The battery serves as an energy reservoir, storing the generator's electrical output in chemical form. The battery's chemical energy is converted again to electrical energy for operating the starter motor, or when needed for lighting and ignition current.

When the engine is operating at a speed too low for the generator to supply all the lighting and ignition current needed, the battery discharges, converting its chemical energy into the needed electrical energy. At normal riding speeds, generator output is sufficient to recharge the battery, restoring its chemical energy.

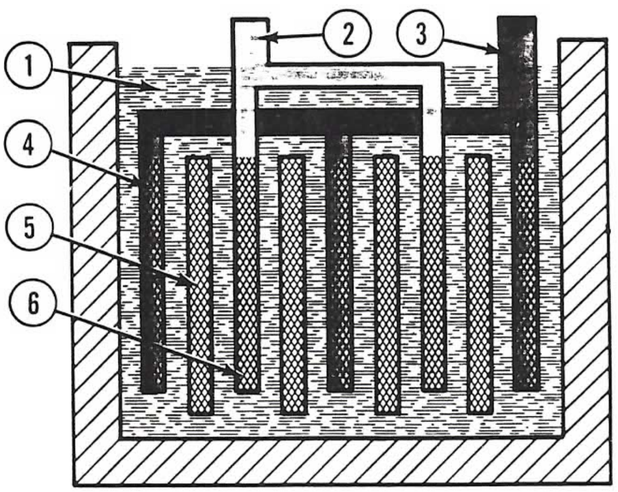
Some motorcycles do not require batteries. Dirt bikes, especially those which have no lighting equipment, do not require an energy reservoir; their ignition current is supplied solely and directly by the generator. These machines are designed without batteries or starter motors for simplicity and to reduce weight.

A battery is required on all motorcycles equipped with starter motors, because the starter motor must operate when the engine is at rest, and the generator cannot supply current until the engine is running. Further, starter motors consume large amounts of current. A battery is also necessary, or at least helpful, if a large amount of lighting current must be delivered at idle speed.

Battery Cell Construction:

Motorcycles are normally equipped with lead-acid batteries. Other metals and electrolytes can be used to construct batteries, but the ordinary lead-acid combination produces the highest cell voltage for the lowest cost.

A simple battery cell is illustrated in Fig. 35. Groups of lead plates are stacked parallel to each other, separated by sheets of insulating material. The cell is filled with dilute sulfuric acid when prepared for service.



① ELECTROLYTE
② POSITIVE TERMINAL
③ NEGATIVE TERMINAL
④ NEGATIVE PLATE (Pb)
⑤ SEPARATOR
⑥ POSITIVE PLATE (PbO_2)

Fig. 35 Lead-Acid Battery Cell

Plates connected to the negative terminal of the battery are made of plain lead (Pb). Plates connected to the positive terminal are made of lead peroxide (PbO_2), which can be distinguished by its brown color.

The plates are arranged alternately; negative – positive – negative, etc. There is a negative plate at each end of the plate group; therefore the cell has one more negative plate than positive plate. There is no technical reason for using negative plates at both ends; it is simply common practice.

Separator sheets of resin treated paper and fiberglass, or other non-conductive materials, are porous to permit the passage of electrolyte, while insulating the lead plates from each other to prevent short circuiting. Additional separators may be placed at the ends of the plate group as packing material, though this is not essential.

Battery Cell Operation:

Chemical action between the electrolyte and the cell plates produces an electric current. As previously stated, the positive cell plates are lead peroxide (PbO_2) and the negative cell plates are plain lead (Pb). When a load is connected between the battery terminals and the cell discharges, the sulfuric acid electrolyte (H_2SO_4) divides into H_2 and SO_4. The H_2 combines with oxygen in the positive plates to form water (H_2O), while the SO_4 combines with the lead (Pb) of both plates to form lead sulfate ($PbSO_4$). When the battery is recharged by the generator, the chemical process is reversed.

$$PbO_2 + Pb + H_2SO_4 = \underset{\xleftarrow{\text{CHARGE}}}{\overset{\xrightarrow{\text{DISCHARGE}}}{2PbSO_4 + 2H_2O + \text{ELECTRICAL ENERGY}}}$$

As discharge continues, the amount of lead sulfate on the plates increases until the sulfate coating becomes so thick that the weakened electrolyte cannot effectively reach the active materials (lead and lead peroxide). When this happens, chemical reaction is retarded and the output of the cell is reduced. In practice, the battery should not be permitted to discharge to this extent, because thick coatings of lead sulfate are difficult to remove in charging. When a battery has been allowed to remain in a discharged condition for a considerable time, sulfation is visible as a white deposit on the plates. Cells which have become badly sulfated may be permanently impaired.

Specific Gravity:

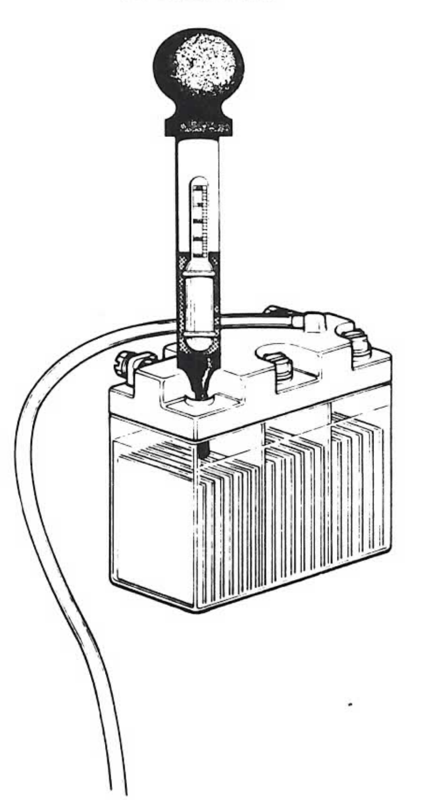
When the cell is being charged, lead sulfate is removed from both positive and negative plates, and sulfuric acid is again formed. In the process, the water content of the electrolyte is decreased, and the acid content of the electrolyte is increased.

Sulfuric acid is heavier than water. Therefore, increasing the sulfuric acid content increases the density of the electrolyte. *Specific gravity* is a measure of the density of the electrolyte, relative to water. Water has a specific gravity of 1.000.

The cell's state of charge is indicated by the specific gravity (density) of its electrolyte and can be checked with a hydrometer (Fig. 36).

The specific gravity must be high enough to promote chemical action in the cell, though excessive acid content can shorten cell life. A well charged cell in a motorcycle battery should have a specific gravity of 1.260 – 1.280. A specific gravity of 1.200 – 1.260 indicates a partial charge. If the specific gravity falls below 1.200, the battery should be recharged as soon as possible; it should not be permitted to remain for a long time in a discharged state.

The specific gravity figures given in the preceding paragraph apply at a standard reference temperature of 77°F. The specific gravity reading for a given electrolyte density will vary slightly with temperature changes. At high temperatures, lower specific gravity readings will be obtained, and vice versa.



Electrolyte level in the syringe tube must allow the float to operate freely; do not overfill or underfill.

For an accurate indication of state of charge, do not test specific gravity immediately after adding water to the cell or during initial re-charging.

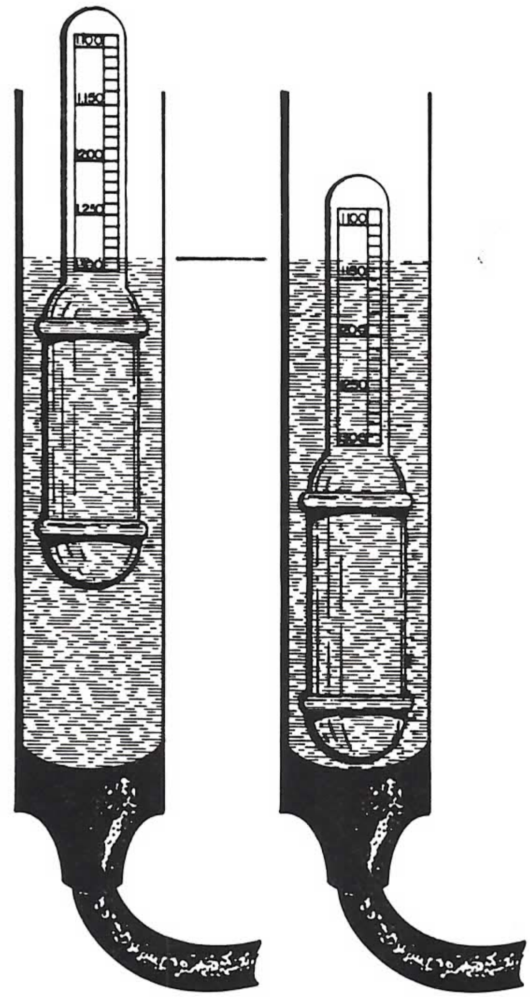


Fig. 36 Measuring Specific Gravity With a Hydrometer (calibrated float reads specific gravity)

As a temperature correction factor, add 0.001 to the specific gravity reading for each 3°F above 77°F. Subtract 0.001 from the specific gravity reading for each 3°F below 77°F. Thus, if a specific gravity reading of 1.260 is obtained at 50°F, the corrected specific gravity is 1.251.

Battery Cell Voltage:

Cell voltage is basically determined by the plate material and electrolyte chemicals used. A lead-acid cell produces a nominal 2 volts.

Regardless of cell size or the number of cell plates (these factors affect ampere-hour capacity), if the plates are lead and the electrolyte is sulfuric acid, then the nominal cell voltage is 2 volts.

Three 2 volt cells are connected in series to make a 6 volt battery (Fig. 37). Six 2 volt cells are connected in series to make a 12 volt battery (Fig. 38).

Note that the cells must be connected in *series* in order for the cell voltages to be additive. If a number of 2 volt cells were connected in *parallel*, you would simply have a large 2 volt battery with greater ampere-hour capacity.

The actual, measured voltage of a lead-acid cell will be slightly more or less than the nominal 2 volts, depending on the specific gravity of the electrolyte.

Open circuit voltage, applicable while the battery is not connected to any load, can be calculated as follows:

VOLTS = SPECIFIC GRAVITY + .84

Thus, the open circuit voltage for a cell with a specific gravity of 1.280 is 2.12 volts. Six such cells, connected in series, will produce a battery open circuit voltage of 12.72 volts.

When a cell discharges, there is a gradual decrease in voltage due to increasing internal resistance as lead sulfate coats the plates and electrolyte weakens. After a gradual decrease to roughly 1.75 volts, the cell's capability is exhausted, and voltage drops sharply below a useful level.

Voltage generated by the motorcycle's charging system must be greater than the battery's nominal voltage. Charging voltage must equal the battery's open circuit voltage plus the voltage necessary to overcome internal resistance within the cells.

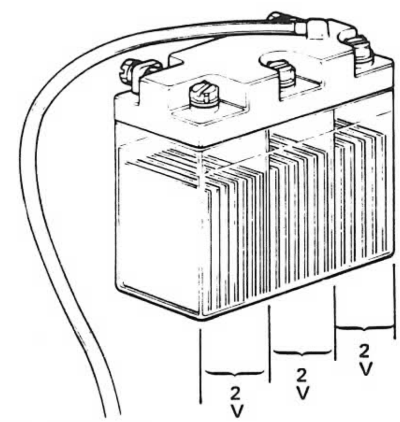


Fig. 37 6 Volt Battery (three 2 volt cells)

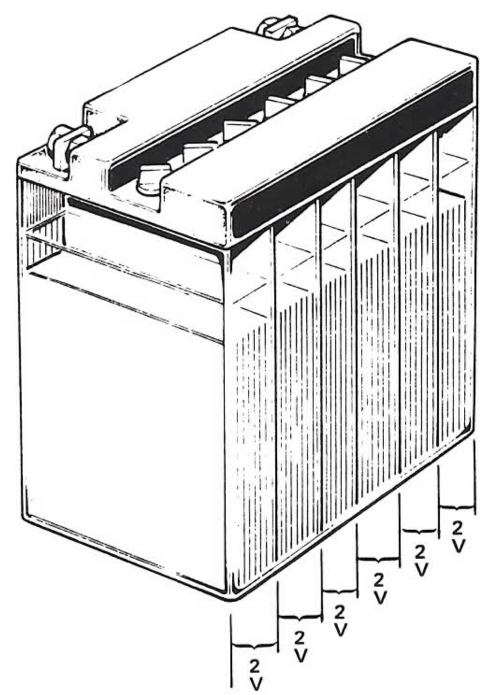


Fig. 38 12 Volt Battery (six 2 volt cells)

B. .ry Ampere-Hour Capacity:

Battery capacity (the ability to deliver electrical energy) is expressed in terms of *ampere-hours.* Ampere-hour ratings are calculated by multiplying battery discharge current, in amperes, times the number of hours the battery is capable of supplying that current.

However, in order for a battery's advertised ampere-hour rating to have any meaning, it is essential to know the particular time period for which the ampere-hour rating was measured. If a battery is slowly discharged, producing low amperage current over a period of many hours, it will produce far more ampere-hours of current than if it is discharged at a very rapid rate, such as occurs when operating a starter motor.

A 12 ampere-hour battery, based on a 10 hour discharge rate, will deliver 1.2 amperes of electrical current for a 10 hour period (1.2A X 10 hrs. = 12 ampere-hours). The same battery will **not** deliver 12 amperes for 1 hour; more likely it would deliver about half that much at a 1 hour discharge rate.

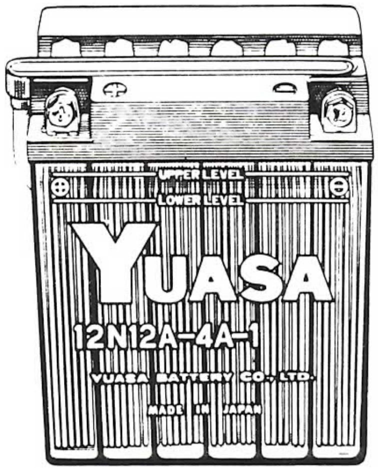
For Yuasa batteries used in Honda motorcycles, a period of 10 hours has been established as the discharge time in rating battery capacity. American automotive batteries customarily use a 20 hour rate for advertised ampere-hour capacity. A 5 hour rate is standard for aircraft batteries.

T ampere-hour capacity of a battery depends mainly on its total effective plate area. A larger battery, with bigger plates or more plates in parallel, will have a higher ampere-hour capacity. Greater ampere-hour capacity can also be obtained by connecting two or more batteries in *parallel.* A battery will also have a somewhat higher ampere-hour capacity at summer temperatures than at winter temperatures, because higher temperatures accelerate chemical reaction. However, cell temperatures in excess of 113^{o}F (45^{o}C) will reduce the service life of the battery.

Battery Identification:

A model identification code is imprinted on the side of all Yuasa motorcycle batteries (Fig. 39). In most (but not all) cases, this code will correspond to the JIS (Japan Industrial Standards) classification number for that type of battery.

Where Japanese-made batteries are concerned, technical literature and battery interchangeability charts usually refer to the JIS number, and it is useful to know how to decipher the code.



Yuasa 12N12A-4A-1 Battery

Number preceding letter "N" indicates battery voltage. Number immediately following "N" indicates ampere-hour capacity. Other symbols identify the physical construction of the battery.

12N12A-4A-1 CODE INTERPRETATION

12—— Nominal voltage (12 volts)
N —— Initial for Nippon (Japan)
12—— Ampere-hour capacity at 10 hour discharge rate (12 AH)
A —— JIS battery identification symbol
4 —— Terminal position code
A —— Vent tube position code
1 —— Yuasa battery identification number

6N6-3B CODE INTERPRETATION:

6 —— Nominal voltage (6 volts)
N —— Initial for Nippon (Japan)
6 —— Ampere-hour capacity at 10 hour discharge rate (6 AH)
3 —— Terminal position code
B —— Vent tube position code

Fig. 39 Battery Identification Codes

Dry-Charged Batteries:

Yuasa batteries for Honda motorcycles are *dry-charged,* which means that the cell plates are charged and then dried before the battery is assembled by the manufacturer. Assembled batteries are sealed to keep out moisture. This process enables batteries to be stored for long periods of time without deterioration.

Preparation of New Dry-Charged Motorcycle Batteries:

1. Unseal the battery and attach the vent tube. The vent tube must be unobstructed in order to vent hydrogen and oxygen that is liberated during the charging process (see page 22).

   If the vent tube is kinked, it should be reshaped prior to use. A kinked vent tube will usually regain its shape if immersed in boiling water for a few minutes.

2. Fill the battery cells with electrolyte and let stand for 1 or 2 hours. Adjust electrolyte level to the upper level line marked on the battery case.

   In cold weather, electrolyte should be brought to room temperature before filling the battery.

3. Charge the battery at one tenth (10%) of its rated ampere-hour capacity for the number of hours shown in the following chart. For example, a 12 ampere-hour battery that is 6 months old should be charged at 1.2 amps for 3 hours.

INITIAL CHARGE FOR NEW BATTERIES

Months elapsed since manufacture*	Charging hours
Less than 12 months	3 hours
12 to 18 months	5 hours
18 to 24 months	10 hours
More than 24 months	15 - 20 hours

*Date of manufacture is stamped on the battery case, below gas vent.

NOTE: If the battery seal is missing, or was removed more than one day prior to activation, charge the battery for 15 - 20 hours.

CAUTION: Do not exceed the recommended charging rate (10% of the battery's ampere-hour rating), and do not allow electrolyte temperature to exceed 113°F (45°C) during the charging process. Excessive charging rate and cell temperature will damage the battery.

Electrolyte Level:

Check electrolyte level every week or so. When the electrolyte level becomes low, add water until the electrolyte reaches the upper level line marked on the battery case. Never allow the electrolyte level to fall so low as to expose the cell plates, as this can damage the plates.

Water loss is a result of the normal charging process. As the cells approach full charge and cannot utilize further current for the chemical changes described on page 17, the excess charging current breaks down electrolyte water into its hydrogen and oxygen components. This can be seen through the transparent battery case as bubbles rising to the top of the cells. These gases escape through the vent tube. Minute amounts of acid inadvertently escape through the vent tube as well. The volume of acid lost in this manner is so small that acid replenishment is never required during the service life of the battery. However, the vent tube must be routed so that it does not discharge near the drive chain or other critical parts that are susceptible to acid damage.

It is preferable to use distilled water in the electrolyte solution. Tap water may contain chlorine, iron, and other elements which would contaminate the electrolyte and reduce its effectiveness.

Battery Vent Tube:

Route the battery vent tube as described in the owner's manual for your motorcycle model. Correct routing is also shown on caution labels (Fig. 40 & 41) attached near the battery area of Honda motorcycles.

It is important that the vent tube be routed so it is not kinked or pinched, and it must be positioned where it cannot discharge acid fumes and droplets on the drive chain. If acid contacts the drive chain, premature wear or breakage may occur (Fig. 42).

Check the battery vent tube occasionally to be sure that it is properly attached and has not become kinked or pinched. Replace damaged vent tubes.

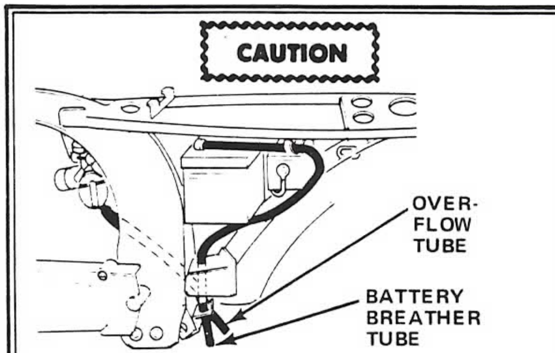


Fig. 40 Vent Tube Routing Label (CB-125S)

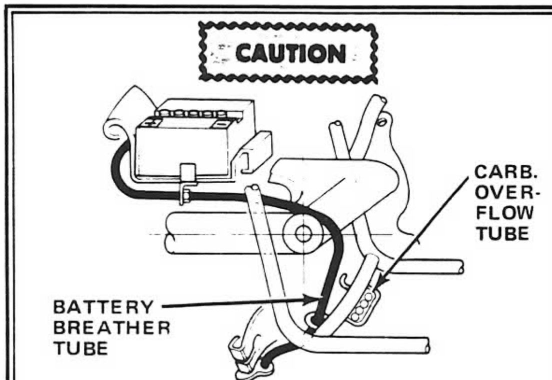


Fig. 41 Vent Tube Routing Label (CB-500)

Battery Cleaning:

Inspect battery terminals and the battery mounting box for signs of corrosion. Clean and repaint the battery box if signs of corrosion appear. Clean all corrosion from the battery terminals. Battery terminals can be coated with petroleum jelly for corrosion protection, but do not allow petroleum jelly to coat the battery case. A solution of baking soda (sodium Bicarbonate) and water can be used to neutralize acid when cleaning the battery and its mounting box.

Soapy water (using mild bar soap) is recommended for general cleaning. If the battery fits tightly in its mounting box, soapy water can also be used to ease installation and removal. No other cleaning agents should be used. Some cleaning and lubricating products contain chemicals which may cause the battery case to weaken or crack. Aerosols and petroleum base products are especially harmful.

CAUTION: Cell caps must be installed when cleaning the battery. Do not allow soap or baking soda to enter battery cells.

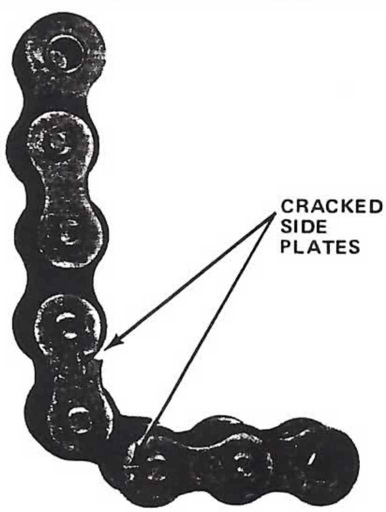


Fig. 42 Drive Chain Damage Caused by Battery Acid

'ery Storage:

When a battery is not in use, it discharges at an average rate of ½% per day. The rate of self-discharge is greater at warm temperatures and less at cold temperatures.

If your motorcycle is to be stored for only a few weeks, disconnect the negative battery cable to prevent possible current leakage within the motorcycle's electrical system. Self-discharge will still occur within the battery, but the amount of discharge will not be substantial over a period of only a few weeks.

If your motorcycle is to be stored for a month or longer, remove the battery from the motorcycle, store it in a cool, dry location, and recharge it at least once a month. A hydrometer can be used to determine the battery's state of charge and establish the best recharging intervals. Never allow the battery to stand in a discharged condition for long periods, or the cell plates will be affected by sulfation. Be sure the battery is fully charged when it is again placed in service.

Battery Charging Equipment:

Recommended charging current for Honda motorcycle batteries (10% of the battery's ampere-hour capacity) ranges between 0.2 and 2.0 amperes, depending upon the ampere-hour capacity. Most of the inexpensive automotive trickle chargers are not suitable, as they generally deliver a current of one to six amperes. An excessively high charging current will damage the battery.

If you are unable to obtain a battery charger with sufficiently small output for your motorcycle battery, you can modify an automotive battery charger to deliver a suitable charging current by connecting a 12 ohm, 50 watt rheostat and an appropriately calibrated ammeter as shown in Fig. 43.

Adjust the rheostat to deliver the recommended amperage. Relatively inexpensive rheostats and ammeters are available from electronics parts supply stores. For a neat, permanent installation, the ammeter and rheostat can be built into a small box next to the charger, but adequate ventilation must be provided to cool the rheostat.

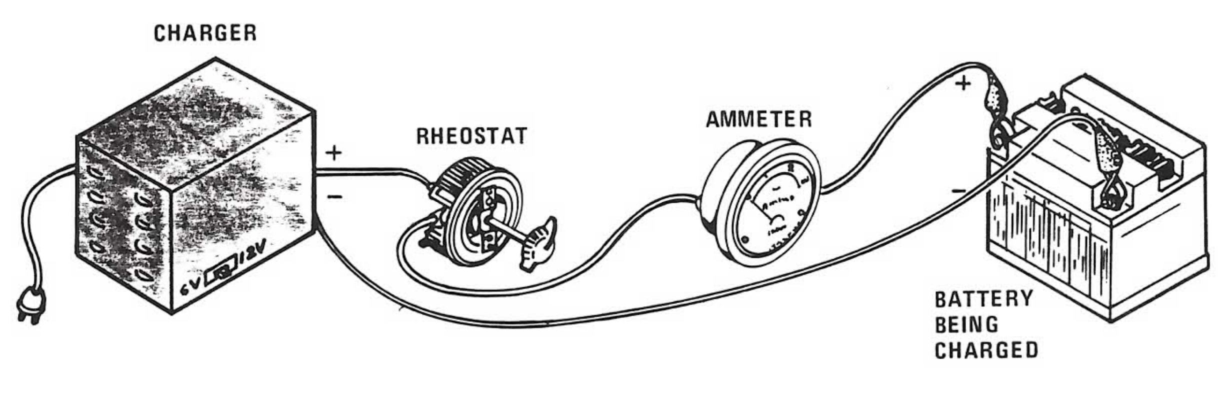


Fig. 43 Adapting an Automotive Battery Charger For Use With Motorcycle Batteries

Battery Safety:

Battery electrolyte contains sulfuric acid. Do not allow electrolyte to contact skin, eyes, or clothing. For safety, wear eye protection when working with batteries and electrolyte. Keep batteries and electrolyte out of reach of children.

> **ANTIDOTE,** external: Flush with water. If electrolyte has contacted the eyes, flush with water and get immediate medical attention.
>
> **ANTIDOTE,** internal: Drink large quantities of water or milk. Follow with milk of magnesia, beaten egg, or vegetable oil. Call a physician immediately.
>
> **Editorial Note:** Electrolyte has a pungent, sour flavor; it tastes really terrible. We cannot imagine why anyone would want to drink the contents of their battery, but our legal staff feels than an antidote should be published in case this might occur anyway. Drinking your battery can be fatal, or certainly more harmful than eating your saddle, or biting your tires. We watch our legal staff very closely to be certain they do none of these things, though tire biting is not particularly harmful unless the motorcycle is in motion.

Batteries produce highly explosive hydrogen gas during the charging process. Be sure the battery vent tube is unobstructed, and the battery charging area is well ventilated. Keep open flames and sparks away from the battery. To prevent sparks, switch off or unplug the battery charger when connecting or disconnecting the battery.

When removing the battery from the motorcycle, disconnect the negative cable first. This procedure eliminates the chance of short circuiting the battery if your wrench or screwdriver should touch the motorcycle frame while loosening the positive cable connection. When installing the battery, connect the negative cable last.

IGNITION SYSTEMS

Basically, a motorcycle ignition system consists of a voltage source (battery or A.C. generator), a switching device to start and stop current flow at predetermined intervals (contact points or an electronic switch), a step-up transformer to produce high voltage (ignition coil), and the spark plug.

The sole purpose of the ignition system is to produce a spark that will ignite the air-fuel mixture in the engine's combustion chamber. The spark must be timed to occur at a precise point relative to the compression stroke of the piston.

In order to produce the ignition spark, an electric current must be made to jump the gap between the spark plug electrodes in the highly pressurized atmosphere of the combustion chamber.