SERVICE MANUAL

1994 SOLECTRIA FORCE

2-SEAT/4-SEAT AUTOMATIC LEAD ACID ELECTRIC VEHICLE
2-DOOR COUPE/ 4-DOOR SEDAN

FORWARD

This manual has been prepared as a supplement to the service information contained in the Geo Service Manual. Information contained in this manual is based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice.

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INTRODUCTION

This manual section contains a description of the Solectria Force automobile and its major features, along with a listing of other related service publications. For operating information, refer to the Solectria Force Owners Manual.

Description

The Solectria Force is a Geo Metro that has been modified by the replacement of the internal combustion engine with the Solectria electric drive system. The three-phase induction drive motor and associated controller receive electric power from a self - contained battery pack. The battery is recharged from any 110 VAC 60 Hz outlet. Optional solar cells, mounted on top of the vehicle, are also employed to recharge the battery. The car utilizes the Solectria automatic transmission.

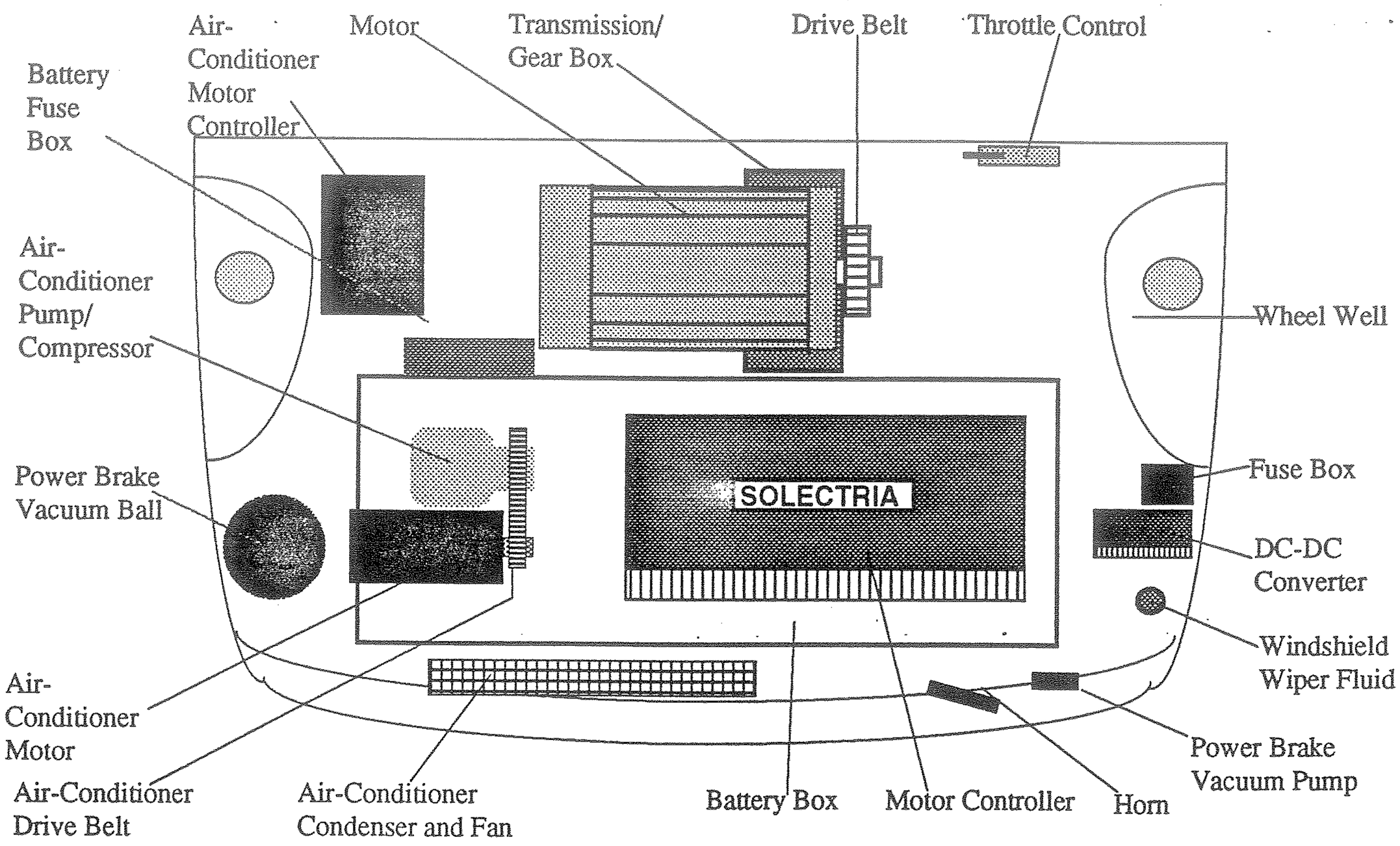


DIAGRAM OF EQUIPMENT UNDER THE HOOD FOR SOLECTRIA FORCE AUTOMATIC

Figure 1

Additional Service Information

The Geo Metro Service Manual ST370 and the Geo Metro electrical diagnosis manual ST370 EDM (not included with this manual but available through a local GEO dealership) should be consulted for service information on all parts of the Solectria Force, except for the following parts:

- Electric Drive Motor
- Automatic Transmission
- Batteries
- Electronic Components
- Solectria - installed wiring

NOTES

1. The diagnostic connector for the Geo is inoperative on the Solectria, because it is used only with the Geo gasoline-powered vehicle.

2. Replacement rear coil springs must be ordered from Solectria Corporation as they are not interchangeable with the standard springs.

3. For safety's sake, always remove the ignition key from the steering column before performing service work on the car.

DRIVE MOTOR

The drive motor is a 3-phase induction motor, located in the rear of the engine compartment behind the battery box, and above the automatic transmission. There are no user serviceable parts on the motor, however the bearings should be checked every 50,000 miles by being sent to the factory.

Adjustment of Drive Belt

A drive belt connects the drive motor pulley to the transmission input shaft. The tension of the drive belt can be checked by applying a 4-1/2 lb. force to the mid-point of the length of the drive belt. The belt should deflect about 1/4-inch. If the drive belt tension requires adjustment, loosen the three motor mount bolts, and adjust the motor position to obtain the desired belt tension. Retighten the motor mounting bolts, then recheck belt tension.

Replacement of the Drive Belt

1. Loosen the two torque arm bolts.
2. Loosen the motor mount bolts, then move the motor in the direction to loosen the belt.
3. Remove the defective belt, then install a replacement belt and adjust the belt tension as described in the previous paragraph.

	Solectria Part No.
Automatic transmission belt	FBA8M-720

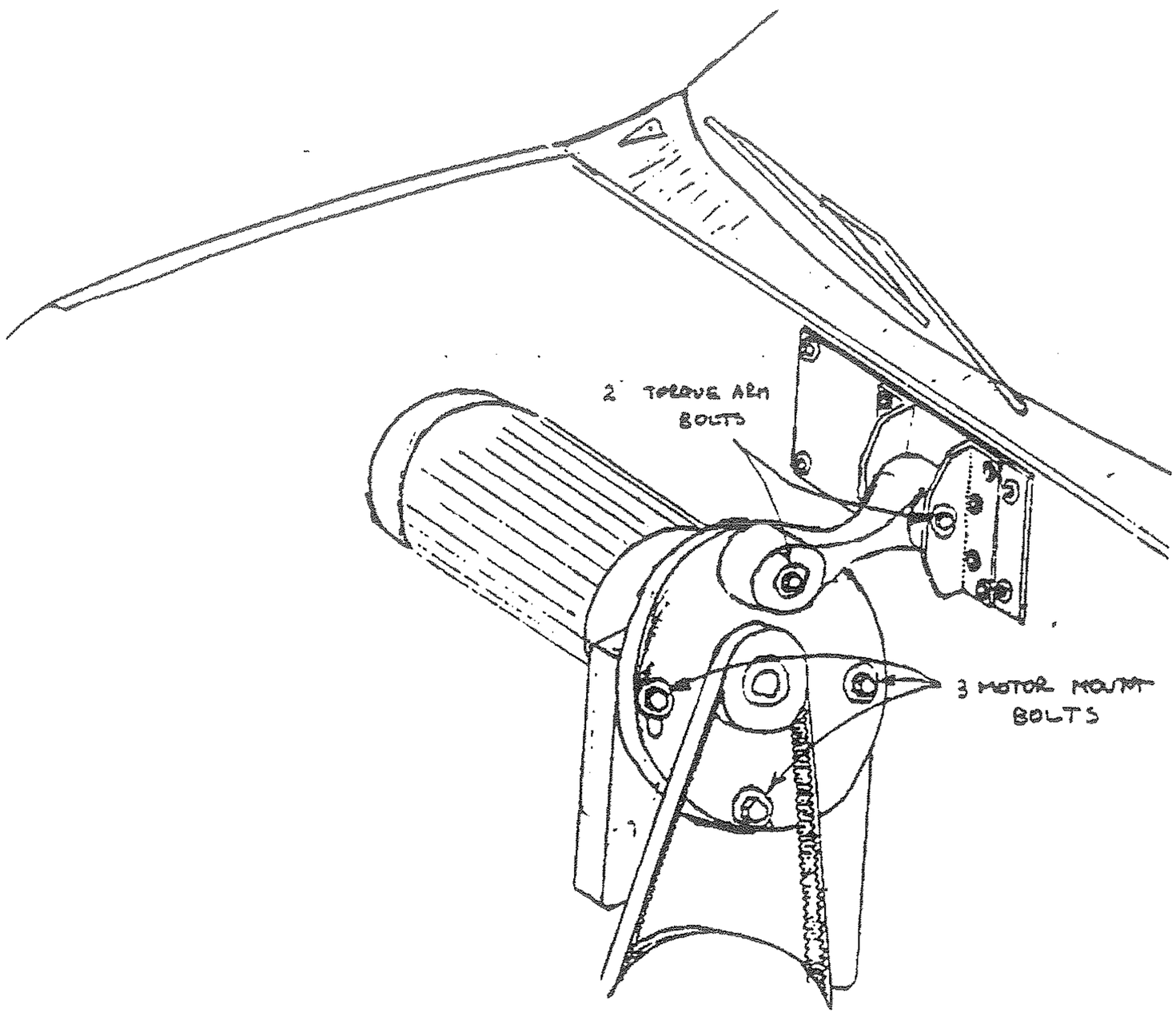


Figure 2

Replacement of Drive Motor

1. Unplug the main power connector (red, white, and blue) which connects the motor to the controller.

2. Carefully unplug the small rectangular logic cables from the controller. The controller is a silver box with a heat sink on one side which is located in front of the AC induction motor.

3. Remove the torque arm bolts then remove the torque arm.

4. Loosen the motor mount bolts, then remove the drive belt.

5. Remove the motor mount bolts, and lift the motor from the car.

6. Remove the pulley off the motor's shaft as you would a collet: unscrew each of the 3 (or 4) hex bolts and place these in the holes next to them. Then screw these into the pulley. Turn each bolt a 1/4 rotation. Repeat this procedure, alternating between bolts, until the pulley is loose. Remove the bushing by gently tapping it off the shaft. Follow in reverse order once you have the new motor.

7. To install a replacement motor, follow the above procedure in the reverse order.

AUTOMATIC TRANSMISSION

The automatic transmission is a single-speed, double reduction drive with an integral differential. The transmission is located underneath the drive motors. To service this, periodically check the transmission oil level: during the first six months - check oil once a month. Change the oil after the first 750 miles, and thereafter change the oil after every two years.

Checking Transmission Oil Level

To check oil look at the sight glass located on the passenger side of transmission behind the front half shaft. The oil level should be visible in the glass. If necessary add Kendall Elite synthetic motor oil (or consult factory for oil recommendations).

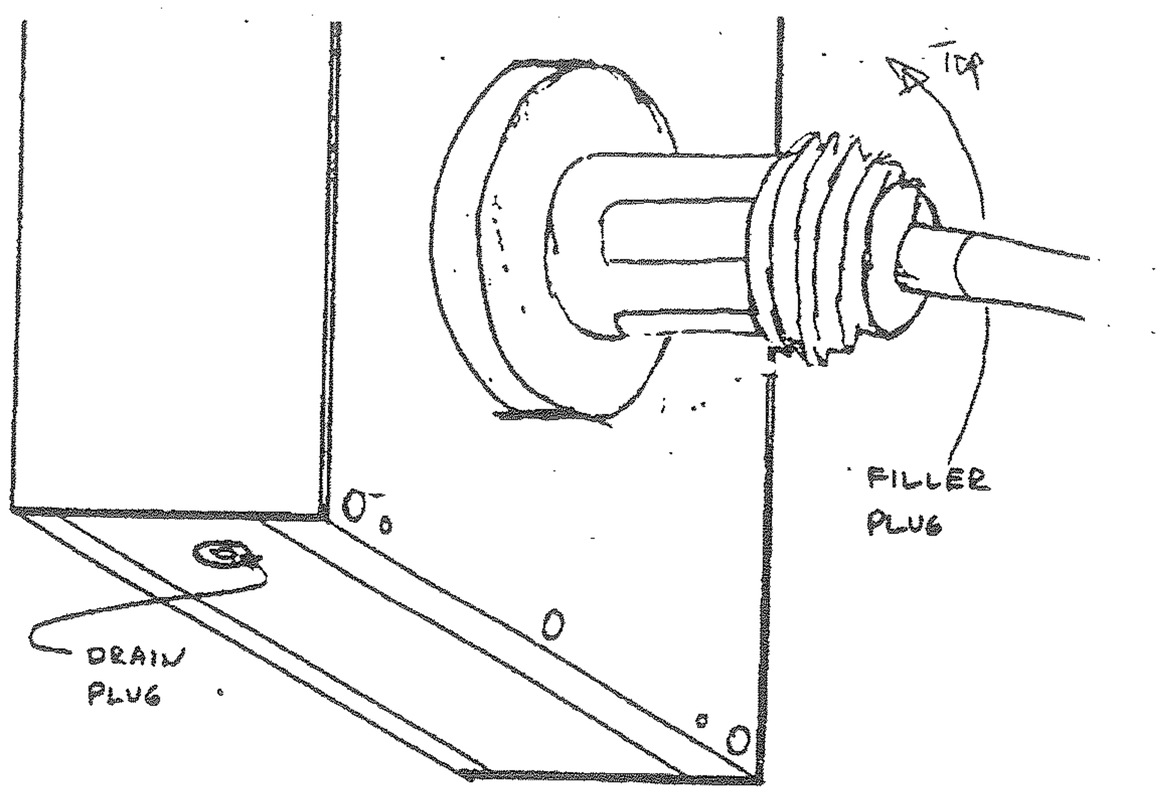


Figure 3 AUTOMATIC TRANSMISSION

Changing Transmission Oil

After 750 miles of operation and every two years thereafter, replace the transmission oil.

1. Put a drain pan under the transmission, then remove the drain plug located on the bottom of the transmission to drain the oil.

2. Clean drain plug. Then using Locktite hydraulic thread sealer re-install the drain plug.

3. Remove the filler plug, located on top of transmission just behind motor controllers and beneath motors.

4. Fill with approximately 1 quart of Kendall Elite synthetic motor oil.

NOTE
Disregard the instructions in the owners manual regarding use of any other type of oil in the transmission.

5. Reinstall filler plug and check for leaks.

Replacement of Lower Transmission Mounts

Use the following procedure to replace both lower transmission mounts. To simplify the procedure, replace one mount, and then replace the other .

1. Raise the front end of the car. Use jack stands to safely keep car above ground.

2. Loosen both bolts located in the upper torque arm on "dog bone".

NOTE
Perform steps 3 through 9 for one mount, then perform these steps for the other mount.

3. Remove 3/8-inch bolt from upper side of rubber mount.

4. Remove two 5/16 inch nuts and bolts from lower side of rubber mount.

5. Raise transmission and motor assembly, and remove the rubber transmission mount.

6. Install new rubber mount and loosely install lower bolts.

7. Lower transmission assembly in place.

8. Install upper 3/8-inch bolt and torque to 35 ft/lbs.

9. Tighten lower 5/16-inch nuts and bolts to 25 ft/lbs.
(Repeat steps 3 through 9 for other mount).

10. Retighten half-inch torque arm bolts to 75 ft/lbs.

11. Lower the car from the raised position.

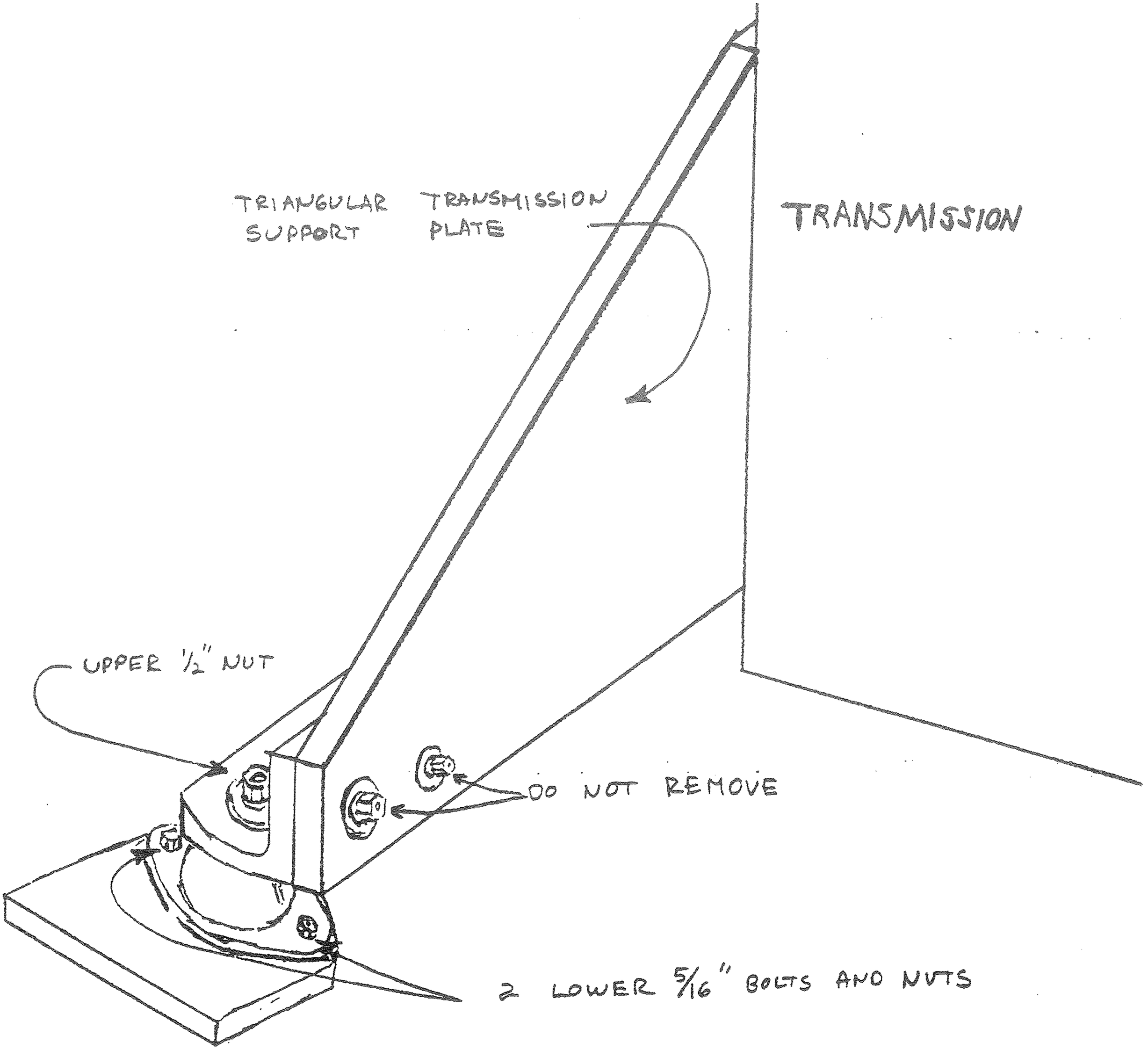

TRIANGULAR SUPPORT
TRANSMISSION PLATE
TRANSMISSION
UPPER ½" NUT
DO NOT REMOVE
2 LOWER 5/16" BOLTS AND NUTS

Figure 4

Replacement of the Transmission

1. Remove the drive motor. Refer to the section on drive motor replacement.

2. Pull up speedometer cable boot at the transmission. Pull out speedometer case clip. Pull speedometer cable from transmission.

3. Remove 3/8-inch bolts from upper side of rubber mounts.

4. Raise car and support on stands so that the front suspension hangs free.

5. Drain transmission oil.

6. Remove ball joint stud bolts as shown.

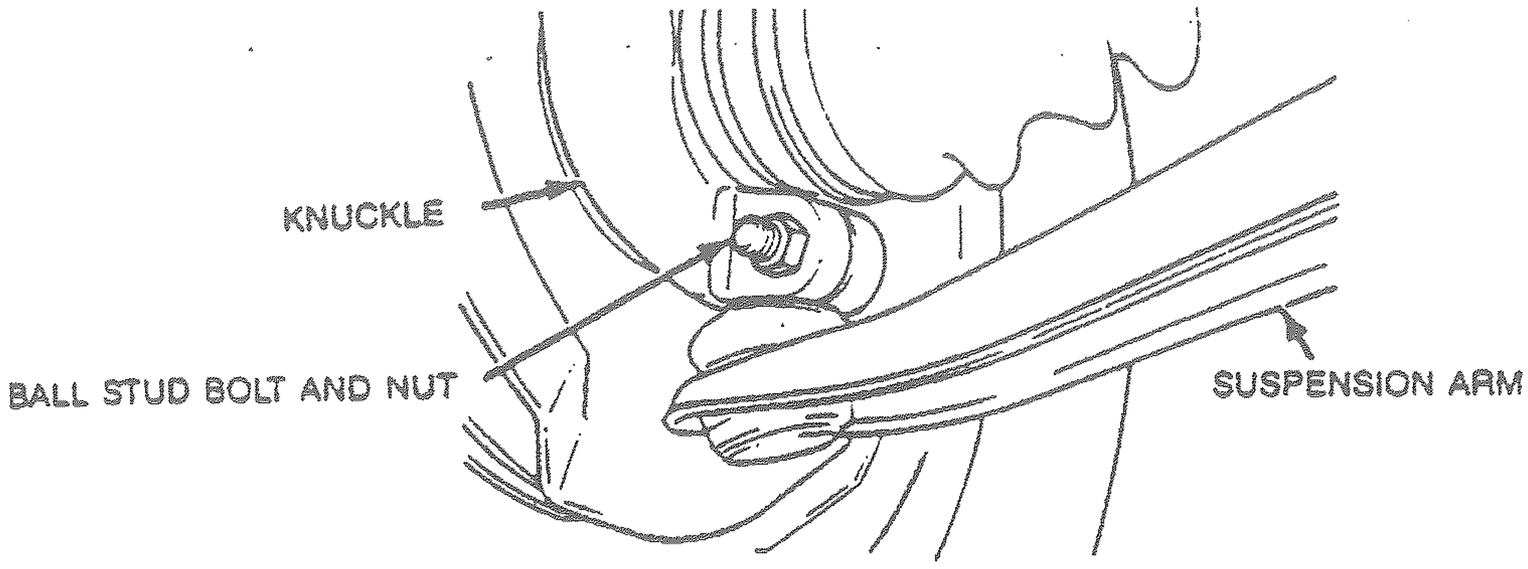


Figure 5

7. Pull lower ball joints from steering knuckles.

8. Pry drive axle out from transmission using a large screwdriver as shown below taking care to avoid damaging the seal.

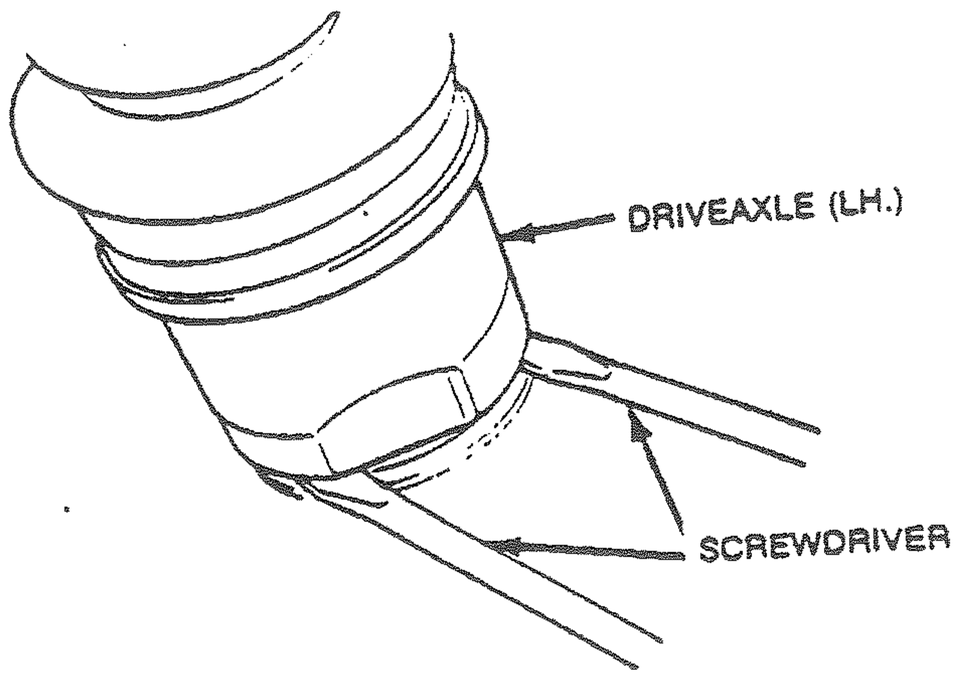


Figure 6

9. Push steering knuckle away from transmission, allowing the drive shaft to hang free.

10. Lift transmission off the rubber mount studs, and lower the transmission from the car.

11. Remove triangular transmission support plate from transmission.

12. Install a replacement transmission by following the above procedure in the reverse order.

BATTERY

The battery pack consists of 12 12-volt deep-cycle lead acid batteries. The batteries are located in two boxes. There are five batteries located in the front battery box, and seven batteries located in the rear battery box.

Preventive Maintenance

CAUTIONS

- Lead acid battery electrolyte is a sulfuric acid solution. Always wear safety goggles or a face shield and rubber gloves when servicing a battery.

- If battery solution spills on clothing or skin, rinse it off with water immediately to minimize the damage.

- **Do not overcharge. The dash-mounted ampere/hour meter records battery usage. For a newly charged battery, the meter will read approximately 0. When the meter reads any more than 5 ampere-hours of battery use, the battery should be recharged. Discontinue charging when the meter reads -2. Over charging may occur if charging is allowed to continue so that the meter reading passes -5 level. Overcharging heats up the battery and causes loss of electrolyte, both of which are detrimental to battery life. A charge controller is set up to shut off battery charger after it reaches a pre-set voltage limit but it is not fail-safe. Be careful to not overcharge!**

WARNING

If electrolyte escapes from the battery or if the battery temperature rises above 125°F, stop charging and wait for battery to return to a safe temperature (less than 120°F).

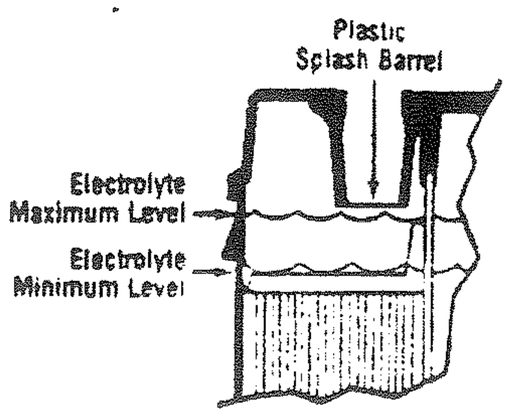


Figure 7

Checking Battery Fluid Level

Every 3 months the fluid level in the cells of each battery should be checked, and **distilled water** should be added if necessary. Do not add ordinary tap water to the battèries. Make sure that the battery connections are clean and tight. Procedures for gaining access to the batteries are contained in the following sections.

Fill battery cells to the bottom of the filler well inside each batter cell.

WARNING

Batteries are connected in series, for a total voltage of 144V. To avoid shock, use rubber insulating gloves and wear eye protection when handling battery terminals.

Also, a fire or explosion hazard may occur if a wrench or other metal object is placed inside a battery box.

To Gain Access to the Rear Battery Box

1. To gain access to the batteries, remove screws from the rear battery box cover.

2. Lift black cover from the case.

To Gain Access to the Front Battery Box (automatic transmission)

To gain access to the battery box cover, the motor controller must be removed and the air conditioning drive unit (mounted on a plate to the left of the controller) if installed must be moved aside. The electrical and hose connections for the air conditioning unit must not be disconnected for this procedure.

1. Remove 2 1/4-20 socket cap screws from the air conditioning drive unit mounting plate.

2. Lay the drive unit assembly upside down on the inner fender.

3. Disconnect the main battery plug (large gray 2-wire connector) from the motor controller.

4. Disconnect the motor connector (large red, white and blue 3-wire connector) from the controller.

5. Disconnect all of the small connectors very gently from the back of the controller. Be careful not to push any of the connectors into the controller.

6. Remove the controller and set it in a safe place. It should not be dropped or allowed to tip over.

7. Remove the remaining 1/4-20 socket button cap screws from the battery box cover.

8. Remove the battery box cover.

Checking Battery Condition

If the range performance of the car following a full recharge has been reported to be declining, perform the following check. Recharge the battery and drive the car at least 25 miles, or until the car will not maintain 30 mph on a level road. Stop the car and open the battery compartments (following above directions). Check each battery's voltage with a reliable voltmeter while keeping the lights, fan and heater on. Any battery that tests less than 10 volts should be replaced.

IMPORTANT WARNING: FAILURE TO FOLLOW MAY DAMAGE NEW BATTERIES

After locating the bad battery or batteries, mark these with a waterproof marker (to identify the bad ones you can write on the battery the reading on the amp-hour meter when the voltage dropped below 10 Volts). DO NOT REMOVE THE BATTERY!! Completely recharge the entire battery pack first, before removing the bad batteries. Once the whole pack has been completely recharged, you can remove the bad batteries and replace with new FULLY charged one(s). It is very important to make sure the battery pack is fully charged before removing or installing new charged batteries. This ensures that all batteries are at the same level of charge when they are used and prevents battery imbalance.

Please be sure that all service personnel receive this notice before beginning any service work on batteries.

Battery Removal

ALWAYS FULLY RECHARGE BATTERY PACK BEFORE REMOVAL USING ON BOARD CHARGER

1. CAUTION: If any cable needs to be disconnected in order to remove any battery, it must be completely removed. Do not disconnect one end of a cable and leave the other end connected, except in the case of:

   a. the cable "INT" coming from the rear battery box to battery #5 in the front.
   b. the cable from the fuse box to battery #1 in the front.
   c. the main positive cable to battery #1 in the rear.
   d. the cable from negative terminal of battery #7 in the rear.

   For these wires, once they have been removed from the battery terminal, tape up the live ends carefully with electrical insulation tape.

2. For all battery removal jobs, disconnect and remove a battery interconnect cable in rear battery pack (preferably the wire with a 160A fuse between rear batteries #5 and #4).

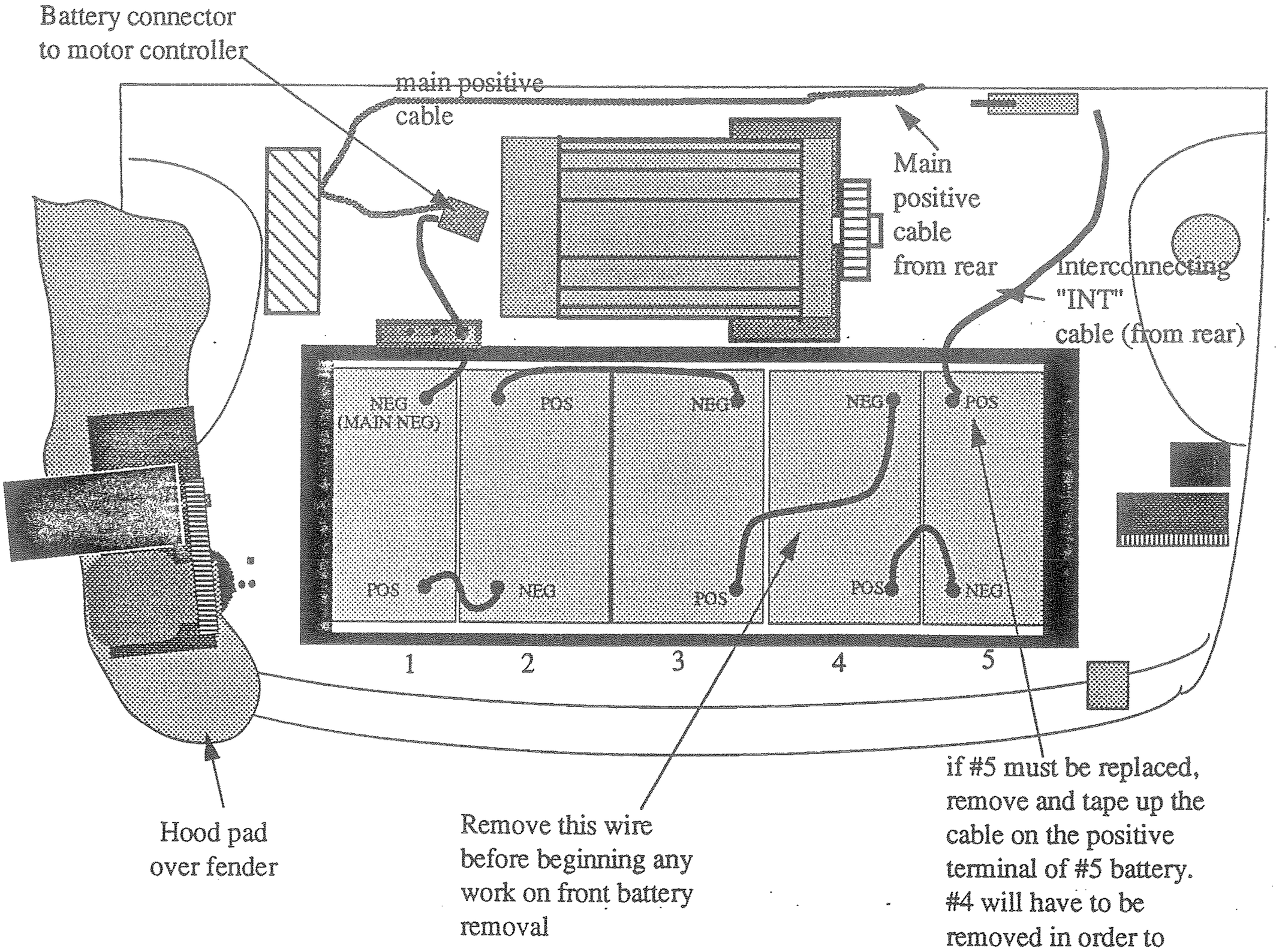
3. In front battery box, for protection, first disconnect 2 short interconnect wires (between #1 and #2 and between #4 and #5).

4. Be careful of hitting radiator, if the car has air conditioning, while removing batteries.

5. In front battery box, to remove battery #1 or #2, battery #3 must be removed and the "bad" battery must be slid to the position of #3. If battery #5 is bad, battery #4 should be removed first.(See attached drawing of front battery box).

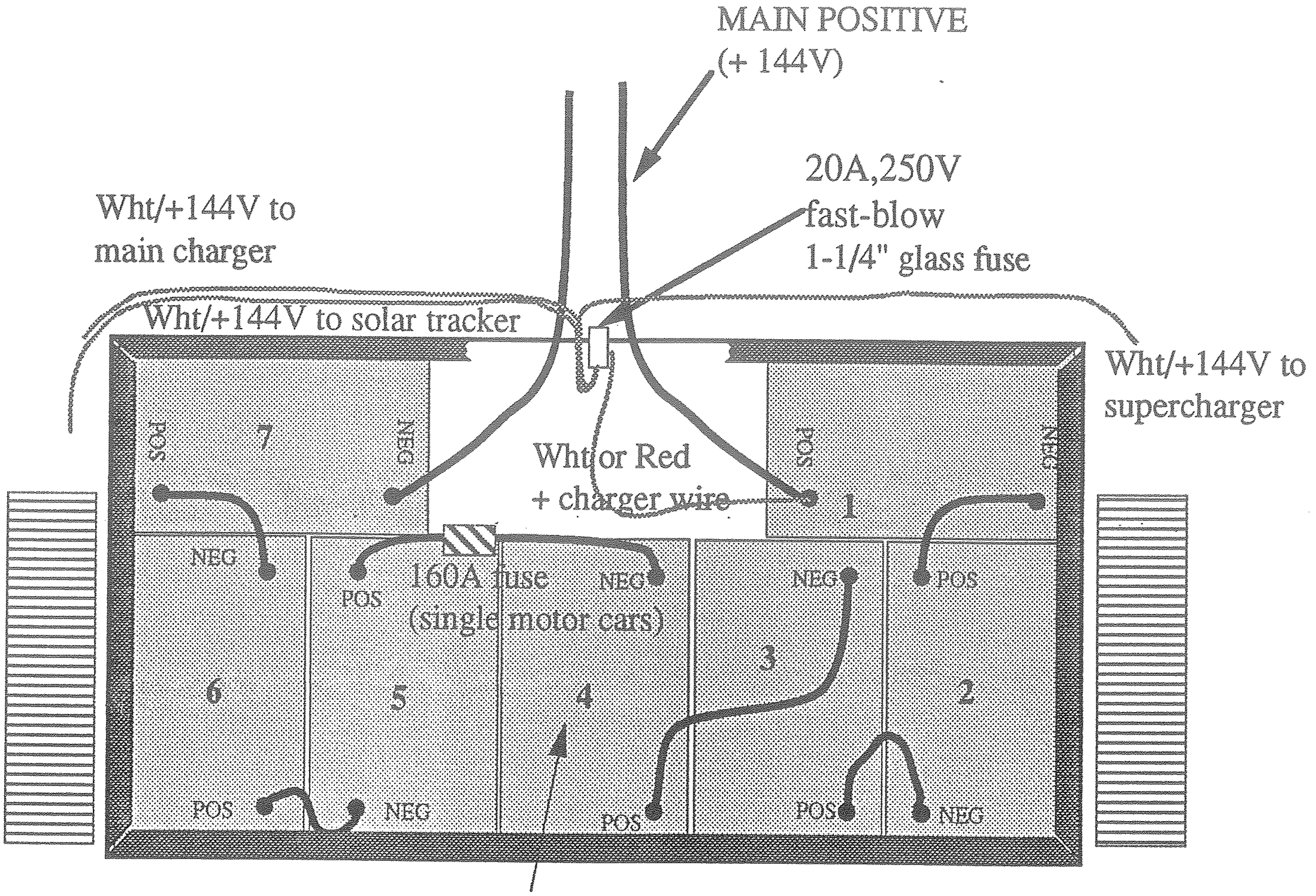
6. In rear battery box, to replace any battery, battery #4 from rear must be removed first to slide batteries around. To replace battery #1 or #2, you must first remove batteries #4 then #3. To replace battery #6 or #7, you must first remove batteries #4 then #5. (See attached drawing of rear battery box).

BATTERY REMOVAL IN FRONT BATTERY BOX OF ALL FORCE LEAD ACID AUTOMATIC CARS



WARNING: ALWAYS REMOVE A BATTERY INTERCONNECT CABLE FROM REAR BATTERY BOX BEFORE REPLACING A FRONT BATTERY

BATTERY REMOVAL IN REAR BATTERY BOX OF SOLECTRIA 4-SEAT LEAD ACID FORCE



Remove wires between #5 and #6 and between #2 and #3 before doing any work.

To replace battery 1 or 2, you must first remove batteries 4&3.

To replace battery 6 or 7, you must first remove batteries 4&5.

BEFORE REMOVING ANY BATTERY, BE SURE TO FULLY RECHARGE THE CAR (WITH ON-BOARD CHARGER). IF BATTERY #1 OR #7 NEEDS TO BE REPLACED, DISCONNECT AND TAPE-INSULATE THE MAIN POSITIVE OR INTERCONNECT CABLE

Battery Box Fan Replacement

A battery box fan is located in the rear battery box only. Use the following procedure to remove and replace the battery box fan.

1. Fold down the car rear seat.

2. Disconnect and remove all battery chargers from the car by unplug them from the 110 VAC side and from the batteries. Place them aside in a safe position. Do not drop them. If you have the charge controllers on the outside of the charger, these will need to be disconnected from the 110 VAC plug also.

3. Remove the battery box cover, using the steps outlined in a previous section.

CAUTION

In the following step, take care to ensure that you cover the main battery cable terminals with electrical tape to avoid shock or fire/explosion hazard. Also cover any other wire terminals that connect to the battery box.

4. Disconnect and remove all the battery cables.

5. Remove all batteries (see above steps).

6. Remove the rubber mat in the bottom of the battery box.

7. Using a Phillips screwdriver, remove four screws located around the fan hole.

8. Remove 4 5/16 inch nuts located under the car, beneath the battery box.

9. Remove 4 5/16 inch flat-head socket cap screws from left and right sides inside the battery box.

10. Lift battery box through the rear hatch.

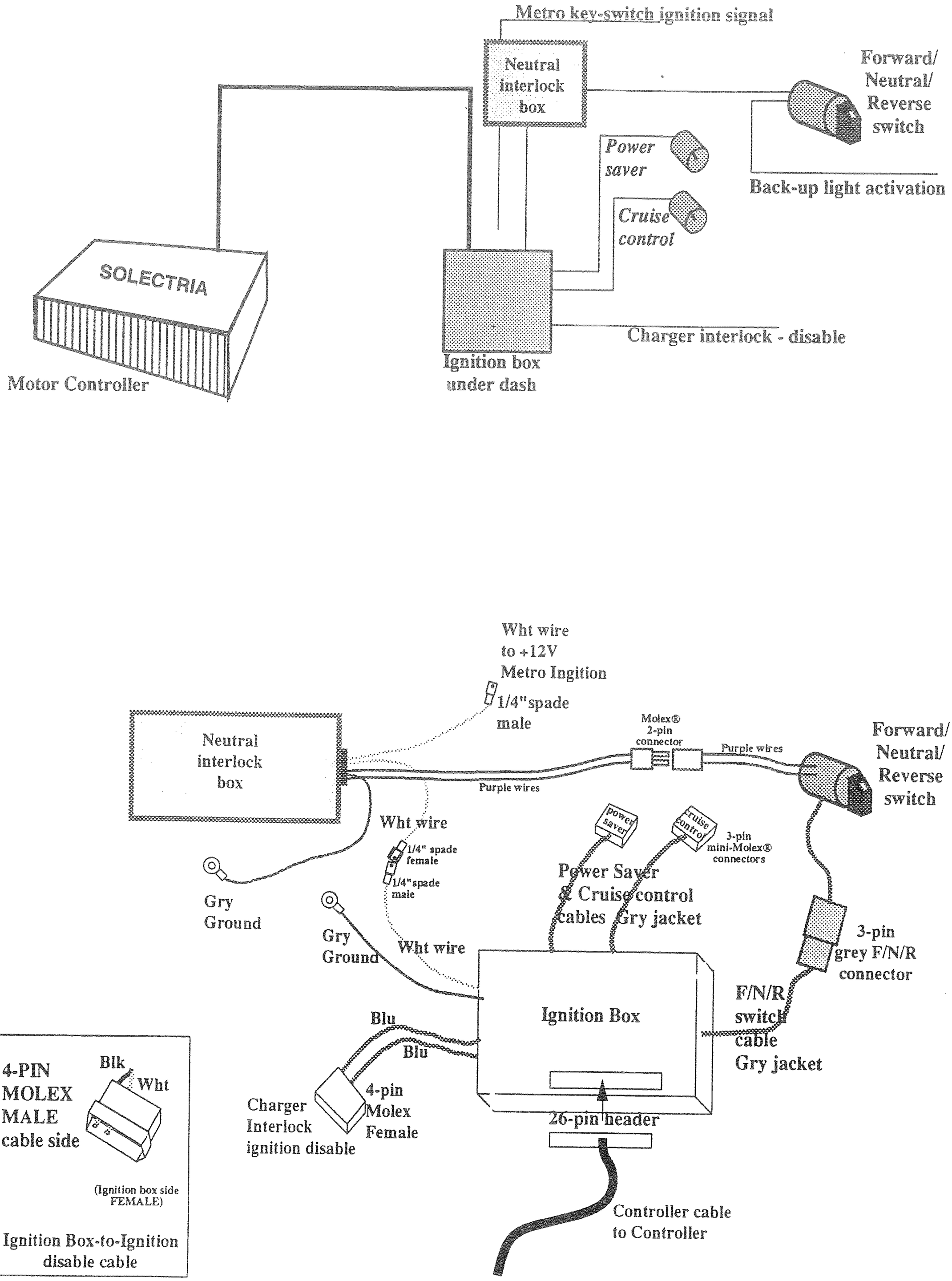
11. Loosen the silicone restraints, disconnect fan wires and remove the fan.

12. Install the replacement fan by following the above steps in the reverse order.

Appendix A

Wiring Diagram

FORCE *AUTOMATIC* IGNITION WIRING (1993)



FORCE *AUTOMATIC* IGNITION WIRING (1993) cont.

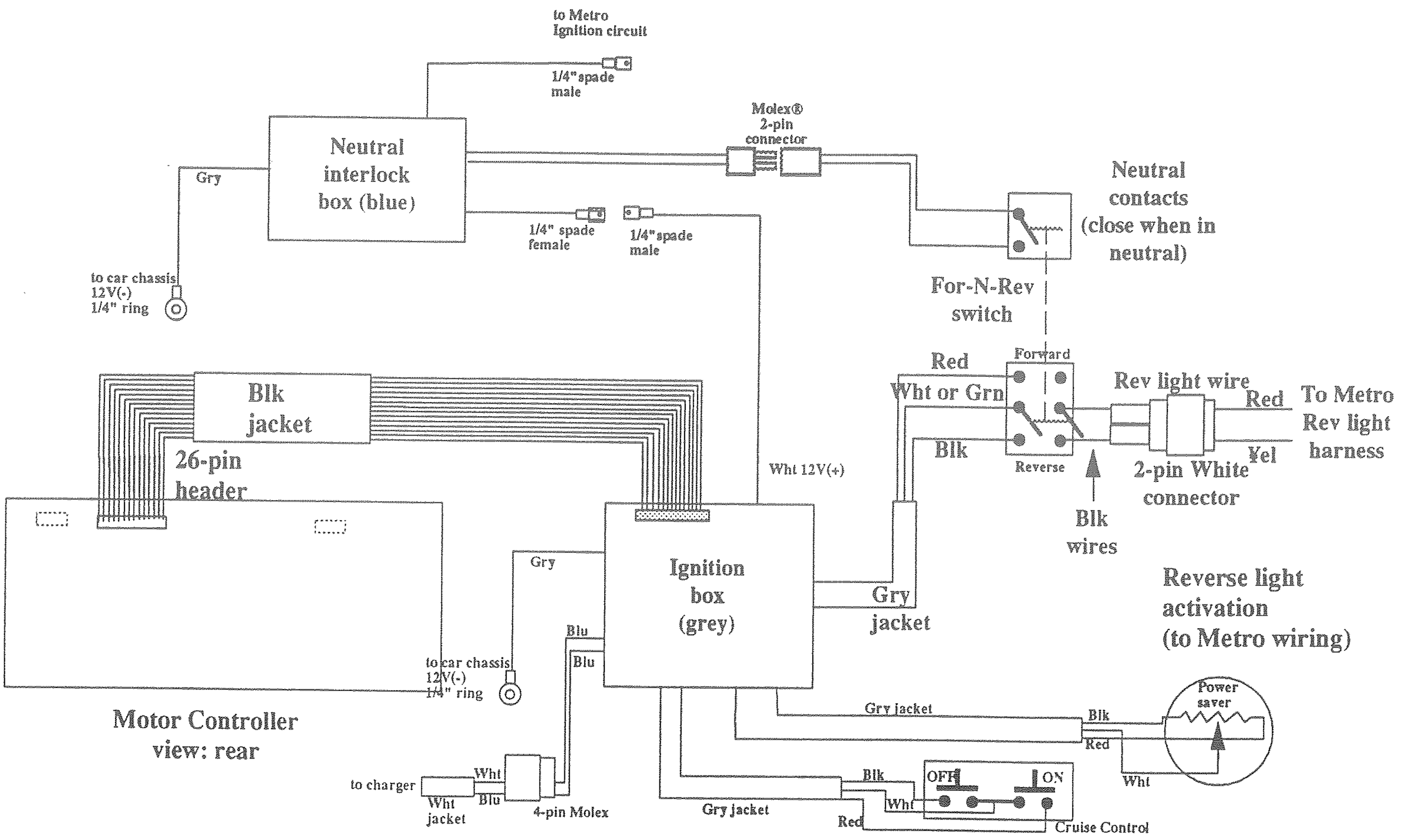
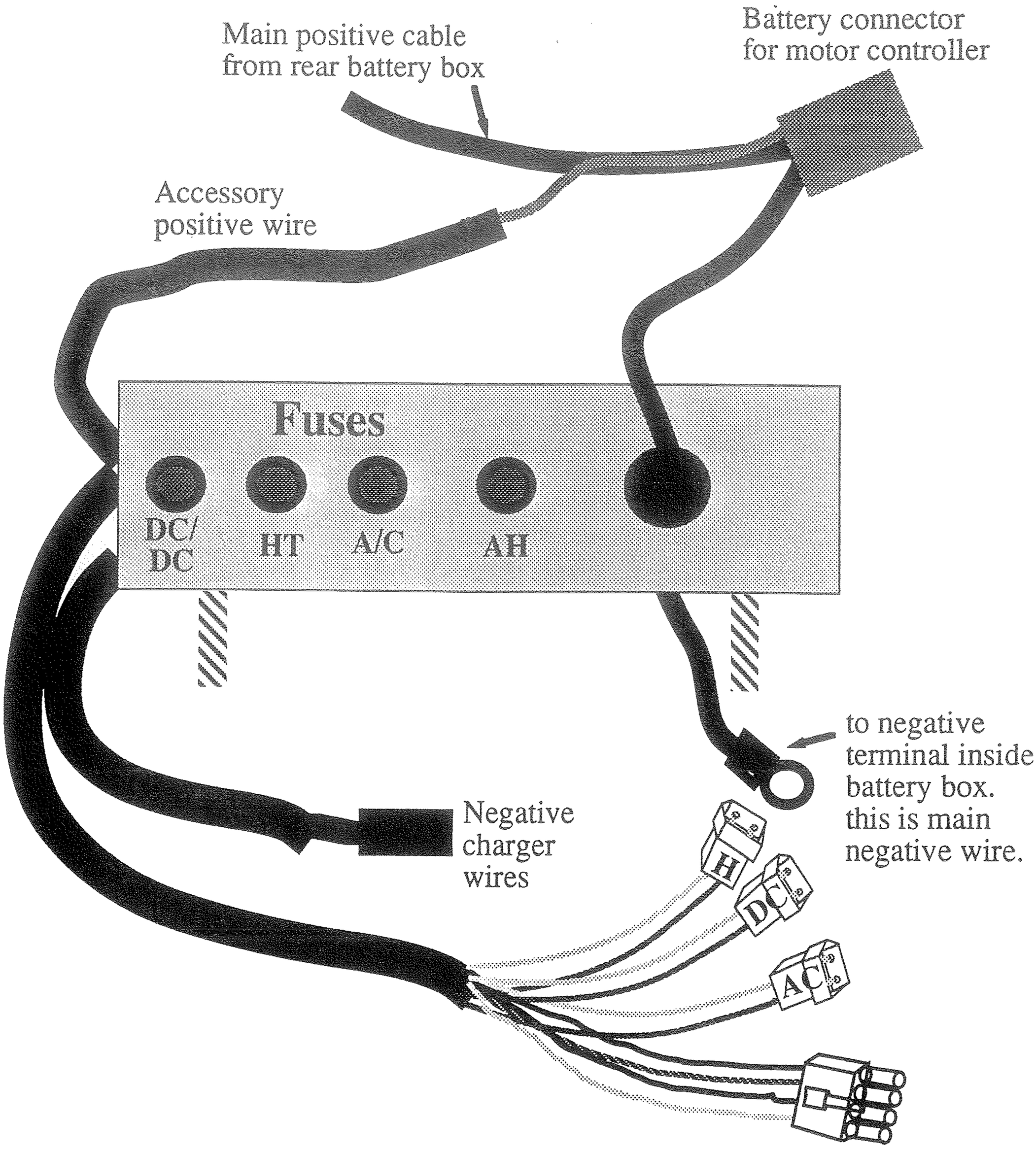
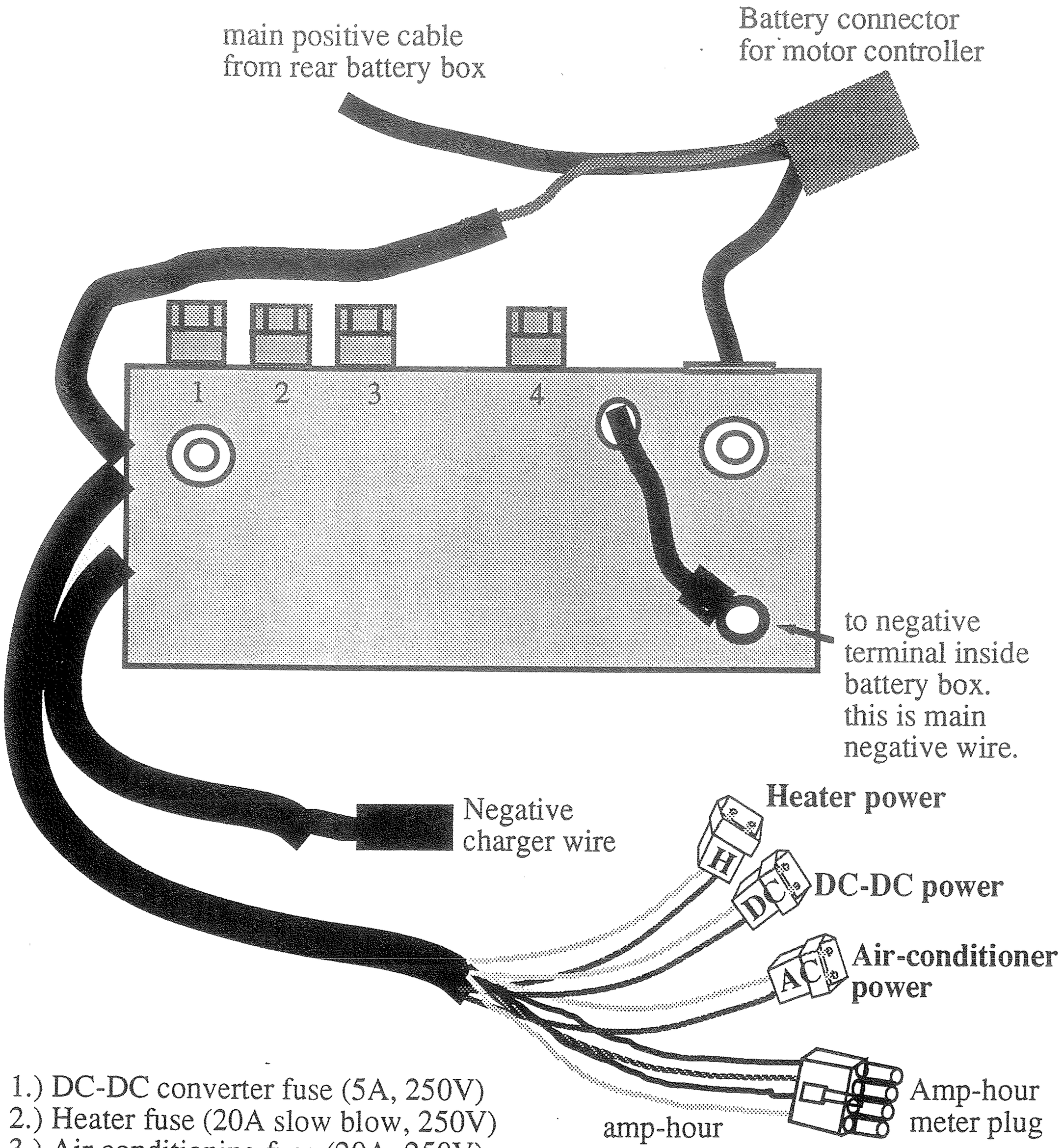


DIAGRAM OF THE FUSE BOX ATTACHED TO THE FRONT BATTERY BOX



FUSE BOX-AS VIEWED FROM TOP

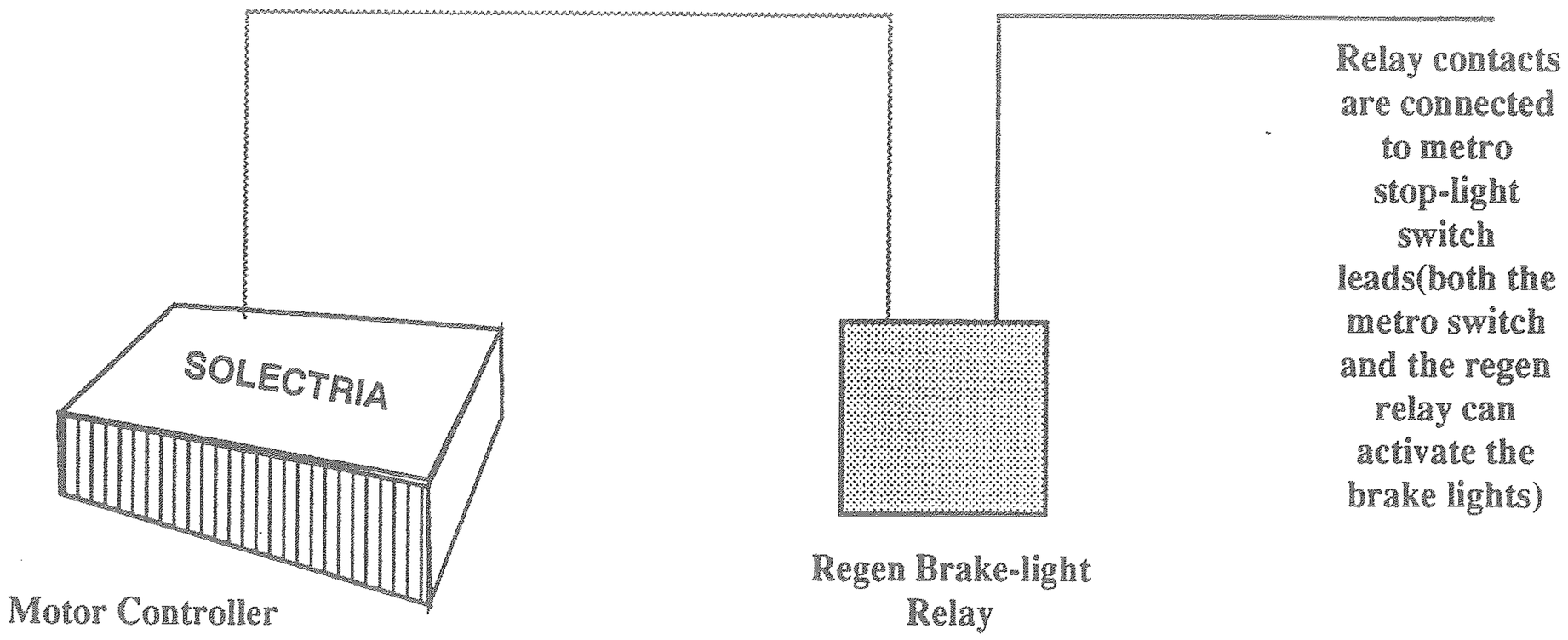
DIAGRAM OF THE FUSE BOX ATTACHED TO THE FRONT BATTERY BOX



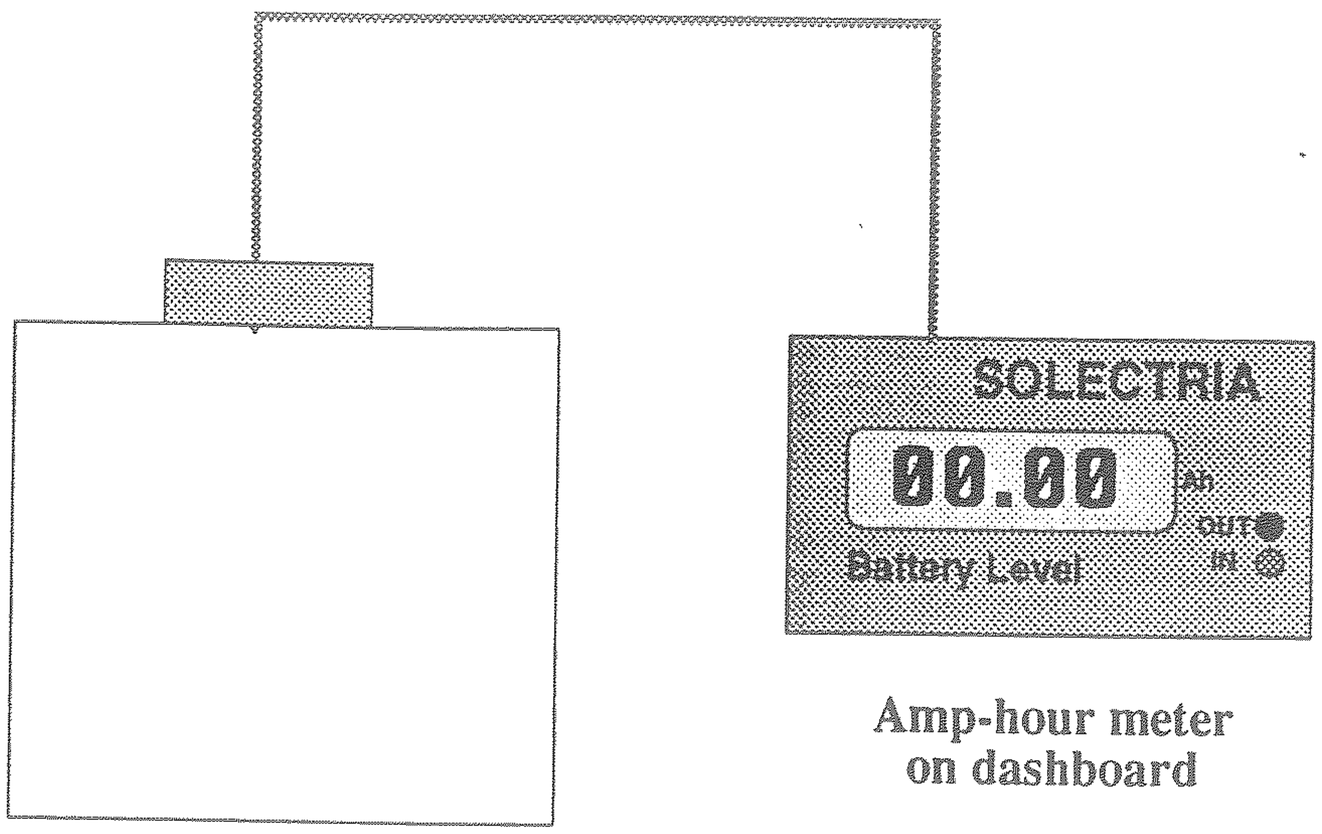
1.) DC-DC converter fuse (5A, 250V)
2.) Heater fuse (20A slow blow, 250V)
3.) Air conditioning fuse (20A, 250V)
4.) Amp hour counter fuse (2A, 250V)

FUSE BOX-AS VIEWED FROM FRONT OF CAR

FORCE REGEN BRAKE LIGHT WIRING (1992-3)

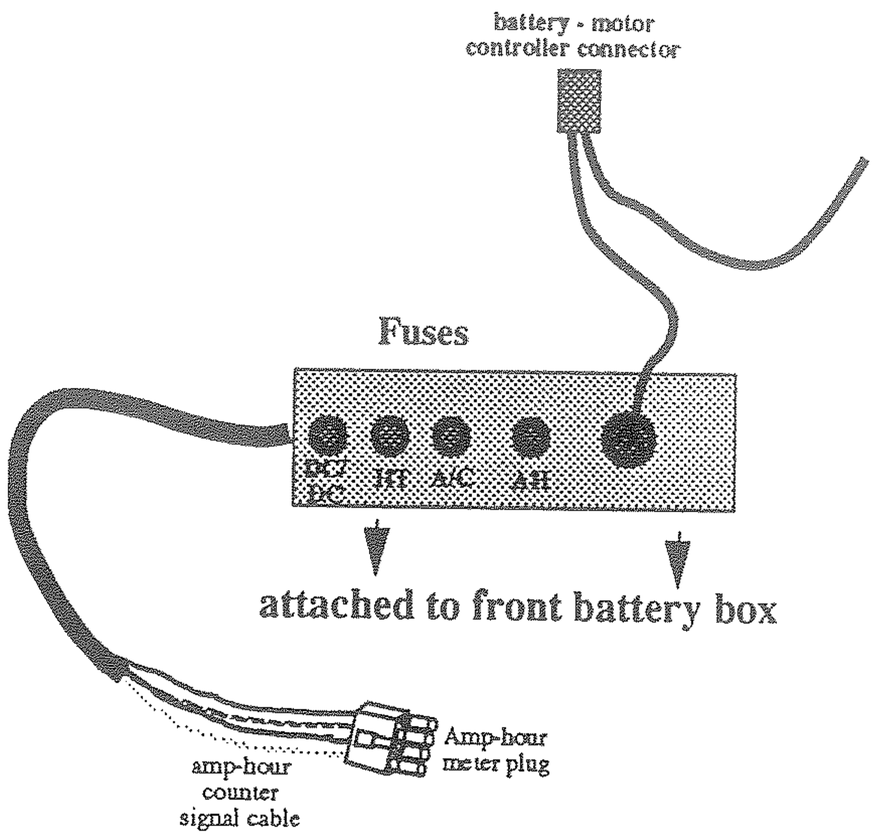


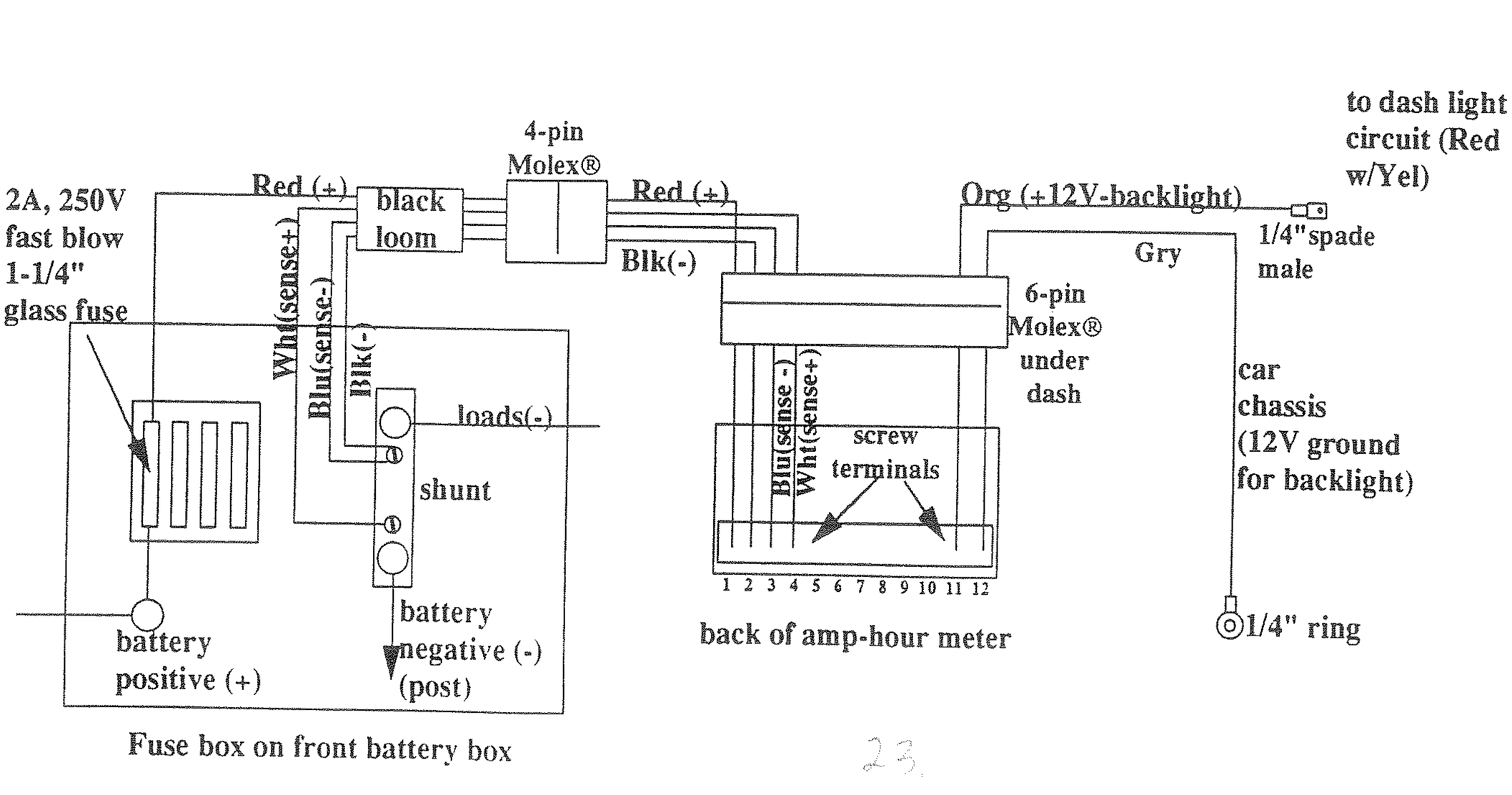
FORCE AMP-HOUR METER WIRING (1993)



Amp-hour meter
on dashboard

Front battery compatment





FORCE HEATER WIRING (1993)