkage regulator mechanism, the drive motor pinion engages with a quadrant gear, which is connected to a rod linkage. The use of this type window regulator mechanism is decreasing. For a flexible cable mechanism, the drive motor turns a cable reel, which operates a flexible cable mechanism (Chapman 1999).

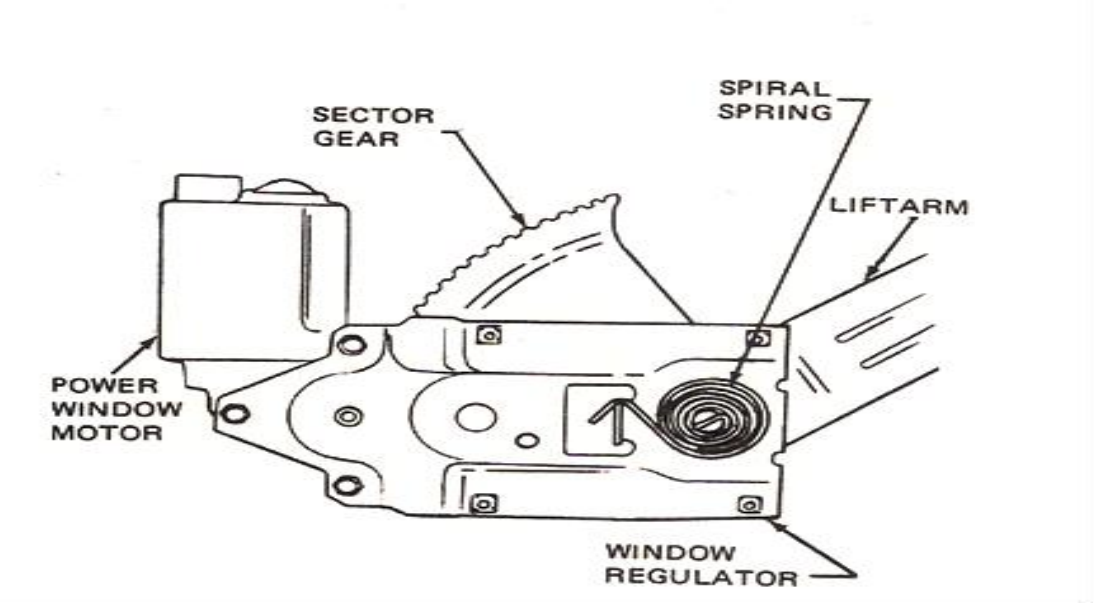

Figure 2.4: Direct drive motor

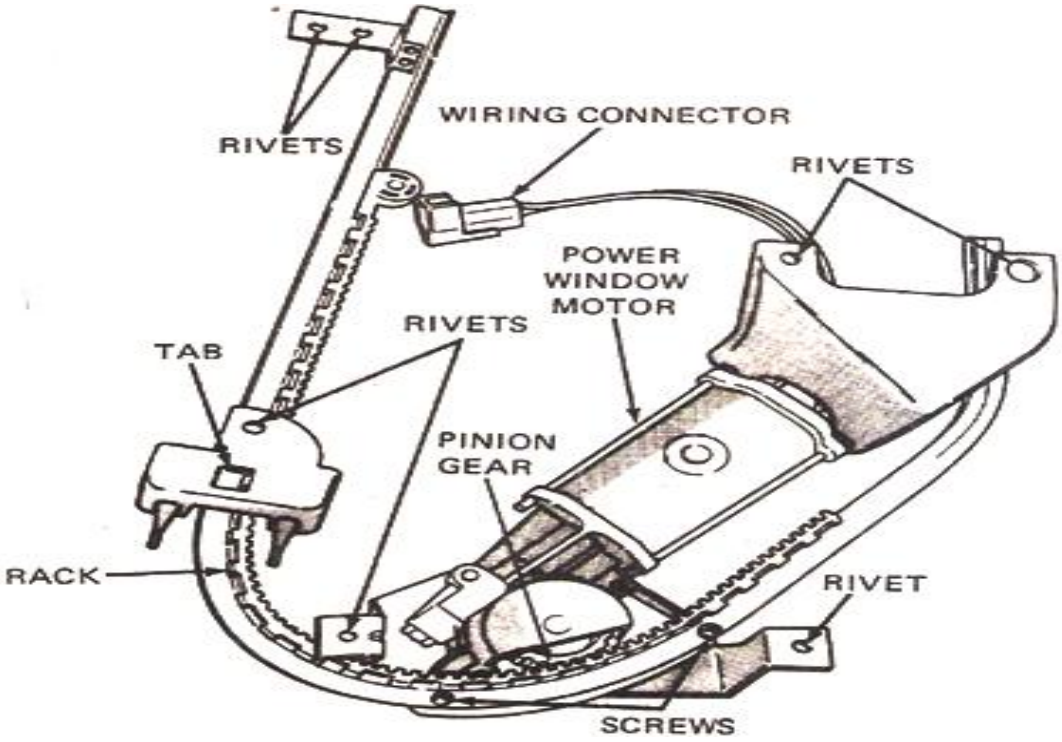

Figure 2.5: Motor use a rack-and-pinion gear set