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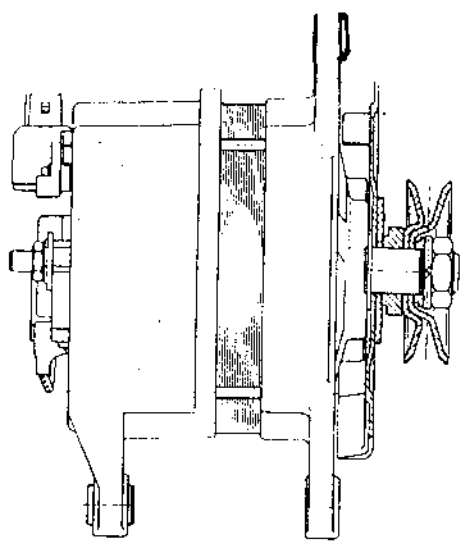
**SUBJECT: Repair Instruction for K1 New Alternator with Battery Sensing EP Regulator and external Cooling Fan.**



## General Description.

The Bosch K1 New alternator is a 3 phase type, incorporating a rotor having 6 pole pairs fitted with a single cooling fan. Rotor current is conveyed to the rotor winding by a pair of sliprings and carbon brushes via the voltage regulator. The unit is designed for negative earth operation.
The output from stator winding is rectified by 6 or 8 rectifier diodes connected in a 3 phase configuration to provide a positive output to the B+ terminal. Where 8 diodes are used these are interconnected to the star point of the stator.

The EP regulator has the ability to detect many faults in the charging system not previously possible with earlier types. Detection of open circuit rotor winding is now possible. Backup regulation is provided should a malfunction occur other than open circuit rotor, this supplies usable output until service can be obtained. Battery sensing ensures that the correct voltage is available at the battery at all times thus compensating for resistance in the charge cable.

**The alternator has four external connections; the "B+" lead to battery positive, "L" lead to the warning lamp circuit (max. 2 watts), "S" lead to battery positive terminal for battery sensing and an earth connection.**

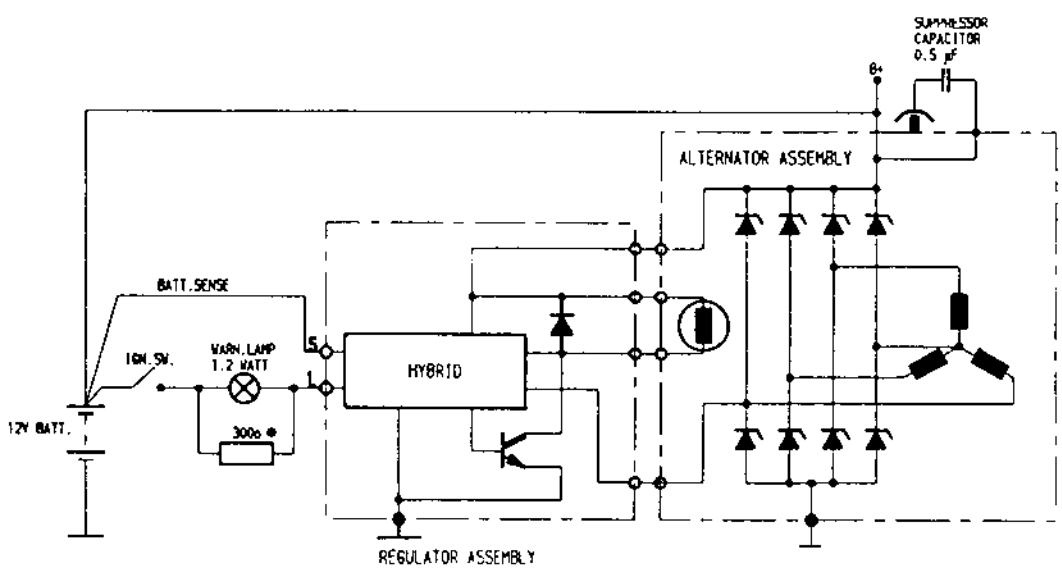
**Explanation of type Inscription.**

**Example: K1 > 14V 23- 55A**

**K = Code for Stator OD (126mm OD ).**
**> = Direction of rotation (clockwise).**
**14V = Alternator Operating Voltage.**
**23 = Stabilised output at 25°C at 1800 RPM. /13.5 Volts.**
**55A = Stabilised output at 25°C at 6000 RPM. /13.5 Volts.**

**Alternator Connections.**

**B+ : Battery Main Connection ( battery positive).**
**S : Battery Sense connection (battery positive).**
**L : Warning lamp (via warning lamp to Ignition switch).**




NOTE: * RESISTOR IS RECOMMENDED TO ENSURE THAT THE ALTERNATOR REMAINS FUNCTIONAL IN CASE OF WARNING LAMP FAILURE

**Warning;**

**Do not reverse S and L connections as this will destroy the warning lamp circuit of the regulator. Ensure good electrical contact between alternator earth and battery negative.**

## Operation

With the Ignition switch turned "ON", current is supplied via the warning lamp to the "L" terminal of the regulator. Base current is fed to T15 which turns on, current then flows from B+ through the rotor winding via the regulator brushes and the collector emitter junction of T15 to earth completing the circuit. The current in the rotor causes a magnetic field between adjacent poles to be created, this field is rotated and cuts the windings of the stator at right angles inducing a voltage into them. As the speed is increased this induced voltage increases and results in current being rectified in the 3 phase diode bridge and supplied as DC to the B+ output and hence to the battery. When the voltage at the B+ terminal of the battery reaches around 14.2 volts, this voltage is monitored by the "S" lead and turns the regulator Hybrid base current to T15 OFF removing rotor current, resulting in a decrease in output voltage to below the regulating voltage, T15 base current turns ON and the whole cycle is repeated very rapidly. D38 protects T15 and the regulator against the back voltage developed across the rotor winding when T15 turns OFF. The new generation EP regulators incorporate current limiting in the warning lamp circuit.

## Backup Regulation.

The EP regulator will limit the output voltage to a safe level should either the main B+ cable or the battery sense wire become decoupled, the output voltage will be slightly above the normal setting (1 - 3 volts).

## Start up phase.

When the Ignition switch is turned on and the engine is not running, the current to the rotor is reduced by switching it on and off at a 50% duty cycle, the frequency is approximately 4 kHz and may be audible at times. This is quite normal, once the engine is started normal regulation commences.

Warning lamp failure.

Should the warning lamp fail, the alternator will self excite by deriving a small current from the phase connection allowing the voltage to build up to regulating level. Note: no field current will flow when the engine is cranking.

Diagnostics

The EP regulator incorporates diagnostics which will illuminate the warning lamp as a result of fault conditions in the alternator and external circuitry.

These conditions include:

1 An open circuit in the regulator battery sensing wire( S Terminal).
2 An open circuit or excessive voltage drop in the B+ cable.
3 An open circuit in the alternator phase connection.
4 Overcharging of the battery.
5 Regulator output stage short circuit.
6 Open circuit rotor.

The regulator compares the voltage at B+ with the voltage at the "S" terminal connected to battery positive. If the voltage differential exceeds a predetermined threshold, the regulator will operate in backup mode to limit the output voltage to a safe level. The warning lamp will remain illuminated as long as these conditions prevail.
Sources of high resistance which will trigger the warning lamp are:

a Poor contact in wiring harness connectors.
b Poor contact between rectifier and regulator.
c High resistance in fusible link assembly.

Caution:

When bench testing the alternator it is important that the warning lamp wattage of 2 watts is not exceeded. Reversal of the "S" and "L" on the regulator will damage the regulator.
The correct plug for the regulator is 9 122 067 011

**See appendix 1 for diagnostic matrix.**
**Before testing or dismantling the alternator please observe the following points:**

1 **When testing the diodes with AC type testers the RMS. voltage output must not exceed 12.0 volts, it is recommended that the stator should be disconnected during this test.**

2 **Where zener power diodes are used, the breakdown voltage should be tested to ensure all diodes have the same zener voltage.**

3 **Insulation tests on the rotor and stator should use a voltage not exceeding 110v for a series test lamp. The rectifier must be disconnected from the stator prior to testing.**

4 **When carrying out repairs to the charging system always disconnect the battery negative first, and reconnect it last.**

5 **During current output tests please make sure that the ammeter is securely connected into the charge circuit.**

6 **Some battery powered timing lights can produce high transient voltages when connected or disconnected. Only disconnect or connect timing lights when the engine is switched off.**

7 **Make sure the warning lamp circuit is functioning normally before commencing tests.**

8 **Battery isolation switches must only be operated when the engine is stopped.**

9 **To protect the charging system when using 240 volt chargers it is recommended that the battery is disconnected whilst charging.**

10 **Due to the very low resistance value of the stator winding it may not be possible to obtain accurate readings without special equipment.**

11 **12 volts must never be connected to the "L" terminal of the regulator as this will damage the lamp driver circuit.**

12 No loads apart from the warning lamp can be connected to the "L" terminal . The "W" terminal is provided for this purpose.

Dismantling the unit. (see illustration at rear of instruction)

1 Mark the relative positions of the end housings in relation to the stator assembly to aid reassembly. Use a permanent marking pen do not use centre punches as this can cause misalignment of the housings.

2 Remove the EP regulator from the slipring end housing by removing the two screws. Tilt the regulator slightly from the plug connection until the regulator clears the housing, then lift clear.

3 Remove the four through bolts (21).

4 Carefully remove the stator assembly (18) along with the slipring end housing (11) taking care not to put strain on the stator wires.

5 To disconnect the stator from the rectifier assembly, grasp the stator wires close to the wire loop with a pair of long nosed pliers, heat the joint with a soldering iron, when the point becomes plastic apply a slight twisting motion to the wires, then pull upwards to release the wires. Remove the stator.
This procedure opens the wire loop to release the stator connections easily.

6 To remove the rectifier remove the three retaining screws and the B+ terminal nut and washers.

7 To remove the pulley, mount an 8mm Allen key in the vice with the short end upwards, place a 24mm ring spanner on the pulley nut, position the internal hexagon of the rotor shaft onto the Allen key, loosen the nut and remove the pulley.

8 The drive end plate should be supported in a press and the rotor (6) carefully pressed out.

9 Remove the bearing retaining plate (3) by removing the retaining screws then remove the bearing noting the position of the shield.

10 Remove the slipring end bearing using a suitable puller.

Cleaning the components.

Thoroughly clean all components except the rotor and stator with an approved cleaning agent. Ensure that all traces of oil and dirt are removed. If an abrasive cleaner is used to remove scale and paint from the housings take care not to abrade the bearing and mounting spigot surfaces. The rotor and stator must be cleaned with compressed air only, the use of solvents could cause damage to the insulating materials.

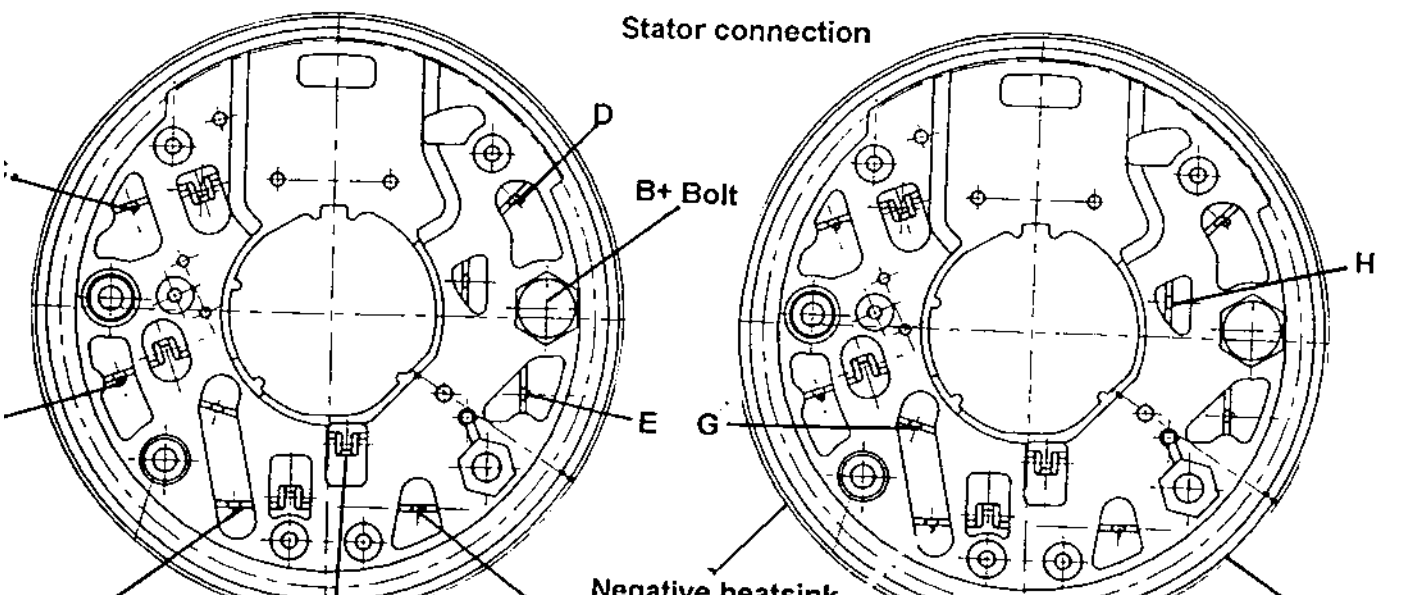
Testing the individual parts.

1 Rectifier assembly. The following test equipment is required.
The rectifier assembly is not repairable and must be replaced if a faulty diode is detected during testing.

**(a) A diode tester where the DC output at the test probes does not exceed 14 volts or in the case of AC testers 12 volts RMS. This is to ensure that when testing rectifiers fitted with zener power diodes the forward and reverse checks are completed and are not masked by the diode turning on due to the zener breakdown voltage.**

**(b) A zener diode tester with a DC output in excess of 30 volts, the tester should also incorporate internal current limiting set to 5 Ma. to prevent high currents during testing.**

**(c) Diodes can be destroyed during service due to high temperature and overload, open circuits are usually a result of excessive voltage.**




6 diode 8 diode

Diode connections

## 1.1 Testing the Power Diodes.

Apply the negative test probe of the diode tester or a multimeter with a diode test feature to the positive heatsink and the positive probe alternatively to A, B, C, a low resistance reading, or the forward voltage drop across the diode should be obtained. Reverse the test probes, a high resistance reading or a higher reverse voltage should be obtained.

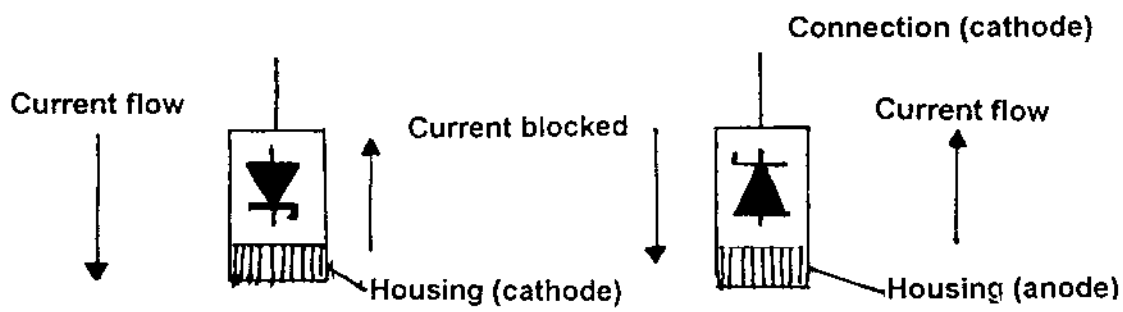
Now connect the positive test probe to the negative heatsink and the negative probe alternatively to D, E, F, a low resistance or forward voltage drop across the diode should be obtained. Reverse the test probes, a high resistance reading or higher reverse voltage reading should be obtained.

For 8 diode rectifier plates tests for G and H should be included.
When the reverse voltage test is done the applied voltage should be less than 14 volts DC or 12 volts RMS for AC testers.

## 1.2 Testing Zener Diodes.

The basic tests in 1.1 should be undertaken first before the diode zener voltage is tested. Diodes are grouped together according to their zener voltage i.e. all diodes within a rectifier must have the same zener voltage.

Connect the test probes as for the reverse test listed above i.e. reverse biased apply the test voltage from the zener diode tester (current limited to 5 ma) and read to zener breakdown voltage this should be a steady reading and not increase with increased voltage from the tester.



**Readings for Zener diode groups 011 to 042**

| Zener voltage at 5 Ma. | Positive diode | Negative diode | Forward current Rating |
|---|---|---|---|
| 17.8v-19.2v | 011 | 012 | 25A |
| 18.8v-20.2v | 013 | 014 | 25A |
| 19.8v-21.2v | 015 | 016 | 25A |
| 20.8v-22.2v | 017 | 018 | 25A |
| 21.8v-23.2v | 019 | 020 | 25A |
| 22.8v-24.2v | 021 | 022 | 25A |
| 17.8v-19.2v | 031 | 032 | 35A |
| 18.8v-20.2v | 033 | 034 | 35A |
| 19.8v-21.2v | 035 | 036 | 35A |
| 20.8v-22.2v | 037 | 038 | 35A |
| 21.8v-23.2v | 039 | 040 | 35A |
| 22.8v-24.2v | 041 | 042 | 35A |

Note: Diode number is stamped on the rear of the diode.

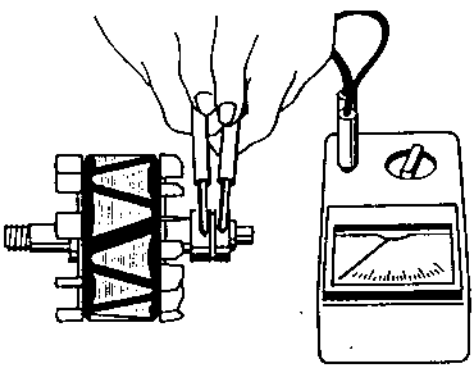
2 Testing the Stator

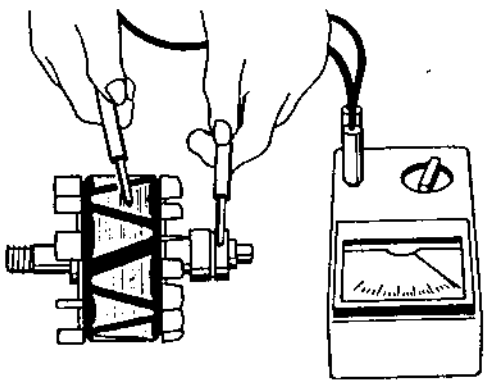
Test the stator insulation resistance to ground with an insulation tester or a series test lamp up to 110 volts. The insulation resistance must be greater than 1 megohm.
The winding resistance is measured between phases using a low reading ohmmeter designed for the purpose, the values are given at the rear of this instruction.

3 Testing the Rotor

Test the rotor for insulation resistance to ground using an insulation tester or a series test lamp up to 110 volts.
The insulation resistance must be greater than 1 megohm.
Measure the rotor resistance between the sliprings using an ohmmeter or apply 12 volts across the sliprings and measure the rotor current draw, then divide 12 by the measured current, the result is the rotor resistance in ohms.
The values are given at the rear of this instruction.

**If the sliprings are worn or out of round they must be re-machined to a minimum diameter of 26.7mm and should have a runout not exceeding 0.060mm. If the slipring is below these limits it must be replaced with a new one.**





4 Replacing the brushes (inbuilt regulator)

**Check the brushes for length, this is measured from the brush holder to the end of the brush along it's centre line. Also inspect for any sideways wear. If worn replace both brushes.**
**The minimum length is 3.8mm. Inspect the brush springs for signs of corrosion or loss of tension or uneven tension.**

**Replacing the brushes, using a soldering iron apply heat to the soldered joints on the rear of the brush holder of the regulator, using a small lever prise up the retaining tabs to release the brush lead and spring. Thread the new brush lead up the brush holder along with the spring, pull the lead through the tabs until the brush is protruding 12mm from the holder. Bend down the tabs and solder the brush lead taking care not to allow the solder to run up the lead which will reduce flexibility. Use 60/40 resin cored solder.**

5 Ball Bearings

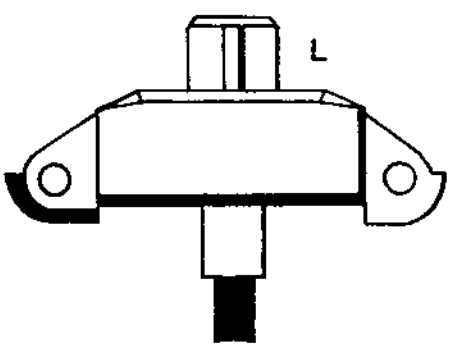
**Please note the bearings used in this K1 alternator are a high tolerance type, only bearings of the same specification are to be used as replacements. It is recommended that the bearings be replaced during the reconditioning process to restore the unit to original specification.**

## 6 Regulator

The regulator can only be tested when fitted into an alternator.

*Warning:* do not reverse "S" and "L" connections or put 12 volt supply to "L" terminal, this connection must not be used as a supply source other than to supply the requirements of the warning lamp (2 watts).
Such action will destroy the regulator warning lamp circuit.

For test voltages refer to Alternator output testing section.
See also additional information on regulator function earlier in this instruction.

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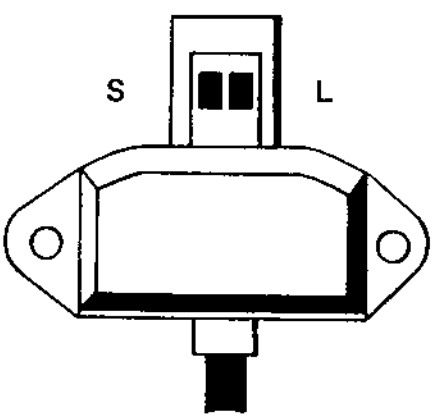



9 190 067 043

## 7 Reassembly of alternator

(a) Press new bearing onto slipring end of the rotor taking care to apply the force to the bearing inner race only, otherwise the bearing will be noisy and it's life will be shortened.

(b) Fit a new bearing to the drive end housing, fit the bearing plate, and four retaining screws, press the rotor into the bearing, using a support tool to take the thrust against the bearing inner. The support is fitted from the pulley side of the bearing. In this way the thrust is not taken by the drive end housing.

(c) To fit pulley, mount an 8 mm Allen key in the vice with the short end upwards, place a 24mm ring spanner on the shaft nut, position the internal hexagon of the rotor shaft onto the Allen key, tighten the nut to the required torque (See torque chart at the rear of this instruction).

(d) Inspect the bearing support ring if used for signs of damage, if in doubt replace the ring by pressing it into the housing by hand, do not use excessive force.

(e) To refit the rectifier, fit the three retaining screws to the rectifier then install into slipring end housing. Tighten the B+ bolt to the required torque.

(f) To refit the stator, make sure the spigot surfaces are clean and free from damage, fit the stator into the slipring end housing noting the correct lead connection positioning. Fit the stator leads into the wire loops in the rectifier. Using a pair of pliers squeeze the loop to retain the stator lead prior to soldering. Repeat for each lead in turn, solder the leads into position using 60/40 resin cored solder. Make sure the leads will be clear of the rotor when it is assembled into the stator.

(g) Carefully install the rotor into the stator/slipring end housing assembly, noting the alignment of the housings and through bolt holes. Fit the through bolts making sure the stator is seated correctly, tighten the through bolts to the correct torque setting (uneven torque can produce magnetic noise levels above normal).

(h) <u>Fitting the regulator.</u> Compress the brushes into the brush holder by hand, slip the regulator through the opening in the rear of the slipring end housing until the brushes come in contact with the slipring. Press the regulator towards the slipring until the holes are aligned then fit the retaining screws and tighten.

## 8 Testing the alternator

Before any in field testing can be undertaken it is important that the battery's condition is established and the terminals are clean and tight.

Check the condition of the alternator drive belt and ensure that it is adjusted in accordance with the engine manufacturers recommendations.

Battery Condition: *(Note: This assessment may be difficult with maintenance free assemblies.)*
Test the specific gravity of the individual cells the readings should be within 10 points of each other, it is recommended that the average SG should be 1.260 or higher.
A load test should be carried out to determine the ability of the battery to supply and accept current. This is a good indicator as to the general condition of the battery.
A load equal to the normal starting current should be placed across the battery, the duration of this load test should not exceed 10 seconds, during this time the terminal voltage across the battery should not drop below 9.6 volts. Observe each cell for signs of excessive gas liberation, usually an indication of cell failure.
If the battery test is clear proceed with the Alternator tests as follows.

Care should be taken when making the following connections.
It is recommended that the battery negative terminal be disconnected before the test meters are connected, and reconnecting the negative terminal when the meters are inserted into the circuit under test. The warning lamp in the D+ circuit should not exceed 2 watts.

Regulating Voltage Test on the Vehicle.
Connect a voltmeter to the alternator, the positive lead to the B+ terminal and the negative lead to the alternator casing. Select the voltage range to suit the system, i.e. 20v for 12 volt systems or 40v for 24 volt systems.
Connect an ammeter in series with the main output cable from the B+ terminal on the alternator, the range selected must be capable of reading the maximum output from the alternator.

Note the voltmeter reading before starting the engine. This reading should increase when the engine is running indicating alternator output, start the engine and increase the engine speed until the alternator is running at 4000 rpm, switch on vehicle loads of 5 - 10 A is indicated on the ammeter, the voltmeter should read 14.0 -14.2 v for a 12 volt system, for a 24 volt system the readings should be 5 -10 A and 27.7 -28.5 volts.

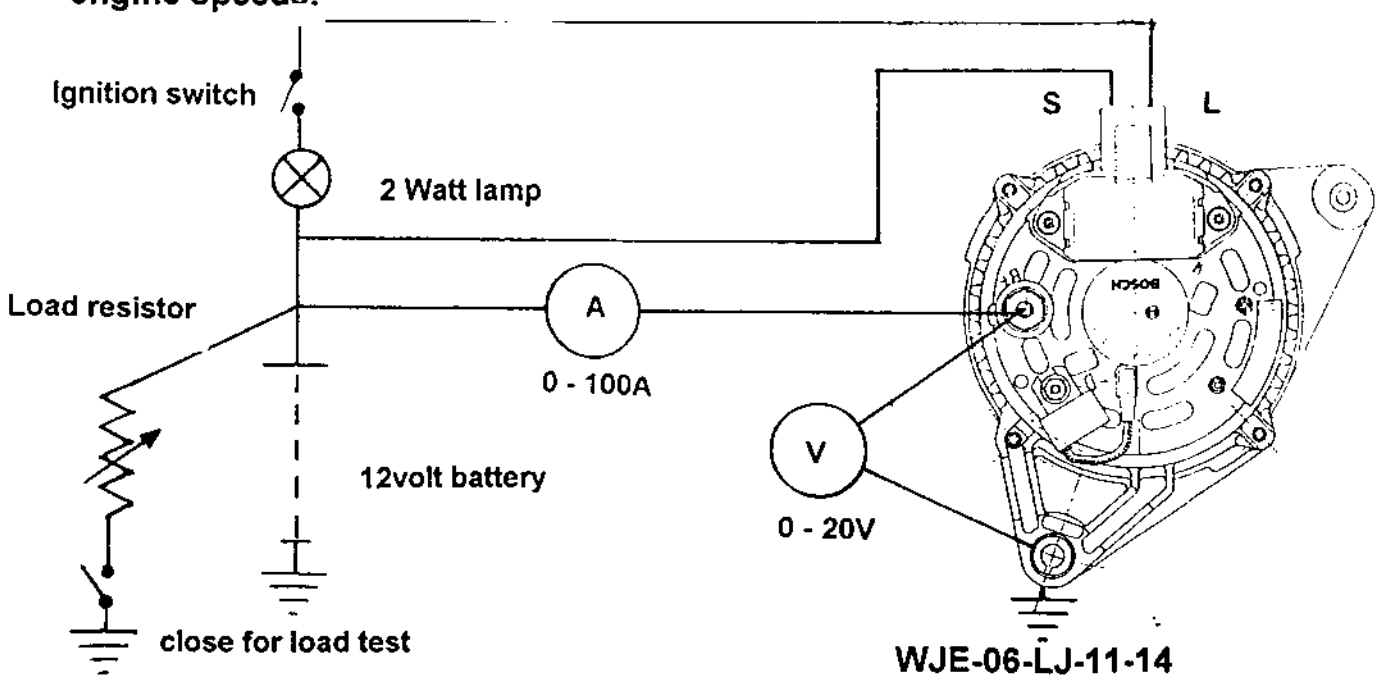
Load Regulation Test

Increase the engine speed until the alternator is running at 6000 rpm, increase the load to 90% of full output, a decrease in the regulating voltage should not exceed 0.50 volts for 12 v and 0.70 v for 24v regulators of the readings obtained in the previous test. If so, the regulator is defective.

Alternator Output Test at Full Load.

Increase engine speed until the alternator is running at 6000 rpm, switch on electrical loads until the alternator voltage drops to 13.5 volts for 12v systems and 26 volts for 24v systems, full output should be obtained under these conditions. It may be necessary to adjust engine speed to maintain alternator speed. If sufficient electrical loads are not available a carbon pile resistance can be connected across the battery and adjusted until maximum output is obtained.

Keep the time for this test to a minimum to avoid undue heating and high engine speeds.




WJE-06-LJ-11-14

## TECHNICAL DATA

| | | | |
|---|---|---|---|
| Brush wear | - | Minimum Length | 3.8 mm |
| Sliprings | - | Minimum Diameter | 26.7 mm |
| Sliprings | - | Trueness | < 0.06 mm |
| Pole Claws | - | Trueness | < 0.05 mm (93.25 ± 0.05 mm) |

### Tightening Torque

| | |
|---|---|
| Pulley retaining nut | 54 - 68 Nm |
| Capacitor retaining Screw | 2.7 - 3.8 Nm |
| Capacitor whiz nut | 1.5 - 2.2 Nm |
| B+ Terminal Nut M8 | 7.5 - 8.5 Nm |
| B+ Terminal Nut M6 | |
| B+ Terminal Rectifier Nut | 6.0 - 7.5 Nm |
| Regulator retaining screws | 1.6 - 2.3 Nm |
| Rectifier retaining screws | 1.6 - 2.3 Nm |
| Bearing retaining plate Screws | 2.1 - 3.0 Nm |
| Through Bolt | 3.8 - 5.5 Nm |

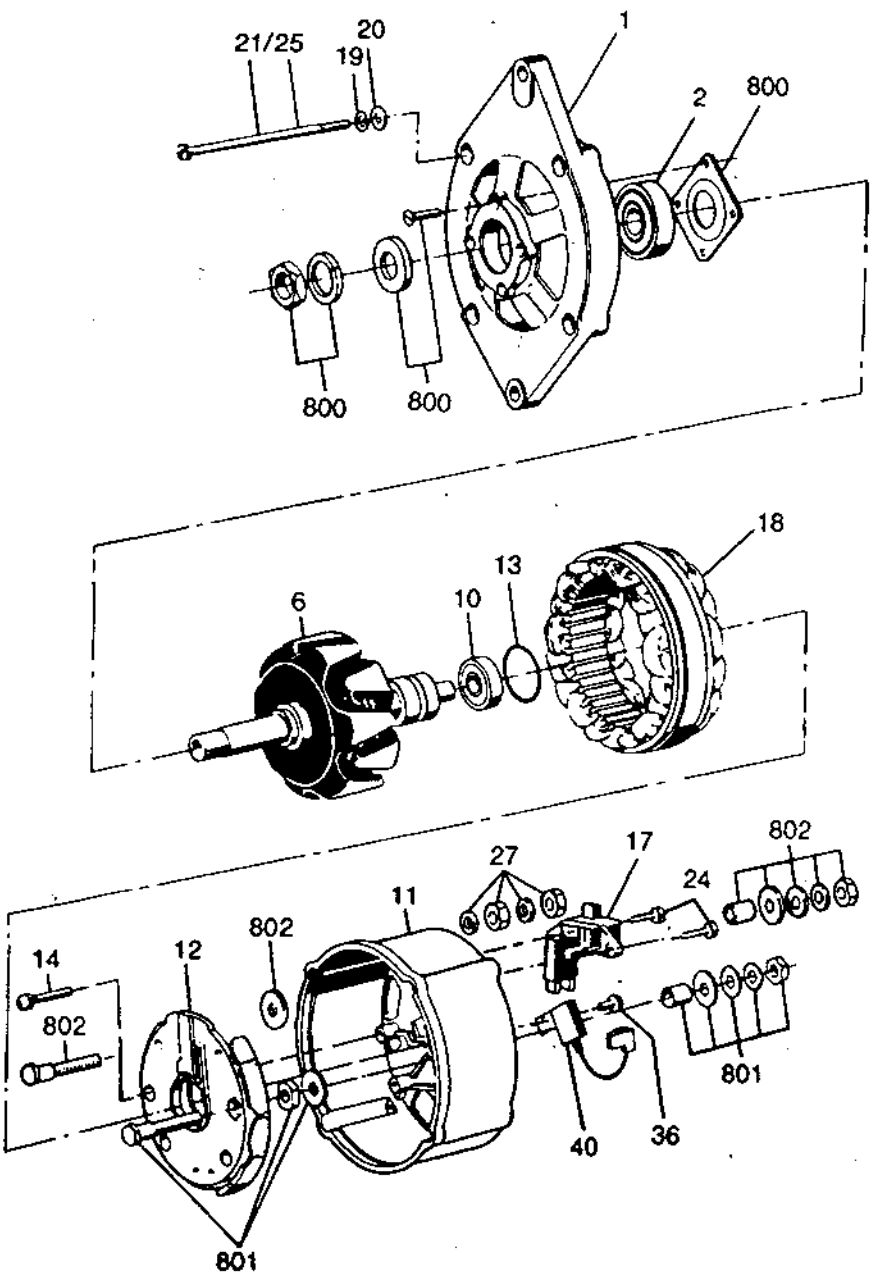
### Winding Resistance (between phases)

| | Stator (Ohms) | Rotor (Ohms) |
|---|---|---|
| 37 Amp Alternator | 0.16 + 10% | 2.6 ± 0.13 |
| 60 Amp Alternator | 0.14 + 10% | 2.8 ± 0.13 |
| 65 Amp Alternator | 0.11 + 10% | 2.9 ± 0.29 |
| 70 Amp Alternator | 0.11 + 10% | 2.6 ± 0.13 |
| 85 Amp Alternator | 0.07 + 10% | 2.6 ± 0.13 |

### Warning lamp fault indication

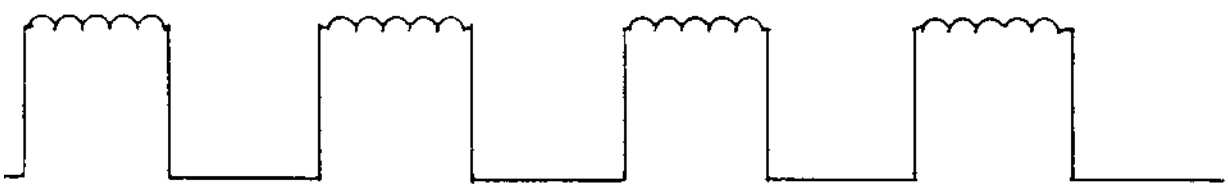
| Fault | Alternator not running Ignition ON | Alternator running Ignition ON |
|---|---|---|
| Alternator out cable O/C | ON | ON |
| Battery " S" cable O/C | ON | ON |
| Battery Overcharged | ON | ON |
| Positive diode short | OFF | ON |
| Negative diode short | ON | ON |
| Positive diode open | ON | OFF |
| Negative diode open | ON | OFF |
| Phase voltage sensing cable open circuit | ON | ON |
| Power Transistor shorted | ON | ON |
| Warning Lamp driver O/C | OFF | OFF |

## EXPLODED VIEW



**Output wave forms for phase and starpoint connections.**

**Note; the average of these two wave forms are identical from no load to 100% output of rated load.**



Phase voltage

Starpoint voltage

Voltage phase ≅ Voltage starpoint

6.9v @ rated output 7.2v @ Zero output

Note: The phase frequency is one third of the starpoint frequency.