BATTERY AND CABLES

ALL MODELS

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DESCRIPTION AND OPERATION

GENERAL BATTERY INFORMATION

Registration of Battery

United-Delco Battery dealers and distributors are prepared to carry **out** terms of the manufacturer's warranty on Delco-General batteries. In order that Opel owners shall have the protection and benefit of this warranty, it is necessary for the dealer or car owner to register his battery with the local United-Delco **Battery** dealer or distributor on all new car deliveries, and on all deliveries of new replacement Delco batteries. The Battery Owner's Certificate is located in the Owner's Protection Plan Booklet..

Care of Wet Batteries in Storage

Batteries in stored new cars, as well as batteries, in stock, must be given regular attention to prevent sulphation of plates that may result from inactivity and self-discharge. All automotive wet batteries will slowly discharge on standing idle, whether in stored vehicles or in stock, and will self-discharge much faster when warm than when cold. *Batteries in stock should be rotated and the older ones used first.*

To minimize the extent of self-discharge always store batteries fully charged and in a cool place where the temperature does not go below freezing. Every 30 days check the level of electrolyte, add water as required and charge the batteries at a 5 ampere rate until fully charged.

Batteries used for display purposes or standing in cars in storage must be treated in the same manner as batteries in stock.

When a new car, or a new replacement battery is delivered, make certain that it is fully charged and the electrolyte is at proper level. This is extremely important because the delivery of a partially discharged battery may not only lead to its **return** for charging but may also result in shortened life of battery.

Importance of Maintaining Electrolyte at PROPER Level

Water is the only component of the battery which is

lost as the result of charging and discharging, and it must be replaced before the electrolyte level falls to the tops of the separators. If the water is not replaced and the plates become exposed, they may become permanently sulphated, which would impair the performance of the plates. Also, the plates cannot take full part in the battery action unless they are completely covered by the electrolyte.

Importance of Keeping Battery Properly Charged

The battery has three major functions: (1) It provides a source of energy for cranking the engine. (2) It acts as a stabilizer to the voltage in the electrical system. (3) It can for a limited time furnish energy when the demand of the electrical units in operation exceed the output of the generator.

In order for the battery to continue to function, it is necessary that current withdrawal from the battery be balanced by current input from the generator so that the battery is maintained in a properly charged condition. If the outgo exceeds the input, the battery will become discharged so that it cannot supply sufficient energy.

The state of charge of the battery as well as the temperature of the electrolyte has an important bearing on its capacity for supplying energy. Battery efficiency is greatly reduced by decreased electrolyte temperature as it has a decided numbing effect on its electrochemical action. Under high discharge such as cranking, battery voltage drops to lower values in cold temperatures than in warm temperatures.

In extremely cold climates it is important to keep batteries in a nearly full charged condition to avoid the possibility of freezing, which will damage any battery!

The following table shows the temperatures at which freezing will occur in electrolytes of *different densities, with specific gravity corrected to 80 degrees F.*

Specific Gravity	Freezing Point
1.220	-35 degrees F.
1.200	-35 degrees F.
1.160	0 degrees F.

Care of Dry Batteries in Storage

A "dry charge" battery contains fully charged positive and negative plates but no electrolyte.

Dry charged batteries should be stored in a dry place away from excessive heat. A dry charged battery should be kept in its original carton until ready to be put into service. This type of battery will retain its "charged" condition indefinitely if protected from moisture. Dry batteries may be stacked in vertical columns provided they are not stacked more than four high.

Preparing Dry Charged Batteries For Service

To prepare "dry charge" batteries for service use approved battery-grade acid electrolyte (1.265 sp. gr. at 80 degrees F). Care should be exercised in its use to prevent bodily injury or damage to clothing or other material resulting from actual contact with the electrolyte.

Electrolyte should be added to dry charged batteries in an area where water is readily available for flushing in case the electrolyte comes into contact with the body. Refer to instructions on side of electrolyte container for antidotes to use if electrolyte comes into contact with the body.

It is strongly recommended that a person filling batteries with electrolyte wear glasses (preferably safety glasses) to prevent possible damage to the eyes should any spattering of the electrolyte occur.

1. Remove dry charged battery from its original carton.

2. Remove the vent plugs.

3. Using a glass or acid-proof plastic funnel, fill each battery cell with electrolyte. *Do not use a metal funnel for filling the battery.* The cell is properly tilled when the electrolyte level rises to the split ring at the bottom of the vent well. Do not overfill or underfill. Overfilling will cause acid corrosion in the battery area; underfilling will cause early battery failure.

4. After tilling cells, wait five to ten minutes and add additional electrolyte, if necessary, to bring the electrolyte to the proper level.

5. Never finish tilling a dry charge battery with water. If electrolyte is spilled, more electrolyte must be obtained.

Test After Batteries are Prepared For Service

The Delco Dry Charge Battery may be put into service immediately after activation. However, to insure good battery performance, the following activation tests are recommended:

1. After adding electrolyte,, check the open circuit voltage. Less than 10 volts indicates a reverse cell or an open circuit and the battery should be replaced.

2. Check the specific gravity of all cells. If the specific

gravity corrected to 80 degrees F.' shows more than a thirty point (.030) drop from the initial tilling with electrolyte, or if one or more cells gas violently after addition of electrolyte, the batteiy should be fully charged before use.

3. For best performance in cold weather (32 degrees F. or less), or if the battery and the electrolyte are not at 60 degrees F., or above at time of activation, warm the battery by boost charging.

TROUBLE DIAGNOSIS

BATTERY AND CABLES. TROUBLE DIAGNOSIS

Quick Check of Battery and Cables

Whenever electrical trouble developes, it is desirable to make a quick check of the battery and cables to make certain that this source of current is in good condition, securely connected, and is functioning properly. This check will also give a good check on the cranking system.

1. Turn on the lights. They should burn steadily and with normal brilliance.

2. With lights burnings, operate the cranking motor. Either have the headlights shining on a wall so their brilliance can be noted, or have someone watching the headlights.

3. When cranking motor solenoid switch is closed, one of the following conditions will occur; (1) Lights will stay bright or will dim slightly if temperature is cold, and engine will be cranked at normal speed; (2) Lights will go out; (3) Lights will dim considerably; (4) Lights will stay bright but no cranking action will take place. The first named condition indicates that nothing is wrong with the battery, cables, and cranking system. The other conditions indicate trouble as follows:

4. If *lights go out* as cranking motor solenoid switch is closed, it indicates a poor connection in the circuit between battery and cranking motor. Check battery cables and clean and tighten loose or corroded terminals.

5. If lights dim considerably as cranking motor solenoid switch is closed, it indicates that the battery is run down, or there is a condition in cranking motor or engine which causes an excessive current drain on the battery. A **low battery** will be indicated by ,a clattering noise in cranking motor solenoid because the battery cannot sustain the voltage required to hold solenoid plunger "in" after switch contacts close and the "pull in" winding is shorted out.

Test battery with a 421 Battery Test. If battery is found to be in good condition check cranking motor.

6. If lights stay bright but no cranking action occurs when cranking motor solenoid switch is closed, it indicates an open circuit in cranking motor, switch, or control circuit.

Testing Resistance of Cables and Terminal Connections

Battery **cables** and terminal connections may be tested with equipment comprising of a voltmeter (5 volts maximum), ammeter of 300 or more amperes capacity, and carbonpile rheostat having a minimum capacity of 300 amperes connected in series with the ammeter.

1. Adjust rheostat to provide maximum resistance ("OFF" position).

2. Connect ammeter positive lead to post on starting motor. Connect ammeter negative lead to one side of rheostat and connect other side of rheostat to ground on engine, preferably at point where battery ground strap is attached. In the instrument shown in Figure 1A-1, the ammeter and rheostat are connected in series inside the case.

3. Connect voltmeter negative lead to post on starting motor. Use prod with voltmeter lead, if necessary, to insure direct contact with the terminal stud. *Do not connect to the ammeter lead clip.* Attach a prod to voltmeter position lead and apply the prod to center of battery positive post (Figure 1A-1.) Make sure that clips of voltmeter leads have clean metal contact with prods.

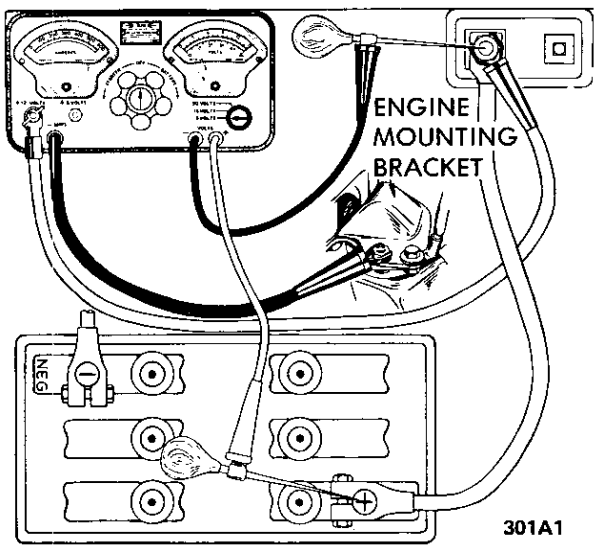

Figure 1A-1 Battery Cable Test Connections

4. Adjust rheostat until ammeter reads 200 amperes, immediately read voltmeter, then turn rheostat to starting ("OFF") position to avoid excessive drain on **battery.** Voltage drop across battery positive cable

and terminal connections should not exceed 2/10 volt.

5. Connect voltmeter positive lead to ground on engine. Attach prod to voltmeter negative lead and apply prod to *center* of battery negative post. Voltage drop across the battery ground cable and terminal connections should not exceed 2/10 volt at 200 amps.

6. A reading in excess of 2/10 volt when testing either battery cable indicates excessive resistance in cable or connections. Clean and tighten cable or connections. Clean and tighten cable terminals (subpara. c, below) and recheck for voltage drop. If voltage drop still exceeds 2/10 volt, replace cable with a genuine Buick-Opel cable to insure ample capacity.

Undercharge Failure of Battery

The most frequent trouble experienced with storage batteries is failure to maintain a state of charge sufficient to crank the engine and also furnish current to the ignition system, lights and accessories. Failure to maintain a proper state of charge may be due to one or more of the following conditions:

1. *Operating Conditions.* When determining cause of premature failure of a battery, consideration must be given /to the conditions under which the car is operated.,

In very low temperatures the capacity of a storage battery is considerably reduced and the energy required for cranking the. engine is considerably increased.

Frequent starting, particularly in cold weather, accompanied by short runs may take more energy from the battery for cranking than the generator can replace in the limited running time. This condition is aggravated by night driving when lights are turned on, or by operation of an air conditioner in heavy traffic.

When the car is operated under these conditions, adjusting the voltage regulator to the high limit may allow enough increase to keep the battery at a safe state of charge. If the high limit setting does not maintain a safe state of charge, an occasional booster charge should be given to the battery.

2. *Low* charging *Rate.* In case of premature battery failure, tbe charging rate of alternator should always be checked and adjusted if below specifications.

3. Internal Condition The internal condition of the battery niay be such that it cannot hold a charge satisfactorily. Check electrolyte level and test the battery using the 421 Battery Test.

Overcharge Failure of Battery

A common cause of battery failure is overcharging, that is, continued input of excessive charging current after the battery has reached a fully charged condition.

One evidence that battery is being overcharged is the need for frequent addition of water to the battery in order to maintain the electrolyte level above the tops of the battery separators, since overcharging causes rapid water loss. When this becomes evident, the charging rate of alternator should be immediately checked, as well as the voltage regulator, and adjusted to avoid internal damage to battery.

ADJUSTMENTS AND MINOR SERVICE

PERIODIC BATTERY INSPECTION AND SERVICE

The battery requires very little attention, but periodic inspection is essential to secure the maximum efficiency and life. The following services are essential to maintain the battery at maximum efficiency.

WARNING: *Never expose battery to open flame or electric spark - battery action generates hydrogen gas which is flammable and explosive. Do not allow battery fluid to contact skin, eyes, fabrics or painted surfaces - fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with battery.*

Maintain Electrolyte Level

Add distilled water as required to maintain the electrolyte level at the split ring at bottom of tiller well. See Figure IA-2.

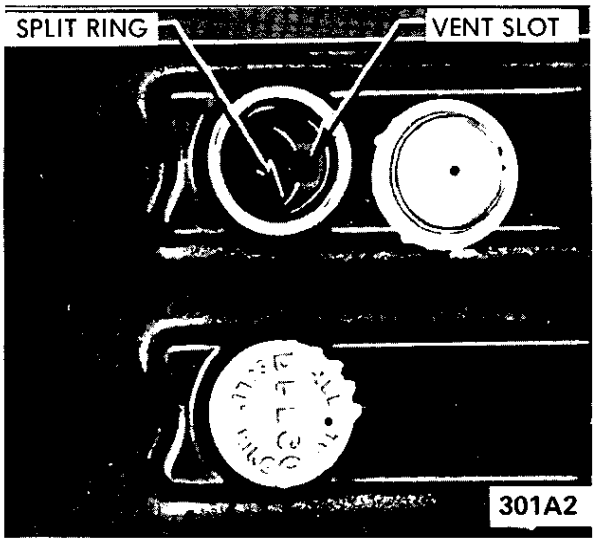

Figure 1A-2 Battery Filler Well

Do not overfill, as electrolyte may be sprayed out by gassing or may overflow due to heat expansion during charging.

If distilled water is not available, it is better to add clean, mineral-free tap water than to allow the electrolyte level to remain below the top of the plates.

In freezing weather the water should be added just before using the car or otherwise charging the battery so that the water will be mixed with the acid before it is allowed to stand in freezing temperatures.

If it is found necessary to add water to the battery more frequently than about every 1,000 miles and the quantity of water added per cell is' excessive, check setting of voltage regulator and adjust, if necessary: Abnormal water loss is an indication that the battery is being overcharged.

Inspect Battery, Mounting and Cables

Check outside of battery for damage or signs of serious abuse such as broken case or broken covers: Check inside of battery by removing the vent caps and inspecting for signs of abuse such as electrolyte level too low to see, or bad or unusual odors. If battery shows signs of serious damage or abuse, it should be replaced.

Check the battery hold down bolts to make certain that battery is securely held in place. The nut should be drawn up to 20 lbs. in.; *excessive tightening may distort or crack the battery case.*

If the top of battery is dirty or the hold down strap is corroded, clean thoroughly with a brush dipped in ammonia or soda solution. Care must be used to prevent any solution from getting into battery cells. After the foaming of solution stops, flush off with clean water and dry thoroughly. If hold down strap is corroded it should be painted with acid-resisting paint after cleaning.

Check battery cables to make certain they are tight at bracket and junction block. If a connection is found loose it should be cleaned before being tight; ened as arcing and corrosion may have taken place in the loose connection. Check condition of cables and replace if badly corroded or frayed.

Special attention must be given to the battery positive cable position to eliminate the possibility of contact with the exhaust manifold on the 1.1 liter engine. The cable clamp must be rotated clockwise as necessary for the cable to run at a 45 degree angle toward the right wheelhouse panel.

Cleaning Cable Terminals

If loose connections are found by inspection, or high resistance is found by voltage test, disconnect the cable for thorough cleaning of terminals. When removing a corroded cable terminal from battery post, do not pry against battery case or hammer on terminal to break it loose, since either practice will result in broken cell covers. Use a screw-type terminal puller if terminal cannot be loosened by hand.

Thoroughly clean all corrosion from disconnected battery cable terminals and terminal posts, using suitable wire brushes. If wire brushes are not available, corroded terminals may be cleaned by brushing with a strong soda solution, using care not to get solution into battery cells.

If cable strands are broken, corroded, or loose in terminals, the cable should be replaced with the correct cable to insure ample capacity.

To prevent corrosion of battery terminals and connections, apply a coating of petroleum jelly over the battery post and cable terminals after cables have been installed on terminals.

421 BATTERY TEST

421 Battery Testers, manufactured and sold by a number of companies, are the only battery testers approved by Delco-Remy Division for testing one-piece cover batteries. They are also used by United Motors Service to determine whether or not a battery is defective.

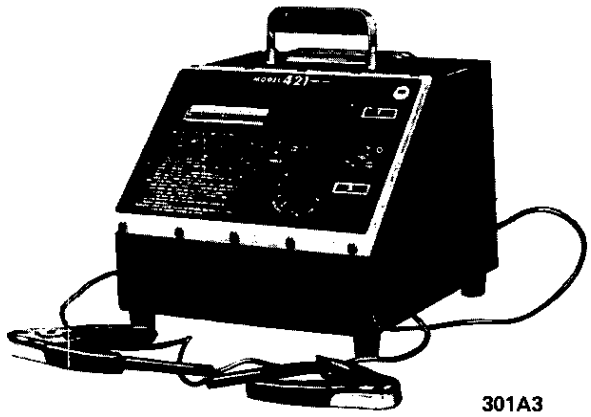

Figure 1A-3 421 Battery Tester-Charger

The 421 Battery Tester shows, in a few minutes, the state-of-charge of the battery and whether it is good or bad. The tester can be used with any 12 volt battery, in or out of the car. The test can be made regardless of the state of charge of the battery; it can also be made when the electrolyte level is low • even below the top of the plates.

421 Test Procedure

1. Visual Inspection - The first step in testing the Energizer or 12-Volt Battery should be a visual inspection which very often will save time, labor and expense in determining the condition.

(a) Check for broken or cracked case or cover.

(b) Check for loose terminal posts.

(c) Check for defective or mutilated sealing compound.

(d) Check for other visible signs of physical damage.

Obvious damage as a result of conditions described above indicates the need for Energizer or battery replacement.

2. The "421" Test is a programmed test procedure consisting bf a series of timed discharge and charge events, requiring approximately 2 to 3 minutes, that will determine the condition of the Energizer or battery with a high degree of accuracy when used in conjunction with this entire test procedure. "421" Testers are produced by a number of different manufacturers and their directions for tester operation should be carefully followed. General comments on overall "42 1" Tester operation follow:

(a) Energizers or batteries *should not be charged prior to making this test.* Defects within the unit can be hidden by the charging and erroneous test results will be obtained.

(b) Erratic, or extremely low, initial meter readings may indicate poor connections at the tester terminals. *Obtain clean and tight connections before performing the 421 Test.*

(c) All meter readings should be made *immediately* after the meter indicator light comes on even if the meter needle is still moving.

(d) If additional discharges are required after the initial discharge, set meter indicator following the *last* discharge cycle.

(e) Batteries designated as "bad" by the tester should be replaced.

(f) Batteries designated as "good" with no owner's complaint or indication of poor performance, should be left in service. Posts, cable clamps, and top should be cleaned, water should be added and recharging should be performed, if required. For dependable and reliable battery service, the battery should be in at least a 75 per cent state-of-charge.

(g) Batteries designated as "good" that are suspected of being questionable because of owner complaint, or age of the battery, should be further tested by the Hydrometer Test.

HYDROMETER TEST OF BATTERY

The 421 Battery Test as described in the previous paragraph is the fastest and most accurate means of determining the serviceability of a one-piece cover battery. However, if a 421 Battery Tester is not available, a hydrometer test may be used on a battery that has failed to give proper service.

Hydrometer Test

1. Fully charge battery.

2. Measure specific gravity of each cell as described in sub-paragraph below.

Decide battery serviceability as follows:

(a) If all cells read between 1.230 and 1.310, the battery is okay. All it needed was a full charge.

(b) After fully charging battery, if any cell reads less than 1.230, the battery is defective and should be replaced.

Use of Hydrometer

The Hydrometer measures the percentage of sulphuric acid in the battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition, the acid leaves the solution and enters the plates, causing a decrease in specific gravity of electrolyte. With a hydrometer, an indication of the concentration of the electrolyte is obtained.

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid, it also varies with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts so that the specific gravity increases. Unless these variations in specific gravity are taken into account, the specific gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

Correction can be made for temperature by adding .004, usually referred to as 4 "points of gravity", to the hydrometer reading for every 10 degrees F. that the electrolyte is above 80 degrees F. or subtracting .004 for every 10 degrees F. that electrolyte is below 80 degrees F. Figure IA-4 shows the exact correction figure to use for any temperature above or below 80 degrees F., the three steps used in obtaining the corrected or true specific gravity, and two examples showing how it is figured.

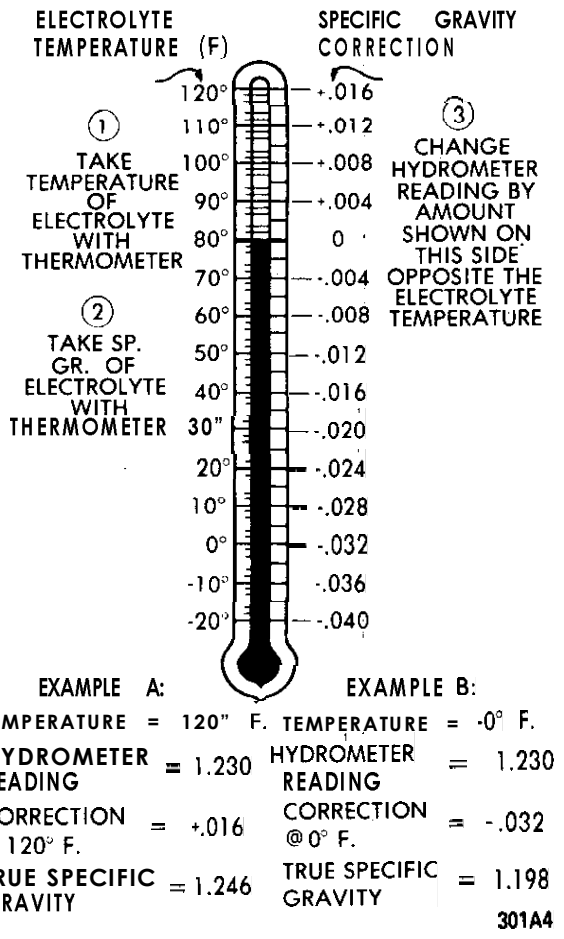

Figure 1A-4 Specific Gravity Temperature Correction Scale

When using a hydrometer, observe the following points:

1. Hydrometer must be clean, inside and out, to insure an accurate reading.

2. Hydrometer readings must never be taken immediately after water has been added. The water must be thoroughly mixed with the electrolyte by charging for at least 30 minutes before hydrometer values are reliable.

3. If hydrometer has built-in thermometer, draw liquid into it several times to insure correct temperature before taking a reading.

4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free floating, and with bulb fully released. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid. Disregard the curvation where the liquid rises against float stem due to surface tension.

5. Avoid dropping liquid on car or clothing as it is extremely corrosive. Any liquid that drops should be washed off immediately with soda solution.

FUSIBLE LINKS

All 1973 Opel Models have fusible links located between the starting motor post and the generator regulator. These links are the weakest point in the electrical supply system for the complete car, and, as such, will act like a fuse for every wiring harness in the car. Every electrical accessory is still protected by a fuse or circuit breaker, of course, but fusible links protect the wiring harnesses *before* the fuses.

A fusible link consists of soldering a smaller gauge wire to a heavier gauge wire end to end. In the event of a circuit overload where the heavier gauge becomes short circuited, the fusible link or smaller gauge wire will burn out first, thus, protecting its circuit from major damage. These fusible links are located in the engine compartment in such a manner that if overheated, the possibility of a fire is very remote.

The attachment of the fusible links and the circuits they protect are as follows: See Figure 1A-5.

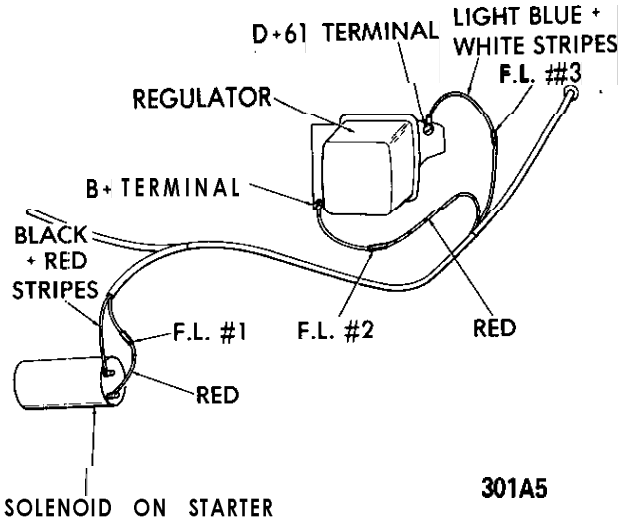

Figure 1A-5 Fusible Links

Fusible link (1) is connected to the starter solenoid at the battery cable terminal, on one end and to the red and white stripped main feed wire at the other end.

Fusible link (2) is connected between the red wire and its terminal of the voltage regulator and protects against a situation where the battery will not accept a charge and the generator is charging to handle various electrical loads. Fusible link (3) is connected between the light blue with white stripes wire and D

plus 61 terminal of the voltage regulator and protects the circuit to the generator telltale light.

BATTERY RECHARGING

There are two separate methods of recharging batteries which differ basically in the rate of charge. In the slow-charge method, the battery is supplied a relatively small amount of current for an extended period of time. In the quick-charge method, the battery is supplied with a high current for a short period of time.

Slow-Charging

Slow charging is the best and only method of completely charging a battery. The slow-charge method, properly applied, may be safely used under all possible conditions of the battery, provided electrolyte is at proper level in all cells. The battery may be fully charged by this method, unless the battery is not capable of taking a full charge. The normal slow charging rate for the 12-volt battery is 5 amperes.

Full charge of battery is indicated when all cell specific gravities do not increase when checked at three intervals of one hour and all cells are gassing freely.

Due to the low rate during slow charging, plenty of time must be allowed. Charge periods of 24 hours or more are often required.

Quick-Charging

Since time is often of most importance to the battery owner, quick-charging must sometimes be used to partially charge the battery so that the engine will start and the owner can be on his way.

Charge at 50 amperes for 20 minutes (50 times 20 equals 1000 ampere minutes). If charger will not give this rate, charge for an equal number of ampere minutes at the best rate available. Too high a current during quick-charging will damage battery plates.

A battery cannot be brought up to a fully charged condition by the quick-charge method. The battery can be substantially recharged or boosted, but in order to bring the battery to a fully charged condition, the charging cycle must be finished by charging at a low or normal rate. Some quick-chargers have a provision for finishing the charging cycle at a low rate so that the battery can be brought up to a fully charged condition.

Used with care, and employing all safeguards provided by the manufacturer, a quick-charger will not damage a battery *which is in good condition.*

BATTERY REMOVAL AND INSTALLATION

Removal

1. Disconnect battery cables (remove negative cable first to prevent possible shorting).
2. Remove battery hold down bracket.
3. Remove battery.

Installation

1. Place battery back in hold down position.
2. Tighten hold down bracket bolts.
3. Connect battery cables (connect positive cable first to prevent possible shorting).

FUSIBLE LINK REMOVAL AND INSTALLATION

Replace a burned out fusible link as follows:

1. Disconnect battery.
2. Disconnect connector eye on end of fusible link.
3. Cut off other end of burned out link, along with solder joint.
4. Strip insulation from end of new fusible link and from end of wiring harness so that each will slide into soldering sleeve.
5. Crimp new link in soldering sleeve and solder carefully.
6. Cover new connection tightly with electrical tape.
7. Install new link connector eye on other end of fusible link.

A burned out fusible link connected to the starter solenoid would be indicated by:

1. All electrical accessories dead.
2. Starter dead - will not even click. Even with a nearly dead battery, the starter solenoid will generally engage; therefore, no click means no solenoid action, possibly due to a burned out fusible link.

SPECIFICATIONS

BATTERY SPECIFICATIONS

Delco-General 12 volt-44 amp hour storage battery is installed as original equipment. Replace with a Delco Energizer Y55.