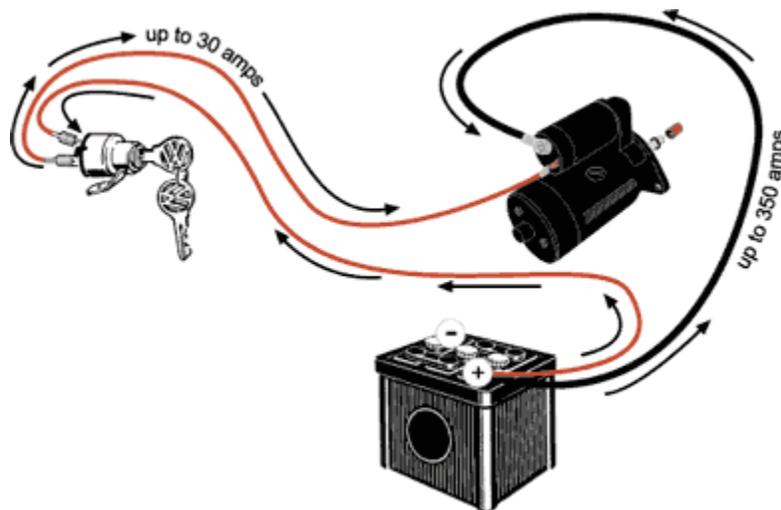


## Starter Circuit Troubleshooting

First, let's look at the heart of the system, the starter. Starters are a very misunderstood electrical component. Bosch claims that warranty returns on starters are mistakenly exchanged in over 50% of the cases. A starter motor is a basic electric motor with a few peculiarities that we should explain. Mounted to the top of the starter motor is a small round cylindrically shaped device known as the solenoid. The solenoid is an electric gadget that engages the sliding gear of the starter into the ring gear of the flywheel, while supplying current to the starter motor at a precise moment. As you can see, the solenoid really has two distinct functions, movement of the drive gear into the flywheel and to supply current to the starter motor itself.

### HOW CURRENT FLOWS THROUGH THE STARTER CIRCUIT.

Voltage from the battery is carried to the ignition switch via a heavy red wire. From the ignition switch, voltage is sent to the starter solenoid. The starter solenoid first moves the starter gear into the flywheel ring gear and secondly applies current from the positive battery cable to the starter motor, thus rotating the flywheel in an effort to start the engine. One important concept to remember is that the ignition switch only supplies current to the solenoid. The solenoid is what does all the work, in terms of switching the starter motor on and off. Starters can demand in excess of 300 amps all of which is controlled through the solenoid.



Unique to the VW supplied starter motor is the way the armature is supported. Most starter motors support the armature on both ends with a self-contained bearing/bushing. All Beetle models with the exception of those possessing the automatic stick shift option support the gear side of the starter with a bushing located in the transmission housing. Bus models used this type of configuration through 1971. Critical to proper operation of the starter, this bushing is often overlooked due

to the difficulty involved with regards to replacement. It is a good rule to inspect and or replace this bushing whenever the engine is removed from the vehicle, and always when replacing the starter.

#### INSPECTING THE STARTING SYSTEM.

Is the battery charged? Turn on the headlights. Are they bright? If they appear dim, chances are the battery is weak and should be charged. If you own a voltmeter you can check the charge of the battery. A fully charged 6-volt battery should have a static voltage of 6.3 volts. At 12.8 volts a 12-volt battery is fully charged. Static charge is the voltage across the battery with all electrical components turned off.

#### HOW ARE THE GROUND STRAPS?

Check both battery and transmission to body ground straps. Both need to be tight and without corrosion. Often overlooked is the transmission to body ground strap. This electrical component grounds the engine and transmission to the electrical system and is very important to a functionally sound electrical system.

#### CLEAN ALL ELECTRICAL CONNECTIONS IN THE STARTER SYSTEM.

Refer to the diagram of the starter electrical system. Insure that all connections in the system are clean and tight. A scotch bright pad works well for removing any corrosion. Tighten any loose push-on connectors by squeezing the ends with pliers.

If the above does not fix the problem, the last step involves troubleshooting the electrical circuit. Isolating the starter from the rest of the circuit is the proper approach. This is easily accomplished by shorting the positive battery wire connected to solenoid, which in turn bypasses all other electrical connections. The positive solenoid wire is easily identified in that it is connected to the solenoid by means of a push-on style connector. Simply take a 6" length of medium gauge wire and strip both ends. Touch one end to the push-on terminal located on the solenoid and the other to the positive battery cable. See diagram. Remember to make sure the car is in neutral and the wheels are properly blocked. If the starter does not crank then replacement will be necessary. If the starter cranks, there is a problem with the ignition switch and/or the wiring extending from the switch to the starter.

Quite often you will go through all of the above steps, including replacing the starter only to find that the starting system functions erratically. Upon further diagnosis you will find that shorting the battery and solenoid terminals as described in the above activates the starter. This is where the use of a hard start relay comes into place.

#### HOW A HARD START RELAY WORKS

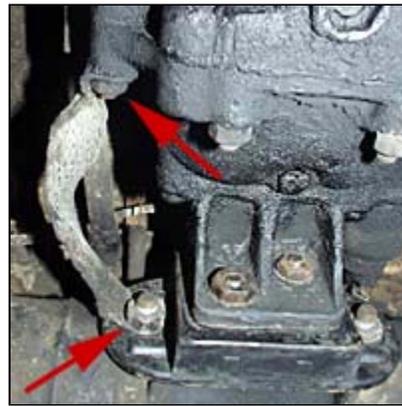
The most common problem with the starter circuit in relation to the starter not cranking can usually be traced via the wiring. The circuit consists of a long run that extends from the battery, which sits in the rear of the car, to the ignition

switch, located in the front of the car, and back to the starter. Old wires, dirty electrical connections or a weak ignition switch can all contribute to the solenoid not receiving adequate current in order to energize. The hard start relay reduces the normal 20-30 amp draw of the solenoid to under 1 amp eliminating all of these variables.

At 12.8 volts a 12-volt battery is fully charged. Static charge is the voltage across the battery with all electrical components turned off. At 13.09 volts, our battery is in tip top shape!

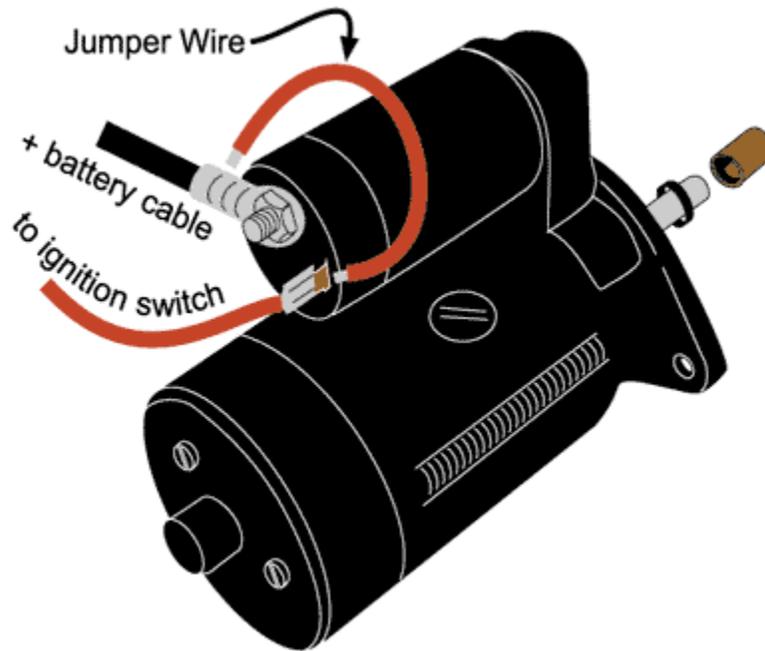


Often overlooked is the transmission to body ground strap. This electrical component grounds the motor and transmission to the electrical system and is very important to a functionally sound electrical system.



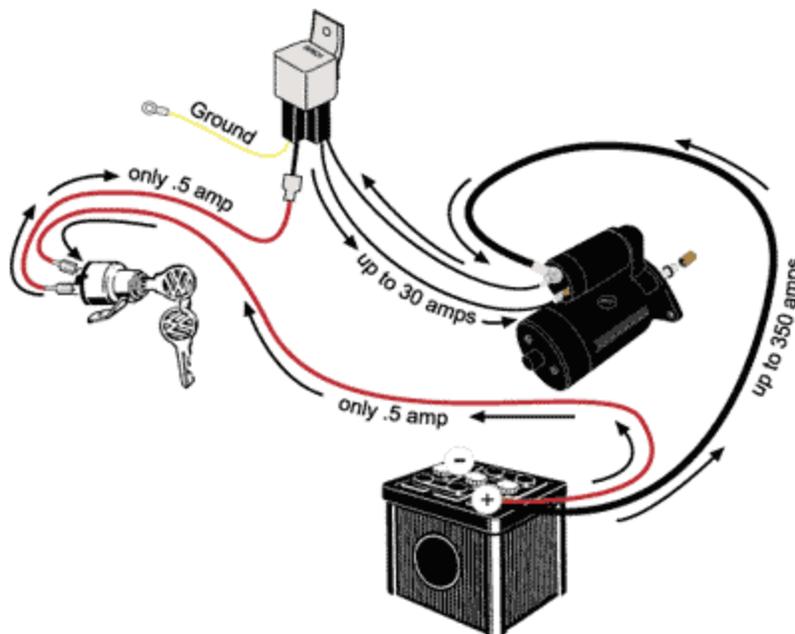
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Here's an example of a car equipped with a hard-start relay. If one is needed for your car, this is the typical mounting position.



The above illustration demonstrates the routing order of the various

wires that comprise the starter system. This wiring schematic includes the use of a hard start relay. Please refer to the upper most illustration for an unmodified version.