Servicing a Valeo Starter

Contributed by Greg Feneis
Wednesday, 01 December 1999
Last Updated Tuesday, 19 July 2005

The chances are very good that your starter problem is relatively cheap and easy to fix. Perhaps your starter has the same symptoms as stated below. If not, you can still check things out with the part marked "Testing", and once a problem is isolated, the remaining portion covers disassembly and re-assembly of the Valeo. Reviewing the symptoms: The starter operates correctly most of the time. When the starter does operate, the engine is cranked over at a reasonable speed and it does not appear that the starter motor is struggling as if the battery is nearly dead. When it does fail, you still hear a clicking noise, every time you press the starter switch. This clicking noise is a rather strong sound from under the starter cavity cover (not to be confused with a small clicking noise which is the starter relay). Most of the time, when it is failing, several successive starting attempts will get the starter motor to eventually operate. If the above wordy sequence is true, your problem most likely has to do with the starter solenoid (rides piggyback on the starter motor). Perhaps first, some explainin': When you press the starter switch, and all the right conditions are in place i.e., ignition key on, clutch pulled in, and or trans in neutral, etc. a small relay is energized. When this relay "turns on", the starter solenoid is energized. The starter solenoid is an electromagnet that attracts a barrel shaped 'slug' into a cylinder. The starter solenoid serves two functions for the starter.

- The action of the solenoid does most of the work with engagement/disengagement of the starter's drive gear with the gear teeth on the engine's flywheel. When the solenoid is energized its slug works against a spring to move into the cylinder. The slug is linked to the starter drive gear through a lever, and so causes the starter drive gear to move toward the flywheel. When the solenoid is no longer energized, the spring causes the slug to move back to its rest position, which retracts the starter drive gear from engagement with the gear teeth on the flywheel.
- At the bottom of the solenoid's cylinder is a high capacity (momentary) switch. This switch is used to energize the starter motor. This switch is "turned on" when the slug completely bottoms out in the cylinder. So, you have the solenoid energizing, attracting the slug to the bottom of the cylinder. The movement of the slug causes the drive gear to engage the gear teeth on the engine's flywheel. Once the slug gets to the very bottom of the cylinder and hits that switch, the starter motor is energized and starts to turn (one would hope). This whole mess is a sort of mechanical interlock that prevents the starter motor from running until the starter drive gear is fully engaged. **Clue** In the case of a bike having the above mentioned symptoms, chances are good for one or more of the following conditions:
- The solenoid slug and cylinder are dirty/gummed up/corroded/etc. preventing complete bottoming out of the slug to actuate the heavy switch at the bottom.
- The starter drive gear and or lever are binding/gummed up/etc. preventing bottoming of the slug like above.
- The switch at the bottom of the solenoid cylinder is so worn that even when the slug bottoms out in the cylinder, the switch is not energizing the starter motor.
- The solenoid slug's return spring is either broken, or installed wrong (up side down).
- The solenoid and starter drive gear are working correctly, and there is a loose connection at the two large terminals (main battery cable at the top terminal, short starter cable at the bottom terminal) on the end of the solenoid, or there is a problem WITHIN the starter motor. TestingTesting for some combination of 1,2,3 or 4: When the starter is failing as in the above scenario, take the starter cavity cover off of the top of your engine (don't know what this entails for your bike, but on my GS, I found that I only had to remove the gas tank) to get access to the top cover of my engine. Connect a test light between the two large terminals on the starter solenoid. The light should light. This indicates that at that point, the starter's main cable is getting power to the starter. This also indicates that the starter motor completes a circuit to ground, and should work when/if energized. Press the start switch. You should hear/feel some activity from the starter solenoid. If the solenoid does make a noise, and the starter motor does not operate, and the light does not go out, then your problem is more likely 1, 2,3, or 4 above. Results indicating #5 If you press the start switch, and you hear/feel some activity from the starter solenoid, and the motor does not go, yet the light DOES goes out, then your problem most likely is #5 above (less likely). What if the solenoid is quiet? If you press the start switch, and you hear/feel nothing from the starter solenoid, then you need to test if the solenoid's electromagnetic coil is connected and getting voltage from the starter relay when you press the start switch. Connect the test light between the small terminal on the starter solenoid (leaving the wire plugged into it) and the body of the starter and press the start switch again. If the light fails to light while pressing the starter switch, then move the test lead connected to the starter body, to a known good ground, and press the start switch again. If the light lights when connected to a known good ground, but not when connected to the starter body, then the starter is not properly grounded (rare). If the test light fails to light while connected to the small terminal of the starter solenoid, in either of the two grounding conditions, then the solenoid is not getting power from the starter relay. If the starter solenoid is getting power, but is not making any noises, chances are good that the electromagnetic coil in the solenoid is bad. To repair 1,2,3,4 or 5, see the disassembly - re-assembly guide below. Problems with in the starter motor (#5): (motor fails to run or runs poorly even though battery, and main connections are good). A problem internal to the motor, could be a bad or worn brush, or broken brush spring, or burnt segments on the commutator (not likely), or, loose permanent magnets in the motor case (stationary magnetic field that the armature works against). Legend has it that the epoxy that holds these magnets in place and away from the armature has been known to fail. When this happens, the stationary magnetic field that the starter depends on is reduced, and the magnets drag on the armature and may break up into bits. I think I covered all conditions relating to the starter motor and its connections. If you have any questions or if I left out anything, just drop me a line or two. Valeo Starter Disassembly and Re-assembly The procedure below covers a Valeo starter from a '91 R100GS (perhaps yours is similar?). Please read this article from start to finish to

get an idea of what kind of work and tools will be required. This description is for a Valeo starter. The Bosch starter is quite different. The Valeo uses a permanent magnet DC motor. One of the benefits of this type is that you can really abuse it, operate near stall speed, etc. and it will usually take it and not get too hot. The down side is that, compared to a series wound DC motor, it does not develop super duper torque at stall or near stall speeds, so it needs a reduction gear to compensate. I think the Valeo uses a 5:1 reduction (planetary gear set), besides the starter gear to flywheel gear reduction. The Bosches are probably series DC motors. They develop ungodly torque at stalled or near stalled speed, so no additional reduction gearing is necessary. Unfortunately, you can't operate a series wound DC motor at stalled or near stalled speed too long because the current draw is immense and the motor will just burn to a crisp. Getting to the starter and taking the correct safety precautions like disconnecting the battery, are your responsibility. The bolts that hold my starter in are in a fairly tight spot. I used a 1/4" drive breaker bar and a 13mm socket. The bolts have plenty of thread engagement, so be prepared to turn, turn, turn. Take care when disconnecting the heavy wire lugs from the starter. These studs and nuts are only copper, and will not take much abuse. Sometimes it is good to grip the heavy wire's terminal with pliers as a sort of 'back up' wrench when trying to loosen the nut(s). With the starter out of the engine, and in your hands, 3 body bolts and one small "torx" head screw takes off the head of the starter. Use a good torx screw driver. Between the long torx screw that goes through the starter head, and the two short ones that go from the backing plate into the solenoid, I broke the tip of my Sears Craftsman torx screw driver. I replaced those screws with two 4mm x 8mm and one 4mm x 35mm Allen headed cap screws. Justifications for replacing the starter solenoid:

- The solenoid slug and or cylinder are corroded or damaged (corrosion can be cleaned up to temporarily restore operation, but once corrosion starts happening, you can bet it will return to screw you when you least expect it).
- There is an open circuit in the electromagnetic coil.
- The high capacity switch that energizes the starter has failed or only works intermittently. Note: Bendix = Starter drive gear with sprag clutch assembly. The bendix, lever, and solenoid slug will all come off easy if you get the thrust ring off of the main starter shaft first. *(Before you remove the thrust ring, see thrust ring installation (near the end), so you know ahead of time how fun it will be to put this back together.)* To remove the thrust ring, you'll have to knock it toward the bendix, remove a wire ring, and then take off the thrust ring. To do that, first protect the bottom of the starter with two wood blocks (don't want to damage the parts at the tail of the starter). Next, find a deep socket whose inner diameter is just larger than the main shaft, and whose edge lines up with the thrust washer nicely. Place the socket on the end of the shaft and give it a whack with a hammer. This should knock the outer thrust ring back toward the bendix. What should remain is a wire ring in a groove on the shaft. Work the wire ring off (it will get distorted, but don't kill it), then the thrust washer can come off. Push the lever's pivot pin out with your fingers. It's quite easy if you relieve the spring pressure from the pivot point the pin should drop out. Now the solenoid slug, lever, and bendix should all come out together. The spring should stay on the solenoid slug by its self. If you take it off for cleaning, be sure to put it back on the way it came off. One end of this spring is kinked to help hold it in place on the slug. If you put the kinked end at the wrong end of the slug, then the miss-installed spring will hang up the mechanism. Remove the pop rivets that hold the cover plate to the main starter body (2 rivets). I found it easy enough to stick a small punch into the center of the rivets and wag the punch around like I'm stirring coffee. The punch works with the edge of the hole in the plate to sheer off the rivet head. Don't worry about replacing the rivets, they are handy in the factory for holding partial assemblies together, but are not necessary for our uses. Next, if you have not already done so, remove the nut holding the motor terminal to the bottom of the two large copper studs on the back of the starter solenoid. When you separate the cover plate from the motor,you should have the plate and the main starter shaft and planetary gear set in one hand. In your other hand will be the motor case and brushes and armature. Don't expect the armature to come out of the motor case. It is held in place by a snap ring (later). To get at the planetary gears, you will have to "pluck out" the 'donut shaped' sheet metal cover. You should be able to take a utility knife and work it up little by little. When I first looked at that cover I thought that it wasn't coming up without destruction, with all of those little cleats holding it in place. After the cover is off, take the snap ring and shim off of the main starter shaft and the shaft should slide right out. So now you have the backing plate with big plastic ring gear in one hand and the main shaft with planetary gear set in the other. Clean all the waxy grease up. I like using mineral spirits and a scrub brush (rubber gloves too) because it all washes up nice in the laundry tub with hot water when I'm done. Getting the parts hot in the hot water, helps them to dry faster and more completely. Re-grease and re assemble the main starter shaft and planetary gear set to the cover plate/ring gear, install the snap ring, and put the 'donut shaped' sheet metal cover for the planetary drive back on. To service the motor, brushes, and armature end bearing, take off the two copper end nuts and remove the sheet metal cover. There is a rubber gasket for the cover so work it up like a champagne cork. Push up with your thumbs a little, rotate, push up, rotate, etc. With the cover off, you will see a neat method of commutating an electric motor: Axially. There is a fiberglass biscuit between each spring 'leg' and each brush. Don't loose them as they help keep the spring 'legs' from digging into the soft brush material, and they act as an insulator. Lift each spring "leg" and flip it to the side to remove and inspect the brushes. Once the brushes are out, it's easier to remove the brush spring with a narrow pointy tool, like a pick. Simply help the center portion of the spring up over the notch in the motor case, and the ramp shaped area of the plastic brush holder. Take care when doing this as it is easy to crack the brush holder. You can now grip the shinny center bearing cover with a pair of pump pliers and slowly work it upward and off. It is a thin sheet metal cover, so don't squish it dead. Pop the snap ring off of the end of the shaft and keep track of the shims and washers (some are on the snap ring side of the bushing, some are on the armature side). Now you can remove the armature from the motor case. Clean up the motor case and armature. Look for signs that one or more of the 4 permanent magnets have been dragging on the armature, or is loose or is coming loose from the motor case. My armature looked like the shellac was chipping off from not being applied right, but there were no scraping marks. You can use a sewing needle or pick to dig out the crap from between the comutator segments. Don't dig too deep, If you dig too deep and the width of the tool is too wide, you can distort the edges of the segments. If this

happens, you will get some fast brush wear, and crappy operation. If the segments are in bad shape (pitted or burned), you could find a friend with a lathe and have him do a "facing" operation to restore that surface. Then you certainly want to dig the copper filings out of the gaps between the segments. Grease up the shims and washer on the amateur side, the bushing in the motor case, and the shims or washers on the clip side, and reassemble. Be careful not to go wild with the grease, because you don't need to get grease on the comutator or brushes. Once you put the clip back on the shaft securing it in place, you can put a little extra grease in the cover before you slip that back into place. Support the motor case on it's front end so you can work on the brush end without holding it. Two wood blocks will leave a gap for the armature shaft protruding slightly from the front. Otherwise, gently trap it in a vise, or some other holding method. Put the plastic brush holder on and insert the brushes into their slots. Properly route each brush's wire and position their terminals. Put the nuts and washers on their studs to hold the plastic brush holder on the end of the motor case. Install the fiberglass insulators. Install the spring by first starting each 'leg' on the back of each brush's insulator, just on the edge, then get the center portion of the spring, that points toward the armature, started on it's little ramp. While maintaining the 'legs' in place on the brushes, push down on the spring's coils, and the center portion of the spring will lock in place with two clicks. One click for when the spring's center portion passes the end of the plastic ramp, and the other for when it engages the hole for it in the motor case. When reinstalling the sheet metal cover over the end of the starter, be sure that the rubber bumpers and insulators are in place. You don't want those misplaced or left out and have the starter's main power lead ground against the motor case. Put the motor back together and the cover plate with the planetary drive back on the motor. The now clean solenoid should be mounted back on the cover plate, and the solenoid slug-lever-bendix should be reinstalled with its pivot pin. You are now ready to put the head back on, but first..... Thrust Ring InstallationThere is one remaining difficult part. you have to get the thrust washer (that the bendix hits when the starter engages) back in place on the main shaft. Put the thrust washer on the shaft (flat side of the washer faces the drive gear, internal tapered part faces the wire ring and groove). Put the wire ring back in place on the groove of the shaft. You can squish the wire ring and work it into the groove as best you can so it's outer diameter is minimized, using pump pliers or such. the shaft is pretty hard material, so don't worry too much about catching it in the pliers' jaws. You will never get the wire ring squished tight to the shaft, so all that squishing effort will only go so far. After the wire ring is made to fit as tightly in the grove as possible, slide the thrust washer up to the wire ring, and use a good set of pump pliers to squeeze between the end of the shaft and the thrust ring. It is definitely going to go one side, then the other, so don't try to bring it up evenly. Get it set up so that the gap in the wire ring is facing away from where you are applying the pliers, and that the wire ring is deepest in the groove at the same spot where you are applying the pliers. Now squeeze like stink. The whole thing will just pop together. This is sometimes a bitch of a part to reassemble. If you go to a starter/alternator rebuild shop, they should be able to get it back on for you. As HoboMatt has said in the past, sometimes they will do it for free just because you gave them something interesting and new to look at/work on. It's not every day that a person gets to fiddle with a BMW motorcycle starter. I hadn't thought of it before, but you may be able to use a small vise as a press instead of the jaws of a pair of pump pliers. As you squeeze with the vise, you could use a small punch and hammer to help knock the wire ring into place inside the thrust washer. With that tough part out of the way, all that remains is lubricating the starter's main shaft and bushing (in the head), and reassembling the head to the starter. Before reinstalling the starter, it's nice to clean out the starter motor cavity. My GS had all kinds of sand and grit collected in there plus oil from a leaky hose port which was poorly blocked off (apparently part of the 'Shed' system which was later removed) and seeping oil. This oil seepage covered the floor of the starter cavity and worked its way to the starter cavity drain hole (~4mm hole in the side of the engine adjacent to the dip stick) and made an ugly mess of the side of my engine. When reinstalling the starter, it might be nice to run a few tests before completely buttoning everything up. Install the starter and reconnect the electrical connections. Disable the ignition so that the engine will not start, and test the starter for proper operation. With a fully charged, room temperature battery in good condition, you should be able to go through 15 or 20 cycles of 30 seconds of cranking followed by 10 seconds of rest. While testing, listen for improper noises, etc. Directly after several cycles of testing, test for poor main battery connections by using your fingers to feel for toasty warm connections on all of the main cables. After serious cranking tests, a main battery connection that gets warm indicates a poor connection. Good luck with your starters!!