

PART 3 ELECTRICAL SYSTEMS

Chapter 4 CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR

Section	Page
A. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – DESCRIPTION AND OPERATION	1
B. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – SERVICE PRECAUTIONS, PRELIMINARY CHECKS, INITIAL TESTS AND ALTERNATOR COMPONENT TESTS	6
C. CHARGING SYSTEM– A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – OVERHAUL	16

A. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – DESCRIPTION AND OPERATION

Ford Tractors feature a negative ground, alternating current charging system comprising an alternator, alternator regulator, storage battery and the necessary wires to connect the circuit.

Unlike a direct current generator, the alternator does not require a commutator and can be run safely at higher speeds.

Alternators provide a higher maximum output than the equivalent direct current generators and also increased charge rates at lower engine speeds.

This Chapter concerns the overhaul and repair of the A127 55 Amp alternator which features an integral regulator.

PART 3 – ELECTRICAL SYSTEMS

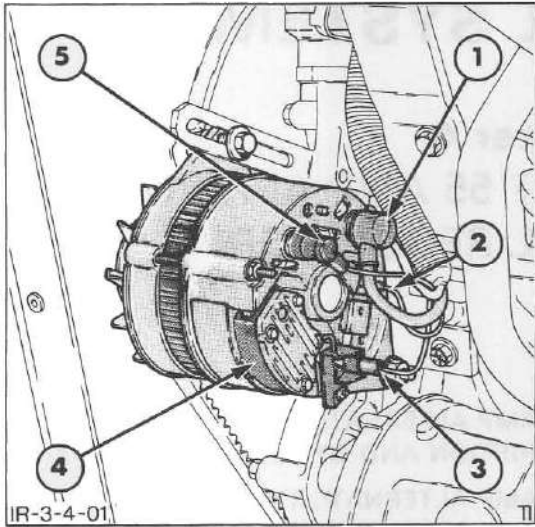


Figure 1
Alternator Installed on Tractor

1. Output Lead
2. Charge Indicator Lead
3. Battery Temperature Sensor Lead
4. Regulator and Brushbox
5. Tachometer Pick Up Lead

The alternator is mounted at the front of the engine being belt driven from the crankshaft pulley, Figure 1.

The alternator terminals are identified in Figure 2.

With reference to Figure 3, the alternator comprises principally:

- Rotor
- Stator
- Rectifier Pack
- Regulator/Brush Box

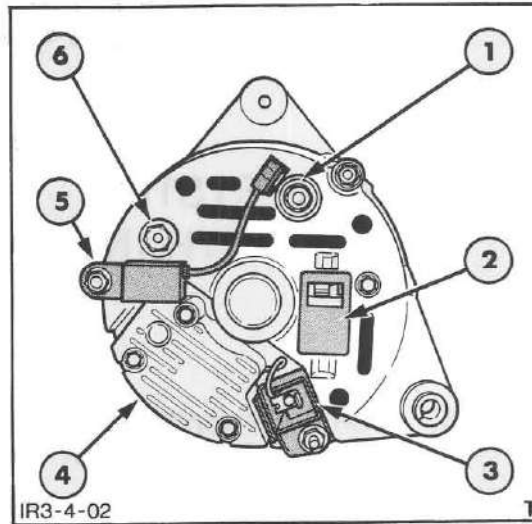


Figure 2
Alternator Terminal Identification

1. Main Output Terminal (+ ve)
2. IND (Charge Indicator) Terminal
3. Battery Temperature Sensing Terminal
4. Regulator and Brushbox
5. Radio Interference Suppressor (where fitted)
6. Phase (Tachometer Pick Up) Terminal

ROTOR

The rotor and brushgear provide the magnetic field of the alternator unlike a direct current generator where the field is stationary.

The rotor is belt driven from the engine through a pulley clamped to the rotor shaft which runs in heavy-duty sealed roller bearings. An integral fan, adjacent to the pulley, draws cooling air through the alternator.

Current is supplied to, and returned from, the rotor field coil via two carbon brushes which bear against slip rings on the rotor shaft.

As current passes through the copper wire of the rotor field coil a magnetic field is produced and contained within an armature formed into pole shoes. The configuration of the pole shoes ensures concentration of the magnetic field.

CHAPTER 4

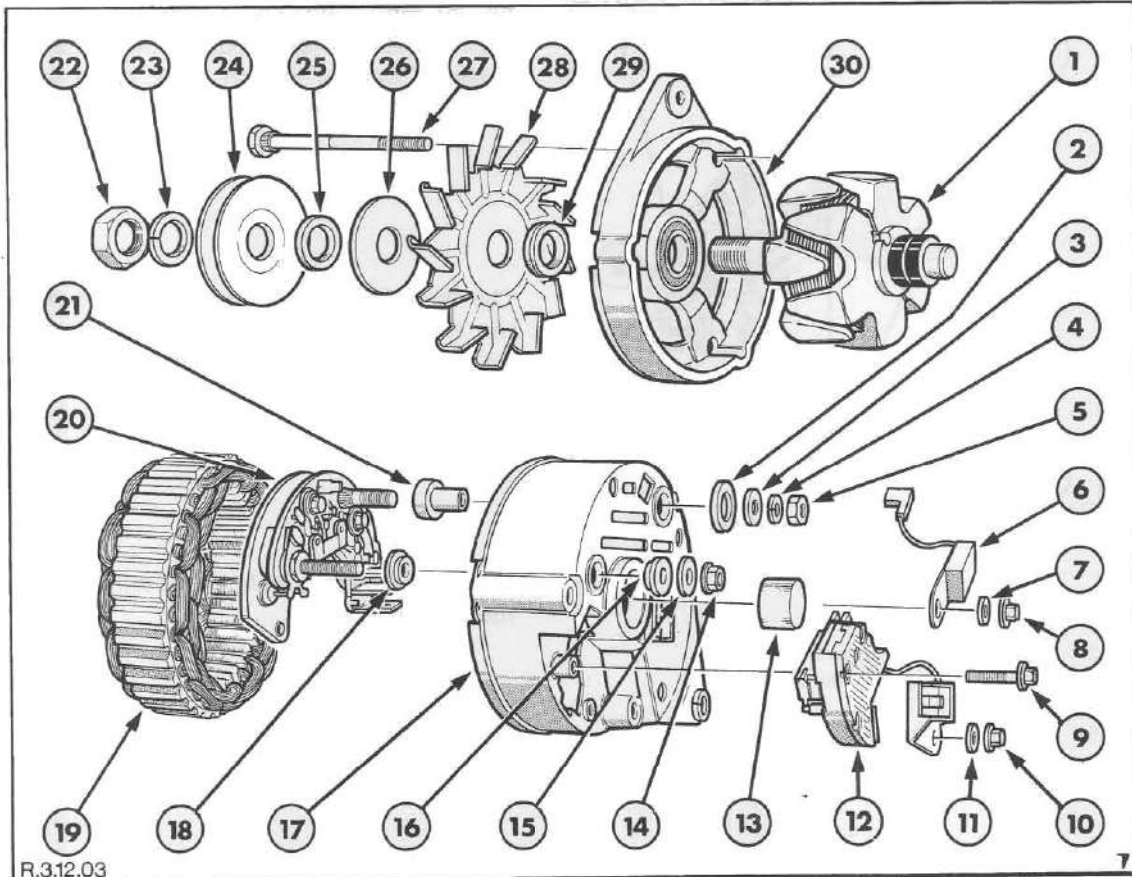


Figure 3
Alternator Components

- | | | | |
|------------------|------------------------|----------------------|-------------------|
| 1. Rotor | 9. Bolt | 17. Rear End Bracket | 25. Spacer |
| 2. Insulator | 10. Nut | 18. Insulator | 26. Washer |
| 3. Washer | 11. Washer | 19. Stator | 27. Through Bolt |
| 4. Spring Washer | 12. Regulator/Brushbox | 20. Rectifier | 28. Fan |
| 5. Nut | 13. Bearing | 21. Insulator | 29. Double Spacer |
| 6. Suppressor | 14. Nut | 22. Nut | 30. End Bracket |
| 7. Washer | 15. Washer | 23. Washer | |
| 8. Nut | 16. Insulator | 24. Pulley | |

STATOR

The stator contains the windings into which current is induced by the revolving magnetic field of the rotor.

The stator is fabricated from laminations of thin steel pressings onto which three separate wires are wound. The laminations are specially formed to concentrate and collect the magnetic field.

During each complete revolution of the rotor, all three stator windings have induced currents passing first in one direction and then the other; in other words a 3-phase alternating current.

Because alternating current is generated in a series of pulsations, the rotor features six pairs of poles to provide an overall smoother output. For every revolution of the rotor the output characteristic of each stator winding completes six cycles.

Alternating current (A.C.) is unsuitable for charging the battery, which requires pure direct current (D.C.). Therefore, the three stator windings are connected to a rectifier pack which rectifies or converts the alternator output to direct current.

PART 3 – ELECTRICAL SYSTEMS

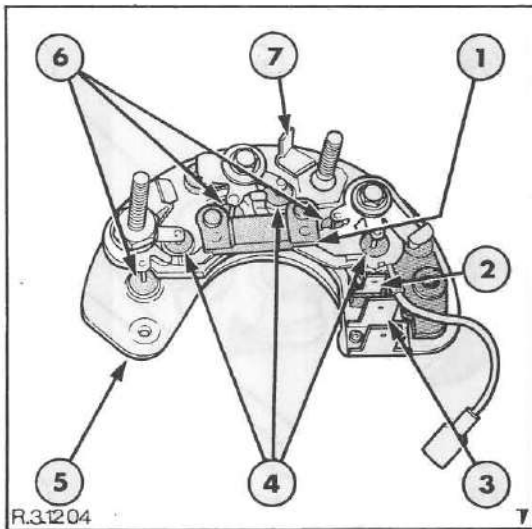


Figure 4
Rectifier Assembly

1. Field Diode Module
2. IND (Indicator) Terminal
3. Alternator Output Terminal (+ve)
4. Positive Plate Diodes
5. Negative Plate
6. Positive Plate Diodes
7. Radio Interference Suppressor Terminal

RECTIFIER

The rectifier consists of a pack of six output diodes and a module containing three field diodes, Figure 4.

NOTE: A diode is basically an electronic 'check valve' which allows current to flow in one direction only.

Three of the six output diodes are mounted in a positive plate and three in a negative plate. The two plates are separated and terminal links enable each of the three stator output wires to connect to a different diode in each plate.

As the rotor revolves, the diodes rectify or convert the alternating current of the stator to a direct current which may be used to effectively charge the battery.

The three field diodes are contained within the field diode module, each of the three stator output wires connects to one of these diodes.

The field diodes supply direct current to the rotor field winding.

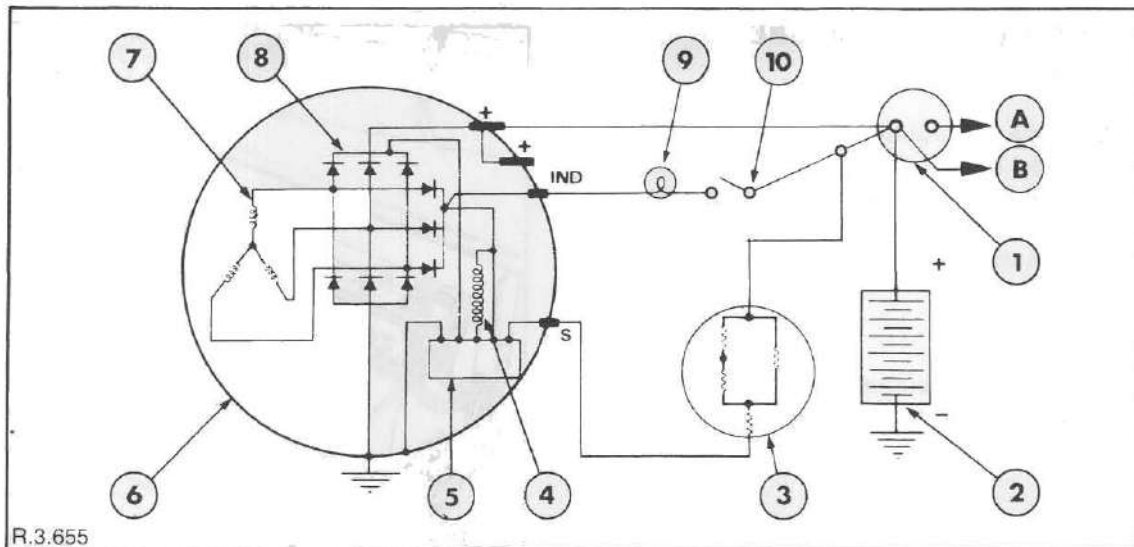
REGULATOR AND BRUSHES

The regulator controls and maintains the alternator output voltage at a safe working level.

The regulated voltage level is established in manufacture and cannot be adjusted in service: The regulator components are housed in a sealed assembly which is integral with the alternator brush box.

Individual brush box and regulator components are not serviceable and have to be replaced as a complete assembly.

CHAPTER 4



R.3.655

Figure 5
Alternator Charging Circuit
(With Battery Temperature Compensation)

- | | | |
|---------------------|-------------------------------|---------------------------|
| A. To Starter Motor | 3. Battery Temperature Sensor | 7. Stator Output Windings |
| B. To Load | 4. Rotor Field Winding | 8. Rectifier Pack |
| 1. Solenoid | 5. Regulator | 9. Charge Indicator Light |
| 2. Battery | 6. Frame | 10. Key Start Switch |

ALTERNATOR OPERATION

With reference to Figure 5.

When the key start switch is turned on a small current flows from the battery through the rotor field winding. The circuit is made via the charge indicator warning light, alternator terminal IND, the rotor field winding, the alternator regulator and ground.

At this stage the warning light is illuminated and the rotor partially magnetised.

When the engine is started and the partially magnetised rotor revolves within the stator windings a 3-phase alternating current is generated. A constant portion of the generated current is converted to direct current by the three field diodes incorporated in the rectifier pack.

This direct current is fed back to supplement the current flowing through the rotor field winding.

This action results in an ever-increasing magnetic influence of the rotor along with an associated rapid rise in generated output current and voltage.

During the rise in generated output voltage (reflected at terminal IND) the brilliance of the warning light is reduced and when the voltage at the IND terminal equates to that at the battery side of the warning light the lamp is extinguished.

The voltage continues to rise until the predetermined regulated voltage level is reached.

In the event of drive belt breakage the voltage will not build up within the alternator and so the charge indicator light will remain on to indicate failure.

Where a tachometer is installed on the vehicle the engine speed is sensed using the phase terminal on the alternator. Electrical pulses from the alternator which are proportional to engine speed are converted by the tachometer to display engine speed.

PART 3 – ELECTRICAL SYSTEMS

BATTERY TEMPERATURE COMPENSATION

Because charging systems are directly affected by changes in battery temperature and loading, the alternator charging system features combined battery temperature and system voltaged sensing.

A circular temperature sensing pad is located in contact with the side of the battery, Figure 6.

The sensor detects any changes in battery temperature and relays this information to the voltage regulator which adjusts the charge rate accordingly.

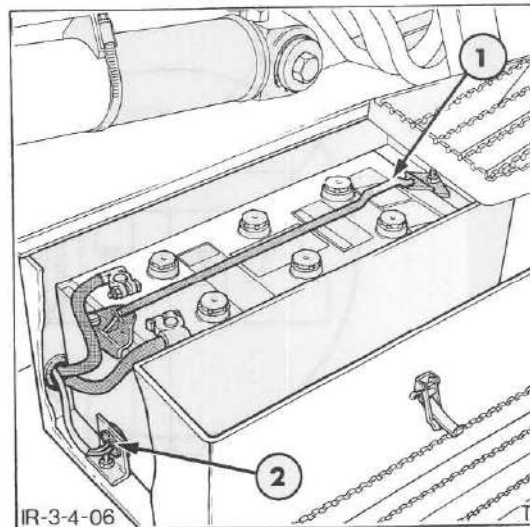


Figure 6
Battery Temperature Sensor

1. Battery
2. Sensor

B. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – SERVICE PRECAUTIONS, PRELIMINARY CHECKS, INITIAL TESTS AND ALTERNATOR COMPONENT TESTS

SERVICE PRECAUTIONS

To avoid damage to the components of the alternator charging system, service precautions must be observed as follows:

- **NEVER** make or break any of the charging circuit connections, including the battery, when the engine is running.
- **NEVER** short any of the charging components to ground.
- **ALWAYS** disconnect the battery ground cable when installing or removing the alternator.
- **ALWAYS** disconnect the battery ground cable (negative) when charging the battery in the tractor using a battery charger.
- **ALWAYS** observe correct polarity when installing the battery or using a slave battery to start the engine.

CONNECT POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE

CHAPTER 4

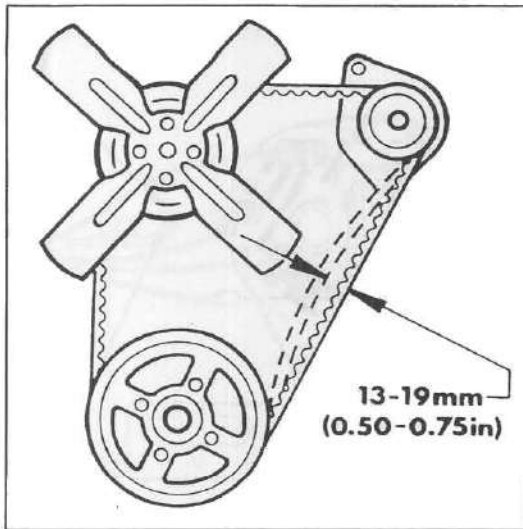


Figure 7
Drive Belt Deflection

PRELIMINARY CHECKS

Prior to electrical testing, thoroughly inspect the charging and electrical system.

Check all leads and connections for continuity and tightness.

1. Check the Battery

With an hydrometer, check the battery is at least 70% charged and in good condition.

2. Check the Drive Belt

Ensure the alternator drive belt and pulley are in satisfactory condition. Allow 0.50 – 0.75 in. (13 – 19 mm) deflection when moderate finger pressure is applied to the longest run of the belt, Figure 7.

3. Check the Warning Light

Turn on the key start switch and check the warning light is fully illuminated.

If the warning light is not fully illuminated, check the bulb. If the bulb is not the cause of the fault, carry out the Alternator Output Lead Test as detailed under "Initial Tests" in this Chapter.

If the warning light is illuminated, start the engine and run above the idling speed when the warning light should be extinguished.

If the warning light does not go out, stop the engine and remove the charge indicator lead. If the warning light is extinguished a faulty temperature sensor or alternator component is indicated. Conduct the "Battery Temperature Sensor Circuit Test" and "Alternator Components Tests" as detailed in this Chapter.

If the warning light remains illuminated, check for a shorting to frame in the area between the charge indicator lead and the warning light.

PART 3 – ELECTRICAL SYSTEMS

INITIAL TESTS

The initial tests may be performed without removing any of the charging circuit components from the tractor and enable the following items to be checked:

- Alternator Output Lead
- Battery Temperature Sensor Circuit
- Alternator Charging Current and Controlled Voltage
- Alternator Charging Circuit Voltage Drop
- Alternator Maximum Output Performance

Test equipment required:

- Voltmeter (0-30 Volts Moving Coil Type)
- Millivoltmeter (0-1 Volt)
- Ammeter (0-70 Amperes Moving Coil Type)
- 1.5 Ohm 70 Amperes Variable Load Resistor
- Jumper Lead (0.25in. [6.35mm] Male to Female Blade Terminal)

NOTE: Most commercial test equipment incorporates several testing devices within a single unit. Use such equipment according to the manufacturer's instructions.

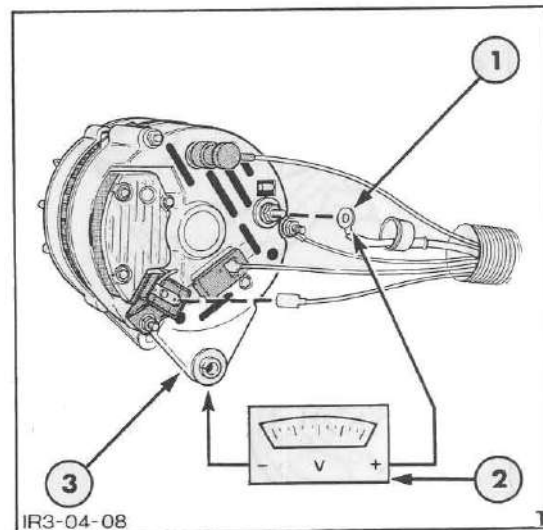


Figure 8
Alternator Plug Connections Test

1. Output Lead
2. Voltmeter (0-30 Volts)
3. Alternator Frame

1. Alternator Output Lead Test

With reference to Figure 8

1. Turn the key start switch on but do not start the engine.
2. Remove the output lead from the alternator and connect a voltmeter between the output lead and the alternator frame (negative side of voltmeter to frame). Battery voltage should be registered.

If battery voltage is not registered, a continuity fault in the external cable circuitry must be traced and remedied, refer to the circuit diagram shown in Figure 5.

CHAPTER 4

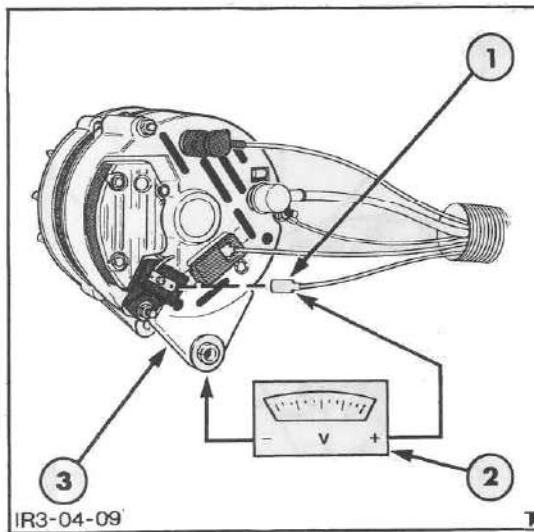


Figure 9

Battery Temperature Sensor Circuit Test

1. Battery Temperature Sensor Lead
2. Voltmeter (0-30 Volts)
3. Alternator Frame

3. Connect one end of a jumper lead to the charge indicator lead and the other end to the alternator frame. The warning light should be illuminated.
4. Disconnect the jumper lead and reconnect the indicator lead to the alternator "IND" terminal.

NOTE: If the warning light fails to illuminate when the lead is reconnected to the alternator, a fault is indicated in the alternator regulator or rotor circuits. Ensure the alternator "IND" terminal is clean and then conduct the "Alternator Component Tests" as detailed in this Chapter.

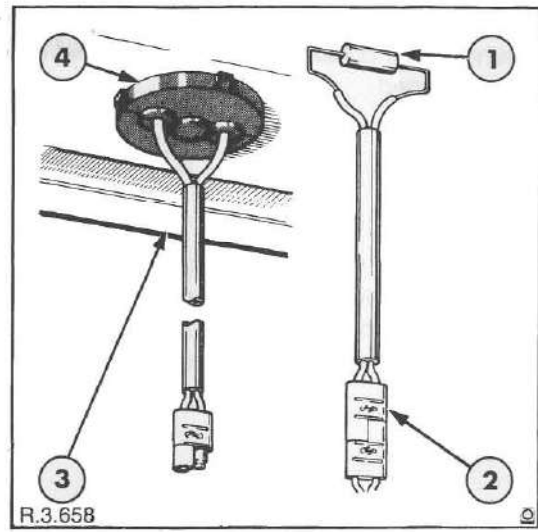


Figure 10

Connection of 205 Ohm Test Resistor

1. 205 Ohm Resistor
2. Harness to Sensor Plug
3. Battery Tray
4. Temperature Sensor

2. Battery Temperature Sensor Circuit Test

With reference to Figure 9.

1. Remove the sensor lead from the alternator battery temperature sensing terminal which protrudes from the regulator box on an orange fly lead.
2. Connect a voltmeter between the sensor lead and the alternator (negative side of voltmeter to frame). Battery voltage should be registered.

If battery voltage is not registered, disconnect the harness to sensor plug and connect a 205 ohm resistor across the plug terminal, Figure 10.

NOTE: It is recommended that a permanent test piece be made by removing the plug and leads from an old sensor unit and connecting a 205 ohm resistor as shown in Figure 10.

PART 3 – ELECTRICAL SYSTEMS

If battery voltage is now registered, the sensor unit is faulty (open circuit) and must be replaced.

If battery voltage is not registered a continuity fault in the external circuitry must be traced and rectified. Reconnect the sensor and confirm battery voltage is registered.

NOTE: *It is very difficult to test prove the effective resistance of a temperature sensor. If such a unit is suspected of being faulty it should be replaced and proved in service.*

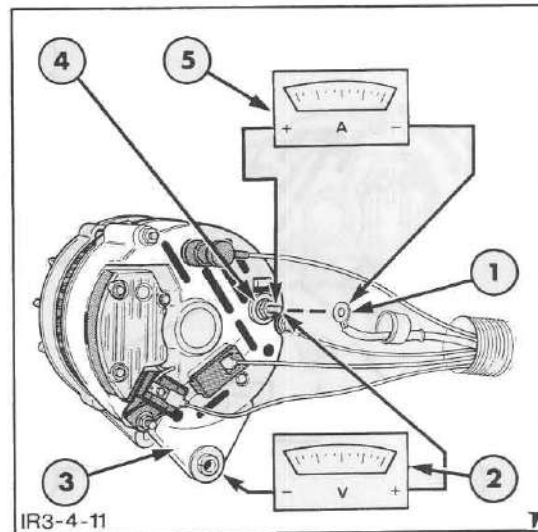


Figure 11

Charging Current and Controlled Voltage Tests

1. Output Lead
2. Ammeter
3. Alternator Frame
4. Main Output Terminal
5. Voltmeter (0-30 Volts)

3. Charging Current and Controlled Voltage Tests

With reference to Figure 11.

1. Ensure all tractor electrical components are switched off and the key start switch is in the "off" position.
 2. Disconnect the battery ground cable (negative) and remove the main output lead from the alternator.
 3. Securely connect an ammeter negative side to the connector plug main terminal and positive side to the alternator output terminal.
 4. Connect a voltmeter between the alternator output terminal and the frame (negative side to frame).
 5. Reconnect the battery and turn the key start switch to the "on" position.
 6. Start the engine and increase the speed to 2000 rev/min. and observe the ammeter and voltmeter readings.
- If the ammeter registers a charging current stop the engine.

CHAPTER 4

If the ammeter registers zero amperes a faulty alternator component is indicated. Turn off the engine and conduct the "Alternator Component Tests" as detailed in this Chapter.

7. Disconnect the harness to sensor plug and connect a 205 ohm resistor across the plug terminals. Refer to Figure 10.
8. Restart the engine and increase the speed to 2000 rev/min. Observe the ammeter and voltmeter readings.

The voltmeter should register in excess of the battery voltage and when the ammeter reading falls below 10 amperes, the voltmeter reading should stabilise at 13.6-14.4 volts.

If the voltmeter reading exceeds 14.4 volts, the alternator regulator must be replaced as described in this Chapter. (When a new regulator has been installed, conduct Tests 4 and 5).

If the voltmeter reading is below 13.6 volts a faulty alternator component or a high resistance fault in the external connections of the charging system is indicated.

9. Stop the engine.

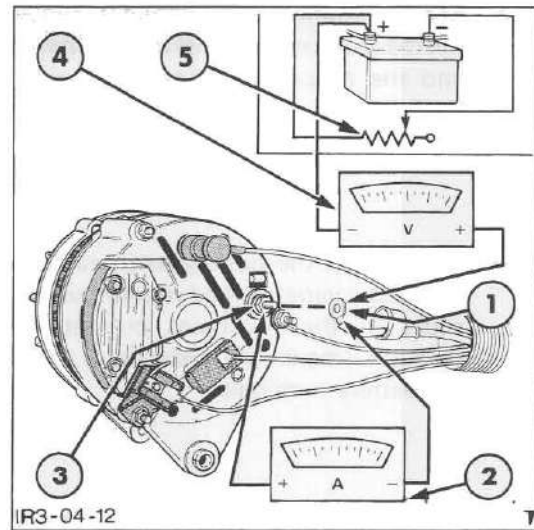


Figure 12
Insulated – side Volt Drop Test
(Inset showing connection of Millivoltmeter and Variable Load Resistor to Battery)

1. Output Lead
2. Ammeter
3. Main Output Terminal
4. Millivoltmeter (0-1 Volt)
5. Variable Load Resistor

4. Charging Circuit Volt Drop Tests
(a) Insulated-side Volt Drop Tests

With reference to Figure 12.

1. Ensure the key start switch is in the "off" position.
2. Disconnect the battery ground cable (negative) and remove the output lead from the alternator.
3. Connect a millivoltmeter between the battery positive terminal and the alternator output lead (positive side to lead).

PART 3 – ELECTRICAL SYSTEMS

4. Securely connect an ammeter between the main output terminal of the alternator and the output lead (negative side to lead).
5. Re-connect the battery earth cable and connect a variable load resistor, with the slider in the minimum current draw position (maximum resistance), across the battery terminals.
6. Start the engine and increase the speed to 2000 rev/min.
7. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.
8. Observe the millivoltmeter reading which should not exceed 400 millivolts.

If the reading is in excess of 400 millivolts, a high resistance fault is indicated in the external circuitry.

If the required alternator output cannot be achieved, and the millivoltmeter reading is less than 400 millivolts, then a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

9. Stop the engine.

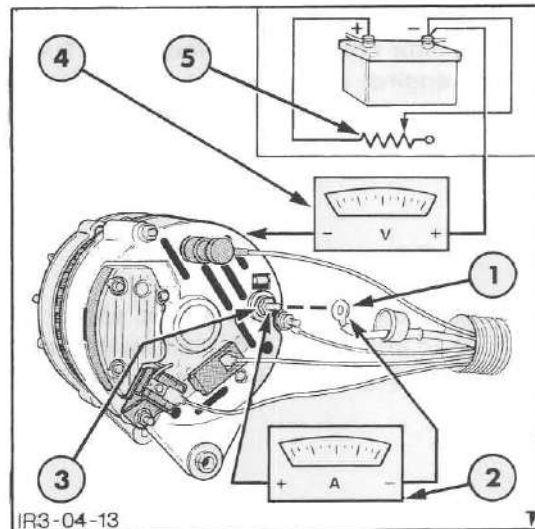


Figure 13
Ground-side Volt Drop Test
(Inset showing connection of Millivoltmeter and Variable Load Resistor to Battery)

1. Output Lead
2. Ammeter
3. Main Output Terminal
4. Millivoltmeter (0-1 Volt)
5. Variable Load Resistor

(b) Ground-side Volt Drop Test

With reference to Figure 13.

1. Ensure the key start switch is in the "off" position.
2. The circuit is the same as that used in the previous test except for the millivoltmeter which is now connected between the battery negative terminal and the alternator frame (negative side to frame).

NOTE: Ensure the variable load resistor is in the minimum current draw position (maximum resistance).

CHAPTER 4

3. Start the engine and increase the speed to 2000 rev/min.
4. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.
5. Observe the voltmeter reading which should not exceed 200 millivolts.

If the reading is in excess of 200 millivolts, a high resistance fault is indicated in the external circuitry.

If the required alternator output cannot be achieved, and the millivoltmeter reading is less than 200 millivolts, then a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

6. Stop the engine.

5. Alternator Maximum Output Performance Test

With reference to Figure 14.

1. Ensure the key start switch is in the "off" position.
2. Disconnect the battery ground cable (negative) and the output lead from the alternator.

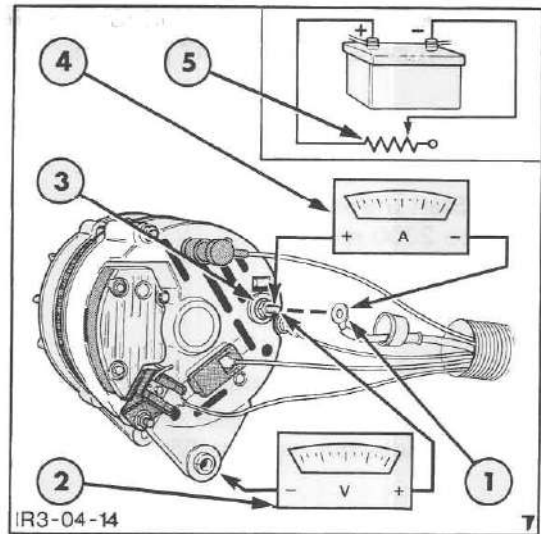


Figure 14
Maximum Output Performance Test
(Inset showing connection of Variable Load Resistor to Battery)

1. Output Lead
 2. Voltmeter (0-30 Volts)
 3. Main Output Terminal
 4. Ammeter
 5. Variable Load Resistor
3. Securely connect an ammeter negative side to the connector plug main terminal and positive side to the alternator output terminal
 4. Connect a voltmeter between the alternator output terminal and the frame (negative side to frame).
 5. Disconnect the harness to battery sensor plug and connect a 205 ohm resistor across the plug terminals. Refer to Figure 12.

PART 3 – ELECTRICAL SYSTEMS

6. Reconnect the battery and turn the key start switch to the "on" position.
7. Start the engine and increase the speed to 2000 rev/min.
8. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.
9. Observe the voltmeter reading which should not fall below 13.6 volts.

NOTE: *The component tests may be performed without removing the alternator from the tractor. Testing of any other alternator components will necessitate removal of the alternator from the tractor. Refer to "Overhaul – Electrical Tests" as detailed in this Chapter.*

IMPORTANT: *Prior to removal of the output lead from the alternator ensure the key start switch is in the "off" position and the battery ground cable (negative) is disconnected.*

If the reading falls below 13.6 volts a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

Test equipment required:

- 12 Volt Battery
- 12 Volt 2.2 Watt Test Lamp

ALTERNATOR COMPONENT TESTS

The component tests, which should only be conducted if the INITIAL TESTS have indicated a faulty alternator component, enable the following items to be checked:

- Regulator
- Rotor Field Winding Continuity
- Brushes-and-Springs and Rotor Slip Rings

1. Regulator and Rotor Field Circuit Test

With reference to Figure 15.

1. Connect a 12 volt battery and a 2.2 watt test lamp in series between the "IND" (indicator) terminal and the alternator frame (negative side to frame).
2. Connect a 205 ohm resistor between the positive terminal of the battery and the sensor terminal.

CHAPTER 4

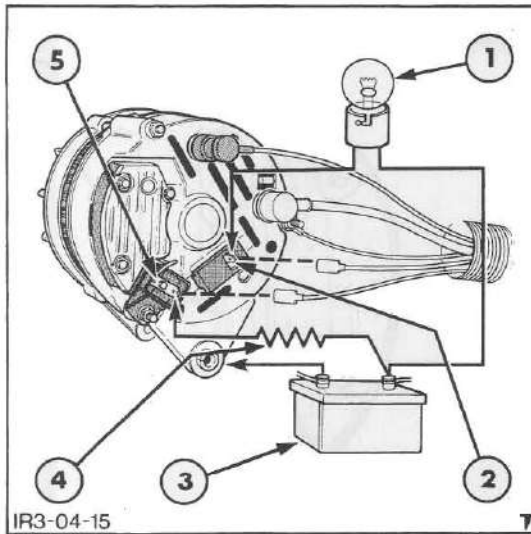


Figure 15
Regulator and Rotor Field Circuit Test

1. 2.2 Watt Test Lamp
2. IND (Indicator) Terminal
3. 12 Volt Battery
4. 205 Ohm Resistor
5. Sensor Terminal

The test lamp should be illuminated.

If the test lamp is not illuminated, a fault is indicated in the rotor circuit. Check brushes, slip rings and continuity of rotor field windings.

If examination indicates these parts are satisfactory the regulator is suspect.

2. Rotor Field Winding Continuity Test

With reference to Figure 16.

1. Remove the regulator and brushbox assembly as described in this Chapter.

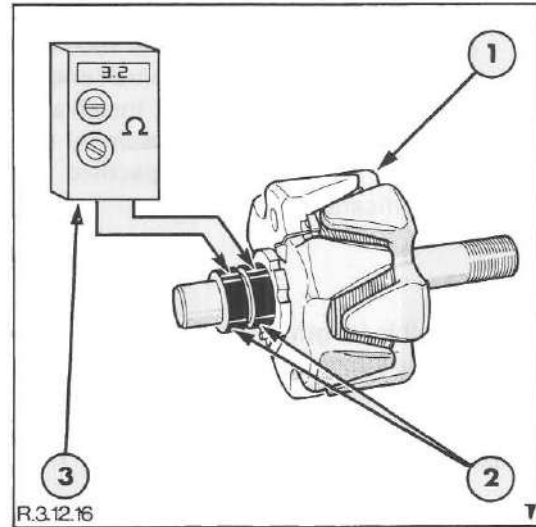


Figure 16
Rotor Field Winding Continuity Test

1. Rotor
2. Slip Rings
3. Ohmmeter

2. Connect an ohmmeter between the two slip rings. The resistance should read 3.2 ohms.

If the resistance is outside of the specification renew the rotor as detailed in the following Overhaul Section.

3. Brushes and Rotor Slip Rings

1. Remove the regulator and brushbox assembly as described in this Chapter.

2. Ensure the brushes and slip-rings are clean and check for freedom of movement of the brushes in the brushbox moulding.

PART 3 – ELECTRICAL SYSTEMS

3. Check the brush spring pressure with a push type spring gauge and record the spring pressure when the brush end face is flush with the moulding. Install a new regulator and brushbox assembly if the pressure is less than specified. See "Specifications".

If the visible length of the brushes in the free position is less than 0.25 in. (5 mm) this is a probable cause of non-continuity in the field circuit and the regulator and brushbox assembly should be renewed Figure 17.

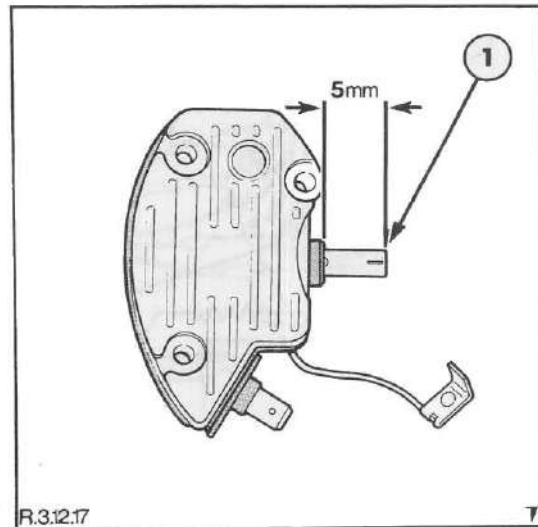


Figure 17
Regulator and Brushbox Assembly

1. Brushes

NOTE: *The brushes are an integral part of the regulator and brushbox assembly and cannot be replaced as individual items.*

C. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – OVERHAUL

REMOVAL

1. Disconnect the battery ground cable (negative).
2. Remove the engine side panel.
3. Disconnect all leads to the alternator. Refer to Figure 18.
4. Withdraw the adjustment and mounting bolts and remove the alternator from the tractor.

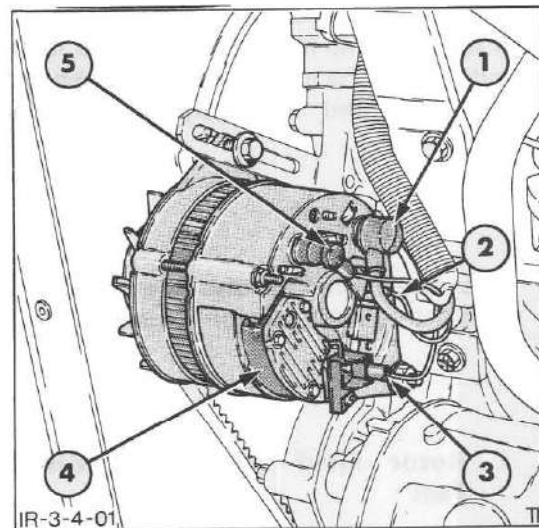


Figure 18
Alternator Installed on Tractor

1. Output Lead
2. Charge Indicator Lead
3. Battery Temperature Sensor Lead
4. Regulator and Brushbox
5. Tachometer Pick Up Lead