

# Charging Systems

Joana Maria Marques Bessa Teixeira

Nº 1031072

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## Summary

- Introduction
- Constitution of the Charging System
- Dynamo vs alternator
- Alternator
- Fault diagnosis of the Charging System
- Assembling and removal of the Charging System
- Troubleshooting in the Charging System
- Battery
- Future Perspectives

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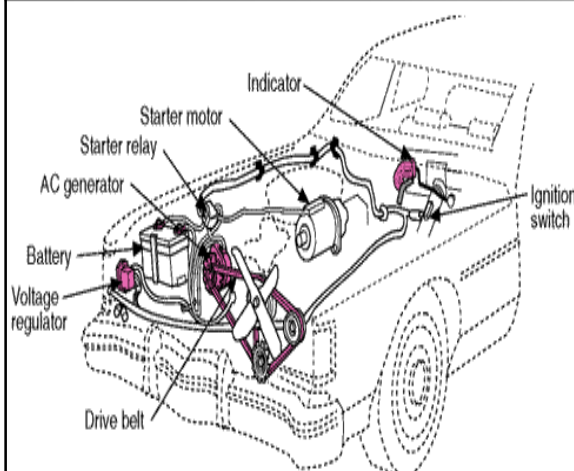


## Introduction

- Taking into account the number of electrical devices that must exist in any car, no matter how small, implies the existence of an electrical system that, at the same time, enables you to store electricity and maintenance of energy.
- It is in this context that the alternator, the car component that is mounted on engine, and when driven by belts and pulleys, generates electricity to power all consumers and charge the battery. For this, the alternator turns AC current, into DC.

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## Constitution of the Charging System



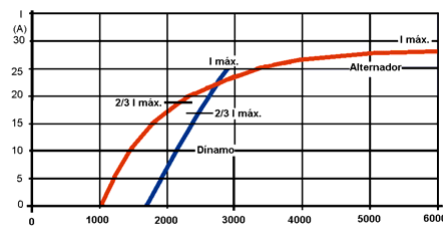
This system consists basically of:

- Battery
- Alternator
- Drive Belt
- Voltage Regulator
- Starter relay
- Fuse protection

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## Dynamo vs Alternator

- The older vehicles used the dynamo to generate direct current
- The dynamo did not have efficiency at idle, which does not occur in the alternator
- This generates a high charge power at lower engine speeds



It appears that the alternator begins to supply electric power with a rotation essentially lower

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## Dynamo vs Alternator

- The alternator and generator, are devices that use the principle of induction Electromagnetic
- The generation of a magnetic field may be made through:
  - Permanent magnets;
  - Electromagnets (inductive coil).

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## Dynamo vs Alternator

- Regardless, electric power generators (which convert mechanical energy in power) can have two constructive types:
  - The inductor is the stator and the armature is the rotor;
  - The inductor is the rotor and the armature is the stator.

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## Dynamo vs Alternator

The production of electricity using the alternator, particularly when the inductor is the rotor and the armature is the stator, instead of the dynamo, has several advantages:

- The alternator has less maintenance;
- The alternator has better cooling than the dynamo;
- For the same electrical power generated, the dynamo is much more voluminous and heavy;
- The alternator has a better return than the dynamo;
- The alternator has a simpler construction.

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## Dynamo vs Alternator

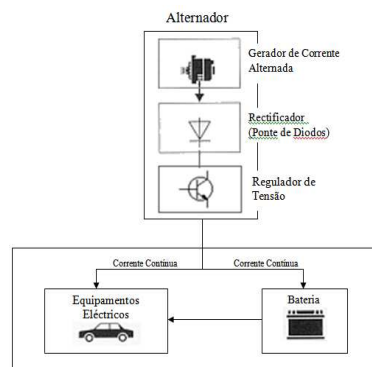
In the particular case of the charging system of cars with combustion engines, the advantages over the alternator to dynamo are even greater:

- The dynamo reaches its nominal voltage to a number of rotations higher than alternator;
- In the alternator, the rotor can run at higher speeds, at the order of 15000 rpm, a value which is almost twice as much as possible to achieve with dynamo.

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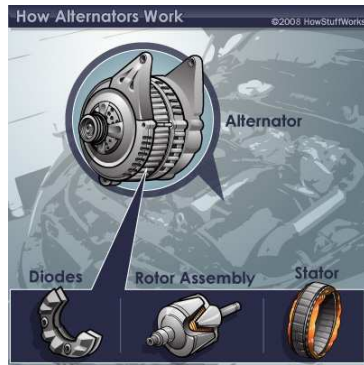
## Dynamo vs Alternator

- The car uses the three-phase alternator
- It should be noted that automotive alternator, is the name given to all: GeneratorAC, rectifier and voltage regulator.



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## Alternator



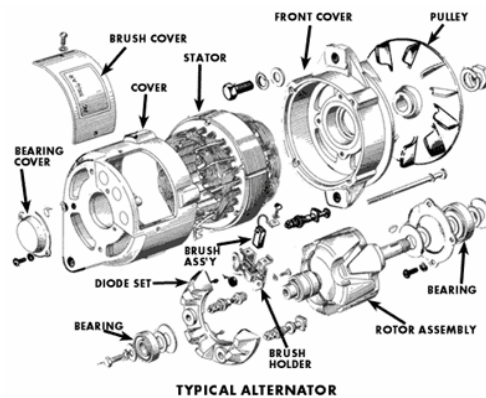
The alternator includes some elements of the system startup:

- Rotor (shaft, bearings, inductive coil, and two polar rings);
- Brushes;
- Stator (three-phase windings, core);
- Bridge rectifying (diode);
- Cooling fan;
- Voltage regulator.

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## Alternator

In the following figure represents is how the various components may be assembled:



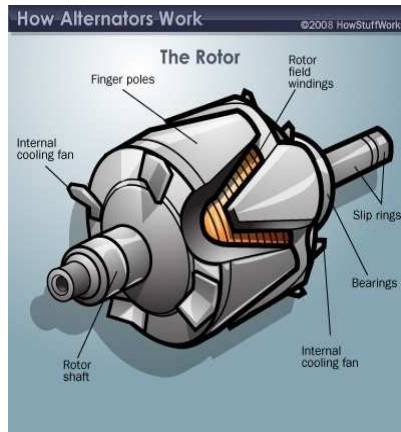
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## Alternator

### Rotor

The rotor consists:

- Two polar cores (magnetic poles North and South);
- A inductive coil (rotor field windings);
- Two slip rings;
- Rotor shaft.



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## Alternator

### Stator

- The rotor is inserted inside the stator;
- The stator of a three-phase alternator has three independent groups of windings



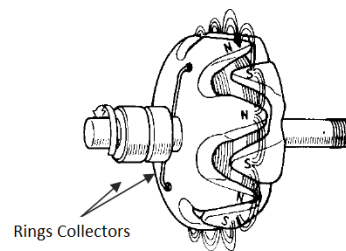
Alternator Stator

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## Alternator

**Rotor**

- The three groups of windings are arranged alternately;
- In the following figure we can see the rotor. It can be seen that the polar cores has six pairs of poles:

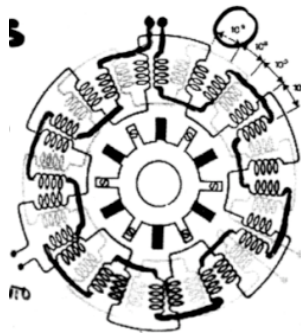


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## Alternator

**Stator**

- We can see in the figure below how the coils of the three windings stator are connected for an alternator with six pairs of poles inductors and twelve rolls per winding:



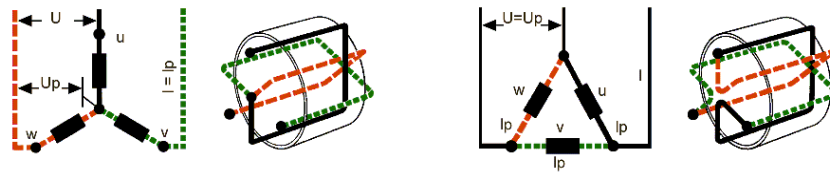
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## Alternator

## Stator

- The connection of the three stator windings can be made in Y or delta, most commonly the first case:



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## Alternator

## Bridge rectifying (diodes)

- The three-phase alternated current generated by the alternator has to be converted into current continuous;
- The system segments that serve to the dynamo can not be used in the alternator, because here the armature does not run (stationary), the solution is to use a rectifier device - a diode bridge

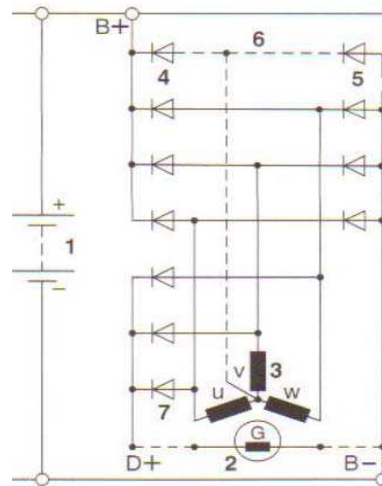


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## Alternator

**Bridge rectifying (diodes)**

1. Battery;
2. Excitation coil (G);
3. Stator Coil;
4. Diodes plate positive;
5. Diodes plate negative;
6. Additional diodes;
7. Excitation diodes;



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## Alternator

**Bridge rectifying (diodes)**

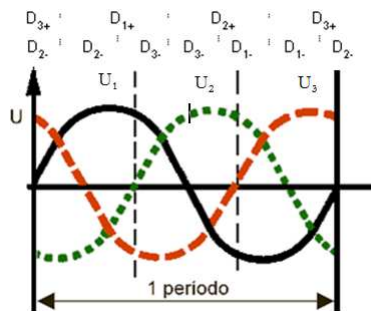
- The correction (full wave) of a three-phase system requires two diodes for each phase, resulting in a total of six diodes.
- At one point in time, only two diodes are driving - are those connected to the outputs of the alternator that have the greatest potential (positive and negative) in the same instant of time.

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Alternator

Bridge rectifying (diodes)

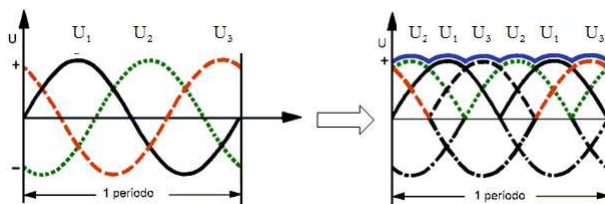
- When they applied three strains ( $U_1$ ,  $U_2$  and  $U_3$ ) staggered 120, the behavior of diodes will be the following Figure :



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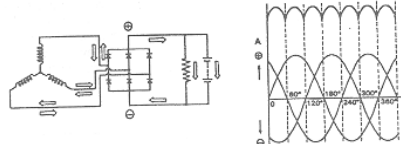
Alternator

Bridge rectifying (diodes)



The three-phase voltage output is converted into direct current slightly wavy

Correction of the three-phase

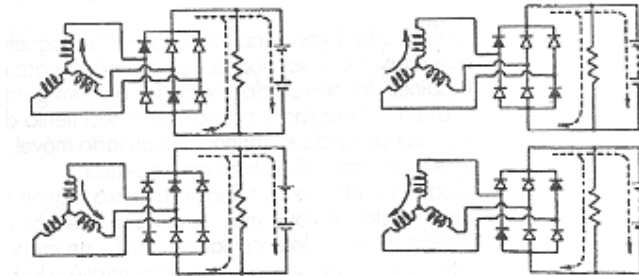


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Alternator

Bridge rectifying (diodes)

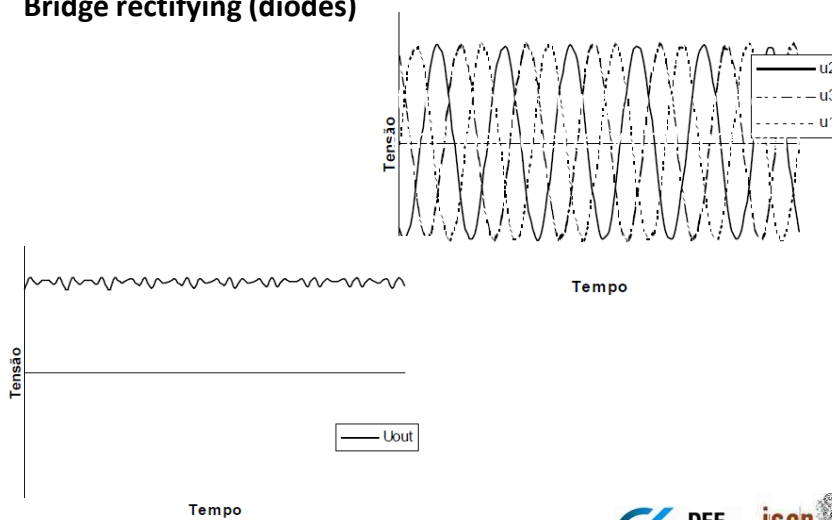
- The direction of currents in stator coils can change of direction, but the direction of current in the load (battery and receiver) is always the same:



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Alternator

Bridge rectifying (diodes)



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## Alternator

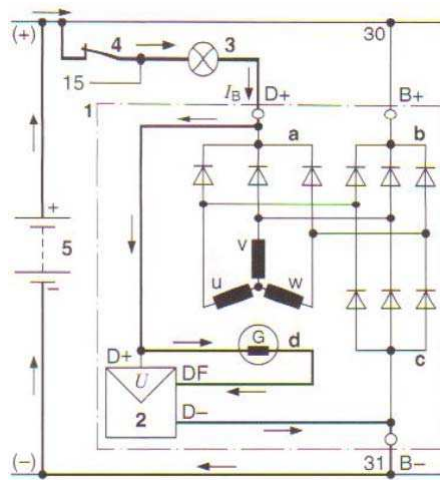
### Pre-excitation current

- In general, the alternators are self-exciting, ie, the excitation current is obtained on the machine, deviated from the mainstream current;
- The field of residual magnetism of the rotor will produce the tension only with a high rotation;
- So that, it is necessary the pre-excitation of the alternator on the start engine. The most practical way is in the form of current on the battery through the indicator load lamp.

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## Alternator

### Pre-excitation current

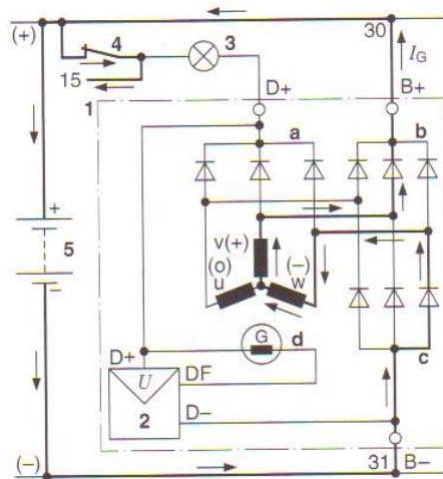


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Alternator

Load current circuit

- In the post "D-" from the alternator, you get the current to charge the battery and feed the consumer electric vehicle.

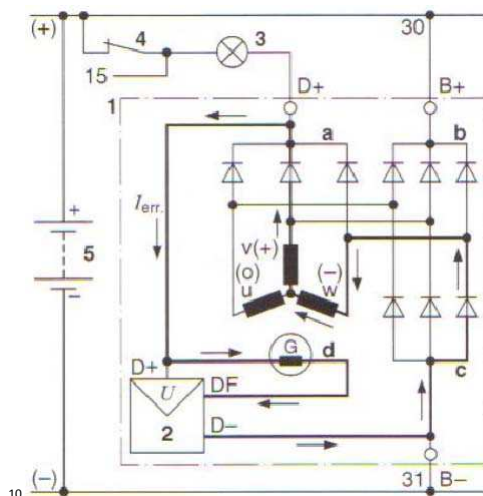


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Alternator

Current excitation circuit

- The excitation current to produce the magnetic field is derived from the stator winding and rectified by three diodes and three special excitation power diodes negative.



Alternator

**Voltage regulator**

- The f.e.m. produced by a given alternator varies with the speed of rotation the rotor and the excitation current of the inductor;
- In the case of the automobile, the speed of the engine varies greatly, from 600-900 rpm up to 6000-7000 rpm;
- In these conditions, the voltage obtained in the alternator would vary, and may reach values in the order of 250 V, which can not happen.
- To resolve this problem it is used the voltage regulator.

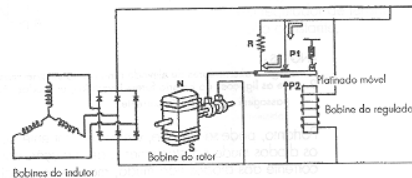
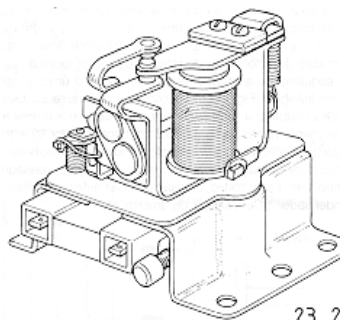
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Alternator

**Voltage regulator**

Electromechanical regulator



Maximum excitation current

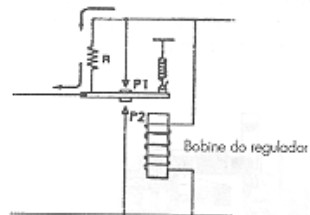
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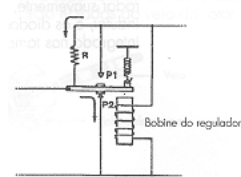
## Alternator

## Voltage regulator

## Electromechanical regulator



Excitation current intermediate



Excitation current zero

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## Alternator

## Voltage regulator

## Electronical regulator – Advantages

- Can be mounted internally in the alternator, avoiding additional wiring required by an external regulator;
- There are no moving parts, it can run up to 7000 switching on/off per second.

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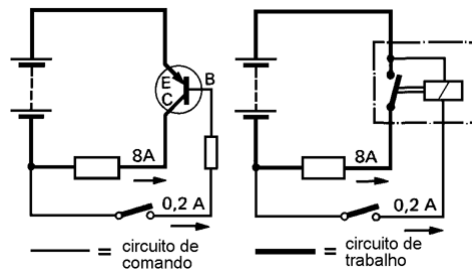


Alternator

**Voltage regulator**

Electronic regulator

- Once perceived electromechanical regulators, whose key element is the relay (right), to realize the electronic is only to be replaced by a transistor, left)

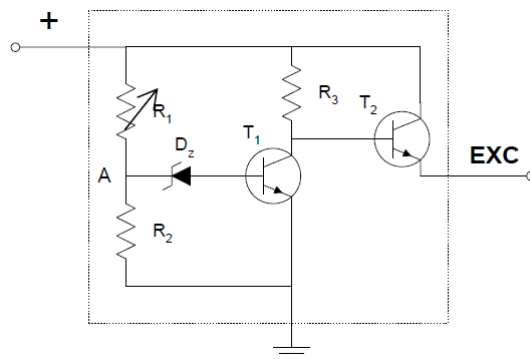


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Alternator

**Voltage regulator**

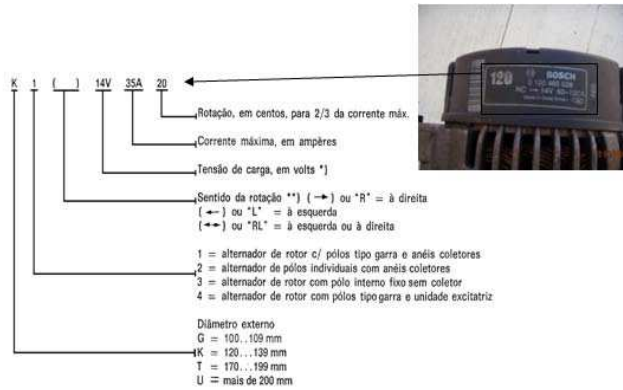
Electronic regulator



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# Alternator

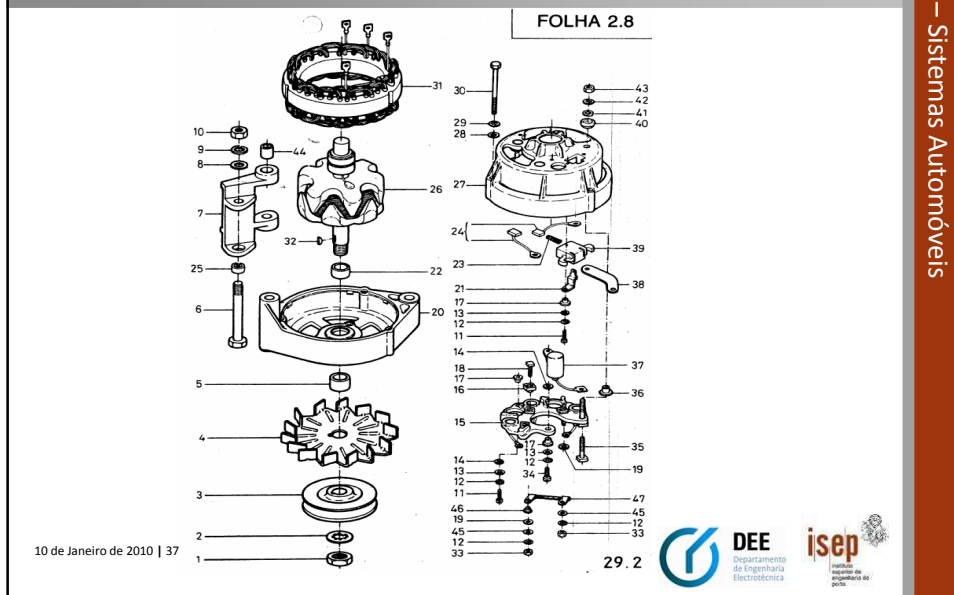
## Description and design of Alternators



## Fault diagnosis of the Charging System

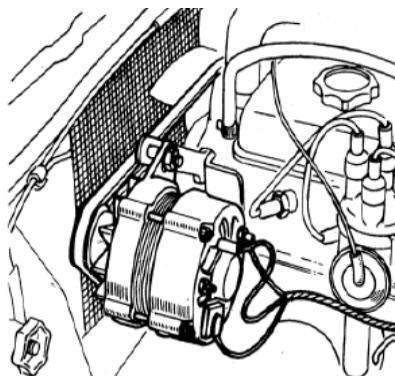
Failure	Possible Causes	Failure	Possible Causes
Voltage greater than 14V	Voltage regulator defective.	The pilot lamp (light) when the engine is accelerated.	<ul style="list-style-type: none"> <li>Check the connections: cable mass of the motor car bodies, battery cables.</li> <li>Diodes excitation open.</li> <li>Diodes positive open.</li> </ul>
Current below current load	<ul style="list-style-type: none"> <li>Defect regulator tension.</li> <li>Short between coils or mass in the winding stator.</li> <li>Diodes short-circuit.</li> </ul>	Pilot light not lit with the engine stopped.	<ul style="list-style-type: none"> <li>Lamp circuit failure or off.</li> <li>voltage regulator disconnected.</li> <li>Battery fully discharged or damaged.</li> <li>Rotor winding stopped.</li> </ul>
The pilot lamp with the ignition off (engine stopped)	<ul style="list-style-type: none"> <li>There is one or more diodes rectifiers positive burned (in short circuit).</li> </ul>	The pilot lamp with low light and not changes.	<ul style="list-style-type: none"> <li>Circuit alternator field stopped.</li> <li>Terminals DF isolates.</li> <li>Brush with bad contact.</li> <li>Ring collector desoldered.</li> </ul>

## Assembling and removal of the Charging System



## Assembling and removal of the Charging System

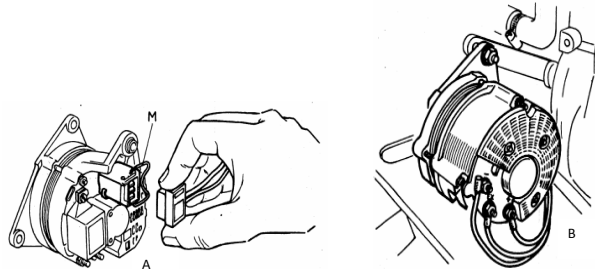
### (Dis) Assembling the Alternator (from) on the Motor Thermal



Assembling and removal of the Charging System

**(Dis) Assembling the Alternator (from) on the Motor Thermal**

Example of mounting the alternator on a longitudinal engine

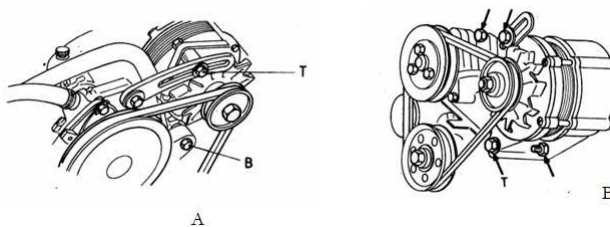


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Assembling and removal of the Charging System

**(Dis) Assembling the Alternator (from) on the Motor Thermal**

Mounting the alternator in a combustion engine with an emphasis on the points of attachment

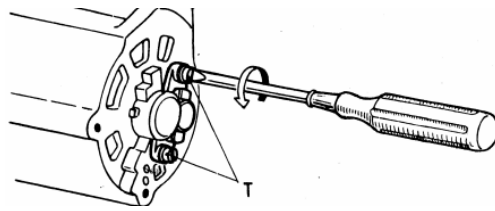


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## Assembling and removal of the Charging System

### (Un) Installation of Brushes

The usual way to fix the set of brush holder

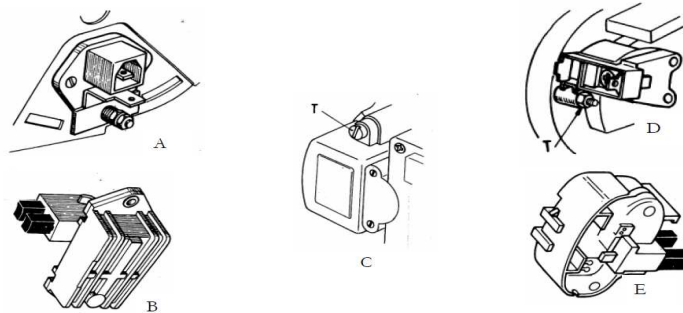


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## Mounting and removal of the Charging System

### (Un) Installation of Brushes

Standard models of setting brush holder

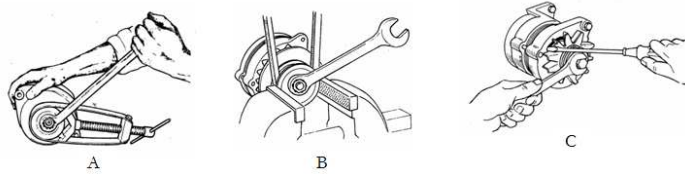
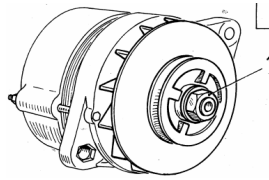


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Assembling and removal of the Charging System

**(Dis) Assembly Pulley and Fan**

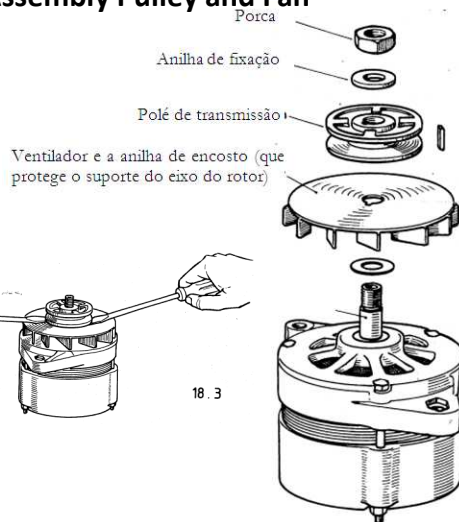
Ways of fixing pulley, for loosening the nut central



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Assembling and removal of the Charging System

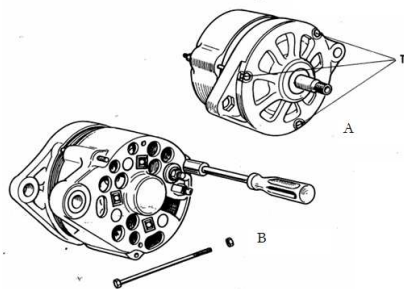
**(Dis) Assembly Pulley and Fan**



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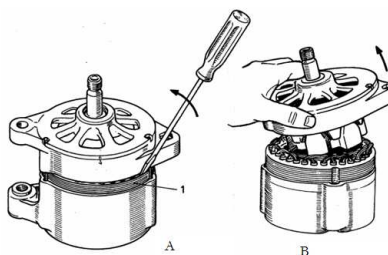
Assembling and removal of the Charging System

**(Dis) Assembly of the Rotor Group**



Identification of screws at the support side of the drive

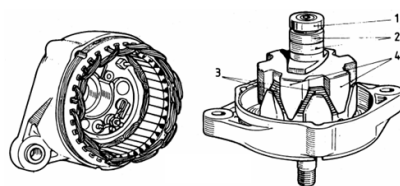
Procedure to remove the cover drive side



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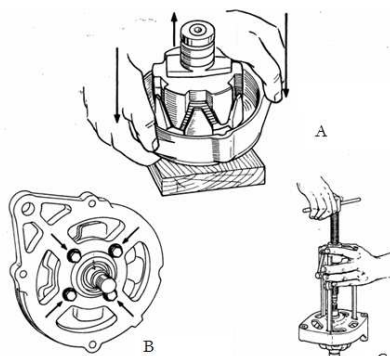
Assembling and removal of the Charging System

**(Dis) Assembly of the Rotor**



1. The roller
2. Rings
3. Rotor field windings
4. Finger poles

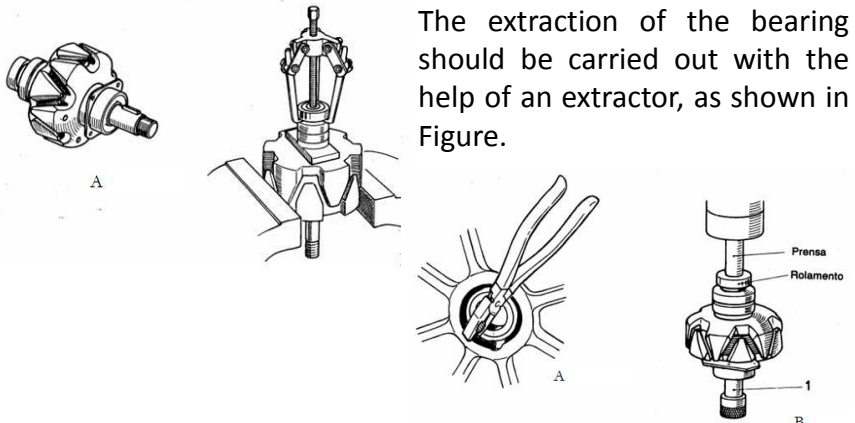
Separation of the cover front bracket of the alternator rotor



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Assembling and removal of the Charging System

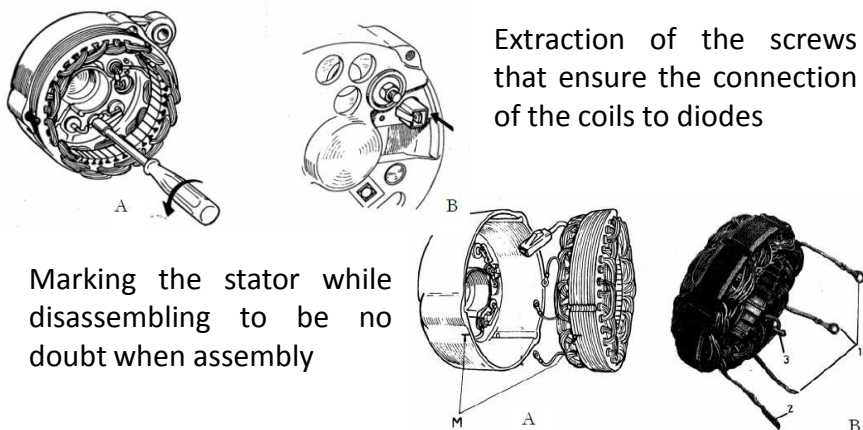
**Replacement of bearings of the Rotor**



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Assembling and removal of the Charging System

**(Dis) Assembly of the Stator**



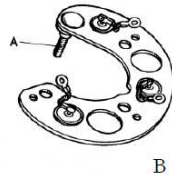
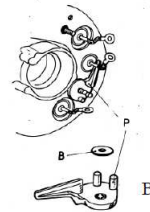
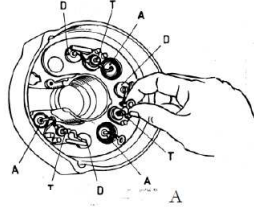
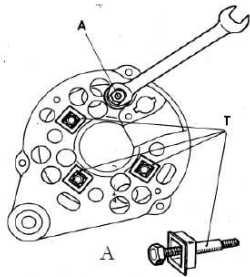
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## Assembling and removal of the Charging System

### (Dis) Assembly the Bridge rectifying (diode)

Extraction of the platform that supports the diodes

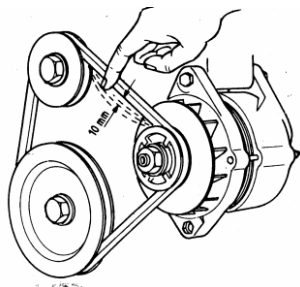


Representation of the screws fixed to the platform diodes and their insulating parts

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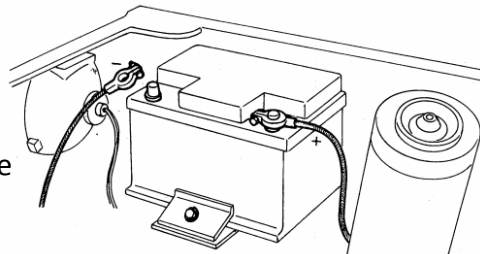
## Troubleshooting in the Charging System

### Troubleshooting - Alternator



Check belt tension that drives the alternator

Disconnect the earth cable Battery

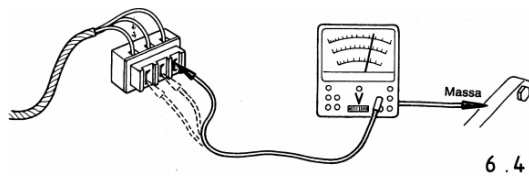


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## Troubleshooting in the Charging System

### Troubleshooting - Alternator

Check the terminals with the help of a voltmeter, apply one end of the voltmeter to the mass and the other will check each of the terminals in the plug



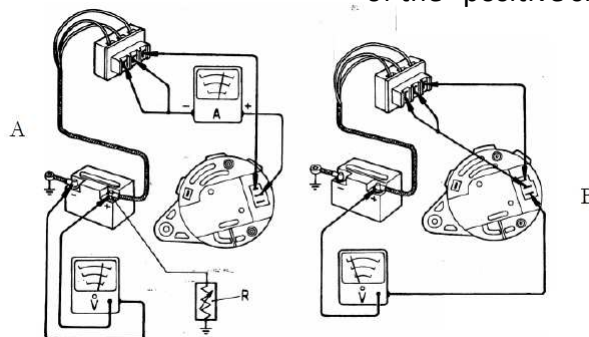
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## Troubleshooting in the Charging System

### Troubleshooting - Alternator

Check the generated current

Check the Voltage drop of the "positive side"

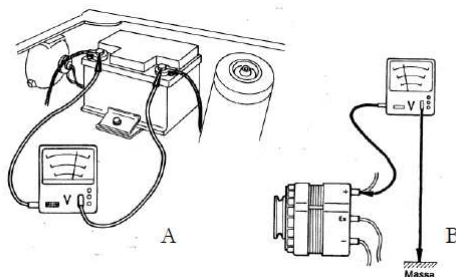


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Troubleshooting in the Charging System

**Troubleshooting - Alternator**

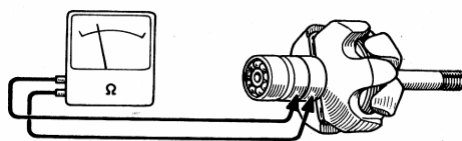
Test on the regulator with the regulator not incorporated



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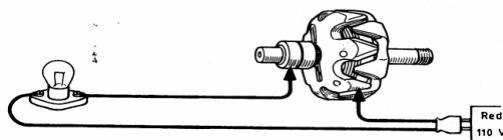
Troubleshooting in the Charging System

**Troubleshooting - Rotor**



Checking the continuity of the shunt excitation

Checking the insulation of the rotor with a lamp of 15 watts with 110 volt power

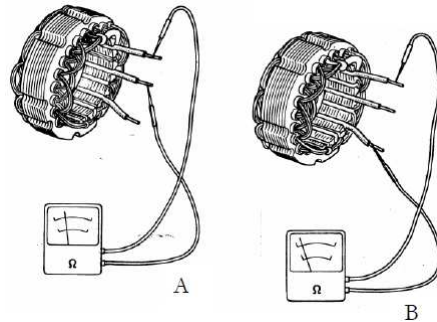


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Troubleshooting in the Charging System

**Troubleshooting – Stator Coils**

Checking the continuity of the stator using an ohmmeter



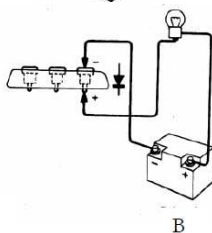
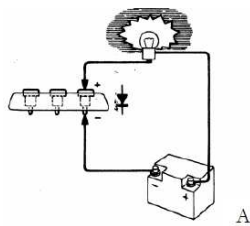
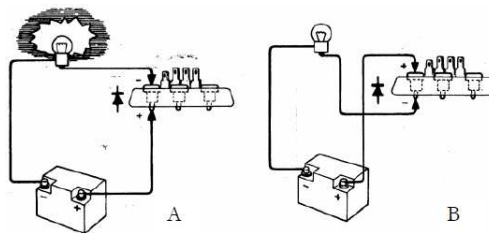
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Troubleshooting in the Charging System

**Troubleshooting – Bridge rectifying (diode)**

Verification of the positive diodes - a sense of drive and direction of cutting



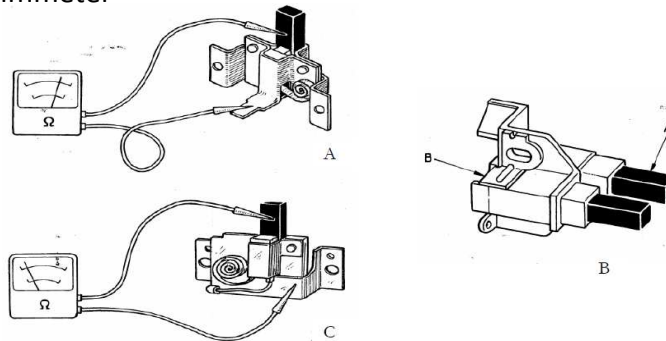
Verification of negative diodes - a sense of drive and direction of cutting

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### Troubleshooting – Brushes

Checking the isolation of one of the brushes with an ohmmeter



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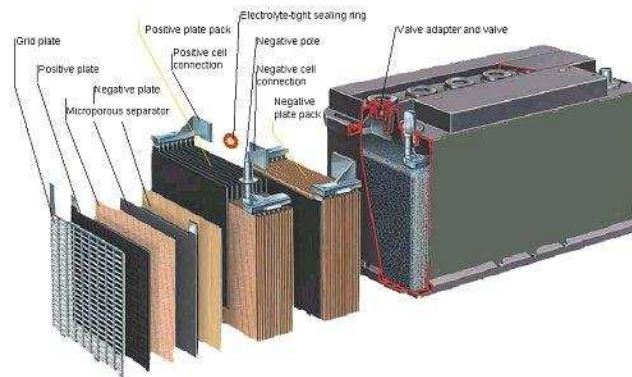
### Funcions

- Provide energy to operate the starter motor;
- Addressing energy bulbs of car lights;
- Act as voltage stabilizer for the system load;
- Provide current when the power demand of the car exceeds the capacity of the system load (alternator).

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## Battery

### Elements:



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## Future Perspectives

Currently the electric cars are undergoing marked changes due to various factors:

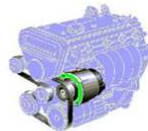
- Due to increased consumption with accessories
- The increasing number of electrical devices to perform functions before driven directly by the engine,
- The incorporation of devices to reduce consumption and assist the driver,
- The incorporation of new safety devices,
- The urgent need to reduce fuel consumption and emissions.

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## Future Perspectives

### Alternostarter

- It is a new system known as alternostarter that meets starter and alternator in one piece
- The alternostarter is an alternator that continues to act as a generator of current but also acts as the starter. As receiving information through a electronic sensor that is activated, the rotor of the alternator turns and through transmission by pulleys and current gear, drives the crankshaft.



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## References

- Mário Alves, Manuel Lourenço, "Automóvel – Sistema de Carga 1ª Edição", ISEP, 2009.

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