GROUP 8 — ELECTRICAL

SECTION 0 — INDEX

SERVICE BULLETIN REFERENCE

DATE	NUMBER	SUBJECT	CHANGES

SECTION 1 — BATTERY

SPECIFICATIONS

Type	12V
Location	In engine compartment
Polarity to earth	Negative (—)
Capacity 1,6ℓ, 1,85ℓ and 2,0ℓ (early) sedan and wagon	7 plate 40 amp hr @ 20 hr discharge rate
2,0ℓ Two Door	7 plate 40 amp hr @ 20 hr discharge rate
2,0ℓ (late) sedan and wagon	9 plate 50 amp hr @ 20 hr discharge rate
2,6ℓ (auto)	11 plate 65 amp hr @ 20 hr discharge rate

TORQUE SPECIFICATIONS

Battery terminal connections	2,5 Nm (20 lb. in.)

SERVICE PROCEDURES

BATTERY VISUAL INSPECTION

(1) Protect paint finish with fender covers.

(2) Disconnect battery cables at battery.

(3) Remove battery hold-down clamp and remove battery from vehicle.

(4) Inspect battery carrier and fender side panel for damage caused by loss of acid from battery.

(5) Clean top of battery with a solution of clean warm water and baking soda. Scrub areas with a stiff bristle brush being careful not to scatter corrosion residue. Finally wipe off with a cloth moistened with ammonia or baking soda in water.

CAUTION: Keep cleaning solution out of battery cells to eliminate weakening the electrolyte.

(6) Replace damaged or frayed cables.

(7) Clean battery terminals and inside surfaces of clamp terminals.

(8) Examine battery case and cover for cracks.

(9) Install battery.

(10) Tighten battery hold-down screw nuts. **Observe polarity of battery terminals to be sure the battery is not reversed.**

(11) Connect cable clamps to battery posts and tighten securely. Coat all connections with light mineral grease **after tightening.**

(12) If electrolyte level is low, fill to recommended level with mineral-free water.

SPECIFIC GRAVITY TEST

A hydrometer is used to measure specific gravity of electrolyte in battery cells. This gives an indication of how much unused sulphuric acid remains in the solution.

A hydrometer should be graduated to read from 1.160 to 1.320, in graduations of .005 specific gravity. Graduated markings should be not less than 1.5 mm (1/16") apart and accurate to within .002 specific gravity. Graduated portion of the stem should be about 50 mm (2") long. Clearance between float and glass barrel, at smallest diameter, should be a minimum of 3 mm (1/8") around all sides and barrel must be clean.

Liquid level of battery cell should be at normal height and electrolyte should be thoroughly mixed with any battery water which may have just been added by charging battery before taking hydrometer readings. See "Adjustment of Acid Gravity."

In reading a hydrometer, the gauge barrel must be held vertically and just right amount of fluid be drawn up into gauge barrel with pressure bulb fully expanded to lift float freely so it does not touch the sides, top or bottom of the barrel. Take a reading with eye on level with liquid level in the gauge barrel. **DO NOT TILT** hydrometer.

Hydrometer floats are calibrated to indicate correctly only at one fixed temperature.

Specific gravity of battery electrolyte strength or density varies not only with the quantity of the acid in solution but also with temperature. As temperature increases, the density of the electrolyte decreases and specific gravity is reduced. As temperature drops, the density of the electrolyte increases and the specific gravity increases.

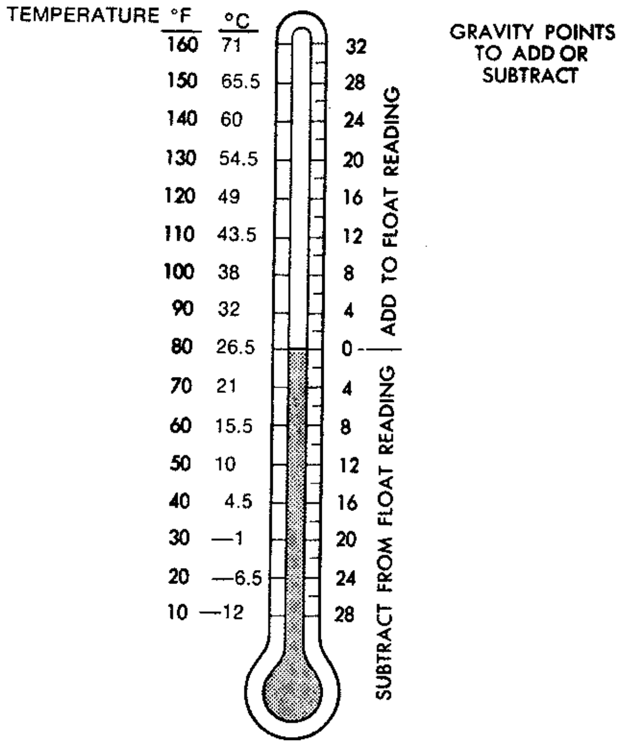


Fig. 1—Hydrometer reading correction chart.

Specific gravity variations caused by temperatures must be considered and corrected to 26.5°C (80°F) in the analysis of the battery, otherwise specific gravity readings will not give a true indication of state of charge.

Use a battery immersion type thermometer of the mercury-in-glass type, having a scale reading as high as 52°C (125°F) and designed for not over a 25 mm (1") bulb immersion. A suitable dairy type thermometer may prove satisfactory for the purpose.

Draw electrolyte in and out of the hydrometer barrel several times to bring the temperature of the hydrometer float to that of the acid in the cell and then measure the electrolyte temperature in the cell.

The temperature correction in specific gravity reading at 26.5°C (80°F) is zero. Add or subtract .004 specific gravity points for every 5.5°C (10°F) from the above zero adjustment point in accordance with the scale shown in Fig. 1 and following examples:

Example 1—

Hydrometer Reading	1.260
Acid Temperature	—6.5°C (20°F)
Subtract Specific Gravity	.024
Correct Specific Gravity is	1.236

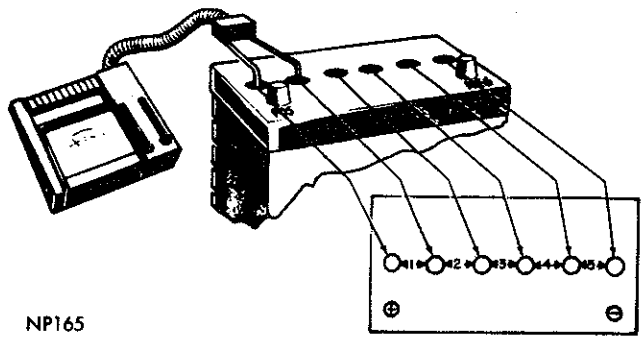


Fig. 2—Testing battery cells with cad-tip battery cell analyzer

Example 2—

Hydrometer Reading	1.225
Acid Temperature	38°C (100°F)
Add Specific Gravity	.008
Corrected Specific Gravity is	1.233

A fully charged relatively new battery has a specific gravity reading of 1.260 plus .015 minus .005.

Test Conclusions

(a) Battery specific gravity is less than 1.220 battery should be recharged. Make a high rate discharge test for capacity. If battery cells test O.K., recharge and adjust gravity of all cells uniformly. Test voltage regulator setting. Thoroughly test the electrical system for short circuits, loose connections and corroded terminals.

(b) **Cells show more than 25 points (0.25 Specific Gravity) Variation.** Short circuit low cell. Loss of electrolyte by leakage or excessive overcharging; try to recharge battery. See "Charging the Battery". See "Adjustment of Acid Gravity".

(c) Battery specific gravity is above 1.220 and all cells are even. Battery state of charge may be satisfactory. Test by making "High Rate Discharge Test of Battery Capacity". Test voltage regulator setting and all electrical connections are clean and tight.

TEST BATTERY CONDITION AND STATE OF CHARGE WITH CAD-TIP ANALYZER (Figure 2)

(1) Check electrolyte level in all cells and add mineral-free water to proper level. When a vehicle is running, the battery is receiving a charge from the alternator. This charge builds up a "surface charge" in the battery that must be removed before an accurate test can be made.

(2) Remove the surface charge by turning the headlights "on" for one minute before testing battery. If the battery has not been operating in a vehicle for at least 8 hours prior to testing, Step 2 is not necessary.

IMPORTANT: Be sure that headlights, ignition and all accessories are "off" during test.

(3) Remove battery filler plugs and place the RED probe in the POSITIVE (+) CELL and the BLACK probe in the SECOND CELL. NOTE READING. (There will be no meter reading if the probes are reversed.) A manual set index pointer is provided to assist in making cell comparisons. Set the manual index pointer for reference.

(4) Move RED probe to SECOND CELL and BLACK probe to THIRD CELL; then move RED probe to THIRD CELL and BLACK probe to FOURTH CELL, etc., until all cells have been tested. Note each cell reading so that CELL COMPARISONS CAN BE MADE. Always store probe assembly in the space provided in the meter case.

TEST READING INTERPRETATIONS (Fig. 3)

A—If the readings of any two cells vary FIVE scale divisions or more on the TOP scale—regardless of the colored sections in which they may fall on the bottom scale—**The battery is at or near the point of failure and should be replaced.**

B—If all cells vary LESS than five scale divisions on the TOP scale and all are in the GREEN section of the Bottom Scale—**The battery is in good condition and a safe state of charge.**

C—If all cells vary LESS than five scale divisions on the TOP scale but if any of the cells test in the RED section of the BOTTOM scale—the battery is in good condition but is in a low state of charge—**Recharge at once to avoid a starting failure.**

D—If ANY cell readings are in the "RECHARGE AND RETEST" section of the TOP SCALE and the balance of the readings are within the first four scale divisions—the battery is too low to make an accurate condition test—Recharge battery and retest.

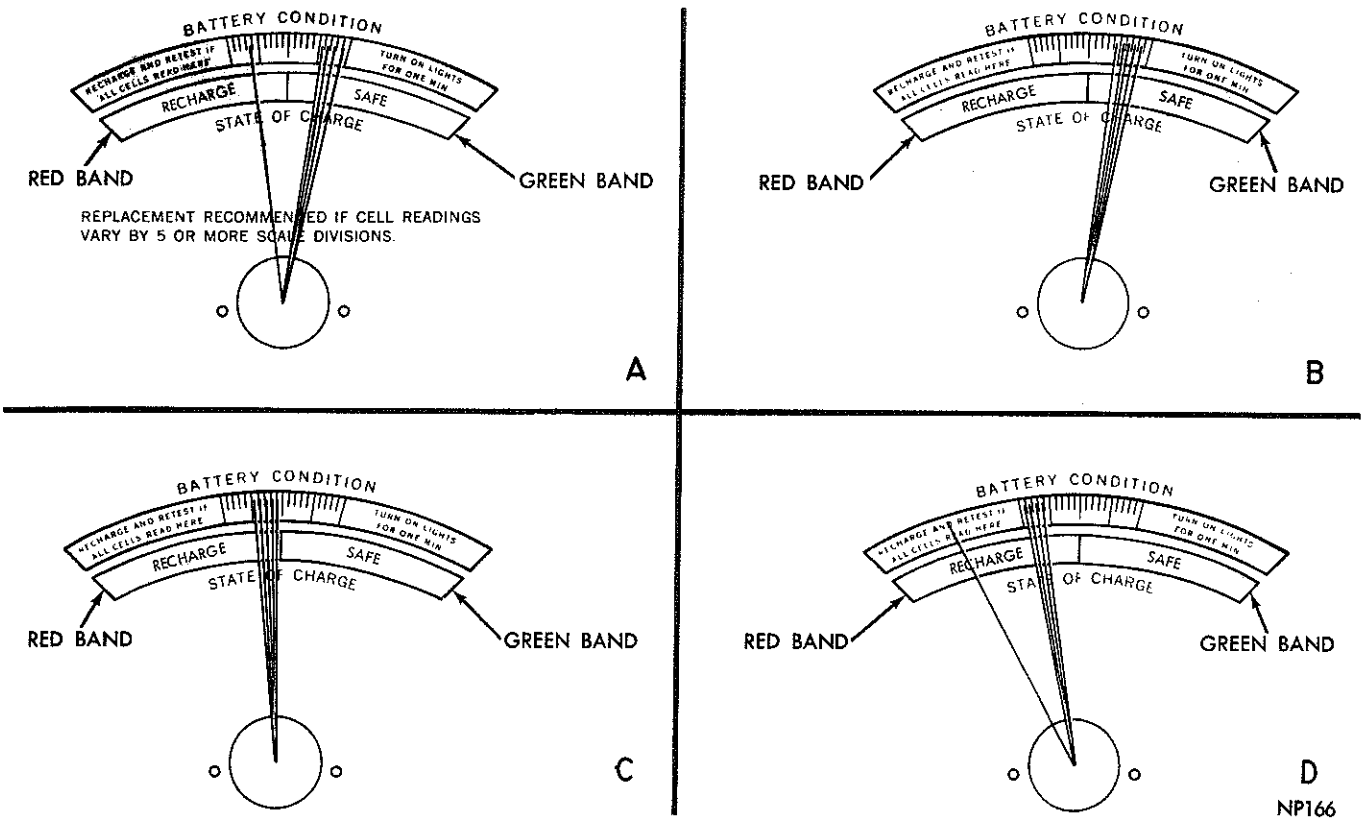


Fig. 3—Battery State of Charge

CAUTION: Be certain to remove "surface charge" after recharge and before retesting. See "Step 2."

ADJUSTMENT OF ACID GRAVITY

Hydrometer floats usually are not calibrated below about 1.160 specific gravity and cannot indicate the condition of a battery in a very low state of charge. Therefore, it may be necessary to give the battery several hours charge before a hydrometer reading will indicate that the battery is taking a charge.

If the specific gravity of all cells are not within .015 points of specified value, corrected to 26.5°C (80°F) at the end of a full charge, remove some of the electrolyte with a hydrometer. Add a like amount of distilled water to reduce the gravity, if too high, or add 1.400 Specific Gravity acid to raise specific gravity, if too low. Continue the charge so as to give the electrolyte a chance to mix and then read the gravity after another hour of charge to note the effect of the additions. Continue this adjusting procedure until gravity is brought to the desired value by charging for one hour after each adjustment.

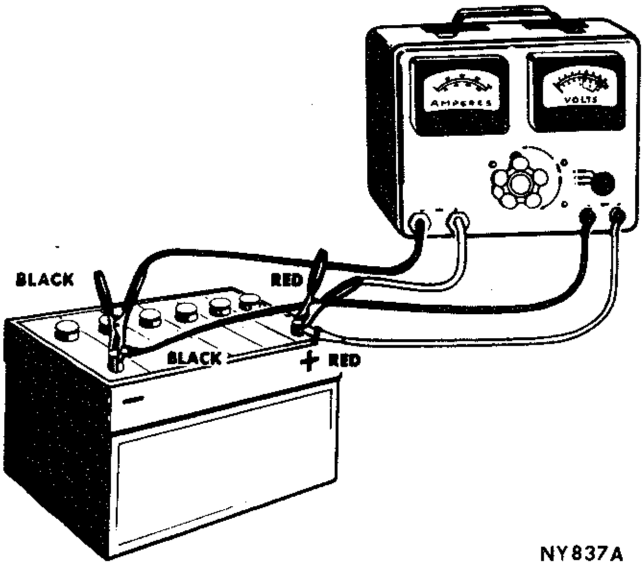


Fig. 4—High rate discharge test

Never adjust the specific gravity of any battery cell which does not gas freely on charge. Unless electrolyte has been lost through spilling or leaking, it should not be necessary to add acid to a battery during its life. Acid should never be added unless one is certain that the cell will not come up to normal gravity by continued charging. Always make the temperature correction for hydrometer readings, as warm electrolyte will read low and this might be mistaken for failure of the battery to rise normally in gravity. It could also be falsely concluded that the battery would not take a full charge.

HIGH RATE DISCHARGE TEST OF BATTERY CAPACITY

Satisfactory capacity tests can be made only when battery equals or exceeds 1.220 specific gravity at 26.5°C (80°F). If the reading is below 1.220 the battery should be slow charged until fully charged in order to secure proper test results.

Test Procedure

(1) Turn control knob of Battery-Starter-Tester to **OFF position.**

(2) Turn Voltmeter Selector Switch to the **16** Volt position on test units so equipped.

(3) Connect test ammeter and voltmeter positive leads to battery positive terminal. Connect ammeter and voltmeter negative leads to battery negative terminal (Fig. 4). **Voltmeter clips must contact battery posts or cable clamps and not ammeter lead clips.**

(4) Turn control knob clockwise until ammeter reading is equal to three times ampere hour rating of battery.

(5) Maintain this load for 15 seconds; voltmeter should read 9.5 volts or more, which will indicate that battery has good output capacity.

(6) After the 15 second test, turn Battery-Starter-Tester control knob to the **OFF** position.

If the voltage in the "High Rate Discharge Test" was under 9.5 volts, the battery should be test charged to determine whether the battery can be satisfactorily charged.

CHARGING THE BATTERY

Three Minute Charge Test (Fig. 5)

This test should not be used if battery temperature is below 15.5°C (60°F).

(1) Connect Battery Charger positive (+) lead to battery positive terminal and negative (—) lead to battery negative terminal.

IMPORTANT: Be sure of correct polarity when charging batteries.

(2) Turn the Battery Charger Power Switch to ON position. Turn timer switch past three minute mark then back to the three minute mark.

(3) Adjust Battery Charger Switch to highest possible rate not exceeding 40 amperes.

(4) When timer switch cuts off at the end of 3 minutes, turn timer switch back to **Fast Charge.**

(5) Use the **16** Volt scale of the Battery Starter Tester and measure total voltage of battery posts while battery is being fast charged. If total voltage during

charge exceeds 15.5 volts, battery is sulphated and should be cycled and slow-charged until specific gravity reaches 1.260 (See "Slow Charging"). **A slow charge is preferable to bring the battery up to a full charge.**

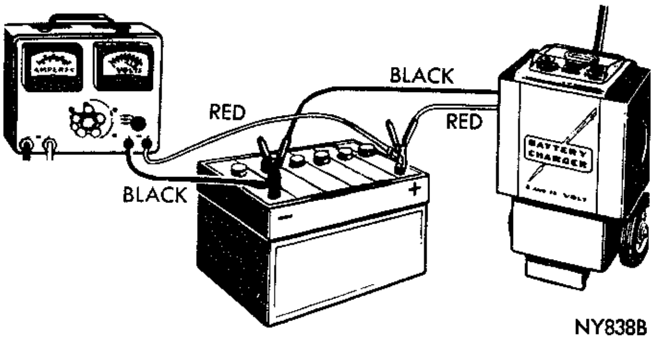
If specific gravity remains constant after testing battery at one hour intervals for three hours, battery is at its highest state of charge.

(6) Make another capacity test. If capacity test does not meet specifications, replace battery.

Fast Charging the Battery (Fig. 6)

If adequate time for a slow charge is not available, a high rate (FAST) charge is permissible and will give a sufficient charge in one hour enabling the battery and alternator to continue to carry the electrical load.

Connect Battery Charger positive (+) lead to battery positive terminal and negative (—) lead to battery negative terminal. If battery is not removed from vehicle, **BE SURE** ignition switch is turned off and all electrical accessories are turned off during charging.



NY838B

Fig. 5—Three minute charge test

CAUTION: The battery can be damaged beyond repair unless the following precautions are taken:

(1) Battery electrolyte temperature must **NEVER** exceed 52°C (125°F).

If this temperature is reached, battery should be cooled by reducing charging rate or remove battery from the circuit.

(2) As batteries approach full charge electrolyte in each cell will begin to gas or bubble. Excessive gassing must not be allowed.

(3) Do not fast charge longer than one hour.

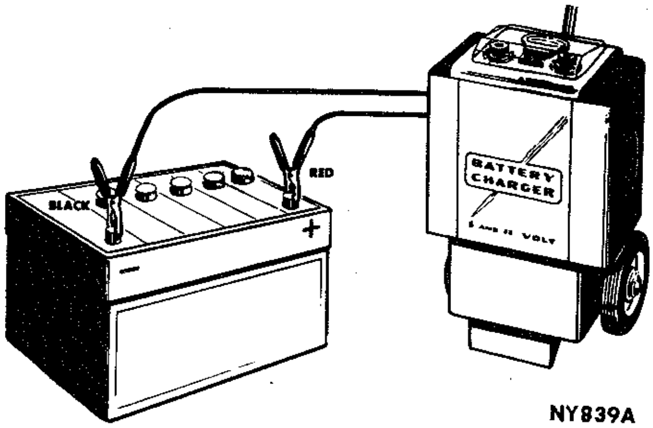
If battery does not show a significant change in specific gravity after one hour of "FAST" charge, the slow charge method should be used.

Remember to use temperature correction when checking specific gravity. **The manufacturers of high rate charging equipment generally outline the necessary precautions and some models have thermostatic temperature limiting and time limiting controls.**

WARNING: When batteries are being charged an explosive gas mixture forms beneath the cover of each cell. Do not smoke near batteries on charge or which have recently been charged. Do not break live circuits at the terminals of the batteries on charge. A spark will occur where the live circuit is broken. Keep all open flames away from the battery.

Slow Charging Batteries

Many discharged batteries can be brought back to good condition by slow charging; especially batteries that are sulphated.



NY839A

Fig. 6—Fast charging the battery.

Battery should be tested with a hydrometer and a record kept of the readings taken at regular intervals throughout the charge. When a cell has a specific gravity reading that is 25 points (0.25) or more below other cells, that cell is faulty and battery should be replaced.

Safe slow charging rates are determined by allowing one ampere per positive plate per cell. Proper slow charging rate would be 4 amperes for a 53 ampere hour battery; 5 amperes for a 59 ampere hour battery; and 6 amperes for a 70 ampere hour battery.

The average length of time necessary to charge a battery by the slow charge method at normal rates is from 12 to 16 hours, however, when a battery continues to show an increase in specific gravity, battery charge should be continued even if it takes 24 hours or more. **Watch the temperature of batteries carefully and if the temperature of any one of them reaches 43°C (110°F), lower the charging rate.**

Battery will be fully charged when it is gassing freely and when there is no further rise in specific gravity after three successive readings taken at hourly intervals. Make sure hydrometer readings are corrected for temperature.

The rate of charge for a sulphated battery should be no more than ½ the normal slow charge rate. Many sulphated batteries can be brought back to a useful condition by slow charging at half the normal charging rate from 60 to 100 hours. This long charging cycle is necessary to reconvert crystalline lead sulphate into active materials. **When a battery takes a full charge, but is returned several times in need of a recharge, check for a cracked cell partition with a syringe to provide air pressure; bubbles will appear in an adjacent cell if a crack is present.**

SECTION 2 — STARTER SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
STARTER FAILS TO OPERATE	(a) Weak battery or dead cell in battery.	(a) Test specific gravity. Recharge or replace battery as required.
	(b) Ignition switch faulty.	(b) Test and replace switch if necessary.
	(c) Loose or corroded battery cable terminals.	(c) Clean terminals and clamps, replace if necessary. Apply a light film of petroleum jelly to terminals after tightening.
	(d) Open circuit, wire between the ignition/starter switch and ignition terminal on starter relay.	(d) Inspect and test all the wiring.
	(e) Starter relay defective.	(e) Test relay and replace if necessary.
	(f) Faulty starter.	(f) Test and repair as necessary.
	(g) Armature shaft sheared.	(g) Test and repair.
	(h) Open solenoid pull-in wire.	(h) Test and replace solenoid if necessary.
STARTER FAILS AND LIGHTS DIM	(a) Weak battery or dead cell in battery.	(a) Test specific gravity. Recharge or replace battery as required.
	(b) Loose or corroded battery cable terminals.	(b) Clean terminals and clamps, replace if necessary. Apply a light film of petroleum jelly to terminals after tightening.
	(c) Internal ground in windings.	(c) Test and repair starter.
	(d) Grounded starter fields.	(d) Test and repair starter.
	(e) Armature rubbing on pole shoes.	(e) Test and repair starter.
STARTER TURNS, BUT ENGINE DOES NOT ENGAGE	(a) Starter clutch slipping.	(a) Replace the clutch unit.
	(b) Broken clutch housing.	(b) Test and repair starter.
	(c) Pinion shaft rusted, dirty or dry, due to lack of lubrication.	(c) Clean, test and lubricate.
	(d) Engine basic timing wrong.	(d) Check engine basic timing and condition of distributor rotor and cap.
	(e) Broken teeth on engine ring gear.	(e) Replace ring gear. Inspect teeth on starter clutch pinion.
STARTER RELAY DOES NOT CLOSE	(a) Battery discharged.	(a) Recharge or replace battery.
	(b) Faulty wiring.	(b) Test for open circuit wire between ignition-starter switch and ignition terminal and starter relay.
	(c) Starter relay faulty.	(c) Test and replace if necessary.
RELAY OPERATES BUT SOLENOID DOES NOT	(a) Faulty wiring	(a) Test for open circuit wire between starter-relay solenoid terminal and solenoid terminal post.
	(b) Faulty solenoid switch or connections.	(b) Test for loose terminal connections between solenoid and starter field.
	(c) Solenoid switch contacts corroded.	(c) Test and replace solenoid if necessary.
	(d) Broken lead or a loose soldered connection inside solenoid switch (brush holder plate).	(d) Test and replace solenoid if necessary.

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
SOLENOID PLUNGER VIBRATES BACK AND FORTH WHEN SWITCH IS ENGAGED	(a) Battery low.	(a) Test for specific gravity of battery. Replace or recharge battery.
	(b) Faulty wiring.	(b) Test for loose connections at relay, ignition-starter switch and solenoid.
	(c) Lead or connections broken inside solenoid switch cover (brush holder plate) or open hold-in winding.	(c) Test and replace solenoid if necessary.
	(d) Check for corrosion on solenoid contacts.	(d) Test and clean the contacts.
STARTER OPERATES BUT WIIL NOT DISENGAGE WHEN THE IGNITION-STARTER SWITCH IS RELEASED	(a) Broken solenoid plunger spring or spring out of position.	(a) Test and repair.
	(b) Faulty ignition-starter switch.	(b) Test and replace the switch if necessary.
	(c) Solenoid contact switch plunger stuck in solenoid.	(c) Remove contact switch plunger, wipe clean of all dirt, apply a film of SAE 10 oil on plunger, wipe off excess.
	(d) Insufficient clearance between winding leads to solenoid terminal and main contactor in solenoid.	(d) Test and repair.
	(e) Faulty relay.	(e) Test and replace relay if necessary.

SECTION 2A — BOSCH DIRECT DRIVE STARTER

SPECIFICATIONS

Chrysler Part Number 1,85ℓ and 2,0ℓ	4065559 (early)
2,0ℓ and 2,6ℓ	4151140 (late)
Make	Bosch
Manufacturers Part Number (Early)	9-000-062-022
(Late)	9-000-062-026
Model (Early)	U-EF(R) 12V 0,9Kw (1.2 H.P.)
(Late)	U-EF(R) 12V 0,8Kw (1.1 H.P.)
Voltage	12V
Number of Field Coils	4 (in series)
Number of Poles	4
Number of Brushes	4
Brush Spring Tension	18 to 20 N (65 to 72 ozs)
End Float — Armature	0,05 to 0,30 mm (0.002" to 0.012")
Drive description	Solenoid actuated positive pre-engaged pinion with over-running clutch
Stall test @ 7V (Early)	520A
(Late)	420A
No load test @ 12V — 10000 r.p.m. (Early)	60A
— 7500 r.p.m. (Late)	65A
Load test @ 9V — 1200 r.p.m. (Early)	300A
— 1000 r.p.m. (Late)	250A
Maximum commutator out of round	0,05 mm (0.002")
Commutator minimum diameter	33,30 mm (1.312")
Armature Brake torque	0,25 to 0,40 Nm (2.2 to 3.5 lbs. in.)
Clutch over-running torque	0,13 to 0,18 Nm (1.1 to 1.6 lbs. in.)
Solenoid pull-in voltage	7.5V
Number of teeth —Pinion Gear	9
Number of teeth — Flywheel	110

SPECIAL TOOLS

Following tools are available through "Bosch" distributors.

EFAW 10	Mica undercutting machine
EFAW 9	Pole shoe clamp and screwdriver
EF 1244 B	Spring balance-checking brush spring tension
EFAL 1	Pinion bush extractor
EFAL 3	Smoothing mandrel for bushes
EFAL 26	Torque balance (Test range 1.3 to 6.9 lbs. in.)
EFAL 27	Torque balance (Test range 0.3 to 1.0 lbs. in.)

SERVICE INFORMATION — PROCEDURES

GENERAL INFORMATION

The Bosch U-EF(R) 12V starter motor is a direct cranking, series parallel wound, four pole, four brush type with solenoid actuated positive pre-engaged pinion operation. The main battery supply is not connected until the pinion is in engagement, unless tooth abutement is experienced. The frictional connection between starter armature and ring gear is automatically broken by the over-running clutch coupling which disengages the drive as soon as the engine speed exceeds that of the starter motor.

Operation

Closing the solenoid switching circuit energises the pull-in and hold-in solenoid windings and the soft iron plunger is drawn in, moving the engaging lever, which in turn moves the drive assembly toward the ring gear. The coarse thread on the armature shaft causes the pinion to rotate and assist in engagement. Should the advancing pinion come up against a tooth, the engaging lever compresses the helical spring at the pinion end until the switch closes. As the pinion is turned it engages with the succeeding tooth space under the helical spring pressure. Before the pinion is completely in mesh the contacts in the solenoid switch are closed by the action of the soft iron plunger, and the starter rotates and cranks the engine. When the starter rotates, the pull-in winding is de-energised by the isolation of its ground connection, providing more starter current for cranking. As the starting speed of the engine exceeds that of the starter, the pinion rotates freely and engine acceleration does not affect the starter.

The drive being under no load, is pulled back by the tensional helical spring, however, the pinion remains partly engaged as the starter switch is operated. Once the starter switch is released, the plunger return spring returns the pinion to its rest position and opens the switch contacts.

ELECTRICAL TESTS OF STARTING MOTOR

The electrical test values depend upon the condition of the battery (capacity and charge). The testing period also plays an important part (heating of the starter, and battery discharge). The unavoidably long cables on the test bench at times also influence starter performance. The test period should therefore be as short as possible. The batteries must be in good condition and well charged or the electrical values of a faulty starter will differ considerably from the specified test data.

Circuit Diagram

The internal wiring of the starter and the electrical hook-up for testing are shown in Fig. 1.

Stall Test

If test bench is available, install starter motor in test bench. Follow instructions of test equipment manufacturer and check stall torque of starter. With the starter locked and battery current applied, quickly note the voltmeter and ammeter readings. Amperage reading should be as specified.

No Load Test

Mount starter on test bench for free running test. Hook up as shown in test wiring diagram (Fig. 1). Take readings of starter current draw, voltage and r.p.m. They should be within specifications.

Load Test

If test equipment available includes provision for carrying out a load test, hook up as in stall test. Operate starter and brake until the prescribed current draw is reached, and read voltage and r.p.m. Readings should be as specified.

SERVICING THE STARTER

Disassembly (Refer Fig. 2)

(1) Disconnect the solenoid switch to starter lead from the solenoid switch terminal.

(2) Remove the two solenoid switch attaching screws.

(3) Remove solenoid by lifting and unhooking the plunger yoke from engaging fork.

(4) Remove the two end cap screws, remove the bearing end cap and remove retaining clip.

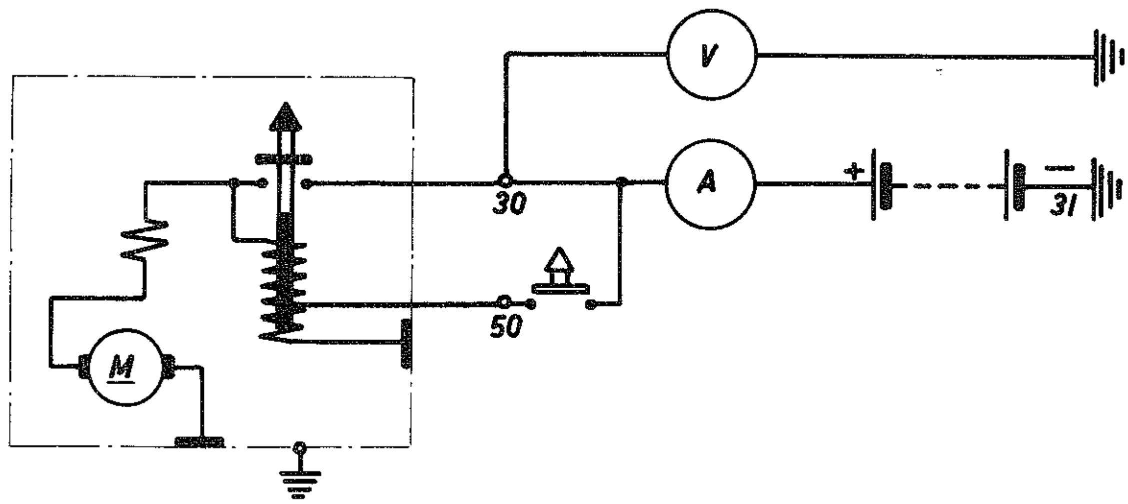
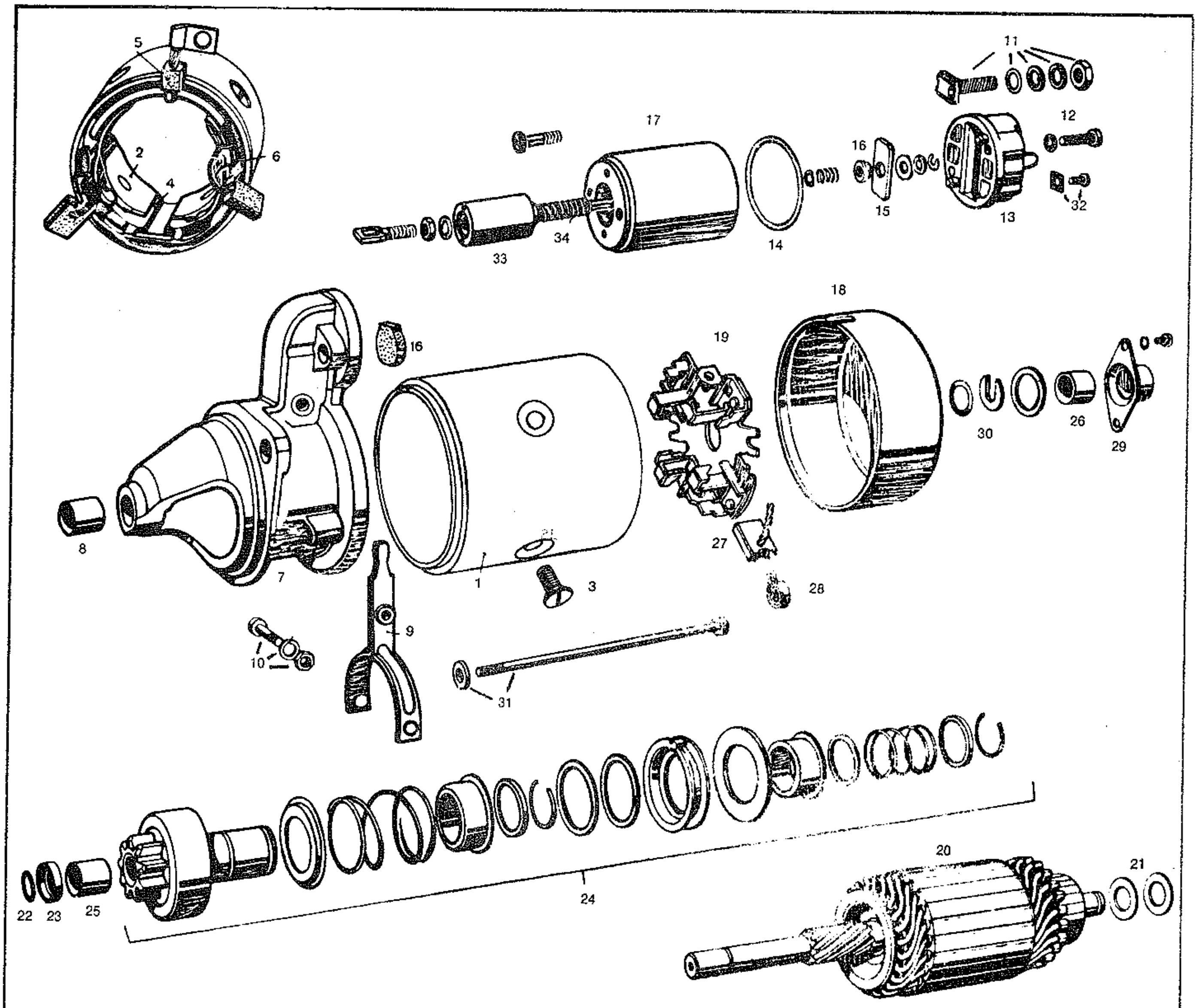


Fig. 1 – Wiring diagram for electrical tests of starter motor



1	Starter Housing	20	Armature
2	Pole Shoe	21	Washers
3	Pole Screw	22	Circlip
4	Field Coil	23	Retaining Ring
5	Grommet	24	Drive Clutch and Pinion Assy.
6	Insulation	25	Pinion Bearing
7	Drive Eng. Housing	26	Bearing — Commutator End
8	Drive Eng. Bearing	27	Brush
9	Fork	28	Brush Spring
10	Pivot Bolt, Washer and Nut	29	End Cap
11	Terminal Bolt, Washers and Nut Solenoid Switch	30	Retaining Clip
12	Solenoid Cover Bolt and Washer	31	Bolt & Washer — Starter Assembly
13	Solenoid Cover	32	Primary Terminal Screw and Plate
14	Cover Gasket	33	Plunger Assembly
15	Retainer	34	Plunger Return Spring
16	Spacer		
17	Solenoid Assembly		
18	Commutator Cover		
19	Brush Holder Plate		

Fig. 2—Bosch Direct Drive Starter

(5) Remove the starter assembly through bolts and washers.
(6) Remove the commutator cover.
(7) Remove four brushes and brush holder plate.
(8) Withdraw armature with drive end housing and engaging fork.
(9) Remove the fork pivot bolt, washer and nut.
(10) Press retaining ring on armature shaft toward drive assembly.
(11) Remove the circlip.
(12) Remove drive clutch and pinion assembly.

Testing Starter Components

General

Replace any damaged parts. Electrical connections (terminal parts) must be in good clean condition. The drive assembly must slide easily on the armature shaft without jamming or binding. Engaging lever should move freely. Replace any bent parts. Re-tap damaged threads.

Field Coils

(a) Field coils should not be burnt or connections unsoldered and should not protrude beyond the pole-shoes.
(b) Disconnect all ground connections and connect high voltage test lamp from field winding connection to ground. Test lamp must not light.
(c) Separate field coils at junction and test for open circuits with a low voltage series light. Test lamp must light in continuity test.
(d) Field coils can be removed with an approved pole shoe screwdriver **(see Special Bosch Tools).**

Armature

(a) The armature must clear both pole shoes and field coils. Check for damage to insulation. The winding must not be larger than the diameter of the armature core.
(b) Check armature windings for short circuits using a growler.
(c) Test armature for grounded windings using a high voltage series lamp.

Commutator

The carbon brushes should show a uniform grey-blue colour and be free from oil or dirt. The commutator should not be eroded or out of round in excess of specified limit. Should it be necessary to re-dress the commutator, ensure that its minimum diameter specification is not exceeded.

Undercut mica between segments to a depth of 0.8 mm (1/32") using a ground down hacksaw blade or undercutting machine.

Carbon Brushes

Make sure brushes slide smoothly in their holders, that the brush connections are good, and that the brushes themselves are clean and not chipped. Brushes worn to less than 13 mm (1/2") should be replaced, at which time the commutator must be machined. Always replace the complete brush set with genuine replacement parts. Check brush spring tension according to the prescribed specification. Lift brush with spring balance, taking care that balance joins spring at point of contact with the brush and that the pull is exerted parallel to the brush holder.

Replace weak springs with genuine replacement parts.

Bearings

Replace worn bearings by pressing the old bushing out with a correctly fitting mandrel and press the new bushing into place in a like manner. New sintered bushings should be soaked in oil for one hour before installation.

Solenoid Switch

Remove switch cover fastening screws and inspect contact bolts and contact plate for excess burning. Replace burnt contacts. The thickness of the contacts determines the switching reserve which is the plunger travel from the contact closing point to the fully pulled-in position.

Switch operation can be checked by connecting a battery supply through a variable resistance to both pull-in and hold-in windings and increasing the voltage gradually until at 8 volts or less the plunger moves into its operational position. The plunger should return to the rest position when the voltage is reduced to between 0.4 and 0.5 volts. A switch not operating according to these specifications must be replaced. Check adjustment of solenoid switch pull rod in its full "pull in" position. This should be 19 mm (3/4") from the inside face of the solenoid switch body to the outer edge of the slot in the pull rod which engages the operating lever. Adjustment can be carried out if required, by loosening the locknut and screwing the rod in or out the required amount. Tighten the locknut.

Re-Assembly

Re-assembly is a reversal of dis-assembly procedure, paying particular attention to ensuring a water tight seal is made at the rubber packing.

The starter motors have a rubber buffer fitted to the armature to absorb the return thrust of the drive assembly disengagement, to provide quieter operation.

Lubrication

(1) Saturate new self-lubricating bushings, in SAE 30 motor oil for 1 hour.

(2) Lightly lubricate the solenoid plunger sliding surfaces, yoke, lever contact areas and fulcrum bolt, starter drive assembly worn area and the armature shaft sliding, thrust and bearing contact areas, with graphited grease M.M.A.L. Part No. 3542158 only.

CAUTION: Do not lubricate commutator or brushes.

MECHANICAL ADJUSTMENTS

Armature End Play

Too little or too much end play results in increased wear of the bearings.

The end play is adjusted by adding or removing shims at the commutator end between the end cover and circlip on the armature. End play should be as specified.

Armature Braking Torque

The total armature braking torque is the force necessary to turn the armature against brush, bearing, and the auxiliary armature brake resistance. Too high a braking torque results in excessive mechanical wear and armature brake heating. Too low a braking torque results in extended starter stopping time. Also, the starter over-running acceleration will be too high.

Armature torque should be within specified limits and can be measured with a torque balance. **(See Bosch Tool List).**

Clutch Over-running Torque

The over-running torque of the clutch assembly is the force necessary to turn the pinion whilst the armature shaft is held stationary.

Too low an over-running torque may prevent starter power application. If the over-running torque is too high, the armature can reach too high a speed and may be damaged.

To measure over-running torque, move the pinion away from the armature at least 10 mm (0.4") with armature stationary and measure torque in direction of rotation. Reading should be inside specified limits. Assemblies not conforming to the specifications must be replaced.

SECTION 2H — MITSUBISHI DIRECT DRIVE STARTER

SPECIFICATIONS

Type	M3T12572	M3T15772/M3T25781	M4T14771
Manufacturer	Mitsubishi	<——	<——
Part Number	MD001553	MD021665/MD021674	MD021666
Output	0,7 kW (1.0 H.P.) 12V	0,9 kW (1.2 H.P.) 12V	1,2 kW (1.6 H.P.) 12V
Turning Direction	Clockwise from pinion side	<——	<——
Armature Shaft O.D. Service Limit			
— Front	11 mm (0.433")	<——	<——
— Rear	14,2 mm (0.559")	<——	<——
Stall Test @ 6V — Current	Less than 400A	Less than 560A	Less than 730A
— Torque	More than 9,2 Nm (6.73 lb./ft.)	More than 14,8 Nm (10.8 lb./ft.)	More than 24,4 Nm (18.1 lb./ft.)
No Load Test — Terminal Voltage	10.5V	11V	<——
— Current	Less than 53A	Less than 55A	Less than 62A
— Speed	More than 5000 r.p.m.	More than 6500 r.p.m.	More than 4500 r.p.m.
Load Test — Terminal Voltage	8,6V	9,6V	9,2V
— Current	150A	<——	200A
— Torque	More than 3,4 Nm (2.5 lb./ft.)	More than 3,0 Nm (2.2 lb./ft.)	More than 5,2 Nm (3.8 lb./ft.)
— Speed	More than 1600 r.p.m.	More than 2200 r.p.m.	More than 1600 r.p.m.
Brush Length — New	17 mm (0.670")	<——	<——
— Service Limit	11,5 mm (0.453")	<——	<——
Brush Spring Load	14,7 N (3.3 lbs.)	<——	<——
Pinion Gap	0,5 to 2,0 mm (0.020" to 0.079")	<——	<——

TORQUE SPECIFICATIONS

Starter Mounting Bolt	19-28 Nm	14-21 ft./lbs.

GENERAL INFORMATION

The Mitsubishi starter motor is a direct cranking, four pole, four brush type with solenoid actuated positive pre-engaged pinion operation. The main battery supply is not connected until the pinion is in full engagement.

Operation

When the starting switch is activated, current flows to the magnetic switch which energises the pull-in and hold-in windings. The soft iron plunger is drawn in, moving the engaging lever, which in turn moves the drive assembly towards the ring gear. The coarse thread on the armature shaft causes the pinion to rotate and assist in engagement. When the pinion is fully meshed, the contacts in the solenoid switch are closed by the action of the soft iron plunger and the starter rotates and cranks the engine. When the starter rotates, the pull winding is de-energised by the isolation of its ground connection. When the engine speed exceeds that of the starter, the pinion rotates freely and engine acceleration does not affect the starter.

The drive being under no load is pulled back by spring force, however, the pinion remains partly engaged as the starting switch is operating. When the starter switch is released, current flows through the pull-in winding in the reverse direction and the plunger is returned to its rest position by spring force.

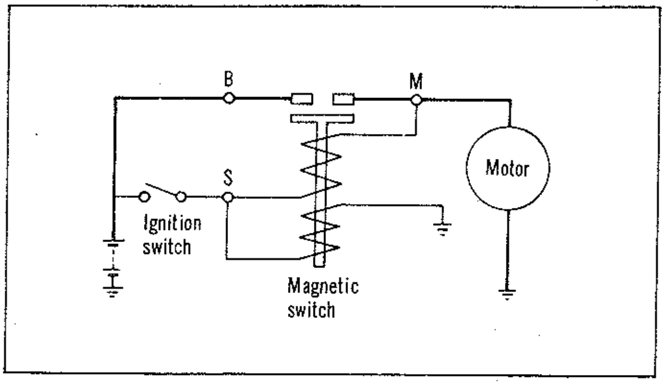
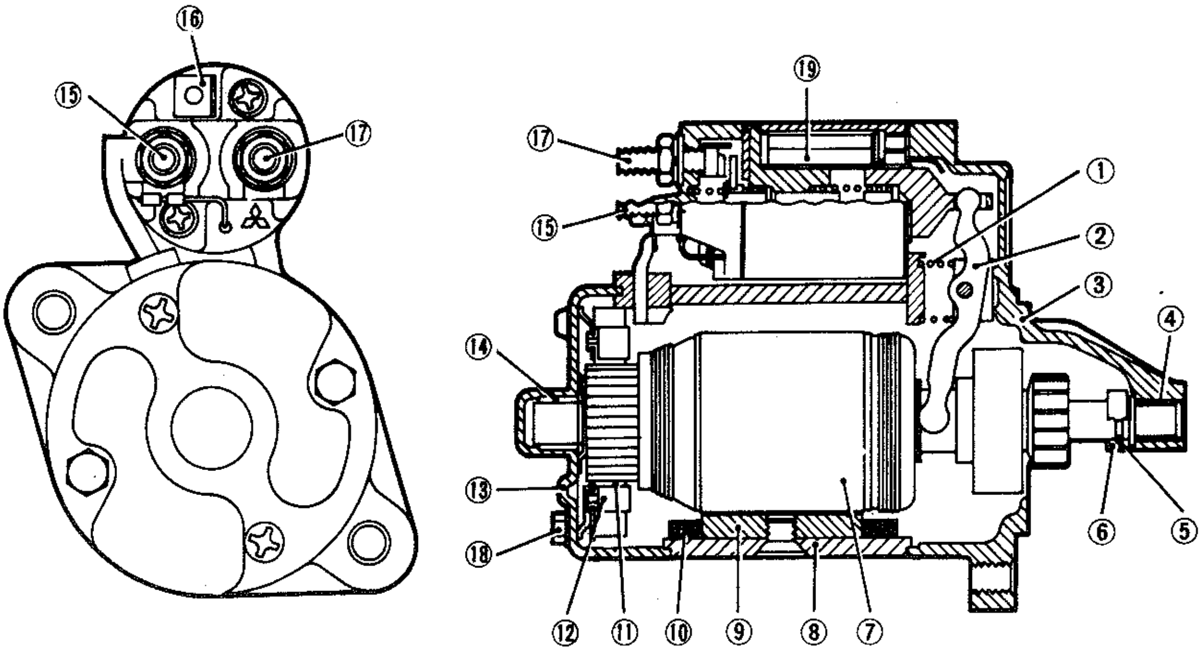


Fig. 1—Starter motor circuit



1. Spring
2. Lever
3. Drive housing
4. Bearing
5. Ring
6. Stopper
7. Armature
8. Yoke
9. Pole
10. Field coil
11. Brush
12. Brush holder
13. Commutator cover
14. Bearing
15. "M" terminal
16. "S" terminal
17. "B" terminal
18. Through bolt
19. Magnetic switch

Fig. 2—Starter motor—M3T12572 type

SERVICING THE STARTER

Removal

(1) Disconnect the negative (ground) battery cable from the battery.

(2) Disconnect the electrical leads to the starter.

(3) Remove the starter mounting bolts and remove starter from engine.

Installation

Install by reversing removal procedure ensuring that the starter to engine mounting surface is clean and that the bolts are torqued to specification.

Disassembly

(1) Remove the connector from the "M" terminal and then remove the solenoid mounting screws, the solenoid can now be removed.

(2) Remove the through bolts and separate the armature and yoke.

(3) Remove the armature and lever from the housing, noting the position of the lever and the order in which the spring and spring holder are installed.

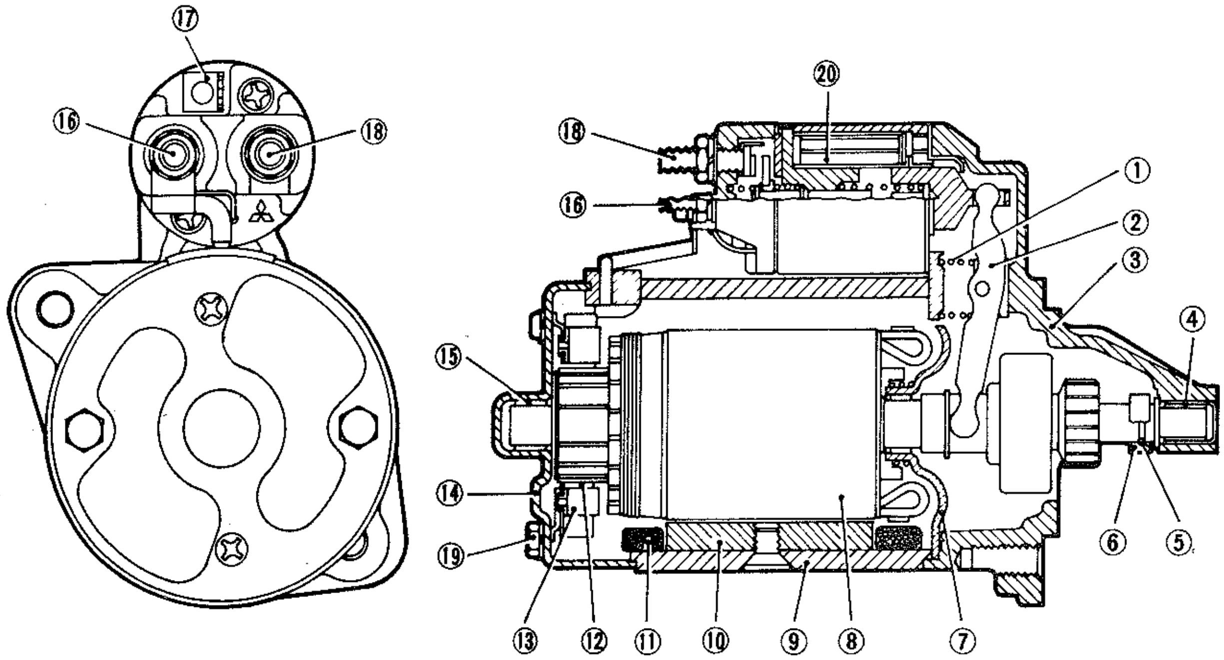
(4) Remove the armature shaft end washer.

(5) Remove the commutator cover screws and remove the cover.

(6) Remove the brushes (attached to the field coils) from the brush holder and remove the brush holder.

(7) Remove the centre bracket (M3T15772 and M4T14771 type starter).

(8) Remove the overrunning clutch by first striking the stop ring towards the clutch, remove the snap ring and then remove the clutch and stop ring.



1. Spring
2. Lever
3. Drive housing
4. Bearing
5. Ring
6. Stopper
7. Centre bracket
8. Armature
9. Yoke
10. Pole
11. Field coil
12. Brush
13. Brush holder
14. Commutator cover
15. Bearing
16. "M" terminal
17. "S" terminal
18. "B" terminal
19. Through bolt
20. Magnetic switch

Fig. 3—Starter motor—M3T15772, M4T14771 type

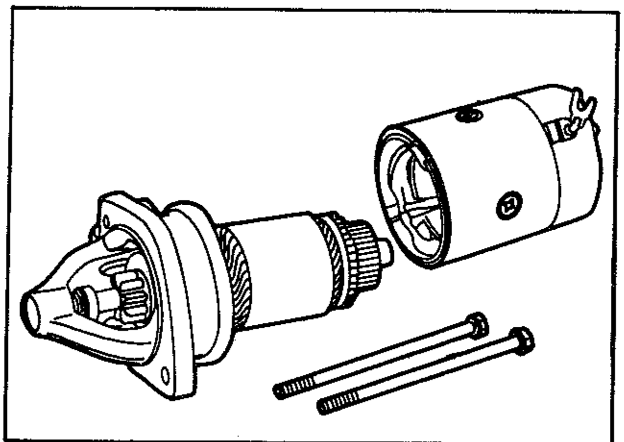


Fig. 4—Armature and yoke disassembled

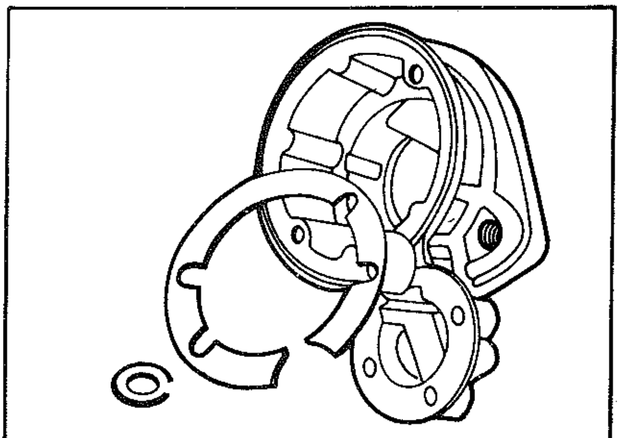


Fig. 5—Armature shaft end washer

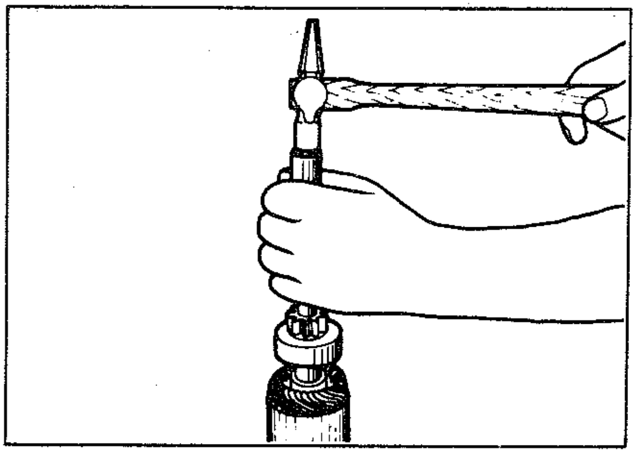


Fig. 6—Removing overrunning clutch

Testing Starter Components

General

Replace any damaged parts. Electrical connections (terminal parts) must be in good clean condition. The drive assembly must slide easily on the armature shaft without jamming or binding. Engaging lever should move freely. Replace any bent parts. Re-tap damaged threads.

Field Coils

(a) Field coils should not be burnt or connections unsoldered and should not protrude beyond the pole-shoes.
(b) Disconnect all ground connections and connect high voltage test lamp from field winding connection to ground. Test lamp must not light.
(c) Separate field coils at junction and test for open circuits with a low voltage series light. Test lamp must light in continuity test.
(d) Field coils can be removed with an approved pole shoe screwdriver.

Armature

(a) The armature must clear both pole shoes and field coils. Check for damage to insulation. The winding must not be larger than the diameter of the armature core.
(b) Check armature windings for short circuits using a growler.
(c) Test armature for grounded windings using a high voltage series lamp.

Commutator

The carbon brushes should show a uniform grey-blue colour and be free from oil or dirt. The commutator should not be eroded or out of round in excess of specified limit. Should it be necesary to re-dress the commutator, ensure that its minimum diameter specification is not exceeded.

Undercut mica between segments to a depth of 0.8 mm (1/32") using a ground down hacksaw blade or undercutting machine.

Carbon Brushes

Make sure brushes slide smoothly in their holders; that the brush connections are good, and that the brushes themselves are clean and not chipped. Brushes worn to less than specified limit should be replaced, at which time the commutator must be machined. Always replace the complete brush set with genuine replacement parts. Check brush spring tension according to the prescribed specification. Lift brush with spring balance, taking care that balance joins spring at point of contact with the brush and that the pull is exerted parallel to the brush holder.

Replace weak springs with genuine replacement parts.

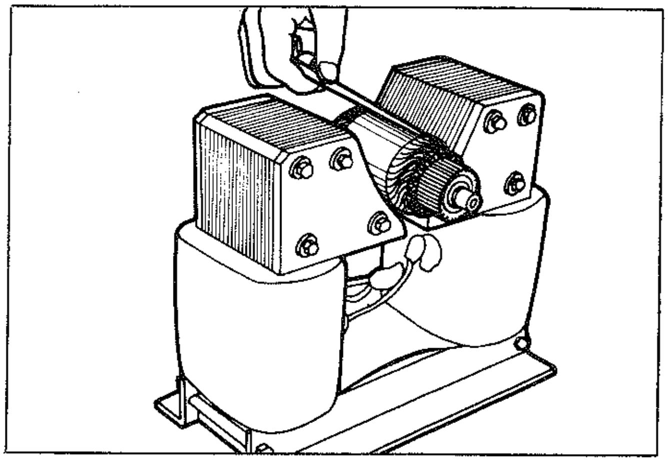


Fig. 7—Testing armature in growler

Check brush holder for grounds by testing for continuity between the (+) brush holder and the brush holder base. If there is continuity replace the holder assembly.

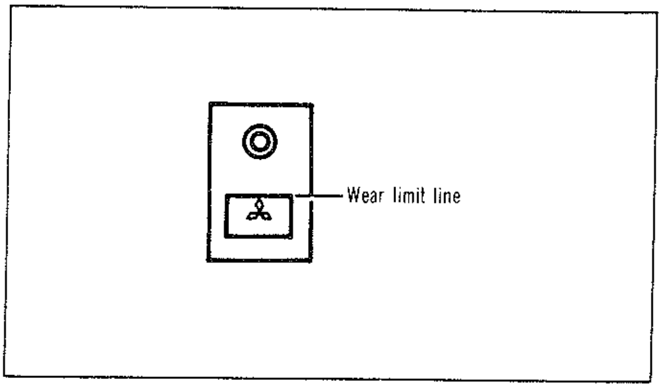


Fig. 8—Brush wear limit mark

Bearings

Replace worn bearings by pressing the old bushing out with a correctly fitting mandrel and press the new bushing into place in a like manner. New sintered bushings should be soaked in oil before installation.

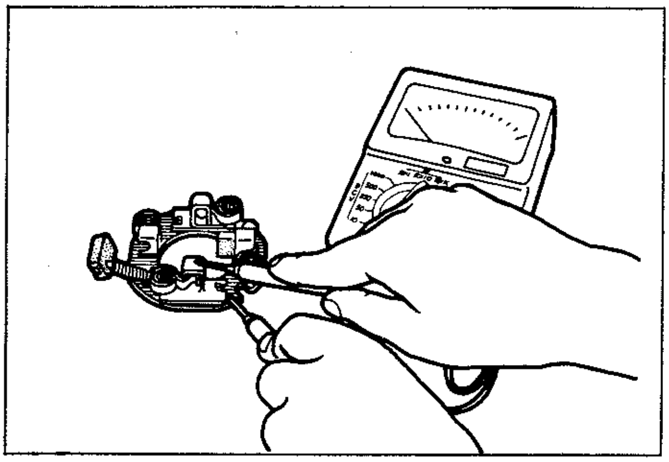


Fig. 9—Brush holder ground test

Assembly

Assemble starter by reversing disassembly procedure, noting the following—

(1) For ease of assembly, the armature, yoke and brush holder should be assembled first.

(2) When fitting the overrunning clutch, position the clutch and stop ring on the shaft and fit the snap ring securely. The stop ring can then be positioned in place against the snap ring.

ELECTRICAL TESTS OF STARTING MOTOR

The electrical test values depend upon the condition of the battery (capacity and charge). The testing period also plays an important part (heating of the starter, and battery discharge). The unavoidably long cables on the test bench at times also influence starter performance. The test period should therefore be as short as possible. The batteries must be in good condition and well charged or the electrical values of a faulty starter will differ considerably from the specified test data.

Stall Test

If test bench is available, install starter motor in test bench. Follow instructions of test equipment manufacturer and check stall torque of starter. With the starter locked and battery current applied, quickly note the voltmeter and ammeter readings. Amperage reading should be as specified (Fig. 10).

No Load Test

Mount starter on test bench for free running test. Hook up as shown in test wiring diagram (Fig. 10). Take readings of starter current draw, voltage and r.p.m. They should be within specifications.

Load Test

If test equipment available include provision for carrying out a load test, hook up as in stall test. Operate starter and brake until the prescribed current draw is reached, and read voltage and r.p.m. Readings should be as specified.

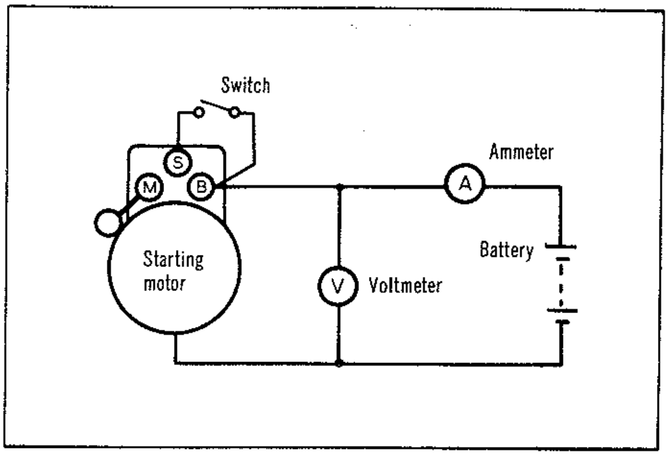


Fig. 10—Test connections

Pull-in Coil Test

Connect the starter as shown in Fig. 11, note that "M" terminal is disconnected. If the pinion comes out smoothly, the pull-in coil is operating correctly.

NOTE: Do not apply current for more than 10 seconds.

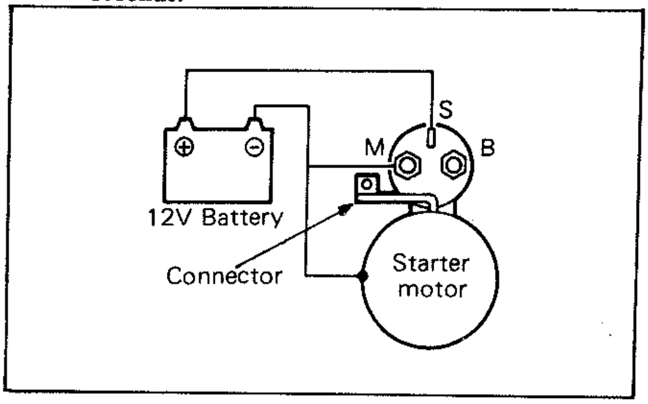


Fig. 11—Pull-in coil test connection

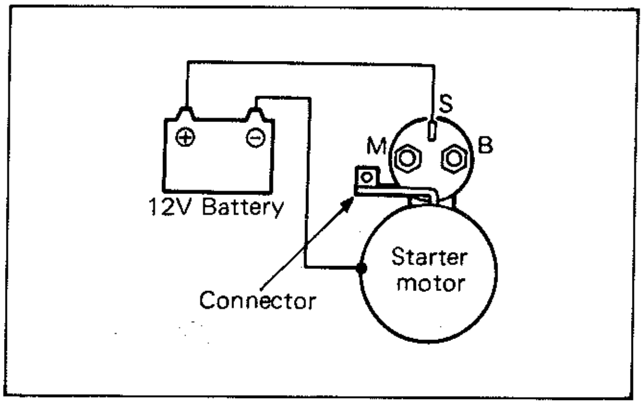


Fig 12—Holding coil test connections

Holding Coil Test

Connect the starter as shown in Fig. 12. Pull out the pinion by hand, as far as the pinion stopper and then release it. If the pinion does not return the holding coil is operating correctly.

NOTE: Do not apply current for more than 10 seconds.

Pinion Operation

Connect the starter as shown in Fig. 13. Pull out the pinion by hand as far as the pinion stopper and then release it. If the pinion returns quickly, both coils are operating correctly.

NOTE: Do not apply current for more than 10 seconds.

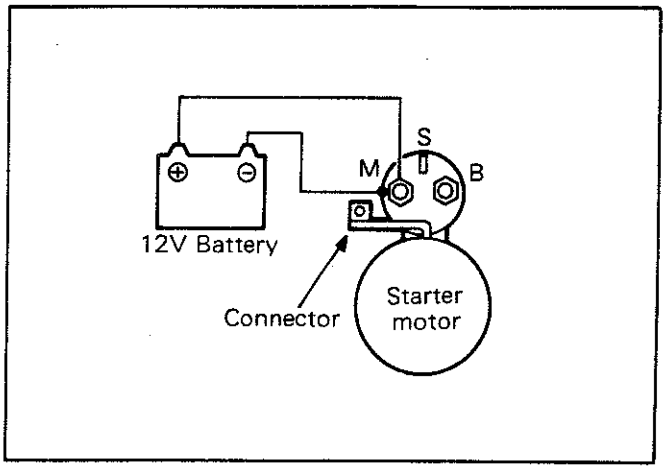


Fig. 13—Pinion operation test connection

MECHANICAL ADJUSTMENTS

Pinion Gap

With starter removed disconnect the lead to the "M" terminal and connect a 12V battery between the "M" terminal and the starter motor body. This will move the pinion to the engaged position. With the pinion in this position check the gap between the pinion and the stopper ring. If the gap is not as specified, check the solenoid for defects or the lever for incorrect installation.

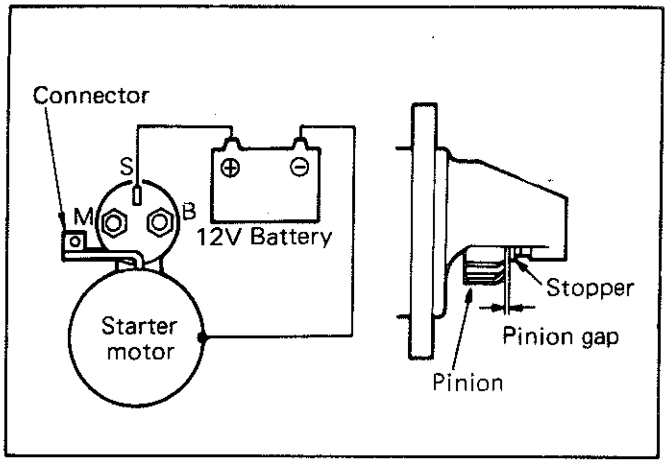


Fig. 14—Checking pinion gap

SECTION 3 — ALTERNATOR and VOLTAGE REGULATOR

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
ALTERNATOR FAILS TO CHARGE (No Output or Low Output)	(a) Alternator drive belt loose.	(a) Adjust drive belt to specifications.
	(b) Regulator Base improperly grounded.	(b) Connect regulator to a good ground.
	(c) Worn brushes and/or slip rings.	(c) Install new brushes and/or slip rings.
	(d) Sticking brushes.	(d) Clean slip rings and brush holders. Install new brushes if necessary.
	(e) Open field circuit.	(e) Test all the field circuit connections, and correct as required.
	(f) Open charging circuit.	(f) Inspect all connections in charging circuit, and correct as required.
	(g) Open circuit in stator windings.	(g) Remove alternator and disassemble. Install new stator if necessary.
	(h) Open rectifiers.	(h) Remove alternator and disassemble. Test the rectifiers. Install new rectifiers if necessary.
	(j) Blown fusible wire in voltage regulator.	(j) Replace wire.
LOW UNSTEADY CHARGING RATE	(a) High resistance in body to engine ground lead.	(a) Tighten ground lead connections. Install new ground lead if necessary.
	(b) Alternator drive belt loose.	(b) Adjust alternator drive belt.
	(c) High resistance at battery terminals.	(c) Clean and tighten battery terminals.
	(d) High resistance in charging circuit.	(d) Test charging circuit resistance. Correct as required.
	(e) Open stator winding.	(e) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.
LOW OUTPUT AND A LOW BATTERY	(a) High resistance in charging circuit.	(a) Test charging circuit resistance and correct as required.
	(b) Shorted rectifier. Open rectifier.	(b) Perform current output test. Remove and disassemble the alternator. Test the rectifiers and install new rectifiers as required.
	(c) Grounded stator windings.	(c) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.
	(d) Faulty voltage regulator.	(d) Test voltage regulator.
EXCESSIVE CHARGING RATE TO A FULLY CHARGED BATTERY	(a) Faulty ignition switch.	(a) Install new ignition switch.
	(b) Faulty voltage regulator.	(b) Test voltage regulator. Adjust or replace as necessary.
OXIDISED OR BURNED REGULATOR CONTACTS	(a) High regulator setting.	(a) Adjust.
	(b) Regulator air gap incorrectly set.	(b) Adjust.
	(c) Shorted rotor field coil windings.	(c) Replace.
REGULATOR VOLTAGE COIL WINDING BURNED	(a) High regulator setting.	(a) Adjust.

Condition	Possible Cause	Correction
REGULATOR CONTACT POINTS STUCK	(a) Poor ground connection between the alternator and the regulator.	(a) Check ground connection, clean and adjust points.
NOISY ALTERNATOR	(a) Alternator mounting loose.	(a) Properly install and tighten alternator mounting.
	(b) Worn or frayed drive belt.	(b) Install a new drive belt and adjust to specifications.
	(c) Worn bearings.	(c) Remove and disassemble alternator. Install new bearings as required.
	(d) Interference between rotor fan and stator leads.	(d) Remove and disassemble alternator. Correct interference as required.
	(e) Rotor or rotor fan damaged.	(e) Remove and disassemble alternator. Install new rotor.
	(f) Open or shorted rectifier.	(f) Remove and disassemble alternator. Test rectifiers. Install new rectifiers as required.
	(g) Open or shorted winding in stator.	(g) Remove and disassemble alternator. Test stator windings. Install new stator if necessary.
	(h) Faulty battery (causing excessive charge rate).	(h) Replace battery.
EXCESSIVE AMMETER FLUCTUATION	(a) High resistance in the field circuit to the alternator or a faulty voltage regulator.	(a) Repair or replace the part concerned.

SECTION 3B — BOSCH ALTERNATOR WITH BUILT-IN ELECTRONIC VOLTAGE REGULATOR

SPECIFICATIONS

Manufacturer	Bosch
Bosch Part Nos.—40A	9 120 060 830
Chrysler Part Nos.	4065855
Nominal Voltage	12V
Polarity to Earth	Negative (—)
Number of Brushes	2
Brush Wear (minimum length protruding from holder)	5 mm (3/16")
Minimum Diameter of Slip Rings	27,30 mm (1.075")
Slip Ring to be True Within	0,030 mm (0.0012")
Claw Poles to be True Within	0,050 mm (0.0020")
Resistance — Stator	0,255 Ohms (+ 10% — 0)
— Rotor	2,9 Ohms (+ 10% — 0)
Wiring Loom Resistor	12,0 to 68,0 Ohms (Fitted to ammeter equipped vehicles)
Regulator Output Voltage	14,1 to 14,5 V
Output Test — 40 Amp Alternator	
— 1300 alternator r.p.m.	7A @ 14V
— 2000 alternator r.p.m.	23A @ 14V
— 6000 alternator r.p.m.	40A @ 14V
Alternator Pulley to Engine Pulley Ratio — Saturn	1.78:1
— Astron	2.18:1

NOTE: To obtain engine r.p.m. where alternator r.p.m. are quoted, divide the alternator r.p.m. by the alternator pulley to engine pulley ratio.

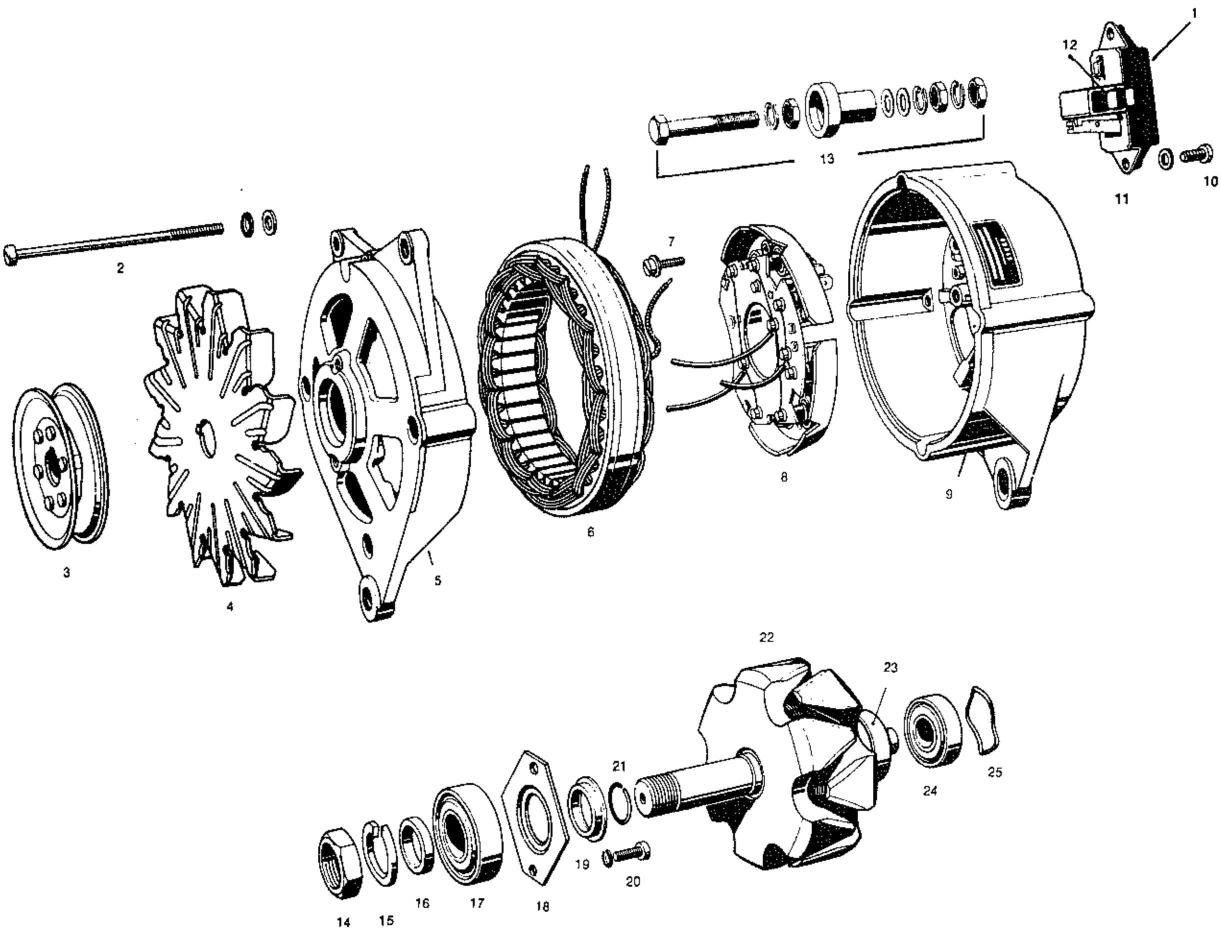
TORQUE SPECIFICATIONS

Pulley Nut	55 to 70 Nm (40 to 50 lb. ft.)
Through Bolts	4,0 to 5,4 Nm (33 to 47 lb. in.)

SPECIAL TOOLS

Battery Load Resistor	Bosch Tester EFAW107
Mounting Adaptor	EFLJ 54

Note: Above Tools are available from "BOSCH" Dealers



1. Voltage Regulator
2. Through Bolt
3. Pulley
4. Fan
5. Drive End Plate
6. Stator
7. Screw
8. Rectifier Assembly
9. Slip Ring End Housing
10. Screw
11. Brush Plate & Voltage Regulator
12. Brush Set
13. Output Terminal Assembly
14. Retaining Nut
15. Spring Washer
16. Spacer
17. Drive End Bearing
18. Bearing Retainer
19. Rotor Shaft Spacer
20. Screw
21. Circlip
22. Rotor
23. Slip Ring Assembly
24. Slip Ring End Housing Bearing
25. Wave Washer

Fig. 1—Exploded view of alternator

GENERAL INFORMATION

The Bosch alternator is designed for negative ground operation and has an external cooling fan retained by the drive pulley. A twelve pole rotor is used and the alternator output is rectified by heavy duty silicon diodes mounted in heat sinks for maximum cooling.

Six diodes are arranged in a three phase bridge connection whereby three diodes have cathodes connected to the output terminal (normal polarity) and three diodes have anodes at the housing (reverse polarity). Three smaller diodes are fitted into the rectifier assembly, these three smaller (exciter) diodes are located in an insulated heat sink (diode carrier) positioned between the two main diode heat sinks. These diodes allow a portion of the stator alternating current (after rectification to DC) to be routed for the excitation of the alternator field coil. A resistor in the wiring loom provides pre-excitation and prevents the exciter diodes from load sharing.

OPERATION — Alternator

With the ignition switch turned on and the engine running, the flow of current through the rotor field coil winding energises the rotating electro-magnet. The rotation of the rotor will cause the stator windings to cut the magnetic lines of force of the rotor. This induces an AC current voltage in the stator windings. The rectifiers convert the (AC) alternating current to (DC) direct current at the output terminal, to carry the electrical load and charge the battery.

The rectifiers prevent the battery from discharging through the alternator.

As the rotor speed increases, the induced voltage in the stator windings increases causing more current to flow to satisfy the load requirements. However, there is another factor, commonly known as "inductive reactance" which has an important bearing on current control.

"Inductive reactance" is a counter voltage (voltage of opposite polarity) which is also induced in the stator windings. The voltage tends to oppose the "induced" voltage in the stator windings.

As the rotor speed increases, the counter voltage also increases. By designing the correct size and shape of rotor and stator, the selection of the correct size and number of windings, the correct air gap between the rotor poles and stator and other design features, the alternator permits "inductive reactance" to limit output current, therefore no current regulator is needed.

OPERATION — Voltage Regulator

Voltage from the D+ is supplied to the voltage divider R5, R6 and R7 (Fig. 6), R7 is adjusted to the correct value during production. The centre tapping of the voltage divider is taken to a zener diode through diode D2 which provides the necessary temperature compensation. The zener diode controls the base of transistor T3 which opens to ground when the set voltage is exceeded, rendering T3 conductive thus switching off T2 and T1, which are arranged in a Darlington pair.

With this switching action the current flow through the excitor winding and T1 to ground is interupted. With the collapse of the excitation the output voltage decreases until the zener diode blocks positive potential from reaching the base of T3. T1 and T2 now become conductive again and the output voltage will rise until the switching cycle is repeated.

Diode D1 protects transistor T1. Condenser C1 is a stabilising condensor to reduce any instability of the zener diode arrangement. In some circumstances a resistor between D+ and ground (R8) provides a permanent high resistance path between D+ and ground. Should the excitation circuit be interupted sufficient current will flow from the battery via the wiring loom resistor through R8 to ground, thus showing a no-charge condition.

TESTING THE CHARGING SYSTEM — ON VEHICLE

Diagnosis of the charging system is based on a series of tests that can be made on the vehicle. Before proceeding with the test, check that the excitation resistor in the wiring loom or charge indicator lamp (where fitted) is functional. A break in this circuit results in loss of pre-excitation.

The following precautions must be observed during testing.

(1) Test the battery. If it is not fully charged, install a fully charged battery for test purposes.

(2) Disconnect the battery negative cable before connecting test equipment.

(3) Test connections should NOT be in the form of alligator clips, etc., quick connectors should be used. This prevents them falling off during the test and causing diode failure.

(4) Do not operate the alternator with the battery disconnected.

(5) Do not disconnect battery during testing, as diode damage will result.

(6) Operate the engine to attain normal operating temperature.

Charging System Test

(1) Disconnect the battery ground cable to avoid accidental shorting.

(2) Disconnect the lead from the alternator main output terminal "B+".

(3) Connect a DC ammeter in series with the alternator "B+" terminal and the lead previously disconnected from the "B+" terminal.

(4) Connect the positive lead of a voltmeter to the alternator "B+" terminal and ground the negative lead to the alternator housing (D—).

(5) Connect the battery ground cable.

(6) Connect a tachometer, start the engine and adjust engine speed to give 4000 **alternator** r.p.m. (refer specifications).

(7) Switch on lights and/or accessories to obtain an 8-10 amp load on the test ammeter.

(8) Readjust alternator speed if necessary.

(9) Read the regulator output voltage within one minute of starting the test, the voltage should be as specified. If the voltage is not within specification replace the voltage regulator.

NOTE: The electronic regulator is temperature compensated and a decrease in regulated voltage of 0.03V will occur for every 10°C (18°F) temperature rise.

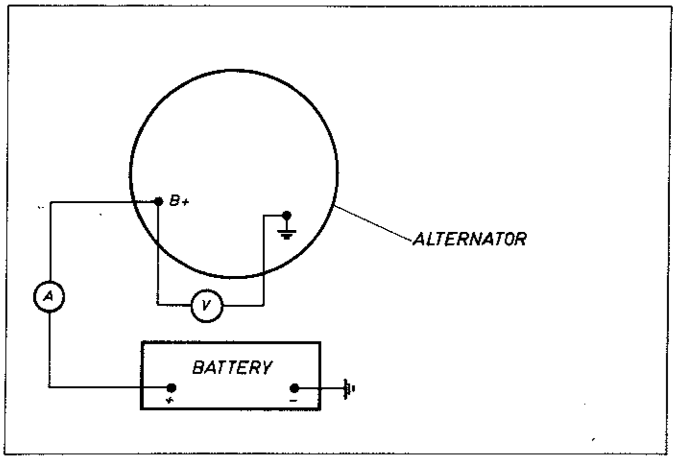


Fig. 2—Charging system test connections

Current Output Test

The current output test can be performed either on or off the vehicle. If off vehicle bench testing is performed, note the following:

- Ensure the fan and pulley is fitted.
- Do not use alligator clip type connectors.
- Connect a 12V battery in parallel with the machine.
- Connect a 12V, 2W lamp between the D+ and B+ terminals.

Testing

(1) Disconnect the battery ground cable.

(2) Disconnect the alternator "B+" terminal and connect an ammeter in series with the lead and terminal.

(3) Connect a voltmeter between the B+ and the alternator housing (D—).

(4) Connect a carbon pile rheostat across the battery (ensure it is in the off position) or a lamp bank of at least 600 watts.

(5) Connect the battery ground cable.

(6) Connect a tachometer, start engine.

(7) Adjust carbon pile to obtain a 14V output for the specified **alternator** speeds. This output should be maintained for 5 minutes prior to making test readings.

NOTE: The carbon pile or lamp bank must be turned off immediately the test is completed.

(8) The current output should be within the specified limits. If the output varies from that specified, the alternator should be removed and tested on the bench prior to dissassembly.

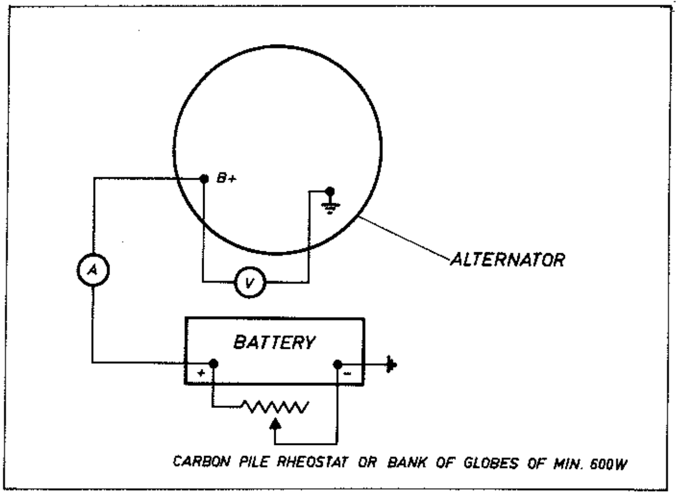


Fig. 3—Current output test connections

Voltage Regulator Test

Use a test unit as shown in Fig. 5 or an equivalent circuit, proceed as follows:

(1) Remove the screws retaining the regulator to the alternator and unsolder the cable from the regulator.

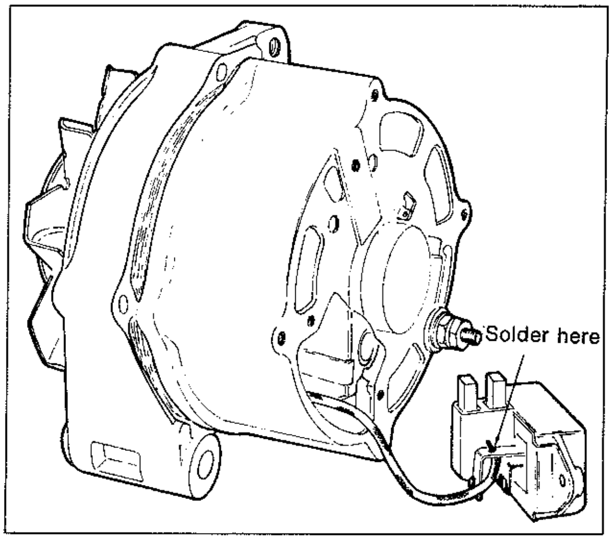


Fig. 4—Regulator cable connection

(2) Connect the D— lead of the test unit to the regulator base plate which is riveted to the regulator housing.

(3) Connect the D+ lead to the brush rail situated furthest from the regulator base plate.

(4) Connect the DF lead to the remaining brush rail (nearest to the base plate).

(5) Switch on test unit and rotate potentiometer until voltmeter reads 12V, the warning lamp should be fully on. If the lamp is not on the regulator is faulty.

(6) Slowly increase voltage until warning lamp turns off. Correct regulator operation is indicated by an extinguishing of the warning lamp within the specified limits, if the regulator does not switch within the specified limits, the regulator is faulty.

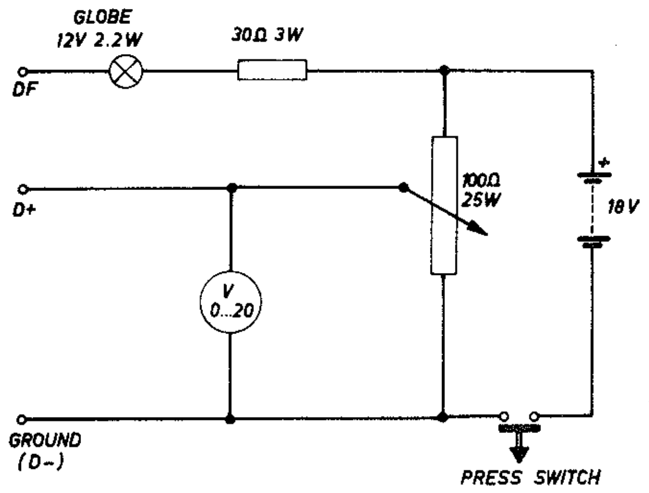


Fig. 5—Regulator testing unit circuit

ALTERNATOR

Removal

(1) Disconnect the positive battery terminal.

(2) Disconnect the B+ terminal lead.

(3) Disconnect the D+ terminal lead.

(4) Remove adjusting strap bolt at alternator end of strap.

(5) Remove pivot bolt attaching alternator to the engine block and remove alternator.

(6) Installation is the reversal of the above procedure.

Disassembly (Refer Fig. 1)

(1) Mark relative positions of the stator and the end plates.

(2) Remove brush holder/regulator screws and lift out assembly. Unsolder the cable from the regulator (Fig. 4).

(3) Remove the four through bolts.

(4) Withdraw drive end plate and rotor complete being careful not to lose wave washer from behind the bear'ng.

(5) Remove three rectifier retaining screws and nut and insulation components from "B+" terminal.

(6) Withdraw stator and rectifier assembly from end plate.

(7) The three stator connections can be unsoldered from the rectifier assembly for test purposes.

CAUTION: TO avoid the possibility of diode failure from excessive heat, a pair of pliers should be used to hold the diode side of this connection during soldering operations. This will dissipate any excess heat — see Fig. 7.

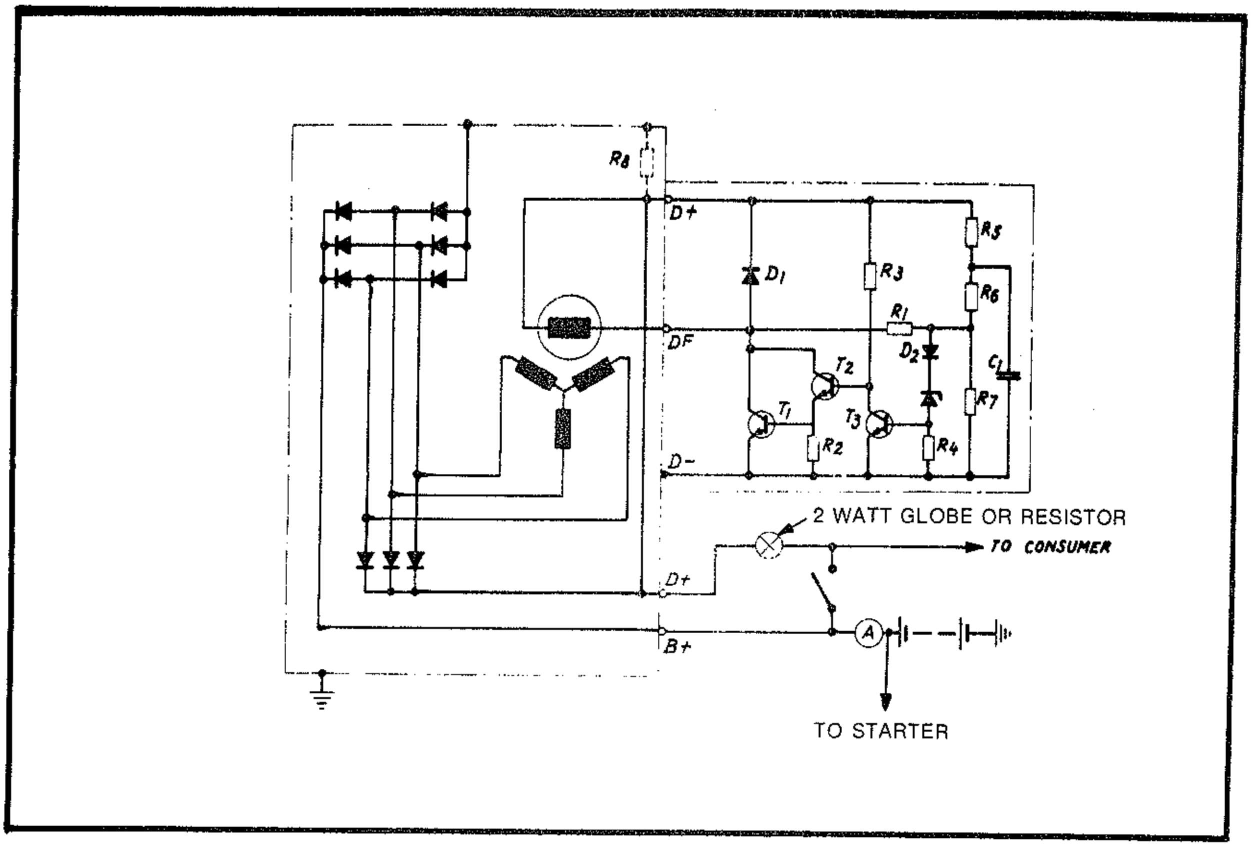


Fig. 6—Charging system

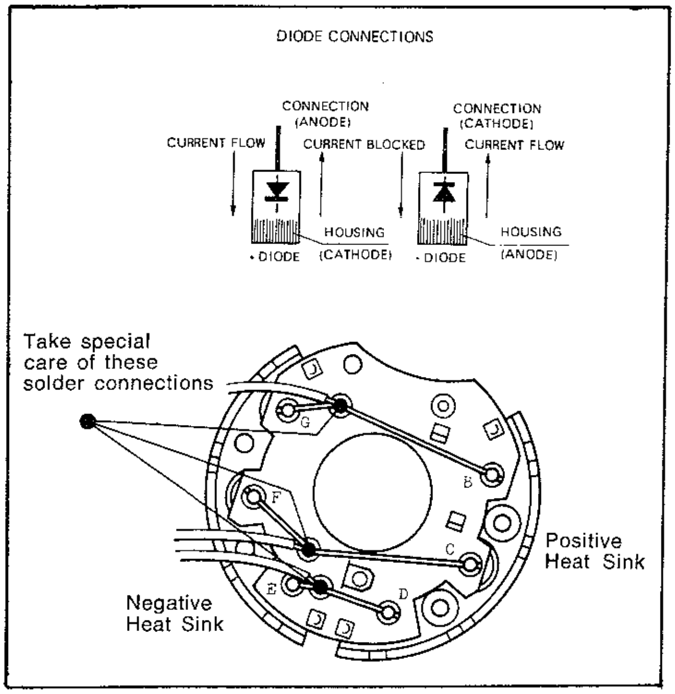


Fig. 7—Diode plate assembly

(8) Grip rotor in a vice equipped with soft jaws and unscrew the pulley retaining nut. The rotor may then be pressed out of the drive end bearing.

(9) Remove the two screws from the drive end bearing retainer and remove bearing. The rear bearing can be pulled from the slip ring end of the rotor shaft using a suitable puller.

(10) Clean all metal parts, except stator and rotor, with cleaning solvent and blow dry with compressed air. Ensure that the rectifier assembly is particularly clean to enable correct transfer of heat.

Inspection and Testing

(1) Test diodes with a series test lamp of up to 24 Volts DC. Apply the test probes between the connecting points (B, C, D and E, F, G) (Refer Fig. 7) and the heat sink. The positive probe of the test light should connect to the anode and the negative probe to the cathode.

NOTE: The housing will form the cathode on the positive heat sink and will form the anode on the negative heat sink (refer Fig. 7).

The test light should light up when connected in this manner, but not light when connected in the reverse direction. If diodes Sets G-B, F-C, or E-D are short circuited, all six diodes will shown a short circuit when tested with the test lamp. A short circuit is indicated if the test lamp lights when connected in both directions.

An open circuit is indicated if the test lamp does not light in either direction. If a diode failure is evident, the complete diode plate must be replaced.

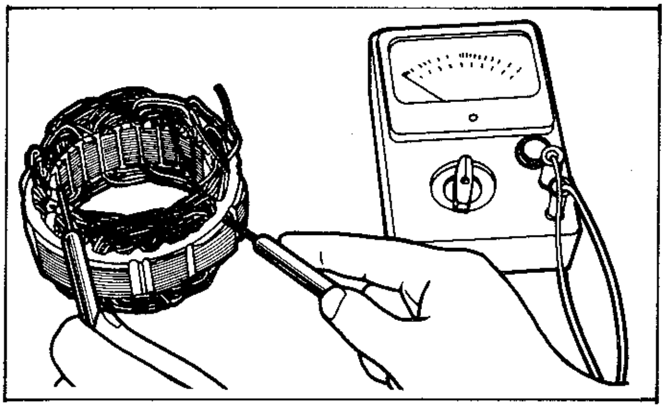


Fig. 8—Checking stator windings for grounds

(2) Test the stator windings with a low voltage test lamp (up to 40 volts) for grounding by connecting the test lamp between any stator lead and the frame. The windings are grounded if the lamp lights. This test can also be conducted using an ohmmeter, a low reading indicates grounded windings.

Measure the resistance between any two leads of the stator windings (see Fig. 9). If the readings are not as specified there is an open circuit in the stator windings. Test the remaining stator winding lead in a similar manner. This test can also be conducted using a low voltage test lamp, the lamp will not light if there is an open circuit.

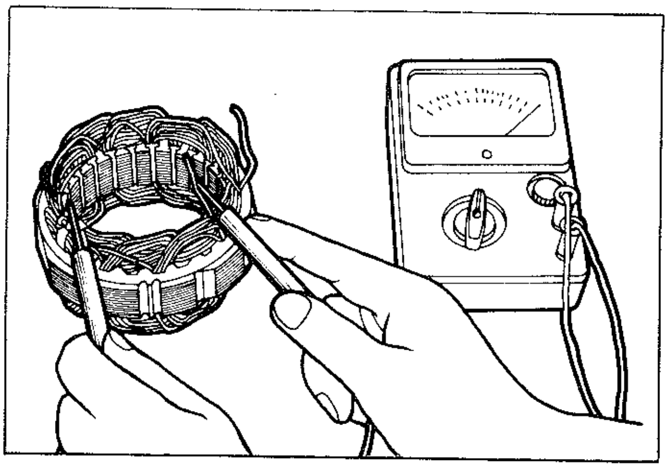


Fig. 9—Check stator windings for open circuit

(3) Test the excitor windings of the rotor for a short circuit to ground using a low voltage test lamp or an ohmmeter as shown in Fig. 10. Connect one test lamp or ohmmeter lead to the slip ring and the other lead to a pole piece. If the lamp lights or the ohmmeter reading is low, the field windings are grounded.

Connect one lead of a low voltage test lamp or ohmmeter to each slip ring to test for an open circuit. The lamp will fail to light or the ohmmeter reading will be high if there is an open circuit — see Fig. 11.

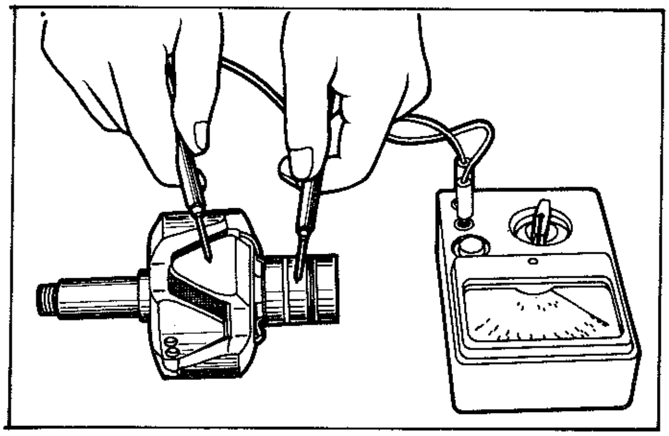


Fig. 10—Checking rotor for grounds

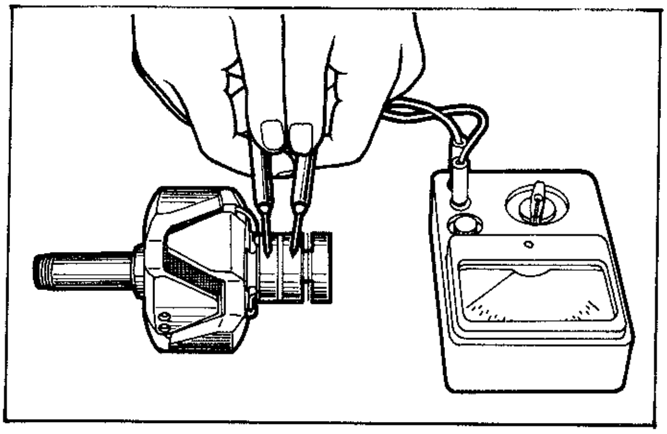


Fig. 11—Checking rotor for open circuit

Check the resistance of the field windings while the ohmmeter is connected for the test above. If the reading is not as specified, the windings are shorted.

NOTE: The three exciter diodes and heat sink are not serviced separately. Should an exciter diode fail it will be necessary to replace the complete assembly.

(4) Check the slip ring and brushes for condition and wear (refer to Specifications). Check brush springs for discolouration, etc., and replace as necessary.

(5) Replace worn bearings with approved replacement bearings only.

(6) Assemble the alternator (by reversal of the disassembly procedure), ensuring that the through bolts are tightened evenly and that the air gap between the rotor and the stator is equal at all points, if not loosen the through bolts again and reposition the end plates to the stator until the gap is equal, then retighten the bolts. Tighten the pulley nut to specifications.

(7) Position the alternator in Bosch adaptor EFLJ54 and set the unit in an approved test bench.

NOTE: The fan must be fitted while the alternator is under test. Do not use temporary connections and ensure that a 12 volt battery is connected in parallel with the alternator to act as a buffer to eliminate voltage peaks which will ruin the diodes.

(8) Connect the test bench voltmeter between B+ and the alternator housing and connect the ammeter between the B+ terminal and the B+ lead. Connect a 12V, 2W lamp between the D+ and B+ terminals. Connect a battery load resistor (Bosch tester EFAW107) in parallel with the battery.

(9) Start the test bench and increase the speed maintaining a reading of 14 volts by adjusting the load resistor.

(10) After the alternator has been running for approximately 5 minutes at maximum output, test output figures according to specifications.

SECTION 3C — MITSUBISHI ALTERNATOR AND VOLTAGE REGULATOR

SPECIFICATIONS

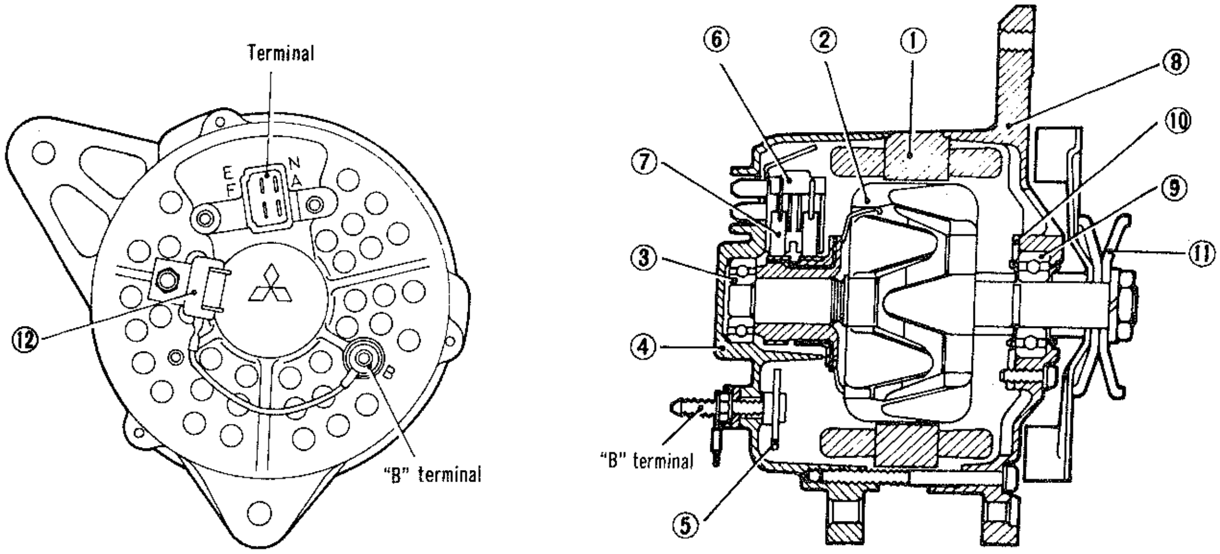
Alternator

Manufacturer	Mitsubishi
Nominal Voltage	12V
Polarity to Earth	Negative (—)
Capacity	45A
Number of Brushes	2
Brush Length — New	18,0 mm (0.709")
— Wear Limit	8,0 mm (0.315")
Brush Spring Tension — New	390 g (14 oz.)
— Wear Limit	220 g (8 oz.)
Slip Ring Diameter — New	33,0 mm (1.30")
— Wear Limit	32,2 mm (1.27")
Slip Ring Out of Round (Max.)	0,20 mm (0.008")
Output Test — 1300 alternator r.p.m. (or less)	15A @ 14V
— 2500 alternator r.p.m. (or less)	37A @ 14V
Alternator Pulley to Engine Pulley Ratio	2.22:1

NOTE: To obtain engine r.p.m. where alternator r.p.m. is quoted, divide the alternator r.p.m. by the alternator pulley to engine pulley ratio.

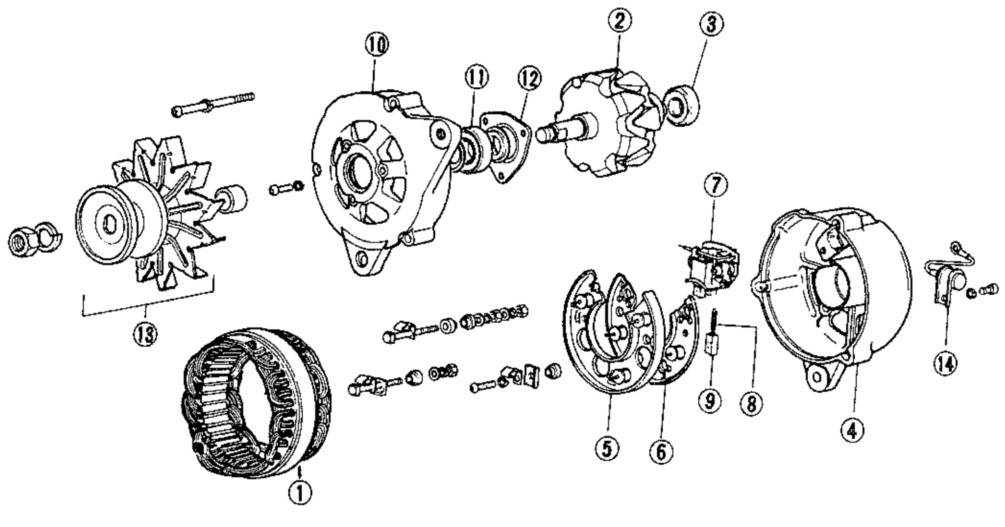
Voltage Regulator

Manufacturer	Mitsubishi
Polarity to Earth	Negative (—)
Adjustment Voltage	14,05 to 15,15V @ 30°C (86°F)
	14,20 to 15,30V @ 20°C (68°F)
	14,35 to 15,45V @ 10°C (50°F)
	14,50 to 15,60V @ 0°C (32°F)
Charge Lamp Relay — Light On	0,5 to 3,0V
— Light Off	4,2 to 5,2V



1 Stator	5 Rectifier assembly	9 Ball bearing
2 Rotor	6 Brush holder assembly	10 Bearing retainer
3 Ball bearing	7 Brush	11 Pulley
4 Rear housing	8 Front housing	12 Condenser

Fig. 1—Alternator sectioned view



1 Stator	6 Heat sink complete (—)	11 Ball bearing
2 Rotor	7 Brush holder assembly	12 Bearing retainer
3 Ball bearing	8 Brush spring	13 Pulley
4 Rear housing	9 Brush	14 Condenser
5 Heat sink complete (+)	10 Front housing	

Fig. 2—Alternator disassembled view

GENERAL INFORMATION

The alternator is designed for negative ground operation and has an external cooling fan retained by the drive pulley. A twelve pole rotor is used and the alternator output is rectified by diodes mounted in heat sinks for maximum cooling.

Six diodes are arranged in a three phase bridge connection whereby three diodes have anodes connected to the output terminal (normal polarity) and three diodes have anodes at the housing (reverse polarity).

OPERATION

With the ignition switch turned on and the engine running, the flow of current through the rotor field coil winding energises the rotating electro-magnet. The rotation of the rotor will cause the stator windings to cut the magnetic lines of force of the rotor. This induces an AC current voltage in the stator windings. The rectifiers convert the (AC) alternating current to (DC) direct current at the output terminal, to carry the electrical load and charge the battery.

The rectifiers prevent the battery from discharging through the alternator.

As the rotor speed increases, the induced voltage in the stator windings increases causing more current to flow to satisfy the load requirements. However, there is another factor, commonly known as "inductive reactance" which has an important bearing on current control.

"Inductive reactance" is a counter voltage (voltage of opposite polarity) which is also induced in the stator windings. The voltage tends to oppose the "induced" voltage in the stator windings.

As the rotor speed increases, the counter voltage also increases. By designing the correct size and shape of rotor and stator, the selection of the correct size and number of windings, the correct air gap between the rotor poles and stator and other design features, the alternator permits "inductive reactance" to limit output current, therefore no current regulator is needed.

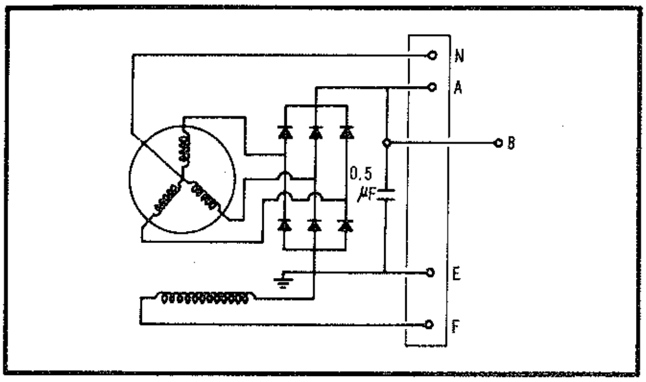


Fig. 3—Alternator circuit

ALTERNATOR OUTPUT TEST

Prior to testing the alternator the following precautions must be observed.

(1) Test the battery, if it is not fully charged install a fully charged battery for test purposes.

(2) Disconnect the battery negative cable prior to connecting test equipment.

(3) Test connections should **not** be in the form of alligator clips, etc., quick connectors should be used. This prevents them falling off during the test and causing diode failure.

(4) Do not operate the alternator with the battery disconnected.

(5) Do not disconnect battery during testing as diode damage will result.

Testing (On Vehicle)

(1) Disconnect the battery ground cable to avoid accidental shorting.

(2) Disconnect the main alternator output terminal "B".

(3) Install a test DC ammeter in series with the alternator "B" output terminal and the wire disconnected from the alternator.

(4) Connect a voltmeter positive lead to the alternator output terminal "B" and ground the negative lead to the alternator housing.

(5) Disconnect the four pin alternator terminal lead and connect a jumper lead between the "F" terminal and the alternator "B" terminal.

(6) Connect the battery ground cable.

(7) Connect a carbon pile rheostat across the battery, ensure it is in the off position.

(8) Connect a tachometer and start the engine.

(9) Adjust the carbon pile to maintain 14,0V on the test voltmeter, and adjust the engine speed to maintain the specified **alternator** r.p.m.

NOTE: Turn the carbon pile off immediately after the test is completed.

The current output should be within the limits shown in the specification. If the output varies from that specified the alternator should be disassembled and the components tested.

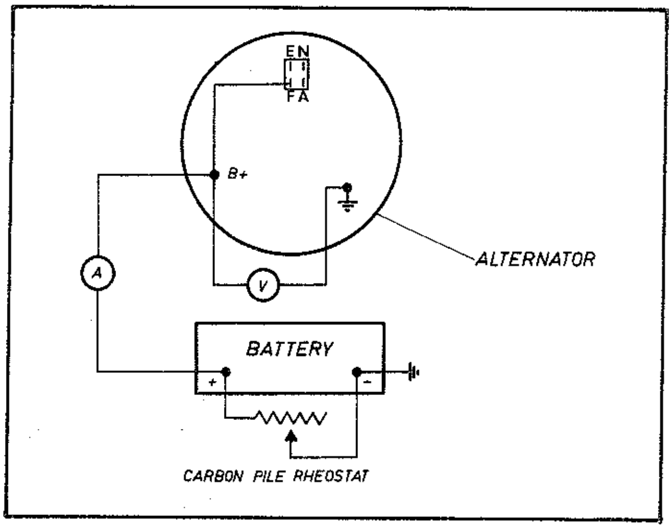


Fig. 4—Alternator test connections

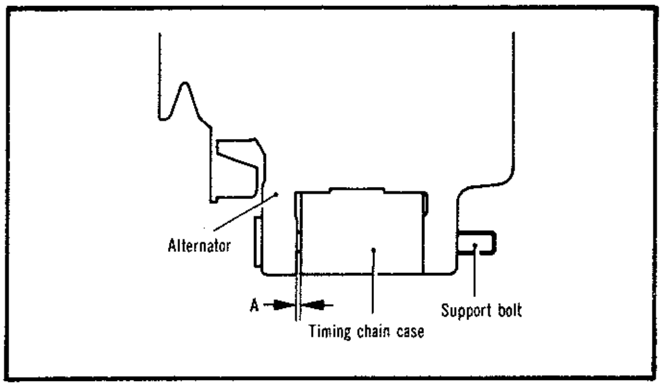


Fig. 5—Alternator mounting gap

ALTERNATOR

Removal

(1) Disconnect the battery negative cable.

(2) Disconnect the alternator B terminal lead and the wiring harness terminal block.

(3) Remove the adjusting strap bolt and the alternator mounting bolt.

(4) Disconnect the drive belt and remove the alternator, being careful to avoid loss of the alternator mounting packing shims.

Installation

Install by reversing removal procedure noting the following.

(1) Position the alternator on the engine and install the mounting bolt.

(2) Pull the alternator forward so that the rear mounting abuts the timing case.

(3) Measure the gap A (Fig. 5) and insert a suitable number of spacers.

(4) Adjust the drive belt tensions as described in Group 7 and tighten the mounting bolts to specification.

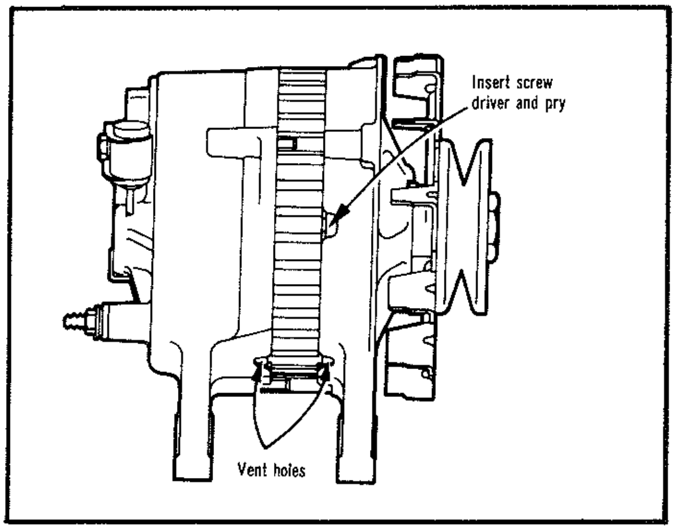


Fig. 6—Separating alternator housing

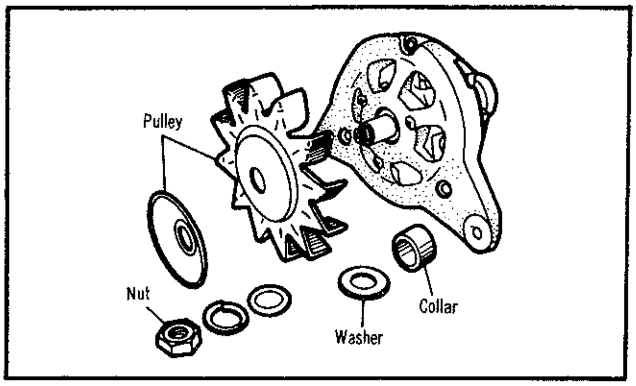


Fig. 7—Alternator front section disassembled

Disassembly

(1) Remove the alternator as previously described.

(2) Remove the housing through bolts.

(3) Remove the front section of the housing with the rotor assembly attached.

NOTE: The housing can be separated by prying with a screw driver in the slot provided, DO NOT insert the screw driver too far, or use the vent holes for prying.

(4) Secure the rotor in a vice equipped with soft jaws and remove the pulley nut, pulley, fan and collar.

(5) Remove the rotor from the housing and then remove the bearing retainer and bearing.

(6) Remove the brush holder mounting screws, rectifier mounting screws and the B terminal retaining nut. The brush holder, rectifier and stator can now be removed as an assembly.

(7) Removal of the brush holder or rectifier from the stator requires unsoldering of the stator leads.

NOTE: When unsoldering diode leads use care not to overheat the diode as damage may result.

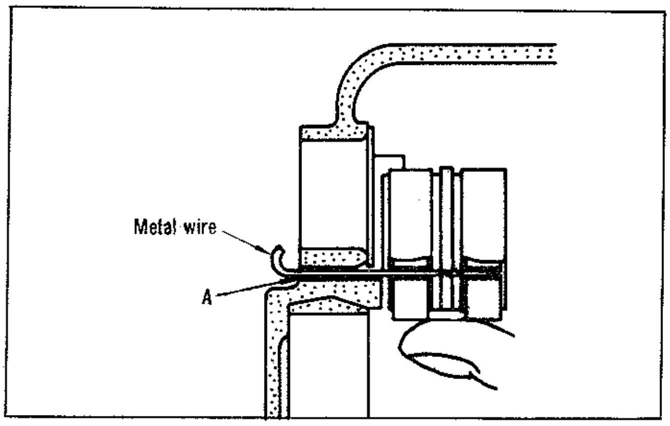


Fig. 8—Holding brushes in position

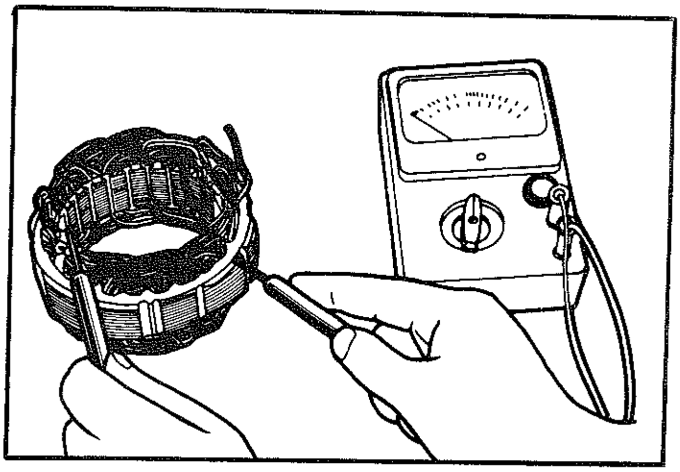


Fig. 9—Stator windings ground test

Assembly

Assemble by reversing disassembly procedure noting the following.

Prior to assembling housing halves, insert a suitable size wire through the rear housing and brushes to hold the brushes up on assembly.

After assembly check for free rotation of the rotor.

Inspection and testing

Diodes

The diodes can be tested with either a 24 volt DC series test lamp or an ohmmeter. Apply the test probes between the connecting point of the diode and the heat sink. If the diode is good the lamp will light (low resistance) when connected one way, will not light (high resistance) when connected the opposite way. A short circuit is indicated if the lamp lights (low resistance) when connected in either direction. An open circuit is indicated if the lamp does not light (high resistance) in either direction. If a diode failure is evident the diode plate must be replaced.

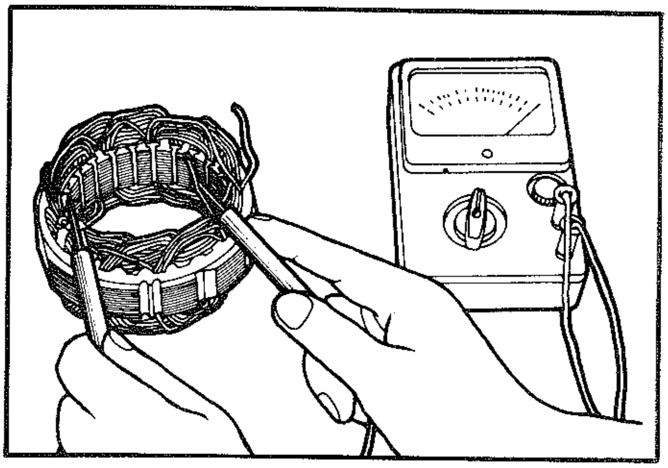


Fig. 10—Stator winding continuity test

Stator

Check the stator windings for grounding by connecting an ohmmeter between any stator lead and the frame (Fig. 9). The windings are grounded if a low reading is indicated.

Check the continuity between any two leads of the stator windings by connecting an ohmmeter between the leads (Fig. 10). The windings are open circuited if a high reading is indicated.

Rotor

Check the rotor circuit continuity by connecting an ohmmeter between the slip rings (Fig. 11). An open circuit will be indicated by a high resistance reading.

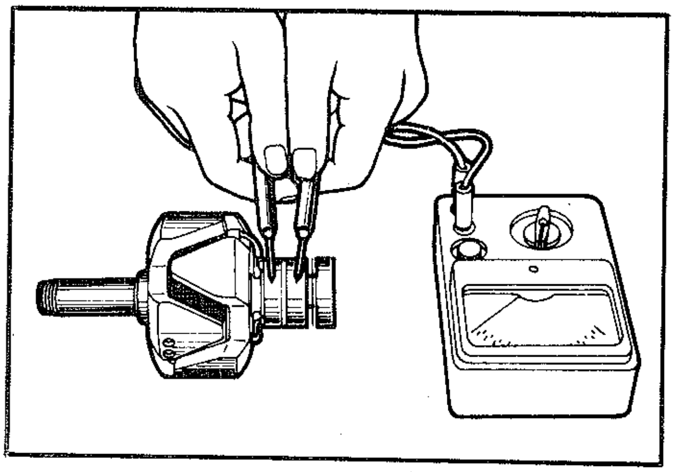


Fig. 11—Rotor continuity test

Check the field coils for grounds by connecting an ohmmeter between the slip ring and the shaft or core (Fig. 12). A ground will be indicated by a low resistance reading.

Check the slip rings for rough or damaged surfaces, if necessary they can be polished with fine sand paper. Excessively worn or damaged slip rings should be replaced.

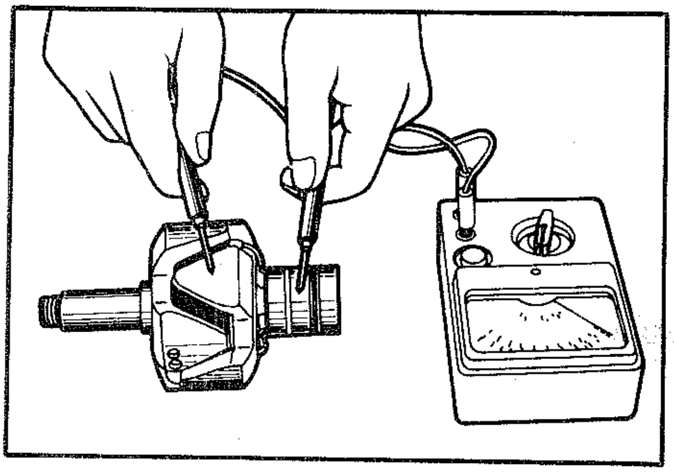


Fig. 12—Field coil ground test

Brushes

If the brushes are worn below the wear limit line they must be replaced. The brush spring tension should also be checked to specification. If the spring is weak, it should be replaced.

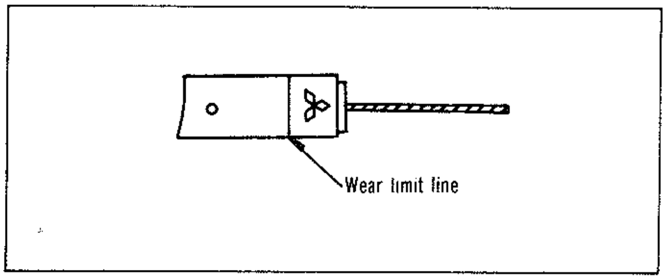


Fig. 13—Brush wear limit identification

VOLTAGE REGULATOR

The regulator consists of two relays, the constant voltage relay and the charge lamp relay. Both relays consist of an electro-magnet, contacts, frame, moving element and coil side plate. The regulator has a temperature compensation gradient which automatically adjusts the voltage relay output to temperature conditions, the higher the temperature the lower the output.

Adjustment

(1) Check the voltage regulator wiring connector for bent, damaged or corroded terminals. Prior to testing the unit ensure the wiring connector is fully inserted.

(2) Connect a voltmeter between the A and E terminals of the regulator.

(3) With the engine operating at idle speed disconnect either one of the battery terminals, this will ensure only the minimum load will be drawn from the alternator.

NOTE: Do not run the engine with the voltage regulator wiring connector disconnected.

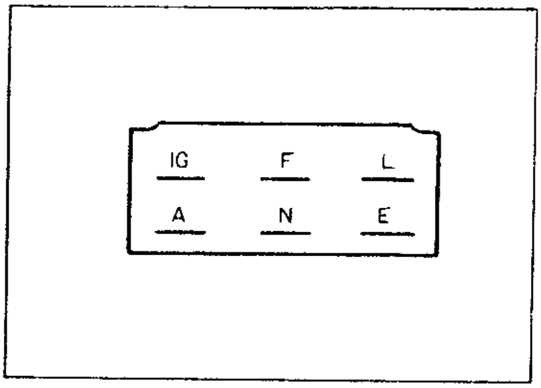


Fig. 14—Regulator connector (as viewed from terminal side)

(4) Raise the alternator speed to approximately 4000 r.p.m. (approximately 2000 engine r.p.m.).

(5) The voltage should be as specified for the temperature conditions.

(6) If the regulator requires adjustment, remove the cover and increase the contact spring tension to increase the voltage or decrease the tension to decrease the voltage. Adjust the spring tension as shown in Fig. 15.

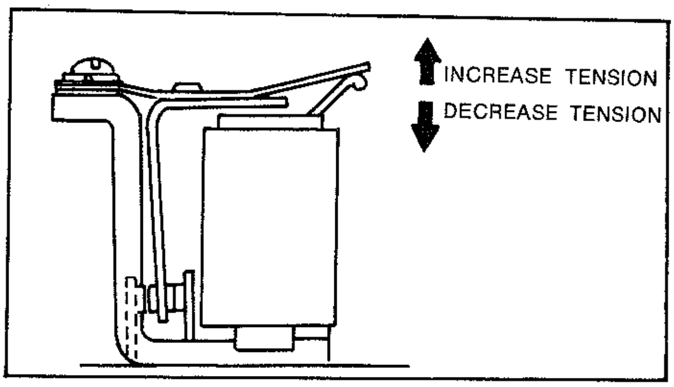


Fig. 15—Regulator adjustment

SECTION 3G — MITSUBISHI ALTERNATOR WITH BUILT-IN ELECTRONIC VOLTAGE REGULATOR

SPECIFICATIONS

Model No.	$AQ2250G_1$
Part No.	MD 022578
Manufacturer	Mitsubishi Elec.
Nominal Voltage	12V.
Polarity to Earth	Negative (—)
Capacity	50A
Rotation	Clockwise
Number of Brushes	2
Brush Length — New	18 mm (0.709")
— Wear Limit	8 mm (0.315")
Slip Ring O.D.	33 mm (1.299")
— Service Limit	32,2 mm (1.268")
Current Output-Alternator Hot at Constant 13,5 Volt at Alternator Speed	
1300 r.p.m.	16A
2500 r.p.m.	41A
5000 r.p.m.	48A
Regulated Voltage	14,1 to 14,7V. at 20° (68°F.)
Temperature Compensation Gradient	—0,1V/10°C. (50°F.)
Alternator Pulley to Engine Pulley Ratio	2.2:1

NOTE: To obtain engine r.p.m. where alternator r.p.m. is quoted, divide the alternator r.p.m. by the alternator pulley to engine pulley ratio.

TORQUE SPECIFICATIONS

Mounting Bolt	20 to 24 Nm (15 to 18 lb. ft.)
Adjusting Bolt	12 to 14 Nm (9 to 10 lb. ft.)

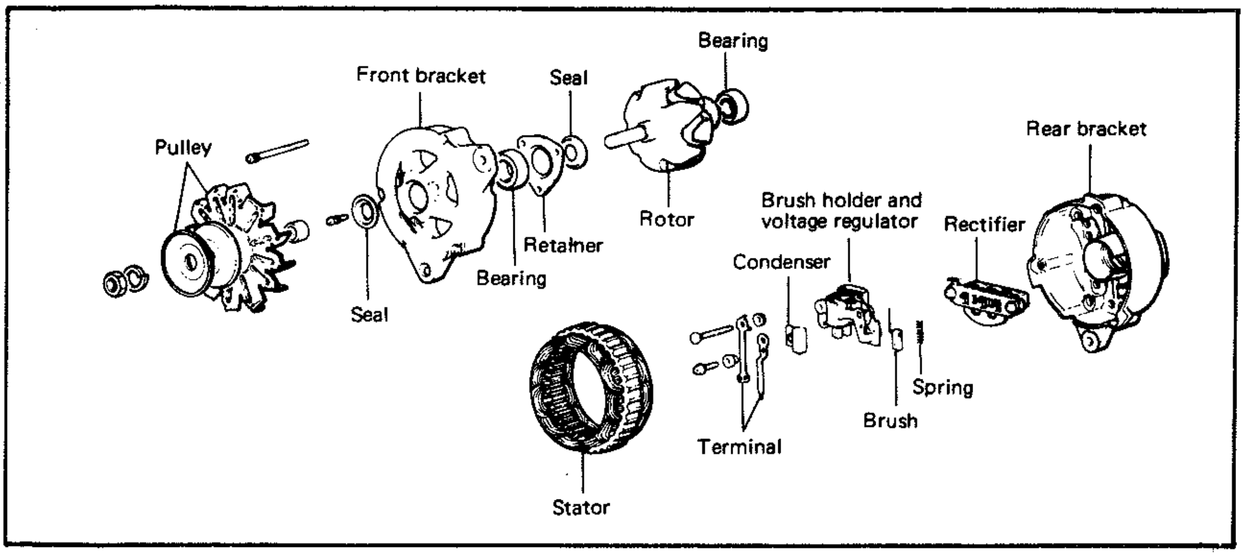


Fig. 1—Alternator disassembled view

GENERAL INFORMATION

The alternator is designed for negative ground operation with an external cooling fan retained by the drive pulley. This three diode excitation type alternator maintains a constant voltage by controlling the field current with the transistor of the integrated circuit regulator placed between the rotor coil and earth.

Operation

When the ignition switch is on and the engine is stationary, current flows from the battery positive terminal to the charge lamp and alternator L terminal, lighting the lamp. Current also flows from the battery positive terminal to the B terminal of the alternator. Some current flows from regulator L terminal to the base of transistor Tr_2 through base resistance, causing transistor Tr_2 to be ON. As a result, field current flows from both R and L alternator terminals through the rotor coils and transistor Tr_2.

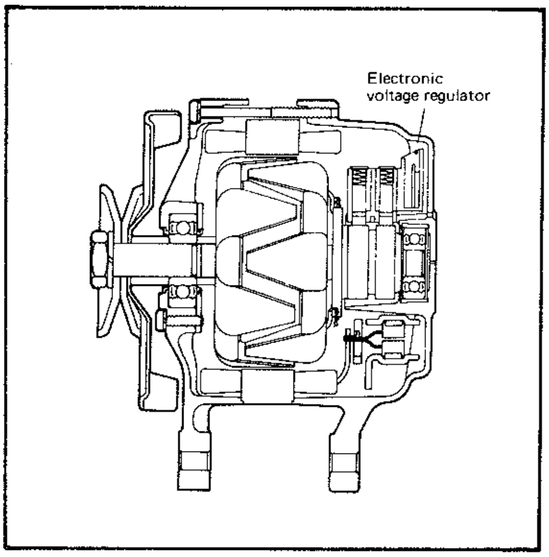


Fig. 2—Alternator sectioned view

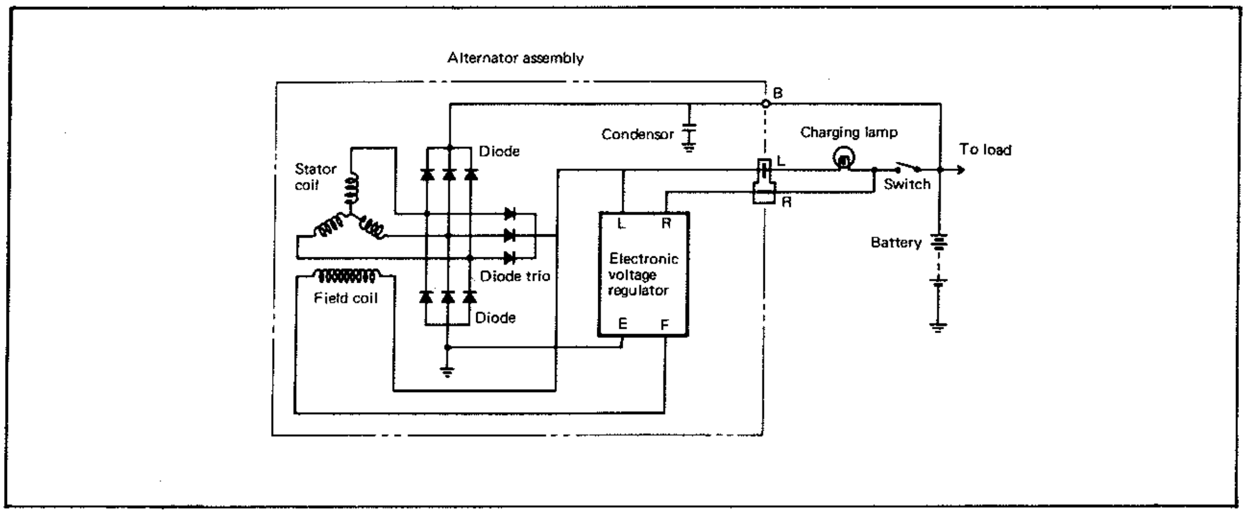


Fig. 3—Charging circuit

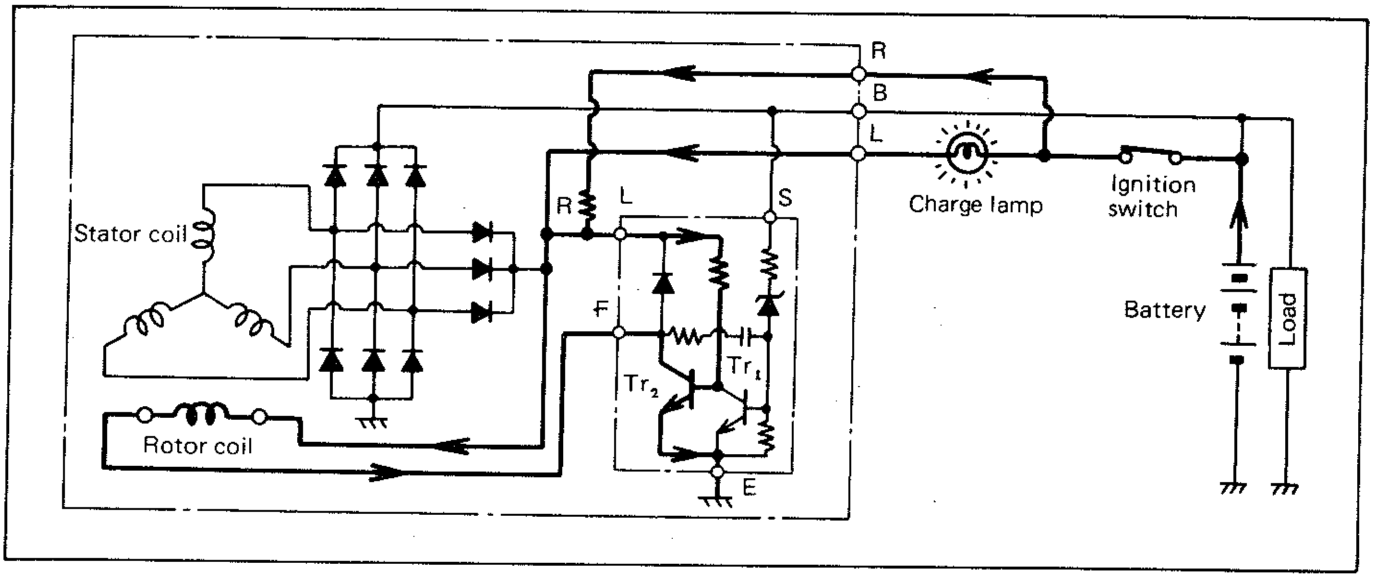


Fig. 4—Initial excitation circuit

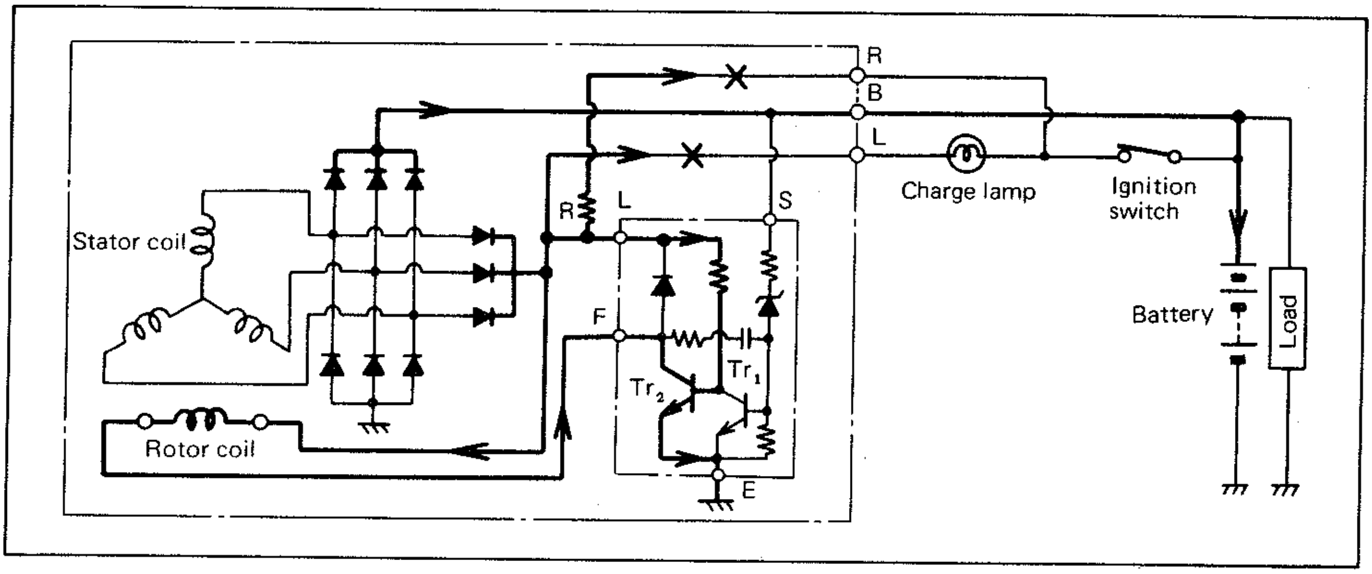


Fig. 5—Alternator starting to generate power

When the engine is started, alternator speed and output voltage increases. When output voltage exceeds battery terminal voltage, battery charge begins. At this point, there is no potential difference between L and B terminals at ends of charge lamp so that current ceases to flow through the lamp extinguishing it to indicate that battery charge has commenced. Current flows directly from the stator coil to the rotor coil of the aletrnator through the three diodes but current does not flow from the three diodes to the battery or load due to the lack of potential difference.

When the alternator output voltage exceeds the regulator setting, the zener diode is driven into the ON state. Alternator or output current flows through regulator S terminal to the zener diode to the base of transistor Tr_1 to emitter of the same transistor, causing transistor Tr_1 to be ON. Potential difference between the base and emitter of transistor Tr_2 is lost so that transistor Tr_2 is forced to the OFF state. Field current decreases and alternator output voltage falls. When output voltage falls below the regulator setting, current ceases to flow through the zener diode, causing transistor Tr_2 to be OFF. As a result, potential difference is created between the base and emitter of transistor Tr_2 causing transistor Tr_2 to be ON again. Field current begins to flow, rotor magnetic field becomes stronger and output voltage begins to increase.

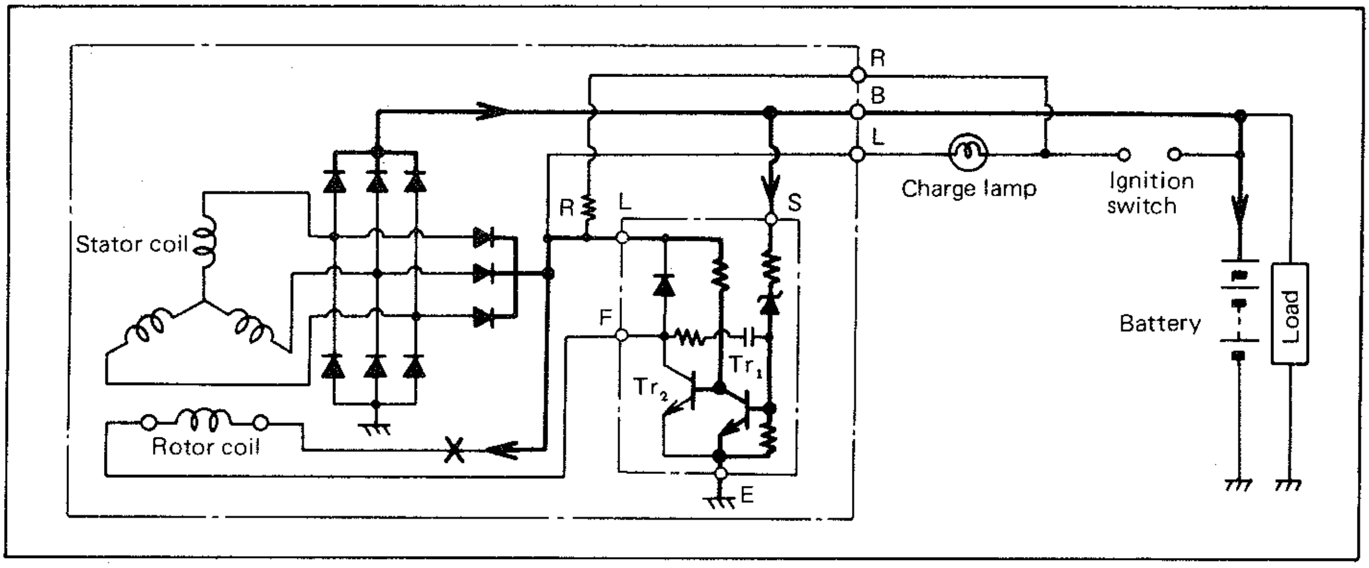


Fig. 6—Output voltage higher than regulator setting

As described previously, when alternator output voltage is lower than the regulator setting, transistor Tr_2 is switched ON allowing field current to flow. When output voltage becomes higher than regulator setting, transistor Tr_2 is forced to the OFF state blocking field current. Any change in alternator output is thereby sensed by the semiconductor system which instantly changes field current so that constant output voltage can be maintained at all times.

ALTERNATOR OUTPUT TEST (ON VEHICLE)

Charging Voltage Test

(1) Ignition switch OFF.

(2) Disconnect the cable from the positive terminal of the battery and connect an ammeter between the cable and positive terminal of the battery.

(3) Connect a voltmeter between the L terminal of the alternator and ground. Check to ensure that the voltmeter reading is "0" (zero). If the pointer of the voltmeter deflects (a voltage present), a defective alternator or wiring is suspected.

(4) Set the ignition switch to ON but do not start the engine. The voltmeter reading should be considerably lower than the battery voltage. If the voltmeter reading is much the same as the battery voltage, a defective alternator is suspected.

(5) With the ammeter terminals short-circuited, start the engine.

NOTE: Make sure that when the engine is started no starting current is applied to the ammeter.

(6) Increase the engine speed immediately to approx. 2000 to 3000 r.p.m. and take the ammeter reading.

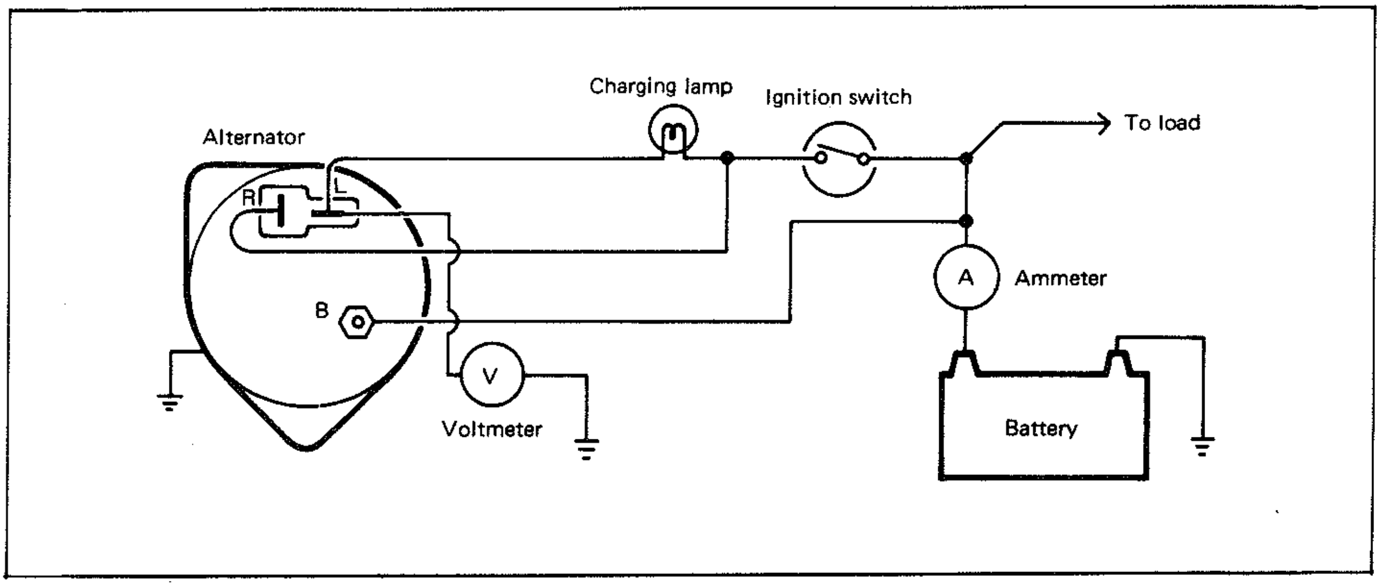


Fig. 7—Charging voltage test

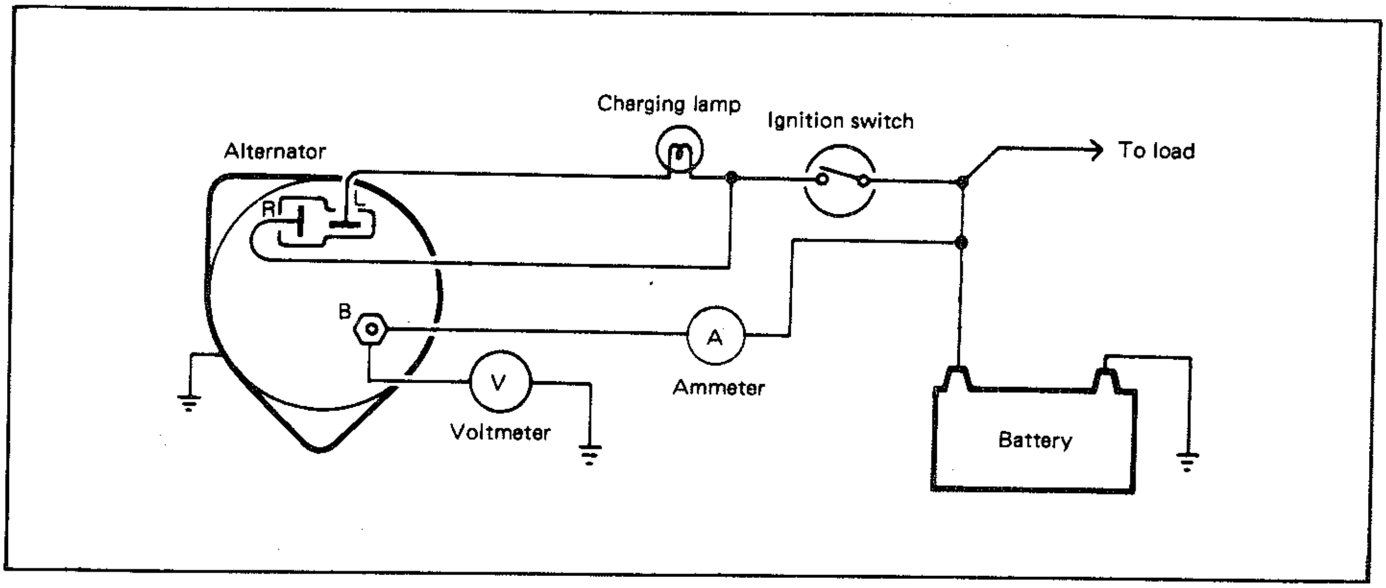


Fig. 8—Output inspection

(7) If the ammeter reading is 5A or less, take the voltmeter reading without changing the engine speed (2000 to 3000 r.p.m.). The reading is the charging voltage.

(8) If the ammeter reading is more than 5A, continue to charge the battery until the reading falls to less than 5A or replace the battery with a fully charged one. An alternative method is to limit the charging current by connecting a 1/4 Ohm (25W) resistor in series with the battery.

(9) Since the electronic voltage regulator is a temperature compensation type, the charging voltage varies with temperature. Therefore, the temperature around the rear housing of the alternator must be measured and the charging voltage corrected to the temperature, (see Specs.).

Output Inspection

(1) Place the ignition switch at OFF.
(2) Disconnect the battery ground cable.
(3) Disconnect the cable from the B terminal of the alternator and connect an ammeter between the B terminal and cable.
(4) Set the engine tachometer.
(5) Connect the battery ground cable to the battery. In this case, the voltmeter should indicate the battery voltage.
(6) Start the engine, turn on the head lamps, accelerate the engine to the specified speed and measure the output current. The output current should be close to specification.

Removal

(1) With the ignition switched OFF, disconnect the battery negative cable.
(2) Disconnect the cables from the "B" terminal and connector of alternator.
(3) Remove the alternator brace bolt and support bolt nut.
(4) Pull out the alternator support bolt and remove the alternator assembly.

Installation

(1) Align the hole in alternator leg with that in the front case and insert the alternator support bolt from the front side.
(2) Install the brace bolt.
(3) Install the belt.
(4) Push the alternator toward the front of the engine and check for a clearance (A) between the alternator leg and the front case or timing chain case. If the clearance is more than 0,2mm (0.008 in.) insert spacers [0,198mm (0.0078 in.) thick] as required. (Fig. 9).
(5) Remove the alternator support bolt, insert the spacers selected under the above item 4, reinsert the bolt, and tighten the nut.
(6) Adjust the belt tension.
(7) Tighten the alternator support bolt nut and brace bolt to the specified torque.
(8) Reconnect the "B" terminal and connector.
(9) Connect the battery negative cable.

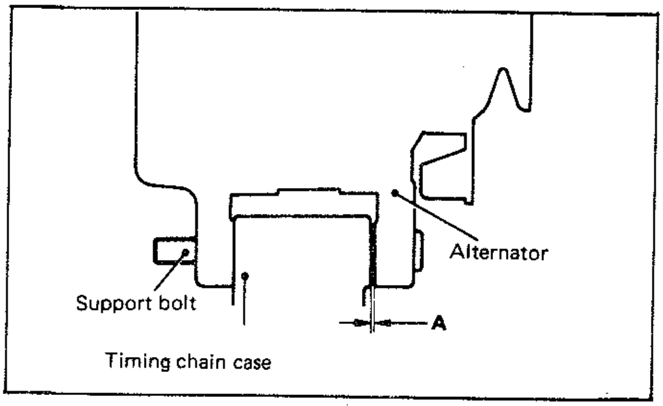


Fig. 9—Alternator mounting gap

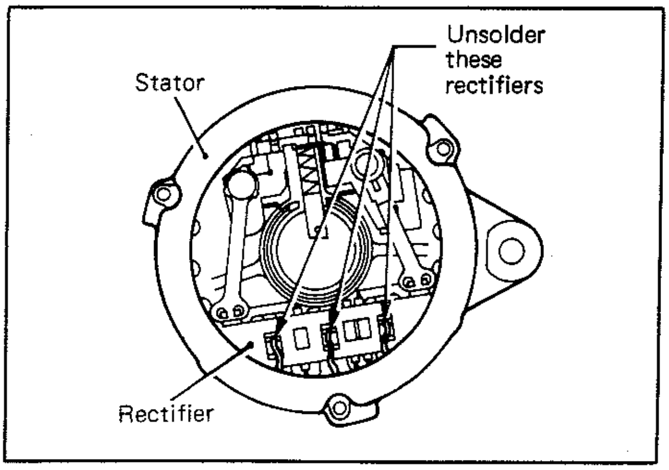


Fig. 10—Removing stator assembly

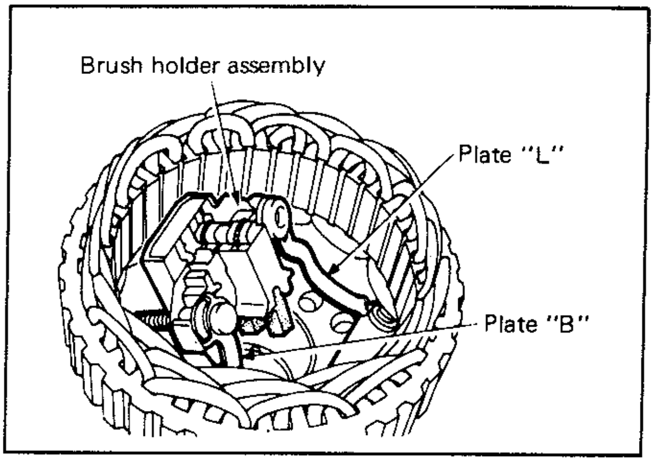


Fig. 12—Replacing brushes

Disassembly

(1) Remove three through bolts.

(2) Insert a screwdriver between the front housing and the stator, and while prying it, remove the front housing and rotor. If the screwdriver is inserted too deep, the stator coil might be damaged.

(3) Hold the rotor in a soft-jawed vice. Remove the pulley nut, and then remove the pulley, fan, spacer and seal. Remove the rotor from the front housing and remove the seal.

(4) Unsolder the rectifier from the stator coil lead wires and remove the stator assembly.

NOTE: Remove the solder in less than five seconds. If the diode is heated above 150 C (310°F), it may be damaged.

(5) Remove the condenser from the "B" terminal.

(6) Unsolder the plates "B" and "L" from the rectifier assembly.

(7) Remove the mounting screw and remove the electronic voltage regulator and brush holder assembly — refer fig. 11. The regulator and brush holder cannot be separated.

(8) Remove the rectifier assembly.

Inspection

Brush and Brush Spring Replacement

(1) When only a brush or brush spring is to be replaced, it can be replaced without removing the stator, etc. With the brush holder assembly raised as shown in Fig. 12, unsolder the pig-tail of the brush.

NOTE: If the "L" and "B" terminals of the rectifier assembly are bent, damage to the rectifier moulding might result. Therefore, the plates "B" and "L" should be gently bent at the centre.

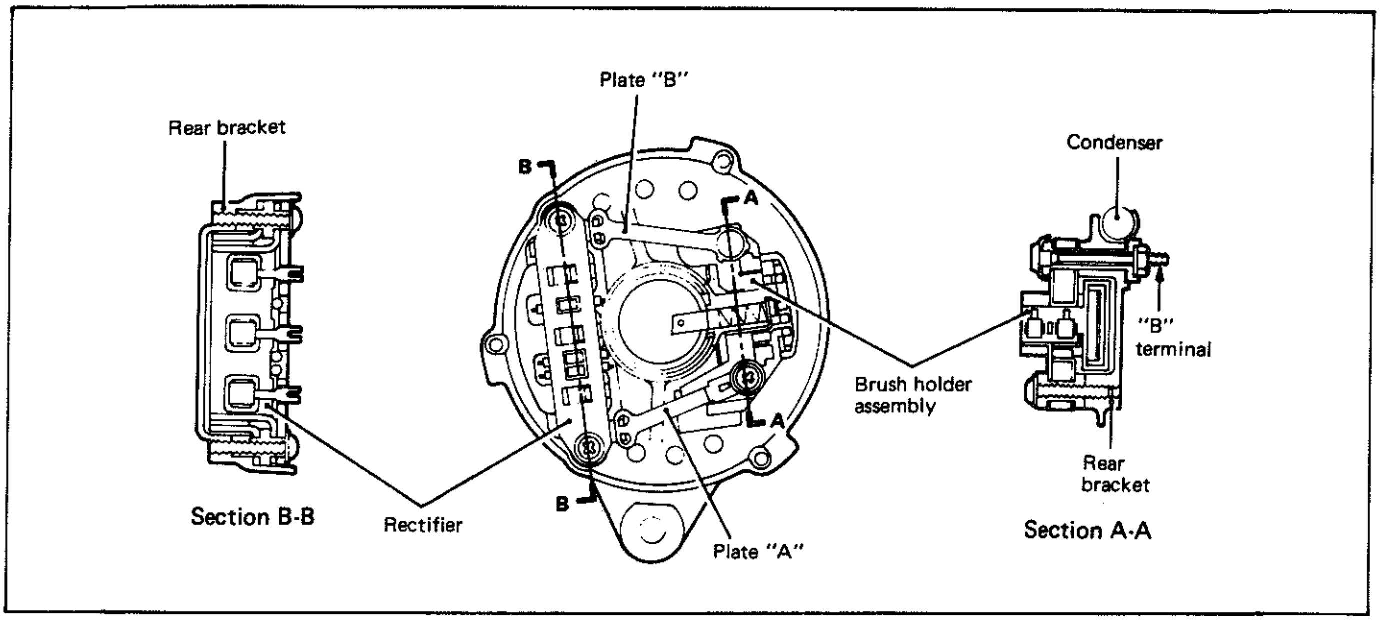


Fig. 11—Removing rectifier and brush holder

(2) Replace brushes that have worn down to the limit shown in Fig. 13.

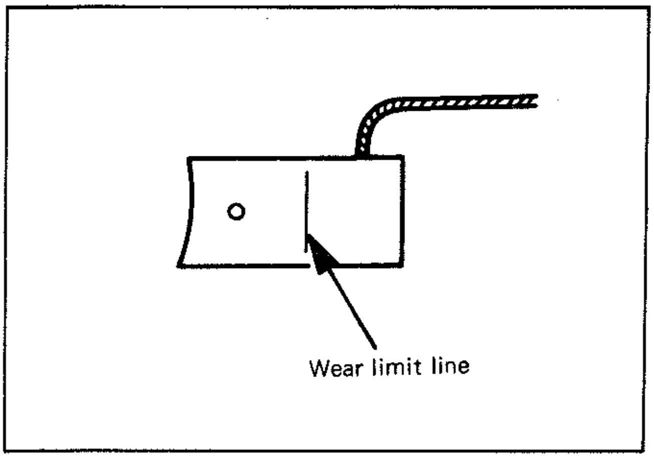


Fig. 13—Brush wear limit

Stator and Rotor

(1) Check the slip ring outside circumference for dirt and roughness. Clean and polish (as necessary) with fine sandpaper. A slip ring that is badly roughened or worn beyond the service limit, should be replaced.

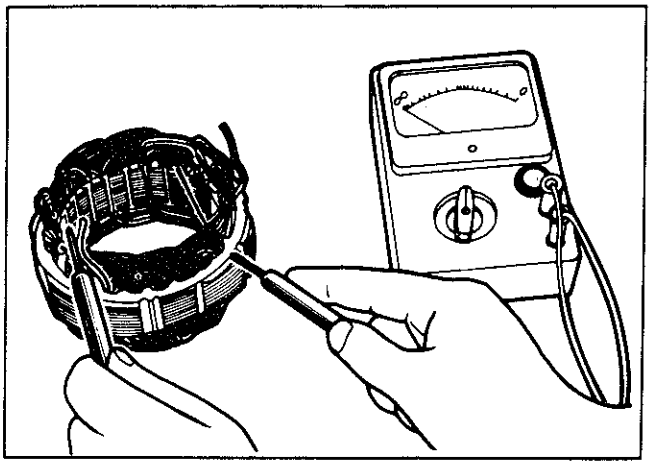


Fig. 14—Checking stator windings for grounds

(2) Test the stator windings with a low voltage test lamp (up to 40 volts) for grounding by connecting the test lamp between any stator lead and the frame. The windings are grounded if the lamp lights. This test can also be conducted using an ohmmeter, a low reading indicates grounded windings (see Fig. 14).

Measure the resistance between any two leads of the stator windings (see Fig. 15). If the readings are not as specified there is an open circuit in the stator windings. Test the remaining stator winding lead in a similar manner. This test can also be conducted using a low voltage test lamp, the lamp will not light if there is an open circuit.

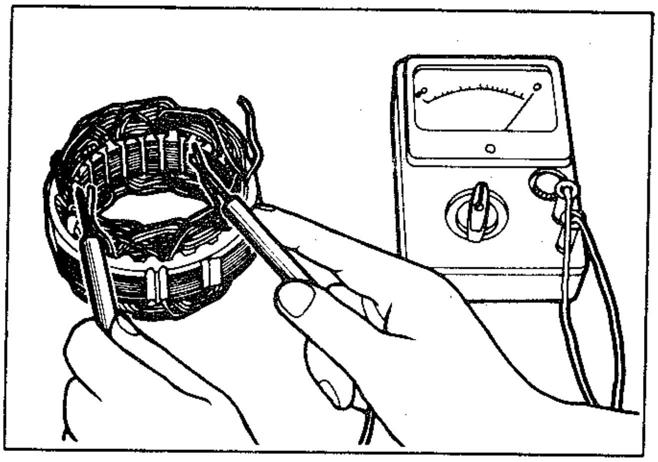


Fig. 15—Check stator windings for open circuit

(3) Test the excitor windings of the rotor for a short circuit to ground using a low voltage test lamp or an ohmmeter as shown in Fig. 16. Connect one test lamp or ohmmeter lead to the slip ring and the other lead to a pole piece. If the lamp lights or the ohmmeter reading is low, the field windings are grounded.

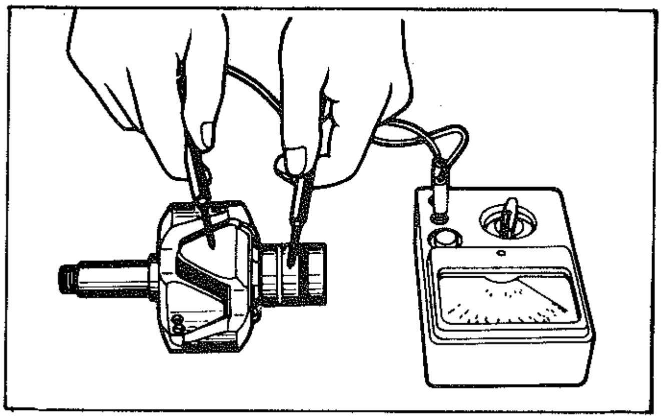


Fig. 16—Checking rotor for grounds

Connect one lead of a low voltage test lamp or ohmmeter to each slip ring to test for an open circuit. The lamp will fail to light or the ohmmeter reading will be high if there is an open circuit — see Fig. 17.

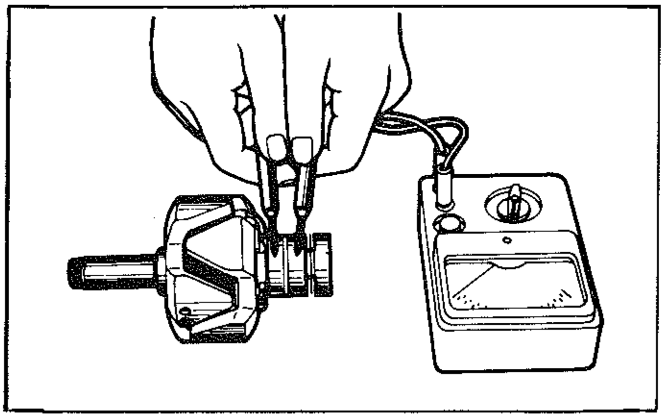


Fig. 17—Checking rotor for open circuit

Rectifier Assembly

(1) (+) Heatsink Assembly Test — Check for continuity between the (+) heat sink and stator coil lead connection terminal with an ohmmeter. If there is continuity in both directions, the diode is shorted. Replace the rectifier assembly.

(2) (—) Heatsink Assembly Test — Check for continuity between the (—) heatsink and the stator coil lead connection terminal. If there is continuity in both directions, the diode is defective. Replace the rectifier assembly.

(3) Diode Trio Test — Check the three diodes for continuity by connecting an ohmmeter to both ends of each diode. If there is continuity or no continuity in both directions, the diode is defective. Replace the rectifier assembly.

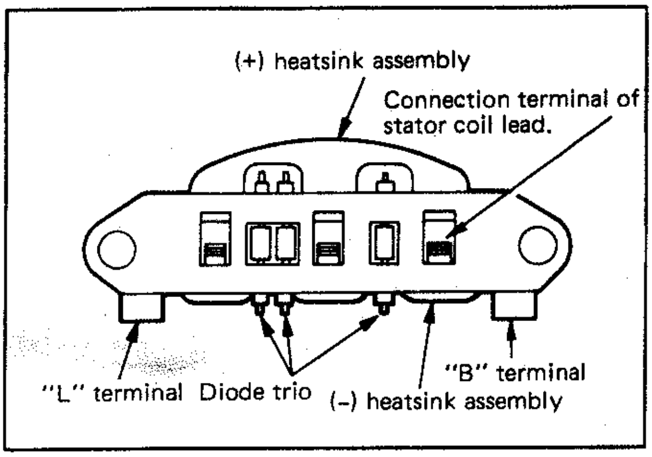


Fig. 18—Rectifier assembly

Assembly

Assemble by reversing the disassembly procedure noting the following.

Prior to assembly of the housing halves, insert a suitable size wire through the rear housing to hold the brushes up on assembly — refer Fig. 19.

After assembly check for free rotation of the rotor.

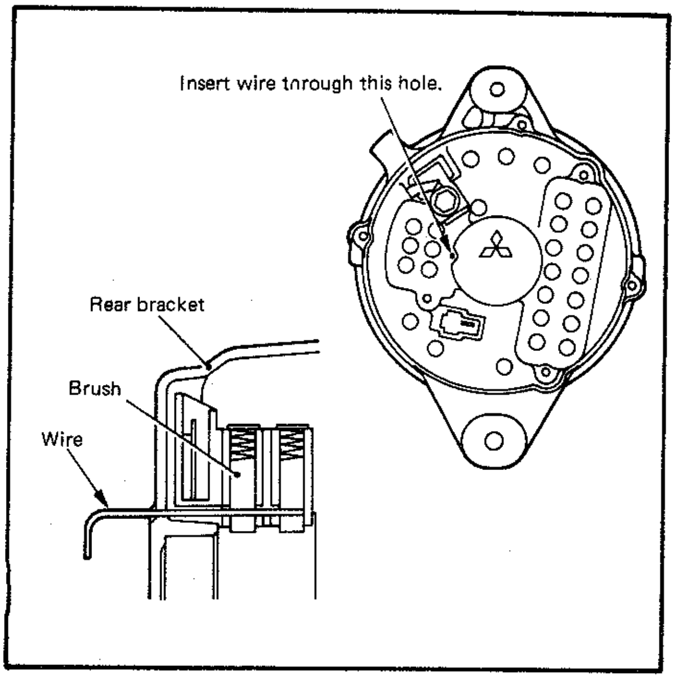


Fig. 19—Holding brushes in position

SECTION 4 — BREAKER POINT IGNITION

SPECIFICATIONS

SPARK PLUG

Make	Champion
Model — 1,6 Litre	N12Y
— 2,0 Litre	N9Y
Thread — Diameter/Reach	14 mm/19 mm (¾" reach)
Gap	0,7 to 0,8 mm (0.028" to 0.031")
Covers	Standard
Sealing Washers	Fitted

BALLAST RESISTOR

Make	Chrysler
Resistance @ 21°-24°C (70°-75°F) No amp draw	0.5 to 0.6 Ohms

COIL

Make	Bosch 9 220 061 412
Primary Resistance	1,45 to 1,55 Ohms
Secondary Resistance @ 20°C (68°F)	6800 to 9200 Ohms

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
BURNED OR PITTED DISTRIBUTOR CONTACTS	(a) Dirt or oil on contacts.	(a) If oil is on contact faces, determine cause and correct condition. Clean distributor cam of dirt and grease, apply a light film of distributor cam lubricant to cam lobes; wipe off excess. See "Distributor Lubrication". Replace contact set and adjust as necessary.
	(b) Alternator voltage regulator setting too high.	(b) Test alternator voltage regulator setting, adjust as necessary. Replace contact set and adjust as necessary.
	(c) Contacts misaligned or gap too small.	(c) Align and adjust contacts.
	(d) Faulty coil.	(d) Test and replace coil if necessary. Replace and adjust contacts.
	(e) Ballast resistor not in circuit.	(e) Inspect conditions, and correctly connect the coil.
	(f) Wrong condenser or faulty condenser.	(f) Test condenser and replace if necessary. Replace and adjust contacts.
	(g) Faulty ignition switch.	(g) Replace ignition switch.
	(h) Bushings worn.	(h) Replace housing or bushings.
	(i) Touching contacts with the hands during installation.	(i) Replace and adjust contacts.
IGNITION COIL FAILURE	(a) Coil damaged by excessive heat from engine.	(a) Replace coil. Inspect condition of the distributor contacts.
	(b) Coil tower carbon-tracked.	(b) Replace the coil.
	(c) Oil leak at tower.	(c) Replace the coil.

SPARK PLUGS

Spark plug appearance or condition can reflect a wide variety of engine conditions as follows:

Normal Conditions

Normal conditions (Fig. 1). This plug has been running at the correct temperature in a "healthy" engine. The few deposits present will probably be light tan or grey in color with most regular grades of commercial gasoline. Electrode burning will be in evidence; gap growth will average not more than about 0.03 mm in 1600 km. (.001"/1000 miles). Chances are the plug, as pictured, could be cleaned, the gap electrodes filed, regapped and reinstalled with good results.

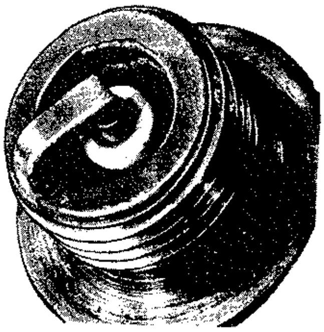


Fig. 1—Normal conditions

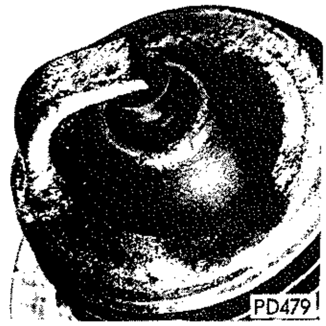


Fig. 2—Cold fouling

Cold Fouling

Cold fouling or carbon deposits (Fig. 2). This dry black appearance is fuel carbon and can be due to over rich fuel-air mixture, possibly resulting from a faulty choke, clogged air cleaner, improper carburettor idle adjustment, or dirty carburettor. However, if only one of two plugs in a set are fouled like this it is a good idea to check for sticking valves or faulty ignition cables. This condition also results from prolonged operation at idle.

Wet Fouling

Wet fouling (Fig. 3) tells you that the plug has drowned in excess oil. In an old engine, suspect worn rings or excessive cylinder wear. Use of a hotter plug may relieve such fouling, but plugs can't take the place of needed engine overhaul.

Remember that "break-in" fouling of new engines may occur before normal oil control is achieved. In new or recently overhauled jobs, such fouling plugs can be cleaned and reinstalled.

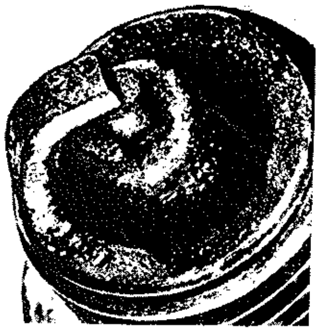


Fig. 3—Wet fouling

Overheating

Overheating (Fig. 4) is indicated by a white or light gray insulator which appears "blistered." Electrode gap wear rate will be considerable in excess of 0.03 mm per 1600 km (.001"/1000 miles). This suggests that a cooler heat range should be used . . . however, over-advanced ignition timing, detonation and cooling system stoppages can also overheat the **correct** spark plug heat ranges.

Cleaning and Regapping

Carefully clean the spark plugs in an abrasive type cleaner. Use a pin type feeler gauge to check spark plug gap. Reset gaps to specification. **Before setting spark plug gap, file centre electrode flat, make adjustment by bending ground (side) electrode, never bend the centre electrode.**

When installing spark plugs, tighten to specified torque (refer to Group 9).

Fig. 4—Overheating

BALLAST RESISTOR

The ballast resistor is a compensating resistance in the ignition primary circuit. During low speed operation, when the primary circuit current flow is high, ballast resistor temperature rises, increasing resistance. This reduces current flow, thereby prolonging ignition contact life. At high speed operation, when primary current flow is low, the ballast resistance cools off allowing more current flow, which is required for high speed operation. During starter operation, the ballast resistor is bypassed, allowing full battery voltage to the ignition primary circuit.

IGNITION COIL

The ignition coil is designed to operate with an external ballast resistor. When testing the coil for output, include resistor in tests.

Inspect coil for external leaks and arcing. Always make two tests when testing the coil. One when the coil is cold, the other after the coil has been warmed up.

Test coil according to coil tester Manufacturer's instructions. Test coil primary resistance. Test ballast resistor resistance. Test coil secondary resistance. Replace any coil and ballast resistor that does not meet specifications.

Every time an ignition coil is replaced because of a burned tower, carbon tracking or any evidence of arcing at the tower, the nipple or boot on the coil end of the secondary cable, replace cable. Any arcing at the tower will carbonize the nipple so that placing it on a new coil will invariably cause another coil failure.

If the secondary cable shows any signs of damage, the cable should be replaced with a new cable with a neoprene nipple since the old cable can cause arcing and therefore, ruin a new coil.

DISTRIBUTOR RESISTANCE TEST

This test indicates the resistance of the ignition primary circuit distributor side of the coil, through the points and the distributor ground. Excessive resistance in this portion of the ignition system will prevent the coil from producing sufficient output for good over-all ignition. To perform test, proceed as follows:

(1) Turn Selector Switch of a Tach-Dwell unit to CALIBRATE position and adjust Dwell Calibrator until Dwell Meter reads on the set line (test leads separated).

(2) Leave Selector Switch in CALIBRATE position, connect Tach-Dwell red lead to distributor terminal of coil and black lead to a good ground.

(3) Turn ignition switch "ON". Observe dwell meter reading. Meter pointer should be well within bar marked "DISTRIBUTOR RESISTANCE". If reading is zero or outside of bar, crank engine with the starter until meter pointer moves as far to right as possible. (This will indicate that contacts are closed.) A reading now within the bar indicates a normal distributor primary circuit.

If reading is outside the bar, high resistance is present in distributor primary circuit.

(4) Remove test lead from distributor terminal or coil and connect to the following points:

(a) Distributor primary terminal (outside).

(b) Distributor primary terminal (inside).

(c) Contact terminal bracket (insulated bracket).

(d) Ground side of the contacts.

(e) Distributor housing.

(5) Repeat test at each connection until a noticeable change occurs in the meter reading. If a poor connection or faulty lead is indicated, clean, tighten or replace as necessary and repeat Step (3).

If faulty contacts are indicated remove distributor for complete inspection, service, testing and calibration.

SECONDARY CIRCUIT INSPECTION

Check high tension cable connections for good contact at the coil and distributor cap towers and at the spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil cap towers and spark plug covers should fit tight around spark plug insulators. Cable connections that are loose will corrode and increase the resistance and permit water to enter the towers causing ignition malfunction. To maintain proper sealing between the towers and nipples, cable and nipple assemblies should not be removed from the distributor or coil towers unless nipples are damaged or cable testing indicates high resistance or broken insulation.

Clean high tension cables with a cloth moistened with a non-flamable solvent and wipe dry. Bend cables to check for brittle or cracked insulation.

When testing secondary cables for punctures and cracks with an oscilloscope follow the instructions of the equipment manufacturers.

If an oscilloscope is not available, secondary cables can be tested as follows:

(a) Engine not running, connect one end of a test probe to a good ground, other end free for probing.

(b) Disconnect cable at spark plug end. Insulate cable end from grounding.

(c) With engine running, move test probes along entire length of wire. If punctures or cracks are present there will be a noticeable spark jump from the faulty area to the probe. Secondary coil wire may be checked in the same manner, be sure one spark plug cable is disconnected from spark plug while running probe along coil wire secondary cable. Cracked, leaking or faulty cables should be replaced.

When installing new cable assemblies, install new high tension cable and nipple assembly over cap or coil tower, entering the terminal into the tower push lightly, then pinch the large diameter of the nipple to release trapped air between nipple and tower. Continue pushing on the cable and nipple until cables are properly seated in the cap towers. Use the same procedure to install cable in coil tower.

The correct method for removal of suppressor type cables is to grasp the rubber insulator at the spark plug end and remove with a combined twisting and pulling action. Do not use pliers and do not pull the cable at an angle. Doing so will damage cable, terminal or the spark plug.

Wipe spark plug insulator clean before reinstalling cable and cover. Resistance type cable is identified by the words "Electronic Suppression" printed on the cable jacket. No additional resistors are necessary.

Use an ohmmeter to check resistance type cable for open circuits, loose terminals or high resistance as follows:

(a) Remove cable from spark plug and install the proper adapter between cable and spark plug.

(b) Lift distributor cap from distributor with cables intact. Do not remove cables from cap.

(c) Connect the ohmmeter between spark plug adapter and the corresponding electrode inside the cap, making sure ohmmeter probes are in good contact. If resistance is more than 30,000 ohms, remove cable at cap tower and check the cable resistance. If resistance is more than 30,000 ohms, replace cable assembly. Test all spark plug cables in same manner.

To test coil to distributor cap high tension cable, remove distributor cap with the cable intact. Do not remove cable from the coil or cap. Connect the ohmmeter between centre contact in the cap and either primary terminal at coil. If the combined resistance of coil and cable is more than 25,000 ohms, remove the cable at coil tower and check cable resistance. If resistance is more than 15,000 ohms, replace the cable. If resistance is less, check for a loose connection at the tower or for a faulty coil.

Inspect coil tower for cracks, carbon tracking or oil leaks.

DISTRIBUTOR CONTACT DWELL

The degrees of distributor dwell are the degrees of rotation through which the contacts remain closed. This is also commonly referred to as "dwell angle" or "cam angle."

The correct distributor point dwell is essential for good ignition performance and contact point life. Test procedures are as follows:

(1) Disconnect vacuum line.

(2) Connect Tach-Dwell red lead to distributor terminal of coil and black lead to a good ground.

(3) Turn Selector Switch to Lobe position required.

(4) Start engine and operate engine at idle speed.

(5) Observe dwell meter reading. If the dwell reading is within "Specifications" the contact gap, cam rubbing block and contact arm are all in satisfactory condition.

If dwell reading is not within specifications, incorrect contact gap, worn cam, worn rubbing block or distorted contact arm may be indicated.

DWELL VARIATION

This test indicates the mechanical condition of the distributor. Excessive wear in distributor mechanical parts cause dwell variations which will affect ignition timing.

Test procedures are as follows:

(1) With engine at idle speed, vacuum hose disconnected and test leads connected as in "Contact Dwell Test", turn Tach-Dwell rpm Switch to the 5,000 rpm position.

(2) Slowly increase engine speed to 1500 rpm then slowly reduce to idle speed while observing dwell meter reading.

If dwell reading varies more than 2 degrees from initial reading between idle speed and 1500 rpm, probable wear in the distributor shaft, bushings or contact plate bearing and pivot pin is indicated. Remove distributor for complete inspection and testing on a distributor tester. Dwell variation at speeds above 1500 does not necessarily indicate distributor wear. Dwell and gap of the contacts must both be within their specified limits at the same time. If this cannot be accomplished, it is probable that wrong contacts are installed or the rubbing block or cam lobes are badly worn or movable contact is distorted.

IGNITION TIMING

To obtain maximum engine performance, the distributor must be correctly positioned on the engine to give proper iginition timing.

The ignition timing test will indicate the timing of the spark at No. 1 cylinder at idle (only).

Test procedures are as follows:

(1) Disconnect vacuum hose at distributor.

(2) Connect secondary lead of Power Timing Light to No. 1 spark plug, red primary lead to positive terminal of battery and black primary lead to negative battery terminal. Do not puncture cables, boots or nipples with test probes. Always use proper adapters. Puncturing the spark plug cables with a probe will damage the cables. The probe can separate the conductor and cause high resistance. In addition breaking the rubber insulation may permit secondary current to arc to ground.

(3) Start engine and set idle to "Specification" (Transmission in Neutral).

(4) Aim power timing light at timing plate. If light flash occurs when timing mark on vibration damper is located ahead of specified degree mark in the direction of engine rotation, timing is advanced. If flash occurs when the vibration timing mark is past the specified degree mark in the direction of engine rotation, timing is retarded. See "Specifications."

(5) If timing has to be adjusted, loosen distributor hold-down arm screw just enough so distributor housing can be rotated in its mounting. (Moving the distributor housing against shaft rotation advances timing, and moving with shaft rotation retards timing).

(6) Tighten distributor hold-down arm screw after timing has been set and recheck timing adjustment with a Power Timing Light.

IGNITION TIMING (using 12 volts test lamp)

(1) To establish correct ignition point of the engine, rotate the crankshaft in normal running direction until the line on the vibration damper is aligned with the markings attached to timing cover at required number of degrees B.T.C. (See specifications).

(2) Loosen distributor clamp bolt so distributor housing can be rotated with a slight drag.

(3) Remove distributor cap and connect 12 volt test lamp between low tension terminal of distributor and good "earth", (with battery connected, ignition switched "on" the lamp will light when contact breaker points open).

(4) Turn the distributor body against normal distributor rotation until the light just comes "on".

(5) Rotate crankshaft one revolution (in running direction) until bulb lights again and check timing marks, they should line up as specified, if not repeat the operations (4) and (5).

(6) Switch off ignition, tighten the distributor clamp bolt securely and remove test lamp. If the operation is performed properly the engine is timed to specifications.

NOTE: If the engine is turned beyond the timing marks during final check, continue turning engine for two full revolutions of the crankshaft, this will place the distributor rotor in approximately original position. DO NOT reverse the engine as this will affect the valve and distributor timing.

IDLE RPM TEST

Engine idle rpm setting should be tested and recorded as it is when the vehicle is first brought into the shop for testing. This will assist in diagnosing complaints of engine stalling.

Test procedures are as follows:

(1) Turn Selector Switch to CALIBRATE position and adjust Dwell Calibrator until Dwell Meter reads on SET line (test leads separated).

(2) Connect red lead of the test unit to the distributor primary terminal at the coil and the black lead to a good ground.

(3) Turn Selector Switch to Lobe position required.

(4) Turn Tach-Dwell RPM Switch to the 1000 RPM position.

(5) With engine at normal operating temperature (off fast idle), momentarily open the throttle and release to make sure there is no bind in the linkage and that idle speed screw is against its stop.

(6) Note engine RPM on 1000 RPM scale and adjust carburettor idle speed to specifications shown in Fuel System Specifications.

NOTE: For all other aspects of distributor service refer to the relevant distributor section.

SECTION 4E — MITSUBISHI DISTRIBUTOR

SATURN ENGINE

SPECIFICATIONS

DISTRIBUTOR

Manufacturer	Mitsubishi	<———
Part Number — Chain Drive Camshaft	MD003616	
Model Number	T3T03875	
Part Number — Belt Drive Camshaft	MD009101 (early)	MD009152 (late)
Model Number	T3T05771	T3T05778
Direction of Rotation	Clockwise	<———
Contact Gap	0,45 to 0,55 mm (0.018" to 0.021")	<———
Dwell Angle	49° to 55°	<———
Breaker Point Spring Tension	0,50 to 0,575 kg (1.10 to 1.26 lbs.)	<———
Firing Order	1, 3, 4, 2	<———
Ignition Timing @ 850 r.p.m. (Vacuum Disconnected)	*5° BTDC ± 1°	<———
Condenser Capacity	0.22 micro farads	<———
Centrifugal Advance (Distributor Degrees @ **Distributor** R.P.M.)	0° below 300	<———
	0° to 0,7° @ 500	<———
	2,5° to 4° @ 1000	5,5° to 6,9° @ 1000
	9,8° to 10,7° @ 2200	10,3° to 11,7° @ 2300
Vacuum Advance (Distributor Degrees @ Millimetres (ins.) of Mercury (Hg))	0° below 70 mm (2.75")	<———
	0° to 2° @ 90 mm (3.54")	0° to 1° @ 90 mm (3.54")
	5° to 7° @ 150 mm (5.90 ")	3° to 5° @ 150 mm (5.90")
	9,75° to 11,75° @ 250 mm (9.84")	6,2° to 8,2° @ 250 mm (9.84")
	10,50° to 12,50° @ 280 mm (11.00")	9° to 11° @ 360 mm (14.17")

*** NOTE: Ignition timing specifications printed are correct at the time of publication. If these specifications differ from those on the Vehicle Emission Control Information Label, use the specifications on the label.**

GENERAL INFORMATION

The Mitsubishi distributor is a breaker point type and is mounted to the timing chain case and gear driven by the crankshaft on chain drive camshaft engines. The belt drive camshaft engine has the distributor mounted on the upper left hand side of the cylinder head and is gear driven by the camshaft.

The vacuum advance control unit is mounted on the outside of the distributor housing, with the diaphragm mechanically connected to the contact breaker assembly.

SERVICE PROCEDURE

Replacing Contact Points

(1) Release distributor cap retaining clips, remove cap and carefully remove rotor.

(2) Remove breaker points locking screws.

(3) Disconnect electrical lead.

(4) Remove breaker points.

(5) Install by reversing removal procedure.

Breaker Point Adjustment

(1) With distributor cap and rotor removed, manually rotate engine until the breaker point rubbing block is positioned on the highest point of the cam.

(2) Loosen the breaker point locking screws and insert a screw driver at point "A" (Fig. 2).

(3) Turn the screw driver to adjust the breaker point gap to specification.

(4) With breaker point gap set, securely tighten the locking screws.

Distributor Removal

(1) Disconnect the vacuum hose from the distributor.

(2) Disconnect the high tension cables from the distributor cap.

NOTE: The correct method of detaching this type of ignition lead is to grasp the rubber insulator and remove by a combined twisting and pulling movement.

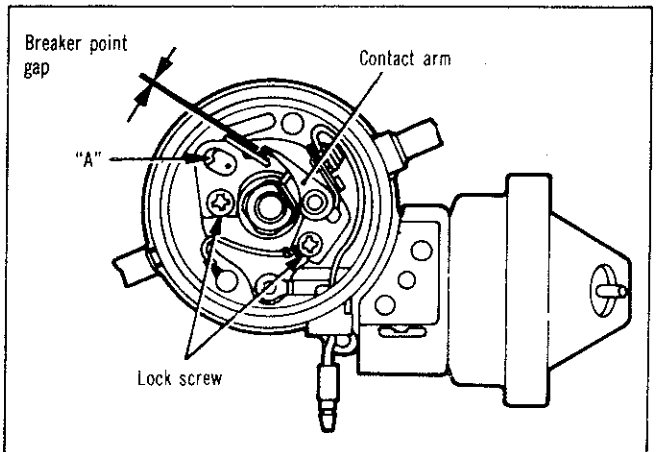
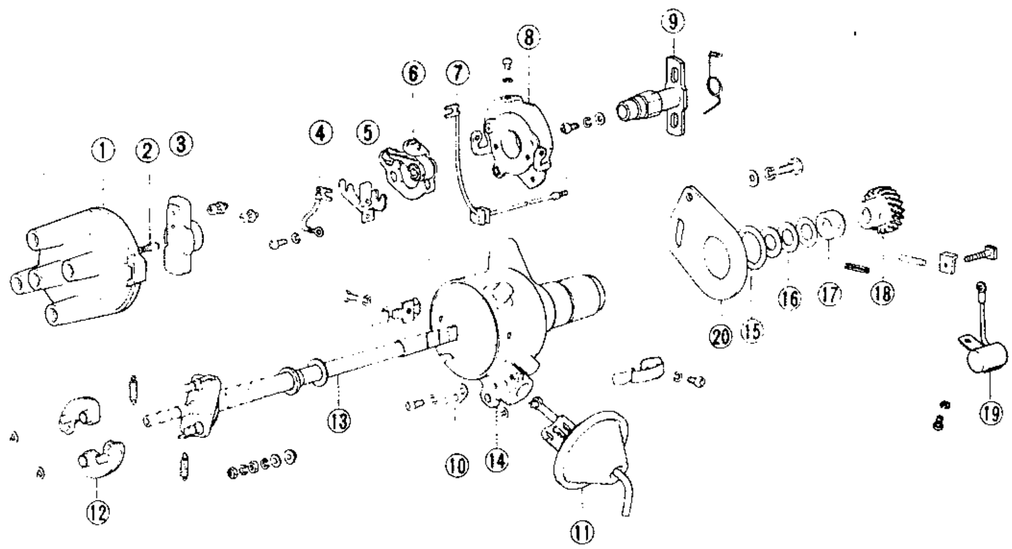


Fig. 2—Breaker point gap adjustment



1 Cap
2 Carbon
3 Rotor
4 Earth wire
5 Cam felt
6 Arm support
7 Lead wire
8 Breaker plate
9 Cam
10 Locking plate
11 Vacuum diaphragm
12 Mechanical advance weights
13 Shaft
14 Housing
15 "O" ring
16 Washer
17 Thrust collar
18 Gear
19 Condenser
20 Bracket

Fig. 1—Distributor components

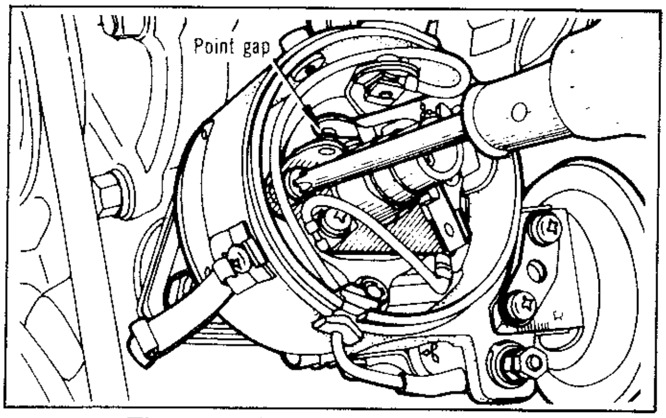


Fig. 3—Adjusting breaker point gap

(3) Remove the distributor cap.

(4) Manually rotate the engine to the top dead centre position with the No. 1 piston on the compression stroke.

(5) Disconnect the primary lead to the distributor.

(6) Remove the distributor mounting nuts and remove the distributor from the engine.

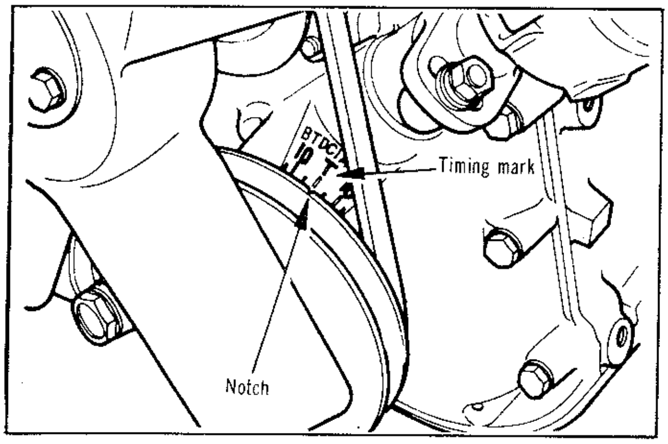


Fig. 4—Timing mark

Disassembly

(1) Remove the distributor cap and rotor.

(2) Remove the "E" clip retaining the vacuum control rod to the breaker point base and remove the rod.

(3) Remove the screws retaining the vacuum control unit to the housing and remove the unit.

(4) Remove the lead and breaker point assembly.

(5) Remove the drive gear roll pin and remove the gear.

(6) Remove the collar and washer.

(7) Withdraw the distributor shaft assembly from the distributor housing.

Cleaning and Inspection

Clean all parts in a suitable solvent and dry with compressed air.

NOTE: Care should be taken when drying distributor cap not to damage or loose the rotor centre contact.

Check all parts for wear or damage, replace any faulty or suspect parts.

Assembly

Assemble by reversing disassembly procedure. Lightly lubricate the distributor shaft, cam, breaker point spindle and vacuum link with a suitable multipurpose grease.

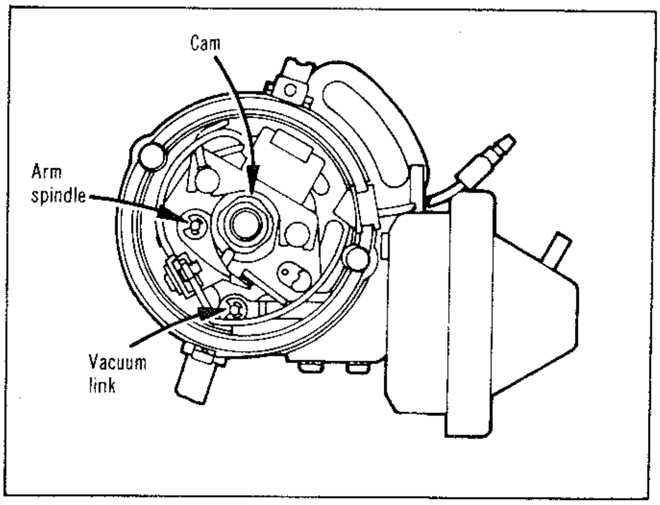


Fig. 5—Lubrication points

Installation (Chain Drive Camshaft Engine)

(1) Ensure the crankshaft is positioned at T.D.C. with No. 1 piston on compression stroke.

(2) Using a screw driver rotate the oil pump drive to the position shown in Fig. 6, i.e. the larger off-set facing the front of the engine.

(3) Align the distributor body and spacer collar mating marks and install the distributor ensuring that the distributor shaft lug fits snugly into the oil pump drive groove. Rotate the crankshaft slightly if distributor installation is difficult, install retaining nuts.

(4) Adjust breaker point gap if necessary.

(5) Install distributor rotor and cap.

(6) Connect high tension leads and distributor primary leads.

(7) Connect vacuum hose ensuring it is firmly positioned.

Installation (Belt Drive Camshaft Engine)

(1) Ensure the crankshaft is positioned at T.D.C. with No. 1 piston on compression stroke.

(2) Align the mating mark (line) of the distributor housing with the mating mark (dot) of the distributor gear.

(3) Insert the distributor into the cylinder head with the mating marks uppermost (Fig. 7) and install retaining nuts.

(4) Adjust breaker point gap if necessary.

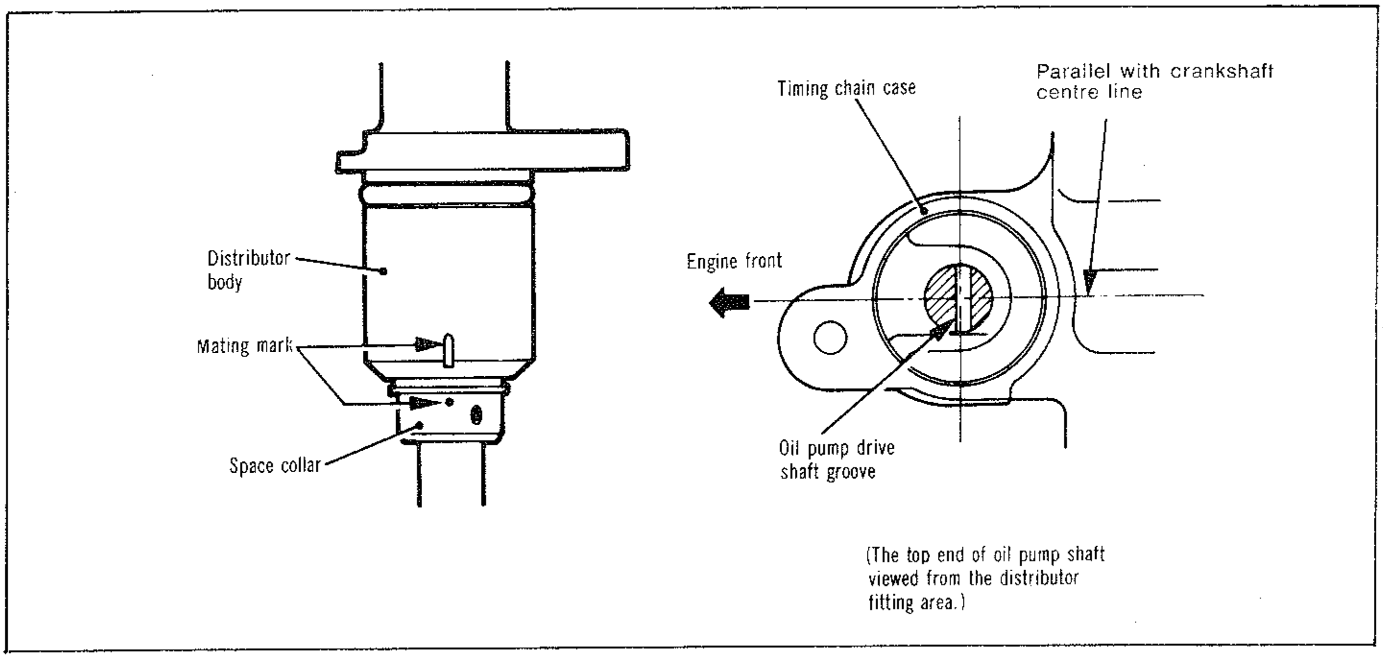


Fig. 6—Distributor alignment marks (chain drive camshaft engine)

(5) Install distributor rotor and cap.

(6) Connect high tension leads and distributor primary lead.

(7) Connect vacuum hose ensuring it is firmly positioned.

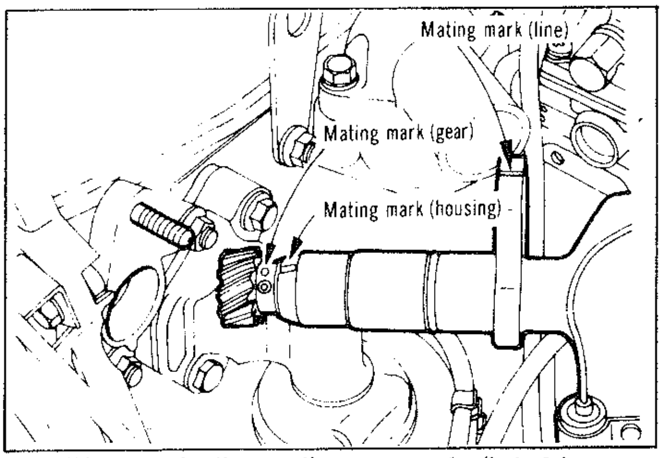


Fig. 7—Distributor alignment marks (belt drive camshaft engine)

Checking Ignition Timing

(1) Check and adjust if necessary breaker point gap.

(2) Disconnect the vacuum hose from the distributor.

(3) With engine idling, adjust the timing to specification by turning the adjusting screw on chain drive camshaft engines or by loosening the distributor mounting nut and rotating the distributor on belt drive camshaft engines.

(4) With the timing set, tighten the distributor mounting nut securely and recheck the timing.

(5) Check whether the timing advances with an increase in engine speed, if no advance is observed the distributor advance mechanism must be checked for wear or damage.

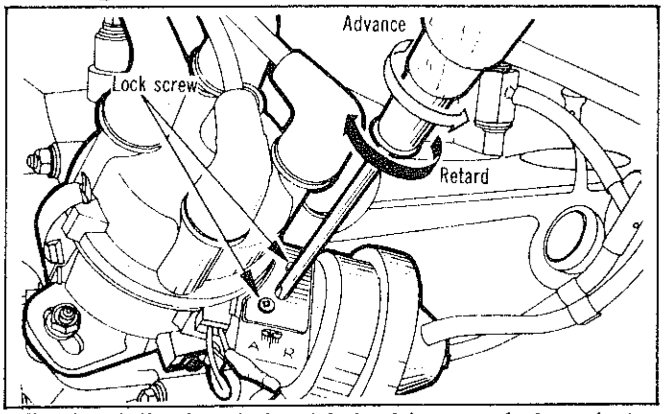


Fig. 8—Adjusting timing (chain drive camshaft engine)

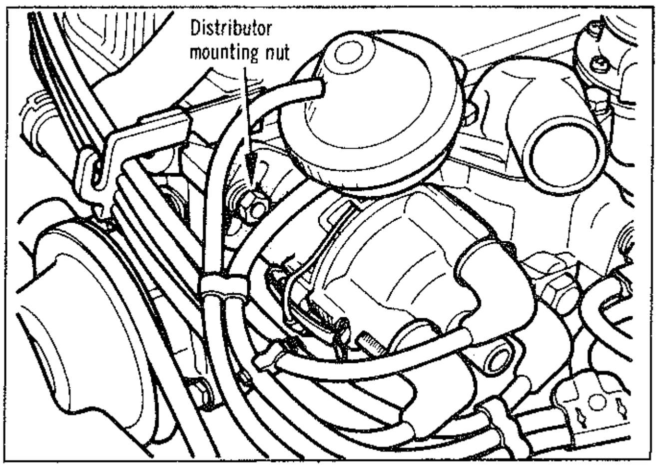


Fig. 9—Adjusting timing (belt drive camshaft engine)

SECTION 4F — MITSUBISHI DISTRIBUTOR

ASTRON ENGINE

SPECIFICATIONS

DISTRIBUTOR

Manufacturer	Mitsubishi
Model Number	T3T04288
Engine Capacity	2,0 Litre
Direction of Rotation	Clockwise
Contact Gap	0,45 to 0,55 mm (0.018" to 0.021")
Dwell Angle	49° to 55°
Breaker Point Spring Tension	0,50 to 0,575 kg (1.10 to 1.26 lbs.)
Firing Order	1, 3, 4, 2
Ignition Timing @ 850 r.p.m. (Vacuum Disconnected)	*5° BTDC ± 1°
Condenser Capacity	0.22 micro farads
Centrifugal Advance (Distributor Degrees @ **Distributor** r.p.m.)	0° Below 400
	0° to 2.2° @ 600
	4,5° to 6,5° @ 1000
	8,5° to 10,5° @ 1750
	7,5° to 10,5° @ 3200
Vacuum Advance (Distributor Degrees @ Millimetres (ins.) of Mercury (Hg))	0° Below 160 mm (6.3")
	0° to 1,5° @ 200 mm (7.9")
	2,5° to 4,75° @ 300 mm (11.8")
	5,5° to 7,5° above 420 mm (16.5")

***NOTE: Ignition timing specifications printed are correct at the time of publication. If these specifications differ from those on the Vehicle Emission Control Information Label, use the specifications on the label.**

GENERAL INFORMATION

The Mitsubishi distributor is the breaker point type and is fitted on the upper left hand side of the four cylinder Astron engine and is gear driven from the camshaft.

The vaccum control advance unit is mounted on the outside of the distributor housing, with the diaphragm mechanically connected to the contact breaker assembly.

SERVICE PROCEDURE

Replacing Contact Points

(1) Release distributor cap retaining clips, remove cap and carefully remove rotor.
(2) Remove breaker points locking screws.
(3) Disconnect electrical lead.
(4) Remove breaker points.
(5) Install by reversing removal procedure.

Breaker Point Adjustment

(1) With distributor cap and rotor removed, manually rotate engine until the breaker point rubbing block is positioned on the highest point of the cam.
(2) Loosen the breaker point locking screws and insert a screw driver at point "A" (Fig. 2).
(3) Turn the screw driver to adjust the breaker point gap to specification.
(4) With breaker point gap set, securely tighten the locking screws.

Removal

(1) Disconnect the vacuum hose from the distributor.
(2) Disconnect the high tension cables from the distributor cap.

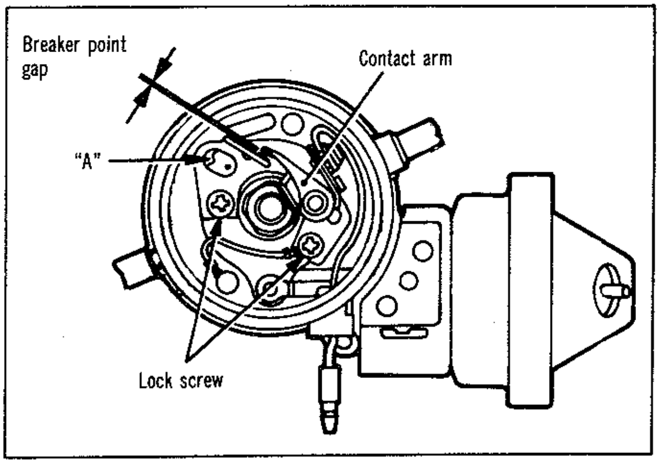


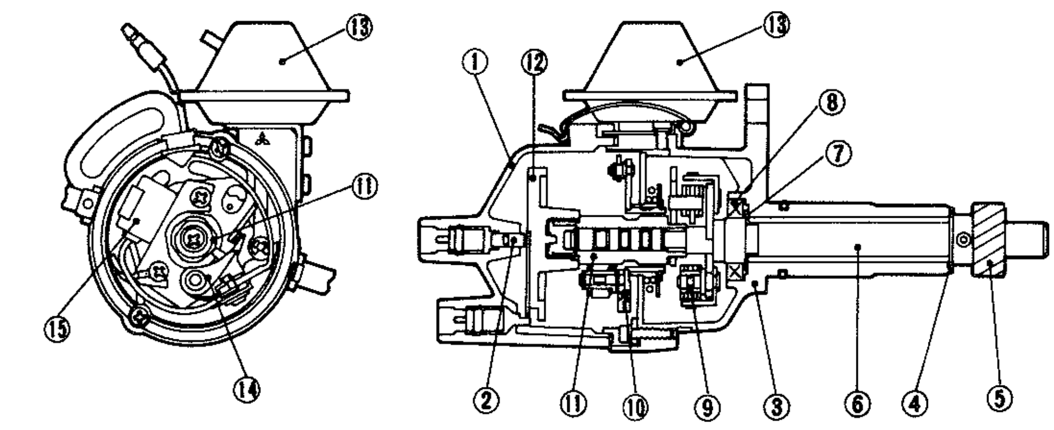
Fig. 2—Adjusting breaker point gap

NOTE: The correct method of detaching this type of ignition lead is to grasp the rubber insulator and remove by a combined twisting and pulling movement.

(3) Remove the distributor cap.
(4) Manually rotate the engine to the top dead centre position with the No. 1 piston on the compression stroke.
(5) Disconnect the primary lead to the distributor.
(6) Remove the distributor mounting nuts and remove the distributor from the engine.

Disassembly

(1) Remove the distributor cap and rotor.
(2) Remove the "E" clip retaining the vacuum control rod to the breaker point base and remove the rod.



1. Cap
2. Contact button
3. Housing
4. Washer
5. Driven gear
6. Shaft
7. Washer
8. Oil seal
9. Mechanical advance weights
10. Brake assembly
11. Cam
12. Rotor
13. Vacuum diaphragm
14. Breaker points
15. Condenser

Fig. 1—Sectioned view distributor assembly

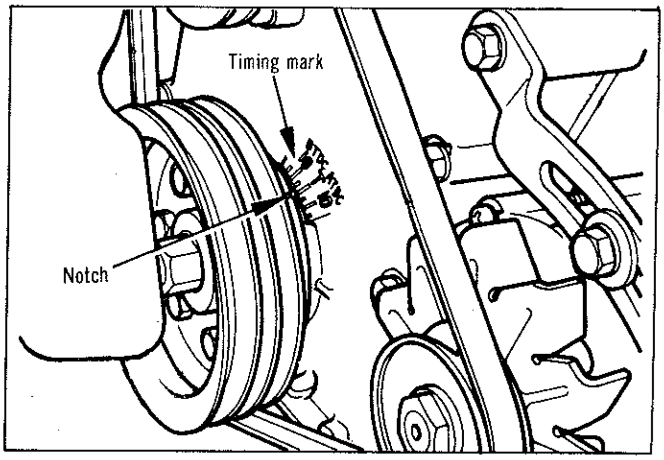


Fig. 3—Timing mark

(3) Remove the screws retaining the vacuum control unit to the housing and remove the unit.
(4) Remove the lead and breaker point assembly.
(5) Remove the drive gear roll pin and remove the gear.
(6) Remove the collar and washer.
(7) Withdraw the distributor shaft assembly from the distributor housing.

Cleaning and Inspection

Clean all parts in a suitable solvent and dry with compressed air.

NOTE: Care should be taken when drying distributor cap not to damage or loose the rotor centre contact.

Check all parts for wear or damage, replace any faulty or suspect parts.

Assembly

Assemble by reversing disassembly procedure. Lightly lubricate the distributor shaft, cam, breaker point spindle and vacuum link with a suitable multipurpose grease.

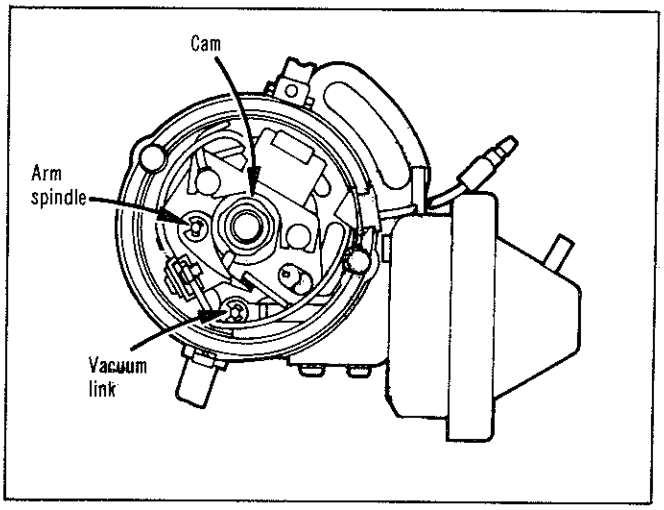


Fig. 4—Lubrication points

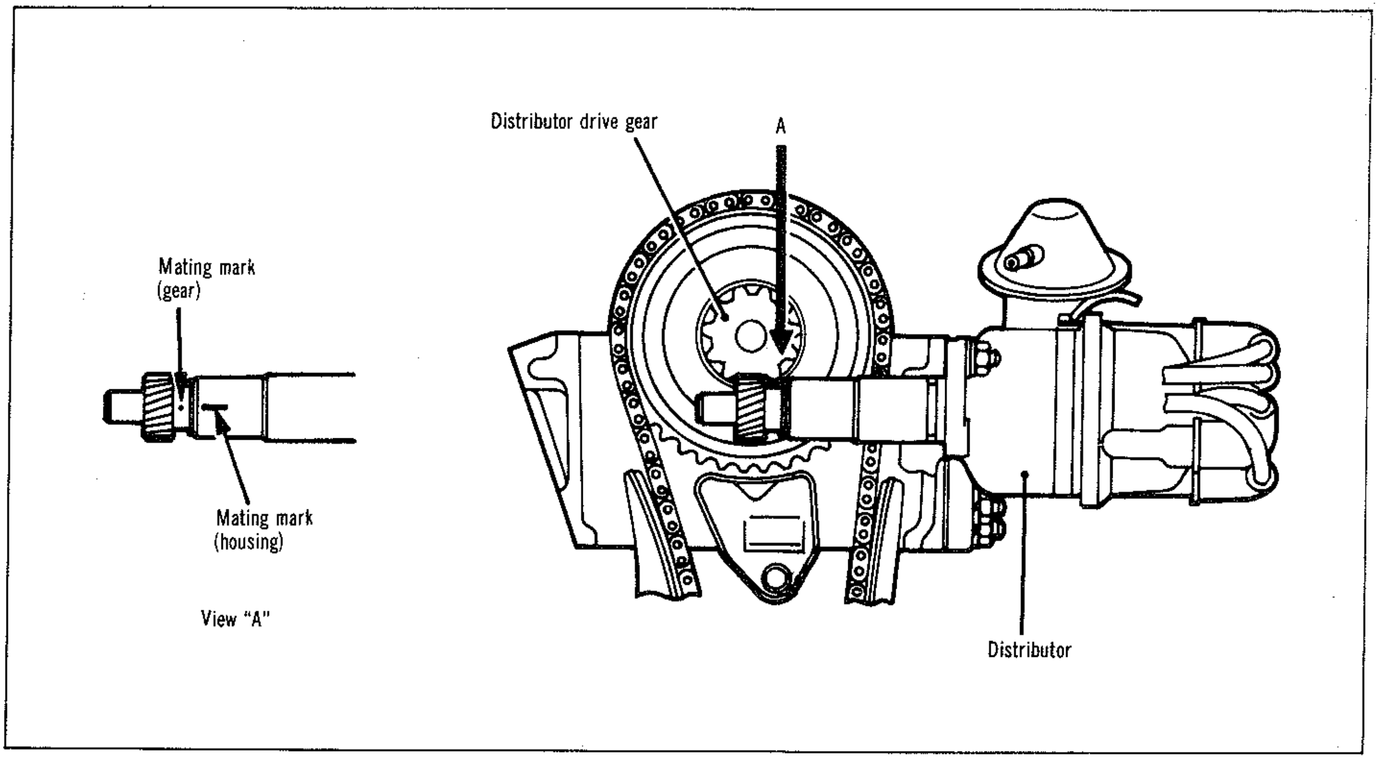


Fig. 5—Installing distributor assembly

Installation

(1) Ensure the crankshaft is positioned at T.D.C. with No. 1 piston on compression stroke.

(2) Align the mating mark (line) of the distributor housing with the mating mark (dot) of the distributor gear.

(3) Insert the distributor into the cylinder head with the mating marks uppermost (Fig. 5) and install retaining nuts.

(4) Adjust breaker point gap if necessary.

(5) Install distributor rotor and cap.

(6) Connect high tension leads and distributor primary lead.

(7) Connect vacuum hose ensuring it is firmly positioned.

Checking Ignition Timing

(1) Check and adjust if necessary breaker point gap.

(2) Disconnect the vacuum hose from the distributor.

(3) With engine idling, adjust the timing to specification, by loosening the distributor mounting nut and rotating the distributor.

(4) With the timing set, tighten the distributor mounting nut securely and recheck the timing.

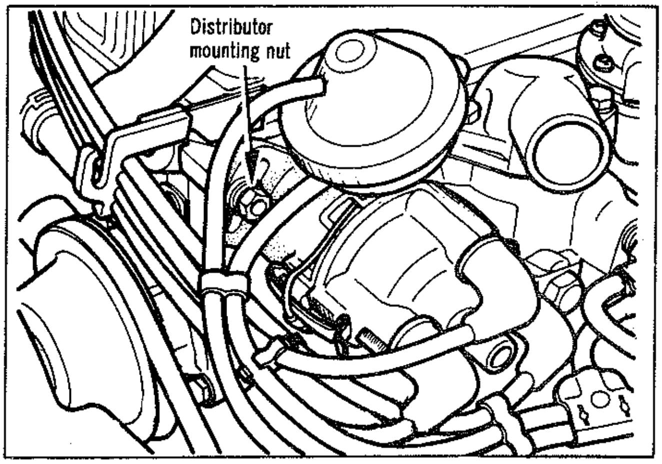


Fig. 6—Distributor mounting nut

(5) Check whether the timing advances with an increase in engine speed, if no advance is observed the distributor advance mechanism must be checked for wear or damage.

SECTION 5 — ELECTRONIC IGNITION

CHRYSLER AND MITSUBISHI SYSTEMS

SPECIFICATIONS

Vehicle Application	Sedan and Wagon— up to V.I.C. JH6	Sedan and Wagon— from V.I.C. JH6	Two Door ('79 Spec.)
System	Chrysler	<———	Mitsubishi
Engine Application	Astron	<———	<———
Engine Capacity	1,85 and 2,00 litre	2,00 and 2,60 litre	2,00 litre
SPARK PLUGS			
Make	Champion	<———	NGK
Type—1,85 and 2,60 litre	N12Y	<———	Not applicable
Type—2,00 litre	N9Y	<———	BP-6ES
Size	1 4 mm	<———	<———
Gap	0,70 to 0,80 mm (0.028" to 0.031")	<———	<———
COIL			
Make and Number	Bosch 9 220 061 412	Bosch 9 220 061 443	Diamond LB-119
Primary Resistance	1,45 to 1,55 Ohms	0,91 to 1,11 Ohms	0,70 to 0,86 Ohms
Secondary Resistance @ 20°C (68°F)	6800 to 9200 Ohms	<———	8700 to 11700 Ohms
BALLAST RESISTOR			
Resistance @ 20°C (68°F)			
Compensating	0,5 to 0,6 Ohms	0,85 Ohms	Not applicable
Auxiliary	4,5 to 5,5 Ohms	0,85 Ohms	
CURRENT DRAW*			
(Coil and Ballast Resistor in circuit)			
Engine stopped	3.0 Amps @ 12V		
Engine at curb idle	3.0 Amps @ 12V		
Engine running at 2000 R.P.M.	2.8 Amps @ 12V		
*Allow 1 minute for temperature to stabilize before measuring			
PICK-UP COIL			
Resistance @ 21°-27°C (70°-80°F)	150 to 900 Ohms	<———	1000 to 1100 Ohms
Gap—Reluctor to Pole Piece	0,15 to 0,20 mm (0.006" to 0.008")	<———	Not adjustable

TORQUE SPECIFICATIONS

Screw—Ballast Resistor to panel attachment	4,5 Nm (40 lbs./in.)

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
ENGINE WILL NOT START (FUEL AND CARBURETTION KNOWN TO BE GOOD)	(a) Rotor and distributor cap	(a) Check for hairline cracks. Replace if faulty.
	(b) Secondary ignition cables	(b) Visually inspect for loose connections and check with ohmmeter or oscilloscope.
	(c) Spark plugs	(c) Check, clean, regap or replace if necessary.
	(d) Faulty ignition coil	(d) Check for carbonized tower and arcing. Check primary and secondary resistances: See Specifications.
	(e) Faulty wiring	(e) Visually inspect wiring for brittle insulation. Inspect connectors. Moulded connectors should be inspected for rubber inside female terminals.
	(f) Dual ballast	(f) Check resistance of compensating and auxiliary ballast sections. (Refer to specifications). Replace if faulty. Check wire positions.
	(g) Faulty control unit	(g) Replace if all of the above checks are negative. Whenever the control unit or dual ballast is replaced, make sure the dual ballast wires are correctly inserted in the keyed moulded connector. (Chrysler system).
	(h) Faulty pick-up or improper pick-up air gap (Chrysler system)	(h) Check pick-up coil resistance and gap, pick-up pole piece to reluctor. (Refer to specifications). NOTE: The distributor must be removed from the engine to adjust the gap. After resetting gap apply a source of vacuum to the advance unit to make sure the reluctor teeth do not strike the pick-up pole piece. Alternatively run the distributor on a test stand and apply vacuum to the advance unit to ensure that reluctor is not striking the pole piece.
ENGINE SURGES SEVERELY (NOT LEAN CARBURETTOR)	(a) Wiring	(a) Inspect for loose connection and/or broken conductors in harness.
	(b) Faulty pick-up leads	(b) Disconnect vacuum advance. If surging stops, replace pick-up.
	(c) Ignition coil	(c) Check for intermittent primary.
ENGINE MISSES (CARBURETTION KNOWN GOOD)	(a) Spark plugs	(a) Check plugs. Clean and regap if necessary.
	(b) Secondary cables	(b) Check cables with an ohmmeter, or observe secondary circuit performance with an ignition oscilloscope.
	(c) Ignition coil	(c) Check for carbonized tower. Check in coil tester.
	(d) Wiring	(d) Check for loose or dirty connections.
	(e) Faulty pick-up leads	(e) Disconnect vacuum advance if miss stops, replace pick-up.
	(f) Control unit	(f) Replace if the above checks are negative.

SERVICE PROCEDURE

SECONDARY CIRCUIT INSPECTION

Check the high tension cable connections for good contact at the coil, distributor cap towers and at the spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil cap towers and spark plug cover should fit tight around spark plug insulators. Cable connections that are loose will corrode and increase the resistance and permit water to enter the towers causing ignition malfunction. **To maintain proper sealing between the towers and nipples, cable and nipple assemblies should not be removed from the distributor or coil towers unless nipples are damaged or cable testing indicates high resistance of broken insulation.**

Clean high tension cables with a cloth moistened with a non-flammable solvent and wipe dry. Bend cable to check for brittle or cracked insulation.

When testing secondary cables for punctures and cracks with an oscilloscope follow the instructions of the equipment manufacturers.

If an oscilloscope is not available, secondary cables can be tested as follows:

(a) Engine not running, connect one end of a test probe to a good ground, other end free for probing.

(b) Disconnect cable at spark plug end. Insulate cable end from grounding.

(c) With engine running, move test probe along entire length of wire. If punctures or cracks are present there will be a noticeable spark jump from the faulty area to the probe. Secondary coil wire may be checked in the same manner, be sure one spark plug cable is disconnected from spark plug while running probe along coil wire secondary cable. Cracked, leaking or faulty cables should be replaced.

When installing new cable assemblies, install new high tension cable and nipple assembly over cap or coil tower, entering the terminal into the tower, push lightly, then pinch the large diameter of nipple (Fig. 1) to release trapped air between the nipple and tower. Continue pushing on the cable and nipple until cables are properly seated in the cap towers. Use the same procedure to install cable in coil tower (Fig. 2). Wipe the spark plug insulator clean before reinstalling cable and cover.

Use the following procedure when removing the high tension cable from the spark plug. First, remove the cable from the retaining bracket. Then grasp the insulator as close as possible to the spark plug and use a straight and steady pull. **Do not use pliers and do not pull the cable at an angle.** Doing so will damage the insulation, cable terminal or the spark plug insulator. **Wipe spark plug insulator clean before reinstalling cable and cover.**

Resistance type cable is identified by the words "Electronic Suppression" printed on the cable jacket. No additional resistors are necessary.

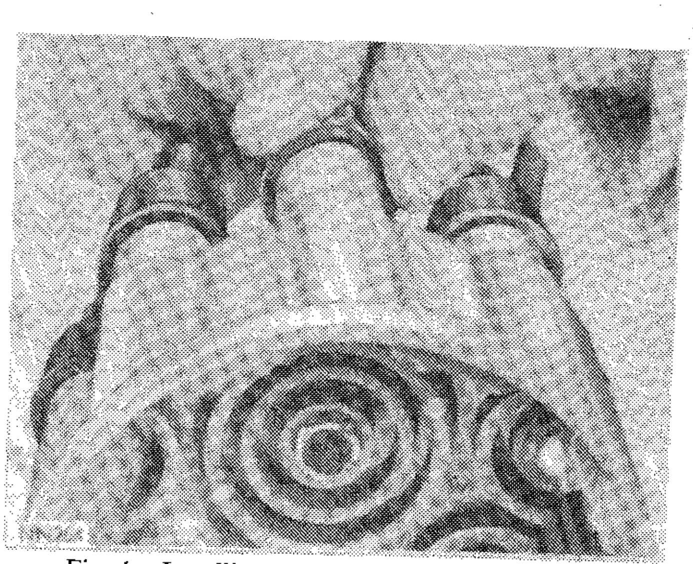


Fig. 1—Installing secondary cable and nipple at distributor cap tower (typical)

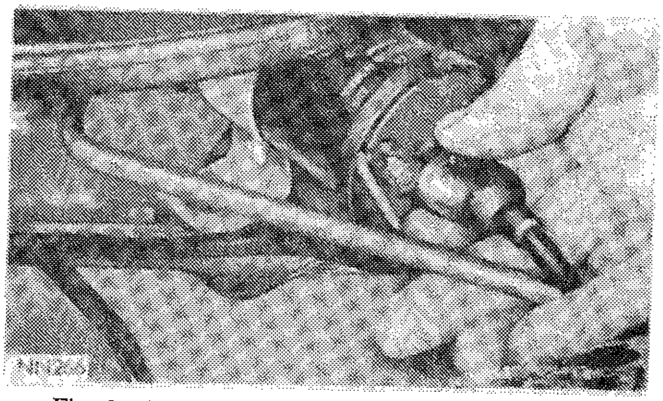


Fig. 2—Installing secondary cable and nipple at coil tower (typical)

Use an ohmmeter to check resistance type cable for open circuits, loose terminals or high resistance as follows:

(a) Remove cable from spark plug and install the proper adaptor between cable and spark plug.

(b) Lift distributor cap from distributor with cables intact. **Do not remove cables from cap.**

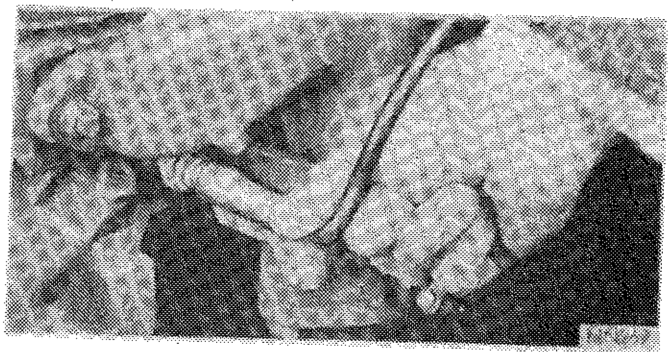


Fig. 3—Removing secondary cable and cover from spark plug (typical)

(c) Connect the ohmmeter between spark plug adaptor and the corresponding electrode inside the cap, making sure ohmmeter probes are in good contact. If resistance is more than 30 000 ohms, remove cable at cap tower and check the cable resistance. If resistance is more than 30 000 ohms on cables under 635 mm (25") long or 50 000 ohms on cables 635 mm (25") long, replace cable assembly. Test all spark plug cables in same manner.

To test coil to distributor cap high tension cable, remove distributor cap with the cable intact. **Do not remove cable from the coil or cap.** Connect the ohmmeter between centre contact in the cap and either primary terminal at coil. If the combined resistance of coil and cable is more than 25 000 ohms, remove the cable at coil tower and check cable resistance. If resistance is more than 15 000 ohms, replace the cable. If resistance is less, check for a loose connection at the tower or for a faulty coil.

Inspect coil tower for cracks, carbon tracking or oil leaks.

IDLE RPM TEST

Engine idle rpm setting should be tested and recorded as it is when the vehicle is first brought into the shop for testing. This will assist in diagnosing complaints of engine stalling, creeping and harsh shifting on vehicles equipped with automatic transmissions. Test procedures are as follows:

(1) Connect red lead of the test tachometer unit to the negative primary terminal of the coil and the black lead to a good ground.

(2) Turn selector switch to the appropriate cylinder position of engine being tested.

(3) Turn tachometer rpm switch to the 1000 rpm position.

(4) With engine at normal operating temperature (off fast idle), momentarily open the throttle and release to make sure there is no bind in the linkage and that idle speed screw is against its stop.

(5) Note engine rpm on 1000 rpm scale and adjust carburettor idle speed to specifications. See "Fuel System" specifications.

CAUTION: On engines equipped with idle speed solenoids, the solenoid must be energized. Adjust curb idle speeds with the curb idle adjusting screw resting on the solenoid plunger.

ADJUSTING RELUCTOR TO PICK-UP AIR GAP (Chrysler System Only)

Check the air gap between a reluctor tooth and the pick-up coil (Fig. 4). To set the gap, loosen the pick-up coil hold down screw. Insert a 0,20 mm (0.008") non magnetic feeler gauge between the reluctor tooth and the pick-up coil. Adjust the gap so that the feeler is snug. Tighten hold down screw. Recheck the gap after tightening the screw.

NOTE: A 0,25 mm (0.010") feeler gauge should not slip between the pick-up coil pole piece and an aligned reluctor tooth.

CAUTION A 0,25 mm (0.010") feeler gauge can be forced between a properly adjusted reluctor and pole piece. Do not use force to insert gauge. No evidence of reluctor teeth striking the pick-up pole piece should be visible.

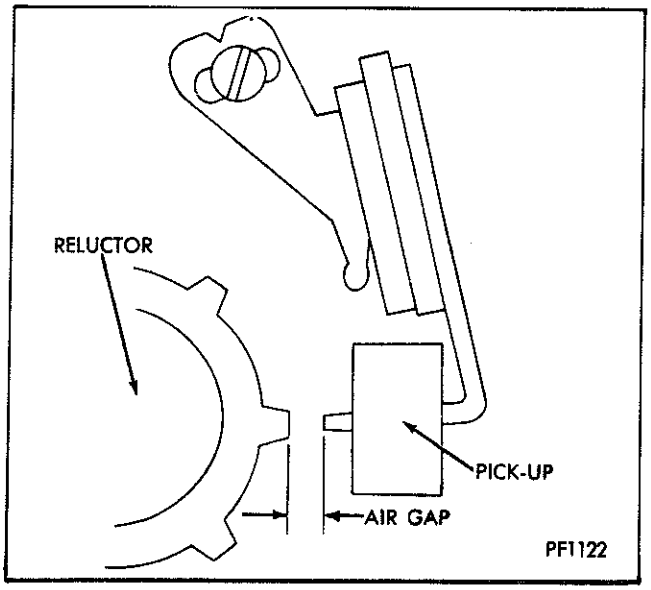


Fig. 4—Adjustment of reluctor to pick-up coil air gap

IGNITION TIMING

To obtain maximum engine performance, the distributor must be correctly positioned on the engine to give proper ignition timing.

The ignition timing test will indicate timing of the spark at number one cylinder.

Test procedures are as follows:

(1) Connect a suitable Power Timing Light to number one cylinder (refer to the equipment manufacturer's instructions for correct connecting procedures). **Do not puncture cables, boots or nipples with test probes. Always use proper adaptors. Puncturing the spark plug cables with a probe will damage the cables. The probe can separate the conductor and cause high resistance. In addition breaking the rubber insulation may permit secondary current to arc to ground.**

(2) Start engine and run until operating temperature is obtained.

(3) Set hot idle engine speed. (Refer to Specifications under Fuel Systems).

(4) Disconnect vacuum hose **at distributor** and plug vacuum hose.

(5) Loosen distributor hold down arm screw just enough so the distributor housing can be rotated in its mounting.

(6) Aim Power Timing Light at timing plate on chain case cover. If light flash occurs when timing mark on vibration damper is located ahead of specified degree mark on timing plate in the direction of engine rotation, timing is advanced. To adjust, turn distributor housing in direction of rotor rotation.

If flash occurs when the vibration damper timing mark is located past the specified degree mark in the direction of engine rotation, timing is retarded. To adjust turn distributor housing against direction of rotor rotation Refer to "Specification." (Moving the distributor housing against shaft rotation advances timing and with shaft rotation retards timing.

CAUTION: Do not use distributor vacuum advance chamber as a turning handle when turning distributor.

(7) Tighten distributor hold-down arm screw after timing has been set and recheck timing adjustment with a Power Timing Light.

(8) When ignition timing is correct, reconnect vacuum hose to distributor.

(9) If engine idle speed has changed, readjust carburettor. **DO NOT RESET TIMING.**

IGNITION COIL

The ignition coil (on the Chrysler system) is designed to operate with an external ballast resistor. When testing the coil for output, include resistor in tests. Inspect the coil for external leaks and arcing.

Test coil according to coil tester Manufacturer's instructions. Test coil primary resistance. Test ballast resistor resistance. Test coil secondary resistance. Replace any coil or ballast resistor that does not meet specifications.

Every time an ignition coil is replaced because of a burned tower, carbon tracking, or any evidence of arcing at the tower or the nipple or boot on the coil end of the secondary cable, replace cable. Any arcing at the tower will carbonize the nipple so that placing it on a new coil will invariably cause another coil failure.

If secondary cable shows any signs of damage, cable should be replaced with a new cable with a neoprene nipple since the old cable can cause arcing, and therefore, ruin a new coil.

DUAL BALLAST RESISTOR — Chrysler System

The normal side of the dual ballast resistor is a compensating resistance in the ignition primary circuit. During low speed operation current is maintained in this side of the ballast resistor for a longer period of time, causing it to heat up, and resistance to increase. This action reduces voltage in the ignition primary circuit, thereby, protects the coil from high voltage during low speed operation. As engine speed is increased the amount of time in which current is maintained in this side of the ballast resistor is shortened, causing it to cool off, and resistance to decrease. This action raises voltage in the ignition primary circuit, which is required for high speed operation. During starter operation the normal side of the dual ballast resistor is bypassed, allowing full battery voltage to the ignition primary circuit. The auxiliary side of this dual unit protects the control unit by limiting voltage to the electronic part of the ignition primary circuit.

SPARK PLUGS

Spark plug appearance or condition can reflect a wide variety of engine conditions as follows:

Normal Conditions

Normal conditions (Fig. 5). This plug has been running at the correct temperature in a "healthy" engine. The few deposits present will probably be light tan or grey in color with most regular grades of commercial petrol. Electrode burning will be in evidence; gap growth will average not more than about 0.03 mm in 1 600 km. (0.001"/1 000 miles). Chances are the plug, as pictured, could be cleaned, the gap electrodes filed, regapped and reinstalled with good results.

Fig. 5—Normal conditions

Cold Fouling

Cold fouling or carbon deposits (Fig. 6). This dry black appearance is fuel carbon and can be due to over rich fuel-air mixture, possibly resulting from a faulty choke, clogged air cleaner, improper carburettor idle adjustment, or dirty carburettor. However, if only one or two plugs in a set are fouled like this it is a good idea to check for sticking valves or faulty ignition cables. This condition also results from prolonged operation at idle.

Fig. 6—Cold fouling

Wet Fouling

Wet fouling (Fig. 7) tells you that the plug has drowned in excess oil. In an old engine, suspect worn rings or excessive cylinder wear. Use of a hotter plug may relieve such fouling, but plugs can't take the place of needed engine overhaul.

Remember that "break-in" fouling of new engines may occur before normal oil control is achieved. In new or recently overhauled jobs, such fouling plugs can be cleaned and reinstalled.

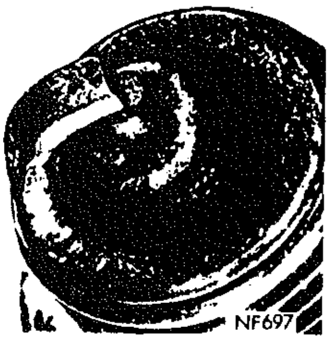


Fig. 7—Wet fouling

Overheating

Overheating (Fig. 8) is indicated by a white or light gray insulator which appears "blistered." Electrode gap wear rate will be considerable in excess of 0.03 mm per 1 600 km (0.001"/1 000 miles). This suggests that a cooler heat range should be used . . . however, over-advanced ignition timing, detonation and cooling system stoppages can also overheat the **correct** spark plug heat ranges.

Cleaning and Regapping

Carefully clean the spark plugs in an abrasive type cleaner. Use a pin type feeler gauge to check spark plug gap. Reset gaps to specification. **Before setting spark plug gap, file centre electrode flat, make adjustment by bending ground (side) electrode, never bend the centre electrode.**

When installing spark plugs, tighten to specified torque (refer to Group 9).

Fig. 8—Overheating