TVET CERTIFICATE IV in AUTO ELECTRICITY AND ELECTRONIC SYSTEMS

CHARGING SYSTEM REPAIRING

AEECR401

Repair charging system

Competence

LEVEL : 4

Learning hours: 70

Credits: 7

Sector: Technical services

Sub-sector: Automobile

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Purpose statement

This module will allow the learner to describe vehicle charging system, conduct diagnosis of charging system and its results will enable the learner to repair or replace alternator components and charging system external wiring. The knowledge gained from this module will enable the learner to perform testing activities of charging system while responding to work needs.

Table of Contents

Total number of pages: 39

Learning Unit 1 – Describe charging system

LO 1.1 – Describe charging system components

- **Content/Topic 1 Introduction to charging system**

A car's electrical power is provided by the charging system. The charging system supplies the loads with energy and keeps the storage battery charged. The battery provides the electrical energy that is required to start the engine. The battery must obviously be in good condition to avoid problems with starting the engine. The important factors for a battery's performance are its capacity and cold-start current. Maintenance work must also include the necessary attention to the battery. The battery should be tested in cases of doubt. Flat batteries need to be charged. The charging method depends on the way in which the battery became flat (whether it was discharged quickly or slowly). The electrical energy that the charging system supplies is generated by the alternator. This takes place according to the following principle: a magnetic field that moves with respect to a conductor generates a voltage in the conductor. In alternators the rotor provides the magnetic field. The conductor comprises numerous turns of copper wire that collectively form the stator. The alternator generates a three-phase AC voltage. Rectification is necessary because an AC voltage cannot be used for charging the battery. Rectification is achieved using diodes. To prevent overloading of the electrical system by an excessive voltage, the voltage has to be limited. This is what the voltage regulator does. The generation and rectification of the AC voltage create heat. Cooling is necessary to prevent the alternator from becoming too hot. Passenger cars use 12 volt electrical systems. These have been shown to be no longer adequate in numerous ways. The 12 V systems are increasingly less capable of enabling the automobile's various electronic control systems to operate properly. They lack the capacity to deal with future electronic valve operating systems. The automobile industry is therefore busy switching from 12 V systems to 42 V systems. (Erjavec, 2010)

- **Content/Topic 2 Definition of charging system**

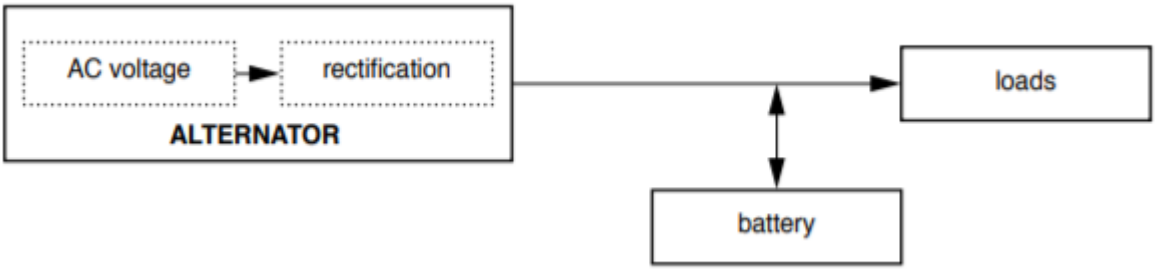
The charging system provides the electricity that powers the starter motor and runs electrical accessories, such as lights, audio system, air conditioner, window defroster and other components. Its main parts are the battery, alternator and voltage regulator. The alternator is the heart of the charging system. It generates all the power needed to keep the battery fully charged and to operate everything electrical in the vehicle. The alternator is mounted on the engine and is belt-driven off the crankshaft pulley by a serpentine belt or v-belt. The alternator produces alternating current (AC), which is converted to direct current (DC) by a six diode rectifier, which is usually located inside the back of the unit. Diodes only pass current in one direction, which is how they convert AC current to DC. Three positive diodes control the positive side of the AC sine wave, while three negative diodes control the negative side.
The alternator's charging output increases in proportion to the electrical load on the charging system and engine speed. Output is low at idle and increases with RPM. Maximum output is typically achieved at speeds above 2,500 RPM.

- **Content /Topic 3: Function of charging system**

During operation motor vehicle, alternator supplies the electrical consumers with electrical energy and charges the starter battery.

- **Content /Topic4 Components of charging system**

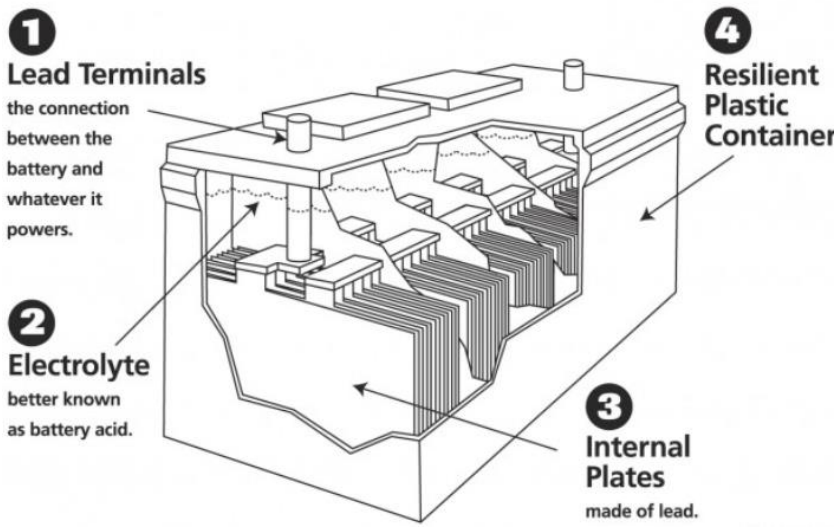
The alternator is an important component in the charging system. Mechanical energy is converted into electrical energy in the alternator. This means that the alternator has to be driven. Belt transmission is used to transfer the rotational movement of the crankshaft to the alternator



- **Content /Topic5 Location of charging system components**

1. Battery

The function of the battery is as a storage of electrical energy. Like a warehouse, the battery will store all the electrical energy generated by the alternator and then this stored electricity is removed when necessary.



2. Fuse and Fuseble links

Fuse and fuseble links have different functions even though have the same shape. Fuseble link can be called as main fuse which is placed near the battery positive terminal. The function of this fuse is to protect the entire electrical system of the car from excessive currents. Generally the fuseble link has a capacity of up to more than 60 Ampere.

While the function of the fuse is as a safety of a series of specific electrical wiring, in conventional charging system there are two fuse with same capacity (its about 10-15 Ampere). A fuse is used as a voltage regulator fuse and another fuse is used to secure the CHG and Voltage relay.

3. CHG Lights

CHG lamp or commonly also called “charging warning light” is an indicator light to indicate the presence failure of charging system. When the ignition key ON then this light will light up normally, as

well as when the engine life of this lamp should turn on, if it is dead then it could mean the charging system failure.

4. Ignition key

The ignition key works as a switch. The charging system will be activated automatically when the engine is running, but to generate a magnetic field on the rotor coil must be done by a switch.

Ignition switch is used as a switch to connect and disconnect power (positive battery curents) from battery to rotor coil. When the ignition key is ON, then the electricity from the battery to the coil rotor will be connected. However, when the ignition key is turned OFF then the power supply will be cut off. So it is not possible the alternator generates electricity when the ignition key is OFF even the engine crankshaft is rotate.

5. Regulator

The function of the regulator is to regulate the voltage generated by the alternator. Why should it be there? because the voltage generated by the alternator depends the engine's RPM. This means that if the engine RPM is low, the alternator voltage is also low, but if the engine RPM is high then the alternator voltage is also high.

- **Content /Topic6 Vehicle battery electrical systems**

Electric Vehicle Battery Systems provides operational theory and design guidance for engineers and technicians working to design and develop efficient electric vehicle (EV) power sources. As Zero Emission Vehicles become a requirement in more areas of the world, the technology required to design and maintain their complex battery systems is needed not only by the vehicle designers, but by those who will provide recharging and maintenance services, as well as utility infrastructure providers. Includes fuel cell and hybrid vehicle applications. (D., 2004)

- **Content /Topic7: Single battery vehicle electrical system**

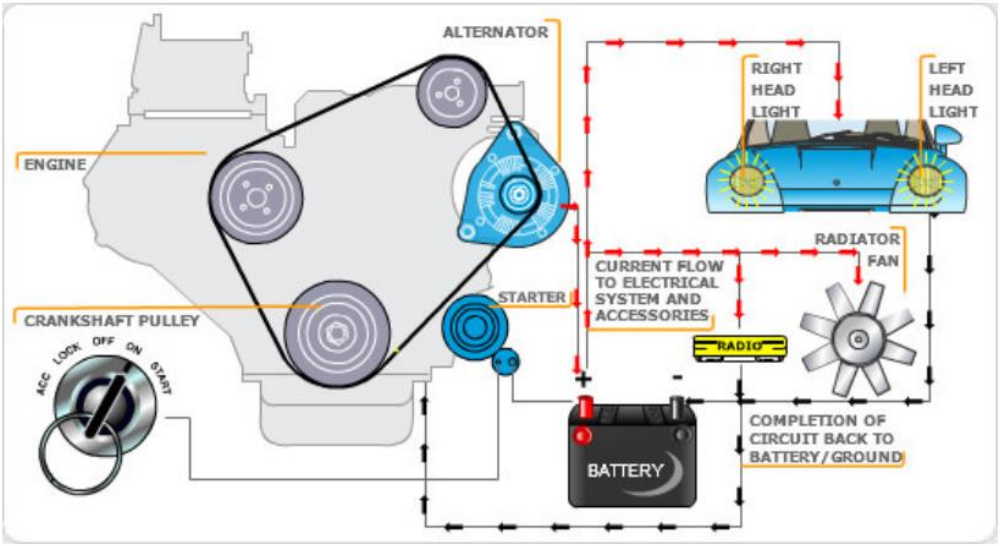


Figure 1: Single battery vehicle electrical system

Until your vehicle starts, your battery is providing the car's entire electrical current. This includes the current to the ignition and fuel systems, which are responsible for creating the combustion necessary for your engine to function.

- **Content /Topic 8: Dual battery vehicle electrical system**

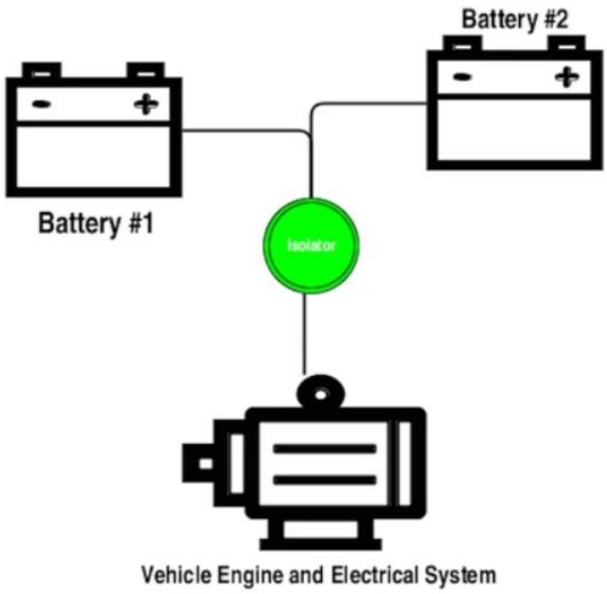


Figure 2: Dual battery vehicle electrical system

The existing stock battery (we'll call it battery #1) is connected to an isolator, as is the new add-on battery (we'll call it battery #2)
The isolator is designed to automatically prevent battery #1 from being discharged when the vehicle is 'OFF'. The isolator may or may not have a manual switch to override this setting.
When the vehicle is 'ON' and the alternator is providing electricity, the isolator "opens" to allow power to flow into both battery #1 and battery #2.
When you're vehicle is parked and not running, battery #1 (usually a starter battery) is isolated from the electrical system and can not be discharged. Battery #2 (which is often a deep-cycle battery) provides all power when the vehicle is off. This way, you don't have to worry about "killing" you starter battery if you plug in a fridge, or run your winch, etc. etc.

Generally speaking, the battery isolator and wiring you need to install a dual battery system in a normal vehicle is a couple hundred dollars, plus you need a mounting tray for your second battery, plus you may need an extended length of low gauge wire if you have to mount your 2nd battery in the rear of your vehicle. The costs can easily reach $300-$400...and that does NOT include the cost of the 2nd battery itself.

LO 1.2 – Describe charging system components

- **Content/Topic 1: Charging system design**

Alternator
An alternator is constructed using a two-piece cast aluminum housing. Aluminum is used because of its lightweight, nonmagnetic properties and heat transfer properties needed to help keep the alternator cool.

A front ball bearing is pressed into the front housing, called the drive-end (DE) housing, to provide the support and friction reduction necessary for the belt-driven rotor assembly.
The rear housing, or the slip-ring-end (SRE) housing, usually contains either a roller bearing or ball bearing support for the rotor and mounting for the brushes, diodes, and internal voltage regulator

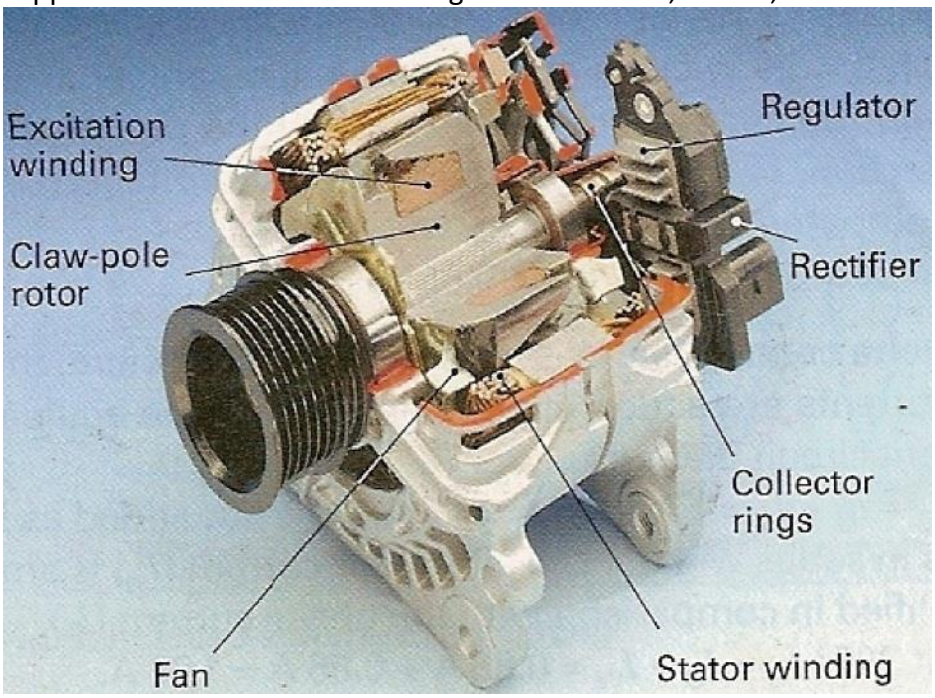


Figure 3: Alternator

- ✓ Stator (housing) with three phrase stator winding as the induction coils
- ✓ Diodes plate with 6 power diodes and 3 excitation diodes to rectify the voltage.
- ✓ 12-pole rotation claw-pole rotor with excitation winding for generating the magnetic field and collect ring and carbon brushes for supply
- ✓ Fan for cooling
- ✓ Voltage regulator for constant operating voltage connection B+/B-for voltage discharge
- ✓ Pulley for driving the alternator at a speed of 2-3 times the engine speed.

ROTOR CONSTRUCTION

The rotor is the rotating part of the alternator and is driven by the accessory drive belt. The rotor creates the magnetic field of the alternator and produces a current by electromagnetic induction in the stationary stator windings. The rotor is constructed of many turns of copper wire coated with a varnish insulation wound over an iron core. The iron core is attached to the rotor shaft.
At both ends of the rotor windings are heavy-gauge metal plates bent over the windings with triangular fingers called claw-poles. These pole fingers do not touch, but alternate or interlace. (Halderman, 2013)

HOW ROTORS CREATE MAGNETIC FIELDS

The two ends of the rotor winding are connected to the rotor s slip rings. Current for the rotor flows from the battery into one brush that rides on one of the slip rings, then flows through the rotor winding, then exits the rotor through the other slip ring and brush. One alternator brush is
Considered to be the positive brush and one is considered to be the negative or ground brush. The voltage regulator is connected to either the positive or the negative brush and controls the field current through the rotor that controls the output of the alternator.

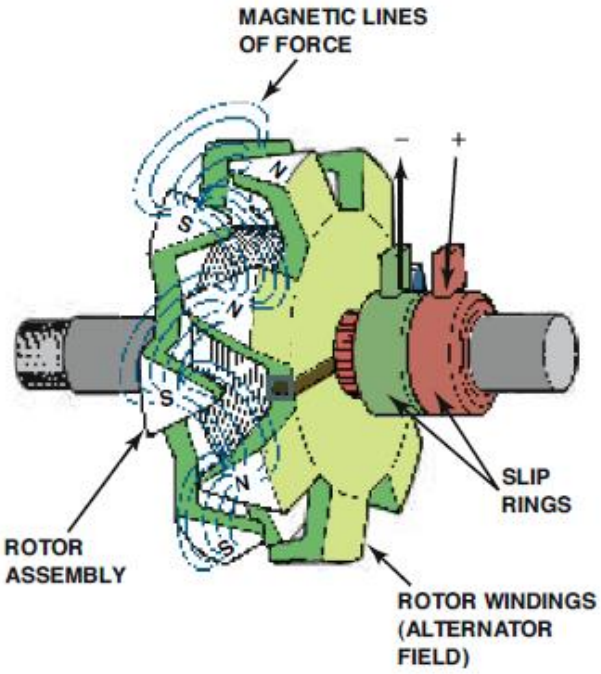


Figure 4: Rotor assembly

If current flows through the rotor windings, the metal pole pieces at each end of the rotor become electromagnets. Whether a north or a South Pole magnet is created depends on the direction in which the wire coil is wound. Because the pole pieces are attached to each end of the rotor, one pole piece will be a North Pole magnet.

The other pole piece is on the opposite end of the rotor and therefore is viewed as being wound in the opposite direction, creating a south pole. Therefore, the rotor fingers are alternating north and south magnetic poles. The magnetic fields are created between the alternating pole piece fingers. These individual magnetic fields produce a current by electromagnetic induction in the stationary stator windings.

ROTOR CURRENT

The current necessary for the field (rotor) windings is conducted through slip rings with carbon brushes. The maximum rated alternator output in amperes depends on the number and gauge of the rotor windings. Substituting rotors from one alternator to another can greatly affect maximum output. Many commercially rebuilt alternators are tested and then display a sticker to indicate their tested output. The original rating stamped on the housing is then ground off.

The current for the field is controlled by the voltage regulator and is conducted to the slip rings through carbon brushes. The brushes conduct only the field current which is usually between
2 and 5 ampere.

STATOR CONSTRUCTION

The stator consists of the stationary coil windings inside the alternator. The stator is supported between the two halves of the alternator housing, with three copper wire windings that are wound on a laminated metal core. As the rotor revolves, its moving magnetic field induces a current in the stator windings.

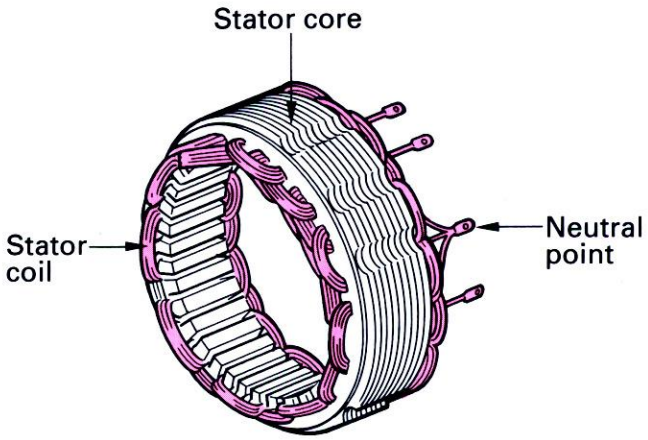


Figure 5: Stator winding

DIODES

Diodes are constructed of a semiconductor material (usually silicon) and operate as a one-way electrical check valve that permits the current to flow in only one direction. Alternators often use six diodes (one positive and one negative set for each of the three stator windings) to convert alternating current to direct current.

Diodes used in alternators are included in a single part called a rectifier, or rectifier bridge. A rectifier not only includes the diodes (usually six), but also the cooling fins and connections for the stator windings and the voltage regulator.

DIODE TRIO

Some alternators are equipped with a diode trio that supplies current to the brushes from the stator windings. A diode trio uses three diodes, in one housing, with one diode for each of the three stator windings and then one output terminal.

Figure 6: Diode plate

Operating principle of the alternator

Voltage generation in the alternator is based on the principal of induction when a magnetic field in a conductive loop charge the voltage is generated in a conductive loop if a rotating magnetic field with north and South Pole passes through a coil this result in a sinusoidal alternating voltage.

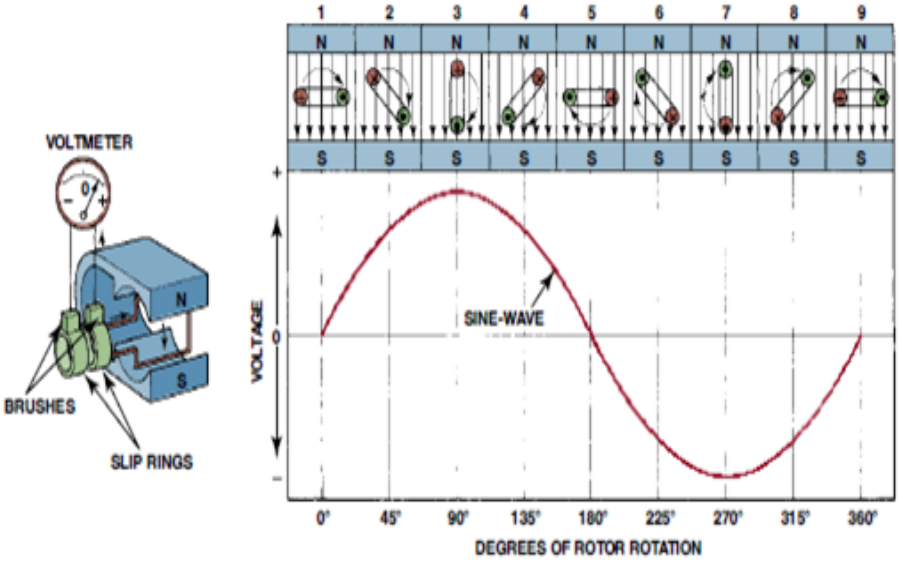


Figure 7: Sinusoidal alternating voltage

FIELD CURRENT IS PRODUCED

A rotor inside an alternator is turned by a belt and drive pulley which are turned by the engine.
The magnetic field of the rotor generates a current in the stator windings by electromagnetic induction. Field current flowing through the slip rings to the rotor creates an alternating north and south pole on the rotor, with a magnetic field between each finger of the rotor.

If this rotating magnetic field passes through three coils, three sinusoidal alternating voltages occur. If these are arranged at $120^0$from each other, the three alternating voltages are phase-delayed by 120^0 three-phase voltages (U_P) are generated at all times. This is shown with an angle of rotation of $90^0$and 300^0

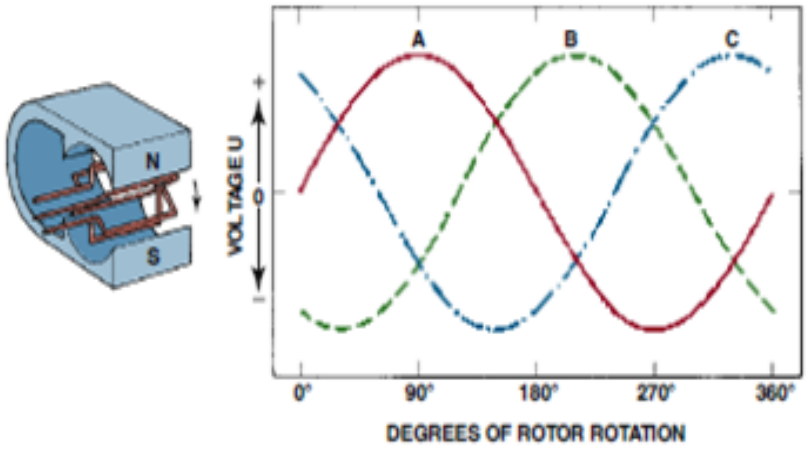


Figure 8: three-phase alternating voltage

ALTERNATOR INTERNAL CIRCUIT AND ELECTRICAL CIRCUITS

In the alternator a distinction is made between the three circuits:

- ✓ Pre-excitation circuit
- ✓ Excitation circuit
- ✓ Charging circuit

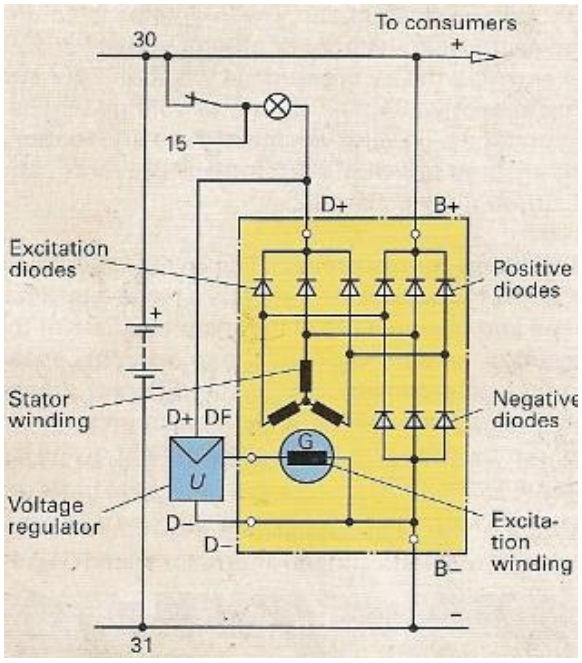


Figure 9: Alternator internal electrical circuit

Circuit of pre-excitation and operation

After activation of ignition switch the pre excitation circuit established a magnetic field in the excitation winding until the excitation current flows to do this the **threshold voltage** (2×0.7v=1.4v) of the positive and negative diodes must be exceeded .

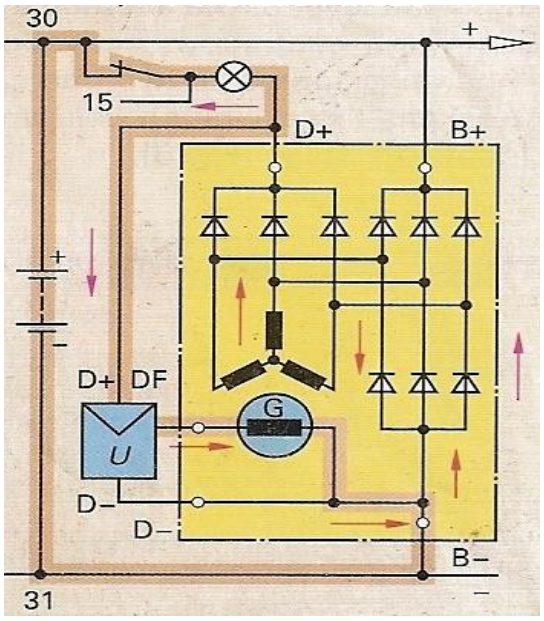


Figure 10: Pre-excitation circuit

After starting the engine the alternator excites itself the excitation current flows and the alternator lamp goes out because the potential at both ends is the same, the pre-excitation circuit runs via the starter battery +/30→ignition switch telltale lamp D+→ regulator D+→ regulator DF→ excitation winding DF → earth D-/B- to the starter battery-/31.if the alternator charge the lamp is defective there is a pre excitation because there is a break in the excitation circuit. (R., 2006)

Circuit of excitation and operation

The excitation current establishes the magnetic field in the excitation winding rotor the regulator supplies the respective required excitation current, if the three phases current bridge circuit also used to rectify the

excitation current three special excitation diodes are available on the positive side on the negative side, rectification is carried out via the negative diodes

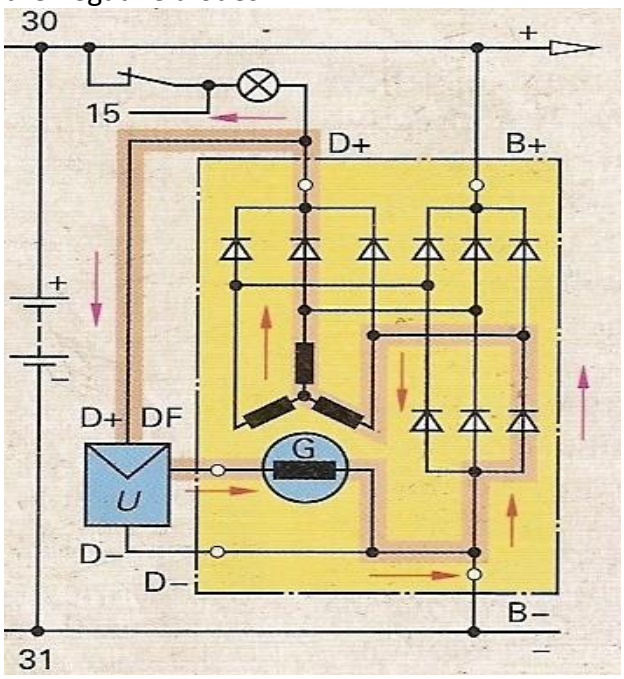


Figure 11: Excitation circuit

The excitation current runs from alternator D+→ regulator D+→ regulator DF→ excitation winding DF → earth D-/B to the negative diodes→ stator winding → excitation diodes to terminal D+ .

Circuit of charging and operation

The charging supplies the vehicle electrical system with electrical energy, it runs via the stator winding → positive diodes →terminal B+→battery /consumer →earth →negative diode to the stator winding part of current generated by the alternator flow via the excitation winding in order to generated by the alternator flow via the excitation diodes and the voltage regulator to the excitation winding in order to generate the required magnetic field induction

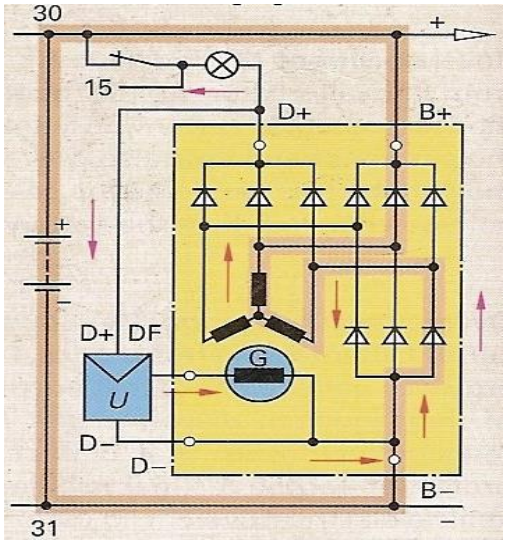


Figure 12: Charging circuit

Regulator

Voltage regulator

The voltage level must be precisely controlled during charging to prevent excessive current flow. Excessive current flow can damage the battery.

PRINCIPLES

An automotive alternator must be able to produce electrical pressure (voltage) higher than battery voltage to charge the battery. Excessively high voltage can damage the battery, electrical components, and the lights of a vehicle. Basic principles include the following: If no (zero) amperes of current existed throughout the field coil of the alternator (rotor), alternator output would be zero because without field current a magnetic field does not exist. The field current required by most automotive alternators is less than 3 amperes. It is the control of the field current that controls the output of the alternator. (R., 2006)

Current for the rotor flows from the battery positive post, through the rotor positive brush, into the rotor field winding, and exits the rotor winding through the rotor ground brush.

Most voltage regulators control field current by controlling the amount of field current through the ground brush.

The voltage regulator simply opens the field circuit if the voltage reaches a predetermined level, then closes the field circuit again as necessary to maintain the correct charging voltage.

The electronic circuit of the voltage regulator cycles between 10 and 7,000 times per second as needed to accurately control the field current through the rotor, and therefore control the alternator output.

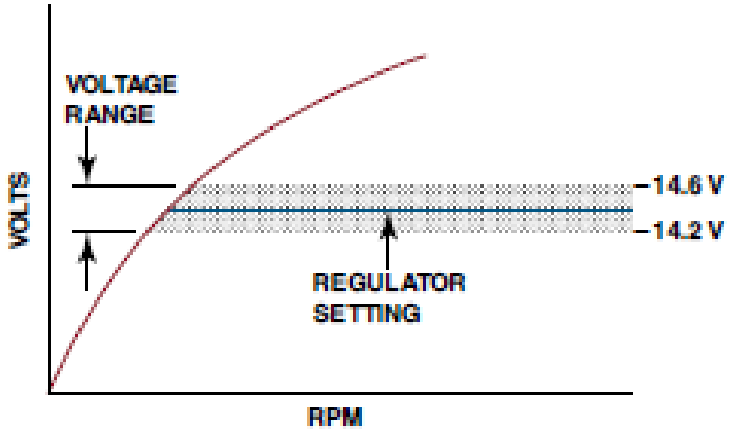


Figure 13:Voltage regulator range

The voltage regulator is an electronic or mechanical device that regulates alternator output according to the battery's state of charge and accessory loads.

Mechanical regulator

AC generators are double-contact units as it is shown on the figure below, when the first set of contacts opens at lower rotor speeds, current passes through a resistor wired in series with the field circuit. These contacts are called the series contacts. The value of the regulating resistor is kept very low to permit high field current when needed. At higher rotor speeds, the coil further attracts the armature and a second set of contacts is closed. This grounds the field circuit, stopping the field current. These contacts are called the shorting contacts because they short-circuit the field to ground. The double-contact design offers consistent regulation over a broad range of AC generator speeds.

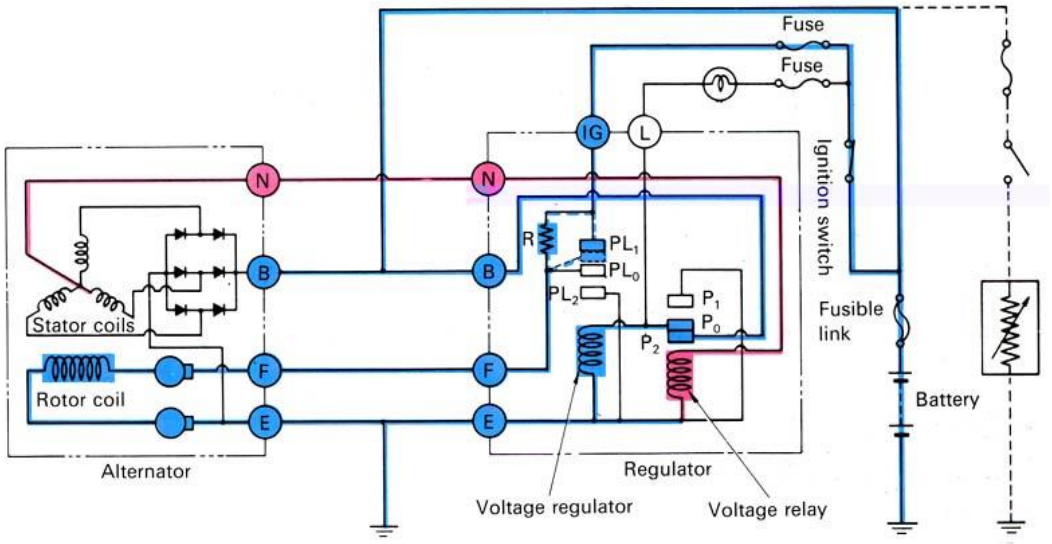


Figure 14:Mechanical voltage regulator

Electronic regulator

Electronic regulators completely replaced the older electromagnetic design on late-model vehicles. They are compact, have no moving parts, and are not seriously affected by temperature

Changes. The early electronic designs combine transistors with the electromagnetic field relay.

The latest and most compact is the integrated circuit (IC) regulator (on Figure below). This combines all control circuitry and components on a single silicon chip. Attaching terminals are added and the chip is sealed in a small plastic module that mounts inside, or on the back of, the AC generator.

Diodes are one-way electrical check valves. Transistors act as relays. A Zener diode is specially

Doped to act as a one-way, electrical check valve until a specific reverse voltage level is reached. At that point, the Zener diode allows reverse current to pass through it.

The electrical resistance of a thermistor, or thermal resistor, changes as temperature changes.

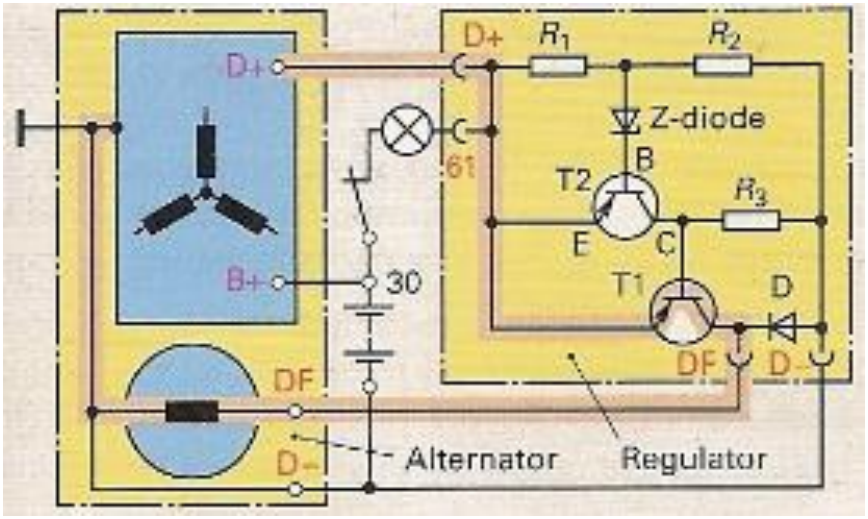


*Figure 15:*Connection *status on*

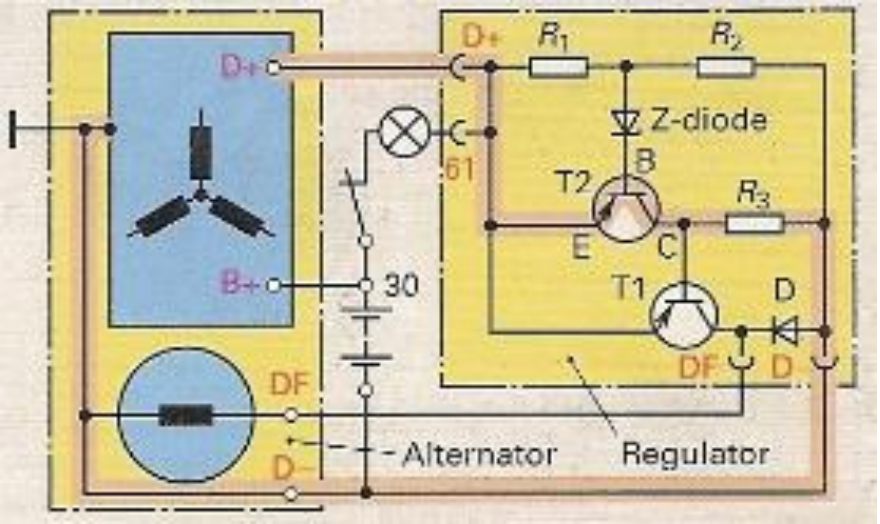


Figure 16: Connection status off

Electronic voltage regulator

Regulator Operation

The figure above is a simplified circuit diagram of an electronic regulator. This A-circuit regulator is contained within the housing. Terminal 2 on the AC generator is always connected to the battery, but battery discharge is limited by the high resistance of R2 and R3. The circuit allows the regulator to sense battery voltage. When the ignition switch is closed in the circuit shown in Figure, current travels from the battery to ground through the base of the TR1 transistor. This causes the transistor to conduct current through its emitter-collector circuit from the battery to the low-resistance rotor winding, which energizes the AC generator field and turns on the warning lamp. When the AC generator begins to produce current, field current is drawn from unrectified AC generator output and rectified by the diode trio, which is charging voltage. The warning lamp is turned off by equal voltage on both sides of the lamp.

When the AC generator has charged the battery to a maximum safe voltage level, the battery voltage between R2 and R3 is high enough to cause Zener diode D2 to conduct in reverse bias. This turns on TR2, which shorts the base circuit of TR1 to ground. When TR1 is turned off, the field circuit is turned OFF at the ground control of TR1.

With TR1 off, the field current decreases and system voltage drops. When voltage drops low enough, the Zener diode switches off and current is no longer applied to TR2. This opens the field circuit ground and energizes TR1. TR1 turns back ON. The field current and system voltage increase. This cycle repeats many times per second to limit the AC generator voltage to a predetermined value. The other components within the regulator perform various functions. Capacitor C1 provides stable voltage across resistor R3. Resistor R4 prevents excessive current through TR1 at high temperatures. To prevent circuit damage, diode D3 bypasses high voltages induced in the field windings when TR1 turns OFF. Resistor R2 is a thermistor, which causes the regulated voltage to vary with temperature. R5 allows the indicator lamp to turn off if the field circuit is open. (R., 2006)

Battery

Purpose The battery supplies electrical energy when the energy that the alternator supplies is insufficient. The battery has a buffer function: it stores energy and supplies it when required. However, electrical energy is difficult to store. Consequently, chemical energy rather than electrical energy is stored in the battery: – if the battery supplies current, chemical energy in the battery is converted into electrical energy – charging the battery converts electrical energy into chemical energy. The battery's principle of operation A chemical reaction takes place when two thin metal plates are placed in a battery case containing dilute sulphuric acid (fig. 6). The lead forms a compound with the sulphur and lead is converted into lead sulphate (PbSO4).

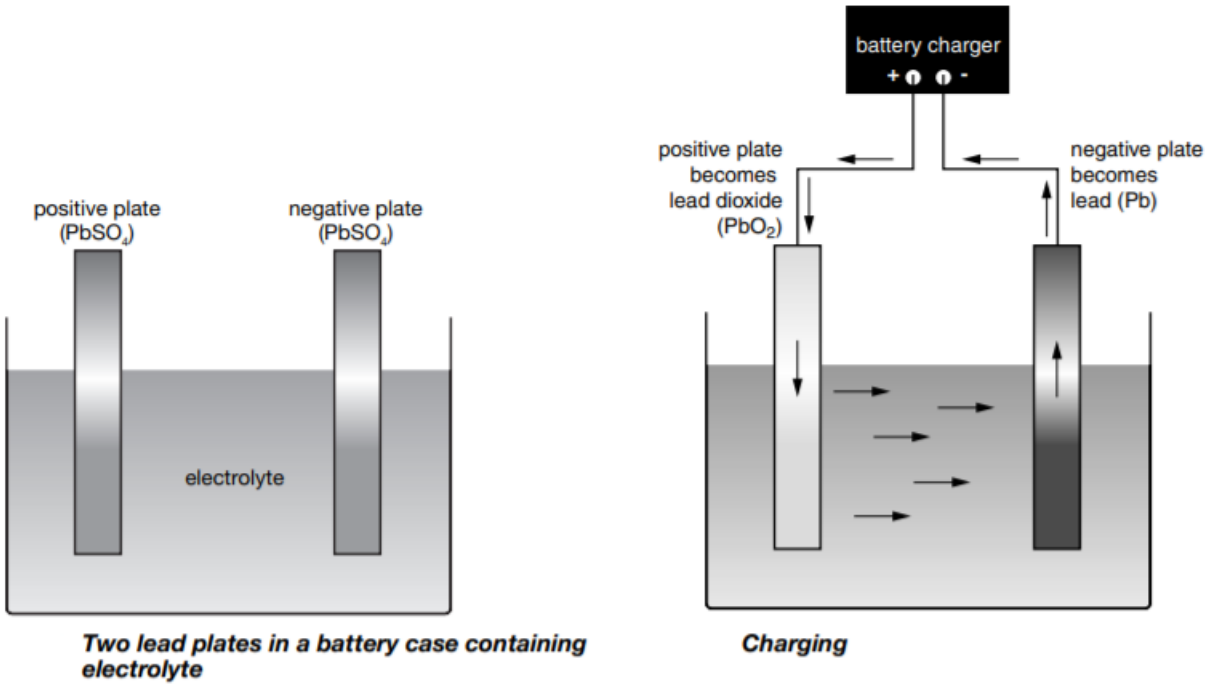
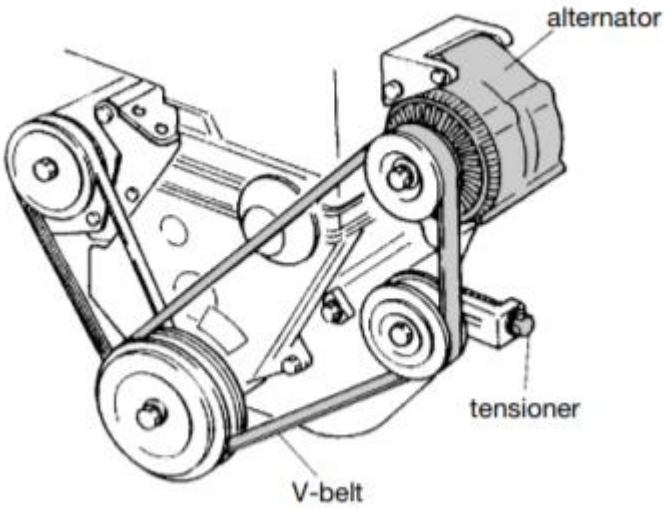


Figure 17:Battery construction

External Wiring

The alternator is an important component in the charging system. Mechanical energy is converted into electrical energy in the alternator. This means that the alternator has to be driven. Belt transmission is used to transfer the rotational movement of the crankshaft to the alternator

The alternator generates an AC voltage. However, the battery cannot be charged with an AC voltage. Charging with an AC voltage would mean that the energy supplied to the battery at a given moment would be drawn from it again shortly afterwards. The AC voltage therefore has to be rectified

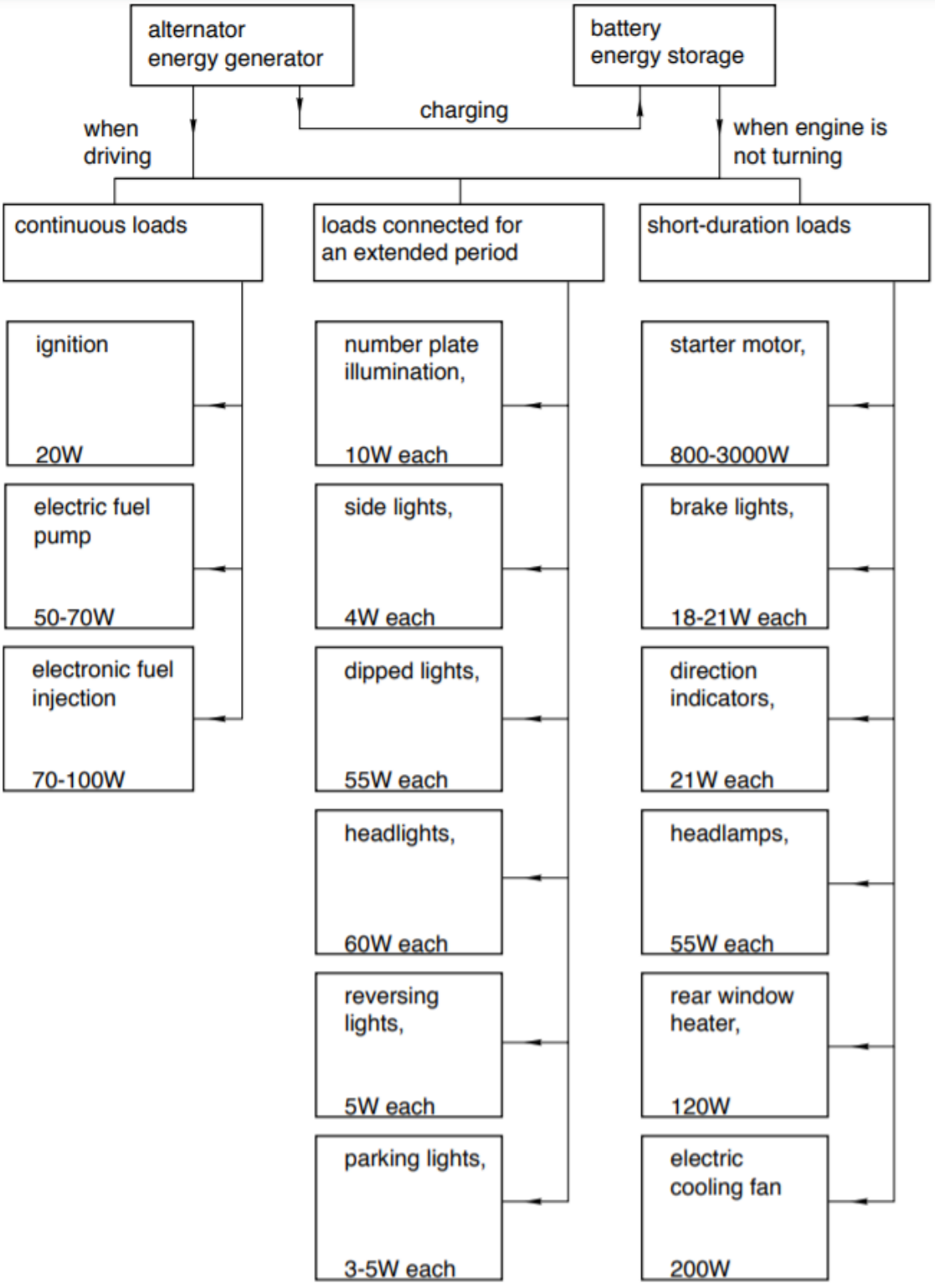


- **Content/Topic 2 Requirement of charging system**

Introduction

When the engine turns, the alternator supplies the energy the electrical loads need to operate. No electrical energy is supplied by the alternator when the engine is being started. The energy required for the starter motor is supplied by the battery. The battery is a buffer that stores electrical energy. Once the engine is turning, the alternator charges the battery. The electrical power that the alternator generates has to be sufficient to supply all the electrical loads. Figure 2 provides an overview of the loads and their power consumption. A distinction is made between continuous loads, loads that are connected for an extended period, and short-duration loads.

Vehicle electrical loads

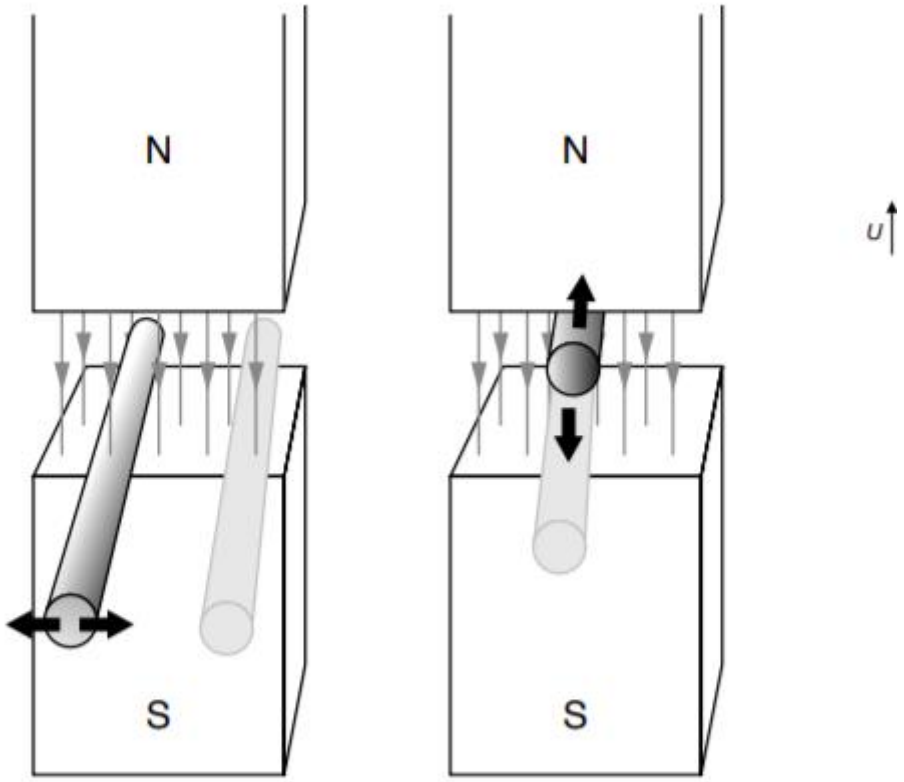


Charging voltage

- **Content /Topic 3: Operating principles**

Generation of electricity

The alternating-current alternators used in automobiles make use of the following principle: a voltage is generated in a conductor that cuts through magnetic lines of force (fig.). It makes no difference whether the conductor moves with respect to the magnetic field or the magnetic field moves with respect to the conductor. A voltage is generated in the conductor in both cases.



a conductor cuts through magnetic lines of force and a voltage is generated

b conductor does not cuts through magnetic lines of force and no voltage is generated

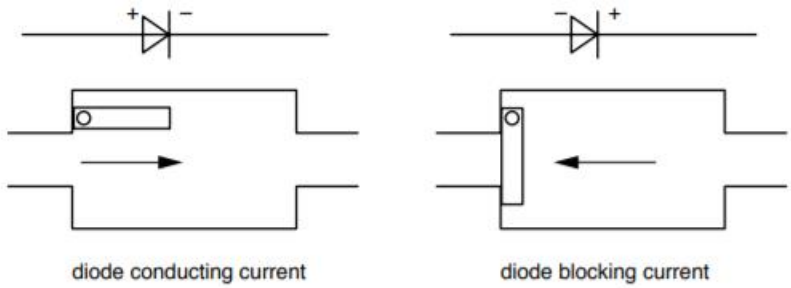
The magnetic field rotates in automobile alternators (.The north and south poles move with respect to the conductor when the magnet rotates. This generates an AC voltage (alternating in size and direction). The conductor (coil winding) is basically constructed .

The size of the voltage generated depends on:

- ✓ The strength of the magnetic field. The stronger the magnetic field, the higher the generated voltage.
- ✓ The rate at which the conductor and magnetic field move with respect to each other. The higher the rate, the higher the generated voltage.
- ✓ The length of the coil winding. The longer the coil winding affected by the magnetic field, the higher the generated voltage.

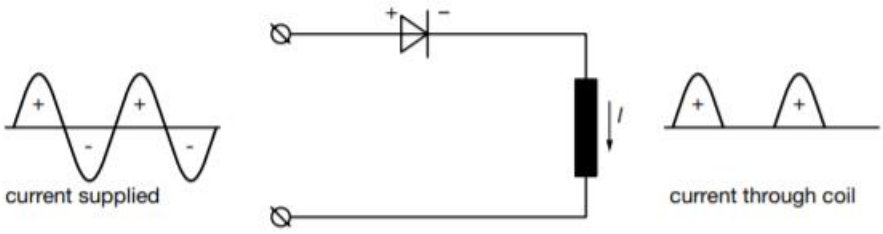
Rectification of AC to DC

An alternating-current alternator generates an AC voltage. The automobile's electrical system is designed to work with a DC voltage. The battery can also only be charged with a DC voltage. The AC voltage generated by the alternator therefore has to be converted to a DC voltage. This is known as rectification. Diodes are used for rectification. A diode is an electronic component that only passes current in one direction. It can be thought of as a one-way valve for electric current



The diode acts as a one-way valve

The diode and coil shown in figure 48 are connected to an AC voltage. Because the diode only passes current in one direction, only the positive component of the alternating current passes through the coil.



Only the positive period of the current passes through the coil

Regulation of output voltage

The negative component of the alternating current is lost. A great deal of the energy that the alternator generates would be lost in this way. However, a circuit consisting of four diodes makes it possible to also use the negative component of the alternating current. The circuit is known as a full-wave rectifier . A current flows as soon as the alternator generates the positive voltage pulse. Connection A of the winding is the positive pole and connection B is the negative pole for a positive voltage pulse. The current flows: – from connection A of the winding – via diode 1 to the positive pole of the battery – then through the battery and diode 4 to connection B of the winding. (NATEF, 1999)

LO 1.3 – Describe charging system external wiring

- **Content/Topic 1 External wiring components**

Battery

The battery has three major functions in the electrical system:

- ✓ It is a source of electrical energy for cranking the engine.
- ✓ Once the engine is cranked, it is getting charged from alternator.
- ✓ Also it provides electrical energy to the vehicle loads whenever the alternator output current is not able to meet the demand or when the alternator is fails.

Ignition switch

An ignition switch, starter switch or start switch is a switch in the control system of a **motor** vehicle that activates the main electrical systems for the vehicle, including "accessories" (radio, **power** windows, etc.).

Fuses

a **fuse** is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby stopping or interrupting the current.

Relays

Relay allows circuits to be switched by electrical equipment: for example, a timer circuit with a **relay** could switch power at a preset time. For many years **relays** were the standard method of controlling industrial electronic systems.

Wires

The purpose of the **wires** in a series **circuit** is to allow the electricity to flow from one device to the next. **Wire** is used to carry the flow of electrons. Metal **wire** is a very good conductor. Materials that do not allow electricity to flow through are called insulators or non-conductors.

Telltale lamp

sometimes called an idiot light or "warning light", is an indicator of malfunction of a system, indicated by a binary (on/off) illuminated light, symbol or text legend.

- **Content/Topic 2 Functions of external wiring**

The three wire types in a three-wire alternator include the battery positive wire, the voltage sensing wire, and the ignition input wire. The battery positive wire connects to the starter. The voltage sensing wire connects to the battery, and the ignition wire connects from the alternator to the key switch. All of these wires pull power from the battery through the alternator to keep the electrical systems running and the car operating.

- **Content /Topic 3: Wiring external diagram**

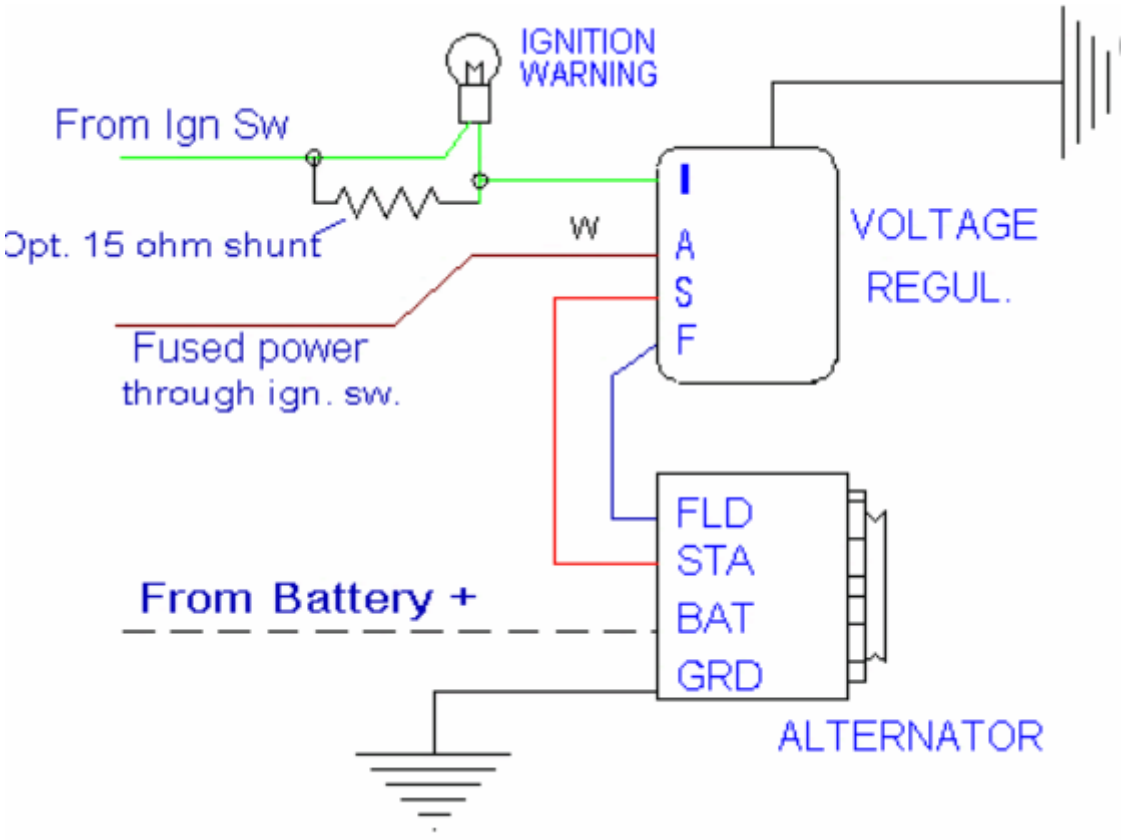


Figure 18: Wiring external diagram

Learning Unit 2 – Repair alternator components

LO 2.1 – Selection of tools, materials and equipment

- **Content/Topic 1 Tools**

Power tools
While many mechanics will take an air-powered **wrench** any time of the day, battery-powered **wrenches** are a great solution for automotive working in the home garage. Milwaukee's 2454-22 3/8 Impact **Wrench** is one such power tool that gets a lot done around most automotive parts.

Measuring tools
Many cars and parts are meant to have at least some level of tolerance when installing or adjusting them. But if you want to reach the top of the mechanical mountain, then you need everything to be accurate down to the nth degree. measuring tools give you exact readings of everything on a car so you know whether it's where it needs to be. Get the tools that separate weekend warriors from championship auto racing mechanics. (Erjavec, 2010)

Examples:
- ✓ Tape Measure. A well-worn tape measure signifies a builder who takes their work seriously.
- ✓ Speed **Square**. A speed **square** can be found on the hip of carpenters and DIYers everywhere
- ✓ Protractor
- ✓ Mechanical Carpenter's Pencil
- ✓ Laser Measure.

Hand tools
Select hand tools like
- ✓ Bit Drivers.
- ✓ Chisels.
- ✓ Files.
- ✓ Gear Ratchet.
- ✓ Hammers.
- ✓ Hex Keys.
- ✓ Lockout **Tools**.
- ✓ Master **Tool** Sets.

- **Content/Topic 2 Materials**

✓ **Grease**

Greases are applied to mechanisms that can be lubricated only infrequently and where a lubricating oil would not stay in position. They also act as sealants to prevent ingress of **water** and incompressible materials. Grease-lubricated bearings have greater frictional characteristics because of their high viscosity.

✓ **Lubricants**

To **lubricate** each part of the bearing, and to reduce friction and wear. To carry away heat generated inside bearing due to friction and other causes. To cover rolling contact surface with the proper oil film in order to prolong bearing fatigue life. To prevent corrosion and contamination by dirt.

✓ **Brushes**

Use brushes for cleaning of the electrical arts like coil and distributor.

- **Content /Topic3 Equipment**

PPE

PPE is equipment that will protect workers against health or safety risks on the job. ... The purpose is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels

LO 2.2 – Diagnose charging system

- **Content/Topic 1 Common problems charging systems**

Faults	Failure causes	Remedies
1. Alternator telltale lamp doesn't 't light up when the engine is stationary and the ignition switch is on	-Telltale lamp burnt out -Battery discharged -Battery damaged -Line released or damaged -Regulator damaged -Short circuit of positive diode -Carbon brushes worn -Oxide layer on collector rings, open circuit in rotor winding	-Replace telltale lamp -Charge battery -Replace battery -Replace lines -Replace regulator -Disconnect charging cable, repair alternator -Replace carbon brushes -Repair alternator
2.At high alternator speed, the alternator telltale lamp burns constantly brightly	-Line D+|has short circuit to earth -Regulator damaged -Diodes damaged, collector ring dirty, short circuit to earth in the D F line or rotor winding	-Replace line -Replace regulator -Repair alternator or replace DF line
3.With the engine Stationary and ignition switched on ,the alternator telltale lamp burns brightly but glows when engine is running	-Contact resistance in charging circuit or in the line to the lamp -Regulator damaged -The alternator damaged	-Replace lines, clean and tighten connection -Replace regulator -Repair alternator

- **Content/Topic 2 Diagnose procedures**

Verify system fault

Whenever this light goes on, it means that the vehicle is running solely on battery power. If the problem continues and your charging system fails, the battery won't be able to recharge and it will soon run down, leaving you with a dead battery. Nothing can ruin a day like a dead battery, so if this light comes on, it's time to take your vehicle to your trusted mechanic to have them find the source of the problem.
Please note that depending upon your vehicle, you might have a battery light and/or check charging system light. Check your owner's manual to learn what warning lights your car has.

Evidences evaluation

Unfortunately, there isn't one answer as to why the battery/check charging system light comes on. The good news is that your mechanic has the know-how to get to the bottom of the issue. The following are some parts that can cause the battery/check charging system warning light to come on.

Alternator issues - Many times, the alternator is the root of the problem when your check charging system/battery light comes on. Have your mechanic test the voltage coming from your alternator. If the voltage is low, your mechanic will likely replace your weak alternator with a new one.

Battery problems - Your battery/check charging system light could be coming on because your battery is low and needs replacing. Take your vehicle to your mechanic and have them test your battery strength.

Drive belt troubles – A failed drive belt prohibits the alternator from doing its job and can cause the warning light to come on. Have your mechanic check the condition of your vehicle's drive belt. It could be faulty and need replacing.

Corroded wires and connections - Have your mechanic clean all of the connections and make sure the battery clamps are clean and tight. Additionally, have them inspect all internal alternator wirings and connections and also have them check all of the fusible links and look for any burned links. If they are burned, get them repaired.

Faulty computer system - If your vehicle isn't having alternator or battery issues, it could be a computer issue. Have your mechanic test your vehicle's computer system after all other issues have been tested and cleared.

Diagnosis systems

Scan Tool Diagnostics

Some parts stores now offer customers a free "diagnosis" if their Malfunction Indicator Lamp (MIL) is on. A store employee will plug a code reader or basic scan tool into your vehicle and read out any codes that appear. The code may provide a clue as to what's going on, but it seldom tells you which part needs to be replaced. Further diagnosis is almost always needed with a scan tool such as AutoTap, a digital storage oscilloscope and/or other test equipment. So don't put too much faith in parts store diagnostics. These people are not in the repair business. They are in the parts business and are anxious to sell their customers parts. Whether these parts actually fix the problem or not is not their primary concern.

One thing to keep in mind about scan tool codes is that codes are primarily for emission faults, not electrical faults. Ignition faults such as misfires certainly qualify as emission faults and will trigger the MIL lamp and set a code if the rate of misfire is high enough to cause a problem. A low battery, or an unusually low (or high) charging voltage may set a code, but a weak battery, poor ground or bad starter probably won't.

Even when you have a code, you'll often have to do additional tests to find out what's causing the problem. A misfire code, for example, will tell you the engine is misfiring and which cylinder is the culprit -- unless you have a P0300 code which indicates a random misfire that can't be isolated to any given cylinder. But even when you have a cylinder-specific code, you still don't know if the misfire is due to fuel, ignition or compression. The cause might be a fouled spark plug, bad plug wire or weak ignition coil. Or, it might be a dirty or dead fuel injector. Or, it might be a compression problem due to a burned or bent valve, a leaky head gasket or a rounded cam lobe. (https://itstillruns.com/main-components-alternator-6966534.html/)

And what do you do when you have a no start/no code condition? The problem might be no ignition, fuel or compression. Or, it might be a bad battery, starter, ignition switch or safety circuit, or anti-theft immobilizer system if the engine won't crank.

Charging Checks

The vehicle's charging system should also be checked to make sure it is operating correctly and is capable of keeping the battery at full charge. As a rule, the charging voltage with the engine at fast idle should usually be about 1-1/2 to 2 volts higher than battery voltage.

Alternator charging output increases in proportion to the electrical load on the charging system and engine speed. Charging output is controlled by a voltage regulator, which may be mounted inside or on the back of the alternator ("internally regulated"), or somewhere else under the hood ("externally regulated"). On newer vehicles, the powertrain control module (PCM) regulates charging output.

If an alternator is overloaded, it may overheat and fail (check for aftermarket sound equipment that may be overloading the stock alternator!). An alternator failure will cause the battery to run down and go dead. Symptoms of a charging problem include a low battery, dim headlights, hard starting or a charging system warning light.

Many parts stores have an alternator test stand and can test alternators to determine if they have failed or are capable of putting out their rated amp capacity. When done correctly, bench testing an alternator is a good way to verify your diagnosis and/or to confirm the output of a new or remain alternator before it is installed.

A replacement alternator (new or remain) should have the same or higher amp rating as the original. If the replacement comes with a pulley (some do not), make sure it matches the original (same diameter, width and belt type). If your vehicle has a high amp, aftermarket sound system, you should consider upgrading to a high output replacement alternator.

Related items that may also need to be replaced include the regulator (externally regulated applications only), drive belt, battery cables and/or battery. If you're installing a high output alternator, larger gauge battery cables, ground straps and charging wire may also be required.

Result report

Today's vehicles are designed with computer processors, microchips, and sensors that can be linked to a computer which scans the operating systems to pinpoint exactly where a problem may exist. They have the capability to produce a large variety of fault codes which get stored in the vehicle’s memory system. Some cars have several units which control engine management, brakes, suspension and even windscreen wipers. With diagnostic equipment, it is possible to identify the correct cause of the fault or problem and rectify it before the problem escalates.

Your auto repair technician has been trained to read the codes indicating a problem or what might need to be replaced during a car tune-up. This saves a lot of time and money troubleshooting a problem because you don't have to pay for repairs performed on a "trial-and-error" basis.

The benefits of a car diagnostic test mean that our mechanics can identify the problem quickly; order parts if necessary and will have the problem fixed before it becomes an inconvenience. As a car owner, you often have no idea why the ‘engine’ light appears in the dashboard, you only know that it is not something good! When you schedule a car tune-up, you are essentially asking for an inspection of your engine and an analysis of car’s performance so that adjustments can then be made as needed. What may be required during a car tune-up will vary from vehicle to vehicle, based on age, mileage and unique manufacturer recommendations for that vehicle.

LO 2.3 – Test alternator components

- **Content/Topic 1 Alternator location**

Alternators are **located** towards the front of your engine and are powered by the engine's serpentine belt. **Alternators** use the power from the crankshaft and serpentine belt to move magnets over a special surface of wires and cables called the conductor.

- **Content/Topic 2 Alternator Dismounting procedures**

Disconnect battery
When removing the old **battery**, remember to **first disconnect** the cables from the negative **terminal**, which is usually black and has a minus (-) sign then **disconnect** the cables from the positive **terminal**, which is usually red and has a plus (+) sign.

Disconnect wires
Disconnect all wires from the alternator

Remove drive belt
Remove the Alternator belt (Refer alternator belt removal procedure).

Unbolt alternator
Disconnect the electrical connection.

Remove
Loosen and remove the front mounting bolts (1) and the rear mounting bolt (2) to remove the Alternator (3).

- **Content /Topic 3: Alternator disassembling procedures**

Remove cover
Unscrew the terminal flanged nut.
Unscrew the rear cover moulding fixing screws 2 Nos.

Remove brush holder
Remove and separate the rear cover moulding fixing screws, spring washer and plain washer.

Remove regulator
Remove and separate the rear cover moulding from the alternator

Remove diode plate
Remove and separate the Spacer from the terminal.

Remove pulley
Remove pulley using special tool

Separate rotor and stator
Separate rotor and stator carefully and start diagnostic

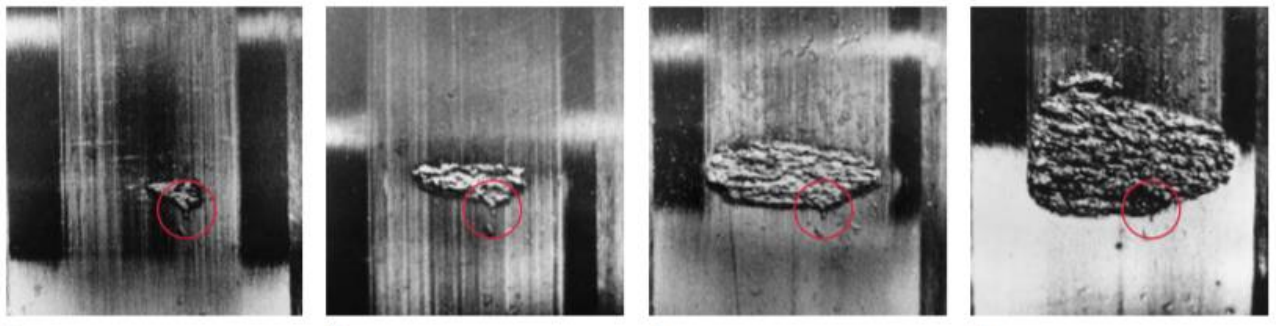
- **Content /Topic4 Examinations of the running surfaces of the pulley for wear and dents**

- ✓ When the pulley is mounted by the customer the dimensional tolerances and the tightening torque must be kept within specified limits. Otherwise the pulley can become loose or the drive shaft can be damaged.
- ✓ It is not allowed to store the alternator in wet condition. This applies for installed as well as for not installed alternators.
- ✓ If the alternator is exposed to an engine cleaning process, a drying process should be done prior to storage of the engine.
- ✓ Do not disconnect the battery cable while engine is running.

- **Content /Topic5 Testing of the roller bearing seat**

A hard contaminant was over-rolled and made an indentation in the inner ring raceway of a cylindrical roller bearing (a). The surface initiated fatigue resulting in a spall started just behind the indentation. Over a period of time, spalling became more and more pronounced (b, c). If the machine was not stopped in time, secondary damage to machine components could have occurred. The initial indentation is no longer recognizable (d).

Fig. 1



Inspecting bearings

Bearings are not always easily accessible. However, when bearings are partially exposed, visual checks can be made. The most practical time to inspect bearings is during routine maintenance. When inspecting a mounted bearing, SKF recommends following these general guidelines:

Preparation

- ✓ Clean the external surface of the machine.
- ✓ Remove the housing cover, or the housing cap, to expose the bearing.
- ✓ Take lubricant samples for analysis. For oil lubrication, take samples from sump/reservoir. For grease lubricated open bearings, take samples from various positions within the bearing. Visually inspect the condition of the lubricant. Often impurities can be detected by spreading a thin layer on a sheet of paper and examining it under a light.
- ✓ Clean the exposed external surfaces of the bearing with a lint-free cloth. Inspection
- ✓ Inspect the exposed external surfaces of the bearing for fretting corrosion. Inspect the bearing rings for cracks.
- ✓ For sealed bearings, inspect the seals for wear or damage.
- ✓ Where possible, rotate the shaft very slowly and feel for uneven resistance in the bearing. An undamaged bearing turns smoothly. (https://axleaddict.com/auto-repair/Alternator-Problems-Troubleshooting/)

- **Content /Topic 6: Alternator windings testing**

- ✓ **Short circuit testing for stator winding and rotor**

2. BENCH INSPECTION:

On dismantling the unit conduct the following checks:

2.1 Brush check:

If the brushes are below the minimum required length renew the brushes in sets not individually.

De' solder the brush lead assy. INSERT New brush assembly and solder. Make sure that the brushes move freely inside the brush box.

NOTE:

*Minimum required Brush Length : **7.5 mm**.*

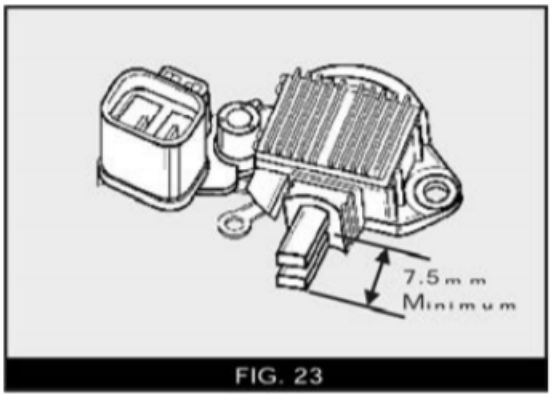


FIG. 23

2.2 Slip ring check:

If the surface is very rough and cannot be polished, replace the rotor assembly. There should not be any trace of oil or grease on the slip ring surface.

NOTE:

Clean slip ring surface with a fine piece of cloth and ensure that the surface is smooth and clean.

replaced.

2.4 Rotor assembly check:

Resistance Check: Use ohm meter 0-10 ohm range and connect as shown in fig. Connect the probes of the meter to the slip ring. The value should be 2.78 + 0.08 – 0.14 o at 20 C ohms. If value is outside this limit, change the rotor assembly.

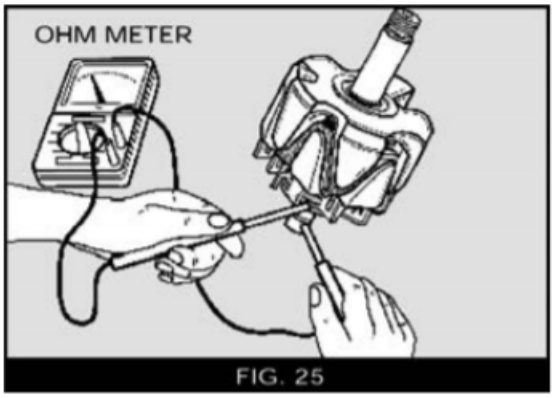
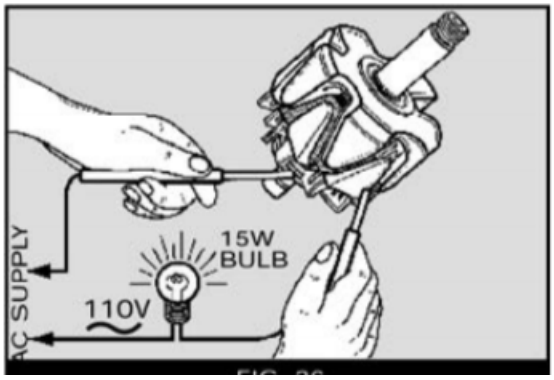


FIG. 25

2.5 Rotor ground test:

Using 230 volt AC main supply, connect a 15W bulb as shown in figure 26. Connect one of the probes to the slip ring and the other to the shaft. The lamp should not glow. If the lamp glows it indicates earthing. Replace the rotor assembly.



✓ **Short to ground testing for stator winding and rotor**

A. Continuity check:

Connect as shown in figure. Use the multimeter with two probes. Connect the negative probe of multimeter to phase connecting points and positive probe to rectifier body. All diodes should indicate continuity. If not, it indicates open circuit. Replace the rectifier assembly.

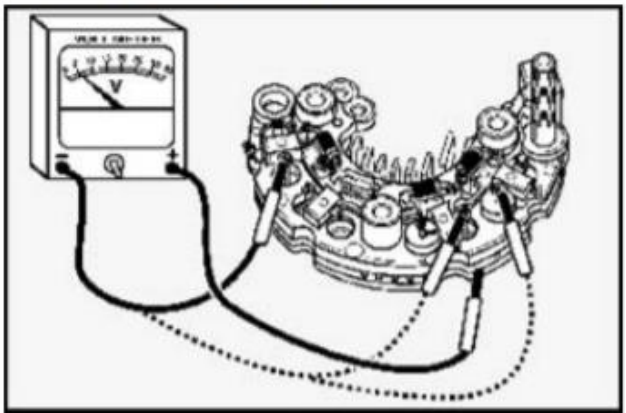
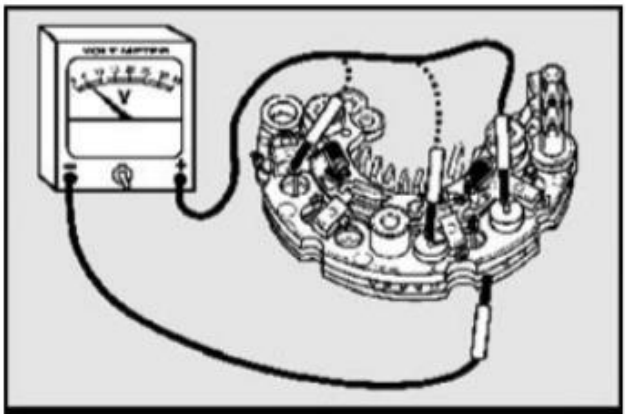


FIG. 31

B. No Continuity check:

Connect as shown in figure. Use the multimeter with two probes. Connect positive probe of multimeter to phase connecting points and negative probe to rectifier body. Now all diodes should indicate no continuity. If not, it indicates short circuit. Replace rectifier assembly.



Use LTVS authorised test equipment for checking Regulators and test as per instructions given in the test equipment manual. Connect the negative to the equipment as per the markings on the Regulator.

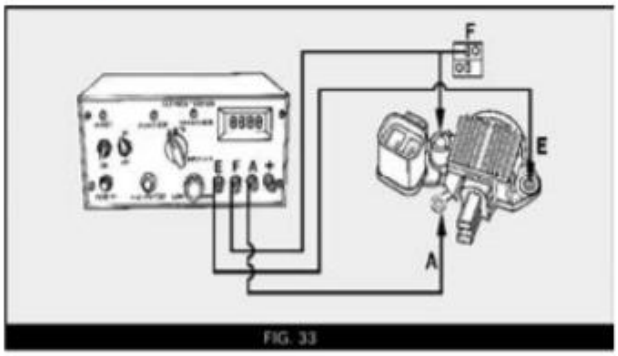


FIG. 33

Open testing for stator winding and rotor

2.6 Stator insulation test:

Using 230 volt AC main supply, connect a 15W bulb. Connect one of the probes to any of the three leads and the other probe to the body. The lamp should not glow. If the lamp glows it indicates poor insulation. Replace the stator assembly.

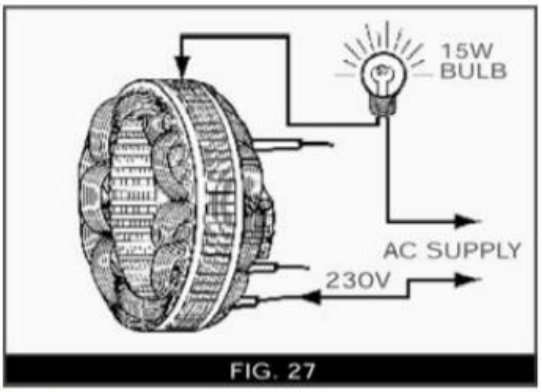


FIG. 27

2.7 Stator winding resistance check:

Use Ohm meter with two probes connect thicker wire and lead 1. The Value should read around 0.180 to 0.202 O Ohms at 20 C. Repeat it between star connection and lead 2 and 3

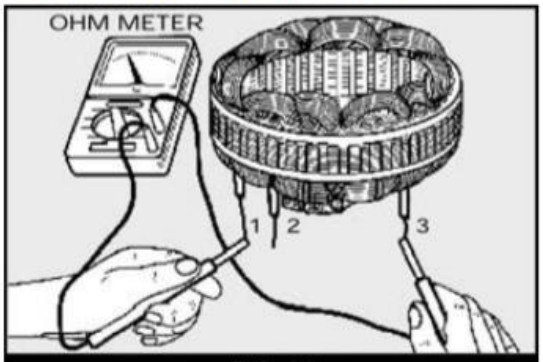


FIG. 28

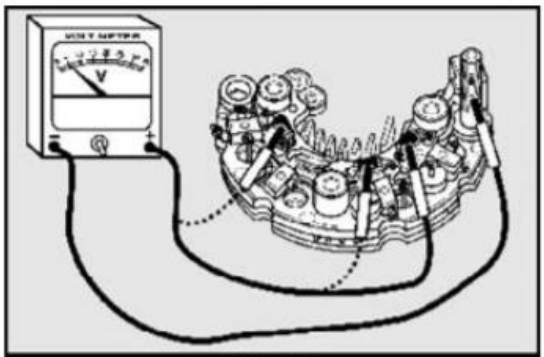


FIG. 29

B. No Continuity check :

Connect as shown in figure. Use multimeter with two probes. Connect positive probe of multimeter to positive terminal and negative probe to phase connector points one by one on the rectifier assembly. All diodes should indicate no continuity. If there is continuity it indicates short circuit. Replace the rectifier assembly.

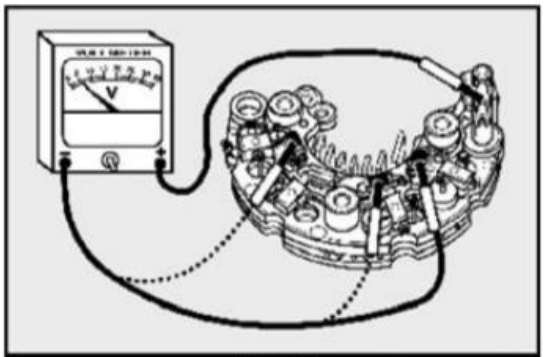


FIG. 30

- **Content /Topic7 Alternator reassembling / Mounting procedures**

Place stator on rear housing

Physically compare the replacement alternator to the original. Compare the case and pulley offsets, pulley size and type, pivot and adjustment hole locations and wire connector locations or rear housing clocking with the original alternator.

Insert front housing

Install the mounting bracket(s). Do not completely tighten the bolts at this time.

Insert bolts and nuts

Using correct nuts and bolts

Re-install brush into brush holder

Using correct tools Re-install brush into brush holder

Install diode plate

Make installation of diode plate correctly

Install cover

Put correctly the alternator cover
Mount alternator
Correct information is accessed and interpreted from manufacturer/component supplier specifications
Place stator on rear housing
Place correctly the housing
Place regulator
Inspection and testing is carried out according to industry regulations/guidelines, OHS, legislation and enterprise procedures/policies
Mount alternator

3. Support the alternator and fasten it into position. Do not completely tighten the bolts at this time.
4. Install the drive belt(s). If the drive belt(s) was found to be worn, stretched, cracked, oily or glazed during the charging system inspection, replace the belt(s).
5. Set the belt tension while tightening the mounting and adjusting bolts. Be sure to set the belt tension and torque the mounting bolts to the vehicle manufacturer's recommended specifications. CAUTION: DO NOT pry or hit the alternator housing to adjust belt tension.
6. Check the drive belt alignment between the alternator pulley and drive pulley(s). Be sure there is no interference
between the drive belt(s) and other components.
7. Re-connect the wire connector(s) to their proper location on the alternator. Be sure there is no interference between the wire harness and other components.
8. Re-inspect that all components are correctly installed, all threaded fasteners properly torqued and there is no interference between components.
9. Re-connect the battery negative cable.
10. Start the engine and be sure there is no interference between components. Let the engine idle for 5 minutes to break-in the drive belt(s). Readjust the drive belt(s) using the "used" tension specification.
11. Shut the engine off and re-inspect that all components are correctly installed, all fasteners properly torqued and there is no interference between components.
12. Re-test the charging system to verify it is performing to the vehicle manufacturer's specifications.

LO 2.4 – Repair or replace damaged alternator components

- **Content/Topic 1 Replacing and repairing procedures**

Stuff will need (gather resources)
Disconnect the negative battery cable from the vehicle. CAUTION: Personal injury or damage to the vehicle or its components may occur if this step is not performed.
Alternator removal
Identify each wire connection and note the location of each on the alternator
Stripping alternator
Disconnect the wires from the alternator.
Loosen the alternator pivot bolt. Do not remove the bolt at this time.
Assess the damage
Loosen the alternator pivot bolt. Do not remove the bolt at this time.
Loosen the tension assembly's lock nut or bolt and turn the adjustment bolt so that drive belt tension is reduced far enough to allow belt removal.
Some vehicles may be equipped with an automatic, spring-loaded tensioner. Rotate the spring-loaded tensioner using the appropriate tool far enough to allow drive belt removal. 6. Remove the drive belt(s) from the alternator.

. Support the alternator and remove the bolts holding the alternator in place. Set the bolts and alternator aside. Be sure to note bracket orientation and fastener length and location before removing the alternator.

Repair the rotor and field winding
One simple reason is , we have to taken out very large amount of current from armature so it not good to **placed** on to the **Rotor** ,due to centrifugal force is acting on to the conductor. We prefer to keep it static and **Field winding** on **Rotor**.

Replace regulator
The voltage **regulator** can be mounted inside or outside of the **alternator** housing. ... When there is no current applied to the field, there is no voltage produced from the **alternator**. When voltage drops below 13.5 volts, the **regulator** will apply current to the field and the **alternator** will start charging.

Replace diode plate
It is possible to **replace** all the parts of the **alternator**, including the **diodes** in the **rectifier** plate. The only sure dead of **an alternator** is a breakage of the case. Even a defect in **one** of the windings is curable, although **it** requires expensive rewinding.

Repair stator windings
Check for the winding if there is any short-circuits
Lubricating the new brushes
Use lubrication oil to lubricate the new brushes to fit correctly
Fitting the new brushes
Using correct tools fix correctly the new brushes
Checking brush
After fixing check for the operation using multimeter and also check for the short circuit
Assembling the alternator
Assembling the alternator correctly with correct tools
Testing
Inspect the condition of the wiring and connectors. Inspect for frayed wire ends, continuity, loose or broken connectors, corrosion and pliability. Repair or replace as necessary.

- **Content/Topic 2 Mount alternator in the vehicle**

Install the new alternator
You want to ensure a nice snug fit. Line up all the bolt holes and tighten the bolts to the correct tension. Replace all the connecting components to their correct counterparts (as you previously labelled).
Next, replace the belt. If you struggle a little with this, there are a few tricks on how to get the belt back on your alternator. Some alternators have a transverse bolt that will allow movement of the alternator on its bracket. This allows adjustment to the belt tension.
If there is no transverse bolt, you can use a 'cheater' to hold the alternator in place while you tighten it into its correct position. Alternatively, a good assistant can help you keep the belt tight while you fasten the mounting bolts.

Check the belt tension
Without the correct tension, you're in danger of creating real problems. Check your repair manual for just how tight your belt should be. After a few days, you should recheck the tension to be sure it's still correct after a period of settling in.

Reconnect the battery
Reconnect the negative terminal of your battery, attach your voltmeter and start the car. The correct output of your alternator should now show a reading of 13.1 to 16.5 volts. If your reading is correct, then you're all done. Pat yourself on the back and reward yourself with a good cup of tea.

Learning Unit 3 – Alternator external wiring repairing

LO 3.1 – Test charging system external wiring components

- **Content/Topic 1 : Testing external wiring components**

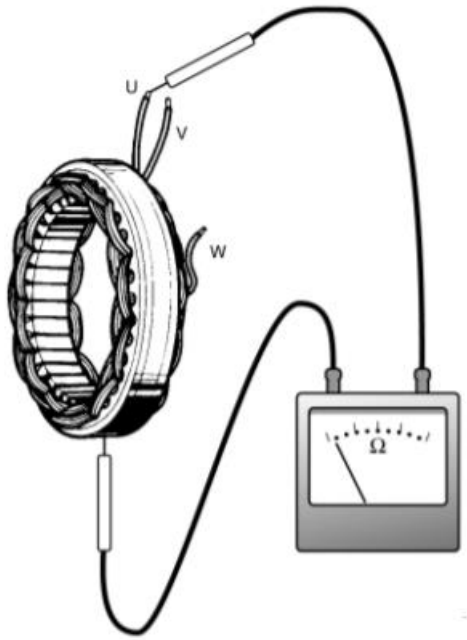
Control switch
Test control switch with digital millimeter for good conditions
Fuses
Test fuse using digital millimeter or using visual test
Another way to **test** the **fuse** is by measuring the voltage across it with a digital multimeter. This is helpful **if** the **fuse** is not able to be easily removed from the **circuit**. To **do** this, leave the **circuit** powered on and switch your meter to measure voltage. ... Place the meter leads on either side of the **fuse**
Relays
Test relay for short circuit
The only tool required to **check** a **relay** is a multimeter. With the **relay** removed from the fuse box, the multimeter set to measure DC voltage and the switch in the cab activated, first **check** to see if there are 12 volts at the 85 position in the fuse box where the **relay** plugs in (or wherever the **relay** is located)
Control wires
Using visual checking test for broken wires
Battery
Test battery for charging and discharging
Telltale lamp
Test telltale lamp for working principle
You should also have the dealer inspect your car if this **indicator** comes on repeatedly, even though it may turn off as you continue **driving**. If you keep **driving with the malfunction indicator lamp on**, you **can** damage your car's emissions controls and engine.

- **Content/Topic 2 Test external charging circuit**

Pre-excitation
Check rotor for short-circuit to earth Check the rotor using an ohmmeter for a short-circuit to earth: – place one of the ohmmeter's measuring prongs on one of the slip rings and the other on the rotor's shaft or pole claw – the resistance should be infinite. If the measured resistance is not infinite, the rotor has a short-circuit to earth.

Excitation
Checking the rotor for a broken wire – Place each of the ohmmeter's measuring prongs on a different rotor slip ring . – The measured resistance should correspond to the value indicated by the manufacturer. An infinite resistance means there is a broken wire.
Charging
Checking for short-circuit copper windings Checking the rotor for short-circuit copper windings involves making the same measurement as that made when checking for a broken wire: – place each of the ohmmeter's measuring prongs on a different rotor slip ring (fig.) – the resistance should correspond to the

value indicated by the manufacturer. A resistance that is too low indicates short-circuit copper windings.
Checking the stator Measuring the stator entails disconnecting the three stator windings (U, V and W) from the diodes.



Checking stator for short-circuit copper windings
Checking the stator for short-circuit copper windings involves making the same measurement as that made when checking for a broken wire.
Short-circuit copper windings are difficult to trace because the coils have a low resistance anyway. Use a sensitive ohmmeter to trace short-circuit copper windings. If there is a short-circuit copper winding, the measured resistance will be noticeably lower than that of the others.
If it has a short-circuit copper winding, the stator will produce extra heat.
Checking diodes
The diodes are checked using a test lamp or a diode tester. Diodes are checked using a test lamp as follows (fig. 85):

- ✓ Connect the lamp and diode to a 12 V supply as shown in figure 85a
- ✓ Close the switch to see if the lamp lights
- ✓ Then connect the lamp and diode as shown in figure 85b (positive and negative poles reversed)
- ✓ Close the switch to see if the lamp lights.

If the lamp lights for the first test and not for the second, the diode is all right. If the lamp fails to light for both tests or if it lights for both tests, the diode is defective.

LO 3.2 – Repair or replace damaged alternator external wiring components

- **Content/Topic 1 Wires Short circuit repair**

Almost all engine testers have a special test program for the charging system. Possible checks that are conducted include:

- ✓ Regulated voltage measured in volts
- ✓ Charging current measured in amps
- ✓ Alternator ripple %. The charging system has to be on
- ✓ Load for these measurements to ensure that sufficient charging capacity is available.

Conduct the test as follows:

- ✓ Switch on as many loads as possible (headlamps, rear window heater, super charger for the heating)
- ✓ Run the engine at approximately 3000 rpm/min. The charging current should now be at least 1 A.

The alternator ripple can be checked too. The difference between the alternator ripple's highest and lowest point must not exceed 3%. Leave the regulator and battery connected when making measurements using the engine tester. This means there is no risk of damage to the alternator when making the measurements. Closely follow the manufacturer's instructions when connecting the engine tester.

- **Content/Topic 2 Wiring Short to ground repair**

ROTOR TESTING

The slip rings on the rotor should be smooth and round (within 0.002 in. of being perfectly round). If grooved, the slip rings can be machined to provide a suitable surface for the brushes. Do not machine beyond the minimum slip-ring dimension as specified by the manufacturer.

If the slip rings are discolored or dirty, they can be cleaned with 400-grit or fine emery (polishing) cloth. The rotor must be turned while being cleaned to prevent flat spots on the slip rings. Measure the resistance between the slip rings using an ohmmeter. Typical resistance values and results include the following:

1. The resistance measured between either slip ring and the steel rotor shaft should be infinity. If there is continuity, then the rotor is shorted to ground.
2. Rotor resistance range is normally between 2.4 and 6 ohms.
3. If the resistance is below specification, the rotor is shorted.
4. If the resistance is above specification, the rotor connections are corroded or open.

If the rotor is found to be bad, it must be replaced or repaired at a specialized shop.

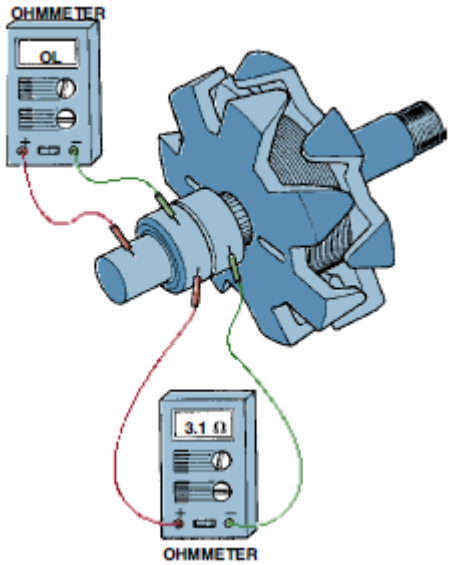


Figure 19: Rotor testing

- **Content /Topic 3 Open wires repair**

STATOR TESTING

The stator must be disconnected from the diodes (rectifiers) before testing. Because all three windings of the stator are electrically connected (either wye or delta), an ohmmeter can be used to check a stator. There should be low resistance at all three stator leads (continuity).

There should not be continuity (in other words, there should be a meter reading of infinity ohms) when the stator is tested between any stator lead and the metal stator core.

If there is continuity, the stator is shorted-to-ground and must be repaired or replaced.

NOTE: Because the resistance is very low for a normal stator, it is generally not possible to test for a shorted (copperto-copper) stator. A shorted stator will, however, greatly reduce alternator output. An ohmmeter

cannot detect an open stator if the stator is delta wound. The ohmmeter will still indicate low resistance because all three windings are electrically connected.

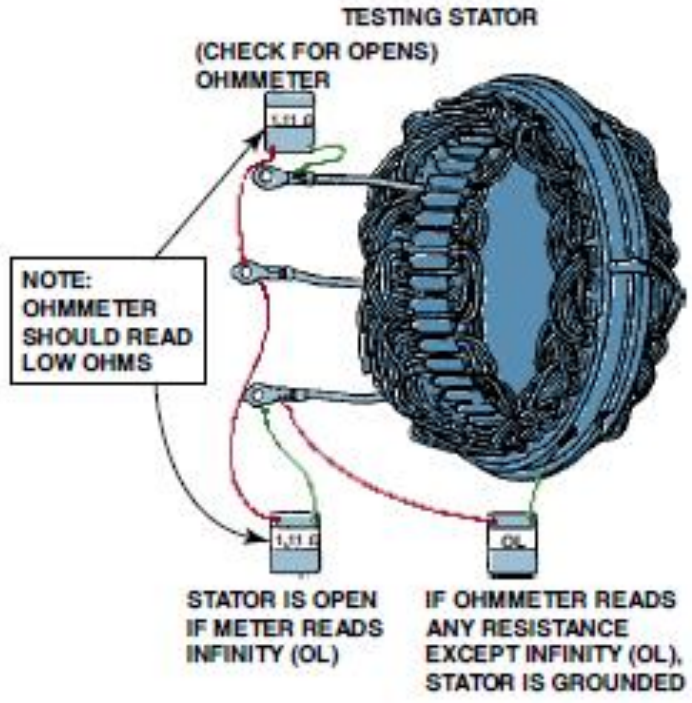


Figure 20: Stator testing

- **Content /Topic4 Replacement of damaged components**

Control switch
Replace the control switch when it damaged
Fuses

1. Unplug electrical appliances. First and foremost, it's important to identify where the outage occurred.
2. Turn the power off. Next, you will need to turn off the main power to the **fuse** box
3. Find the **fuse** box
4. Identify the broken **fuse**
5. **Replace** the **fuse**
6. Test your new setup

Relays
A **bad** ignition **relay** will not only cause starting problems to your vehicle, but it can also cause stalling of the vehicle, draining and damage to the battery, and power loss in the dashboard lights. In modern vehicles, the remote starting key is used, which contains a small computer chip inside it

Control wires
Repair the wire short circuit or replace it with the new one

Dashboard with telltale lamp
Undo **the** screws in **the** glovebox and pull **the** box out of **the dashboard**. Unhook any fasteners or clips holding **the** glovebox door in place. Undo all **the** screws on **the** lower piece of **the dashboard** and allow **the** lower **dashboard** to come loose and drop to **the** floor board.

LO 3.3 – Testing charging system

- **Content/Topic 1 Importance of maintaining equipment and tools**

  Many alternators are equipped with a diode trio. A diode is an electrical one-way check valve that permits current to flow in only one direction. Because trio means three, a diode trio is three diodes connected together

  The diode trio is connected to all three stator windings. The current generated in the stator flows through the diode trio to the internal voltage regulator. The diode trio is designed to supply current for the field (rotor) and turns off the charge indicator light when the alternator voltage equals or exceeds the battery voltage. If one of the three diodes in the diode trio is defective (usually open), the alternator may produce close-to-normal output; however, the charge indicator light will be on dimly

- **Content/Topic 2 Process maintenance**

Cleaning

Before executing any service one has to follow the following precautions and working rules. And this are outlined as follows.

- ✓ Wear protection clothes and goggles
- ✓ Wash any splashed electrolyte on your skin or clothing with plenty of water immediately.
- ✓ Do not put tools, that make short circuit on the terminals, explosion may occur.
- ✓ Avoid any spark or flame in or near the charging room
- ✓ Ensure good ventilation
- ✓ Always pour concentrated sulphuric acid in to water but not the other way round
- ✓ Use distilled water to dilute the sulphuric acid
- ✓ Always keep the battery dry and clean to avoid surface charge.

After finishing your cleaning tasks, dry everything off using a disposable rag. Replace the negative and positive clamps in the reverse order you used to remove them (positive first), then use petroleum jelly or grease on the terminals to prevent the buildup of new corrosion. Specially-formulated anticorrosion grease is also available at Advance. These tasks should be added to complete any guide of how to clean battery corrosion responsibly and efficiently.

Oiling

The **alternator pulley** spins on a shaft, which in turn is supported by either bearings or bushings. **If** the **pulley** is not in correct alignment with the belt, **if** it's canted on the shaft or **if** the bearings and bushing are worn out, the growling or whining noise will let you **know** there's a problem.

- **Content /Topic 3 Process of arrangement equipment and tools**

- ✓ One of the main dangers to a person's health and safety, whether in the home or in a place of work, is the risk from using damaged or faulty equipment. There are many obvious examples, including the risk of electric shock, fire and explosion which can have detrimental effects ranging from minor injuries right up to causing death, not only for the person using the equipment but also those nearby.
- ✓ Broken equipment can also take the form of damaged or defective safety protection which is designed to protect the wearer from harm when it is in good condition, but can fail to provide this protection when it is not in an adequate state.

- ✓ Regulations such as the Health and Safety at Work etc Act (HASAWA) and Provision and Use of Work Equipment Regulations (PUWER) place responsibility for safe equipment on both the employer and the workers themselves. Whilst the employer needs to provide equipment in good condition and provide appropriate protective equipment, it is also a duty of employees to inform their employer in a timely manner of any damage or defects they come across in the equipment so that the employer can take the appropriate action, whether this is getting it repaired by a competent person or replacing the equipment in question. By placing the emphasis on both sides, i.e. both employers and employees, faulty equipment is therefore much more likely to not be used if both parties are keeping a close watch on the state and condition of equipment.

- **Content /Topic 3 Health and safety of equipment and tools**

Hand Tool Safety Rules

1. Carry all sharp tools in sheath or holsters.
2. Tag worn, damaged or defective tools "Out of Service" and do not use them.
3. Do not use a tool if the handle surface has splinters, burrs, cracks or splits .
4. When handing a tool to another person, direct sharp points and cutting edges away from yourself and the other person.
5. Do not carry sharp or pointed hand tools such as probes or knives in your pocket unless the tool or your pocket is sheathed.
6. Do not perform "make-shift" repairs to tools.
7. Do not throw tools from one location to another or from one employee to another.
8. Transport hand tools only in tool boxes or tool belts.

Hammer Safety

1. Use a claw hammer for pulling nails and for driving nails.
2. Do not strike nails or other objects with the "cheek" of the hammer.
3. Do not strike one hammer against another hammer.
4. Do not use a hammer, screwdriver, file, etc., if your hands are oily, greasy or wet.

Power Drill Safety

1. Use brushes or vacuum machinery to remove metal chips, shavings and other debris from the drill table. Do not use your bare hands.
2. Do not use dull, cracked or bent drill bits.

Power Saw Safety

1. Keep control of saws by releasing downward pressure at the end of the stroke.
2. Do not use a saw that has a dull blade.
3. Oil saw blades after each use of the saw.
4. Keep your hands and fingers away from the saw blade while you are using the saw.
5. Do not carry a saw by the blade.

Hand Files & Rasp Safety

1. Do not use a file as a pry bar, hammer, screwdriver or chisel.
2. When using a file or a rasp, grasp the handle in one hand and the toe of the file in the other.

3. Do not hammer on a file.

Chisel Safety

1. Use a chisel that has been sharpened; do not use a chisel that has a dull cutting edge.
2. Hold a chisel by using a tool holder if possible.
3. Clamp small work pieces in the vise and chip towards the stationary jaw when you are working with a chisel.

Tool Boxes, Tool Chests & Cabinets

1. Use the handle when opening and closing a drawer or door of a tool box, chest, or cabinet.
2. Tape over or file off sharp edges on tool boxes, chests or cabinets.
3. Do not stand on tool boxes, chests or cabinets to gain extra height.
4. Lock the wheels on large tool boxes, chests or cabinets to prevent them from rolling.
5. Push large chests, cabinets and tool boxes; do not pull them.
6. Do not open more than one drawer of a tool box at a time.
7. Close and lock all drawers and doors before moving the tool chest to a new location.
8. Do not use a tool box or chest as a workbench.
9. Do not move a tool box, chest or cabinet if it has loose tools or parts on the top

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