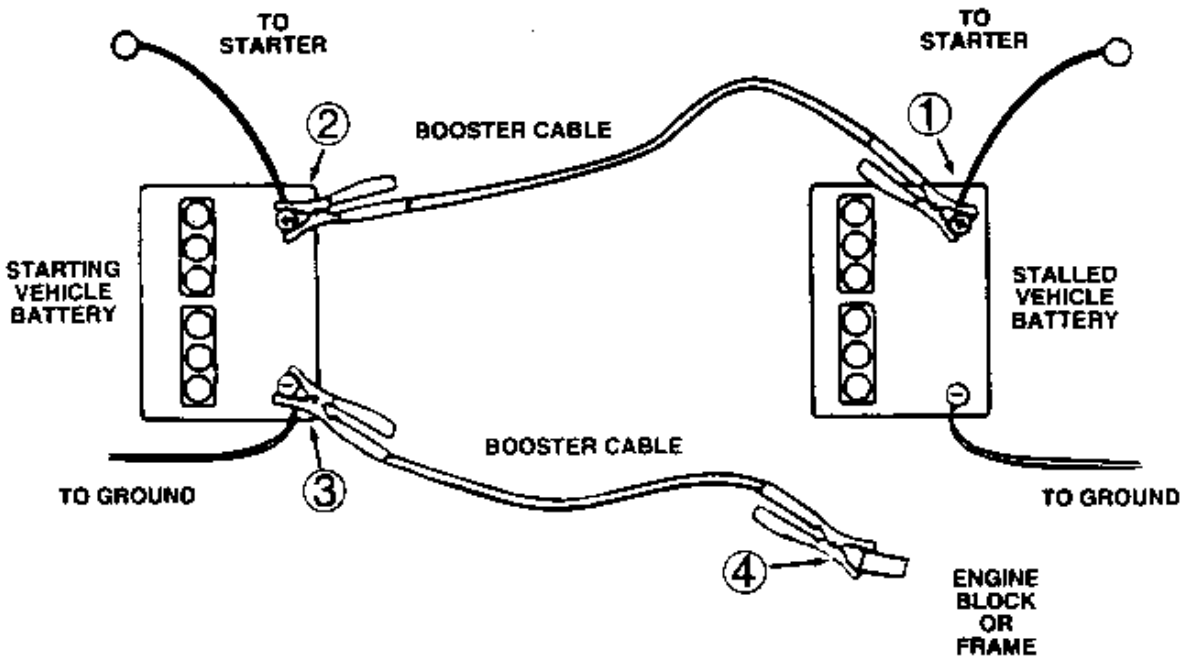
Electrical: Engine Starting, Charging

FAQ Home

Volvo Maintenance FAQ for 7xx/9xx/90 Cars



Jump-Starting Procedures. When jump-starting a car with a dead battery, the proper procedures to ensure personal safety and car reliability are:

1. Ensure that the cars are not touching to prevent unwanted ground/earth paths. Do not allow the cable clamps to touch each other.
2. Put out cigarettes before opening the hoods. Wear safety glasses in case a battery explodes (more common than you would think!)
3. Turn both cars' ignitions "off".
4. Connect one end of red wire to positive (+) bad car battery terminal
5. Connect other end of red wire to positive (+) good car battery terminal
6. Connect one end of black wire to negative (-) good car battery terminal
7. Make last connection with other end of black wire to bad car **engine ground point** (such as a lift metal hook) away from the battery. This eliminates sparking near the bad battery, which may be outgassing hydrogen and could explode. **Do not attach the cable to the negative terminal of the dead battery.**
8. Start good car engine. **Stand away from the batteries.**
9. Start bad car engine
10. Turn on both car headlights (see below)
11. Disconnect in inverse order, being careful to keep cables and clamps from touching.

[Tip from Paul] The book "Bosch Fuel Injection Systems" by Charles Probst notes that after the jump and before cable removal one should put a load on the car by turning on headlights or the rear window heater. A lightly loaded car may experience a spike AFTER you remove the jumper cables since the regulator was set to supply a heavy load. You instantly switched from a heavy to light load and the voltage may spike. You may damage your fuel injection computer with this spike. Avoid it by engaging a load.

Note: You can print these instructions out, xerox onto a plastic sheet, and mount it near your car battery for on-site reference.

Alternator Stops Charging: How to Get Home? My battery charging light just came on and I am far from home. Belt is fine. What to do? [Steve] No reason to be stranded because of this problem. You can get it home like this: Simply run a hot wire from the battery positive and connect it to the terminal on the back of the alternator....the one with the small red wire connected to it. This wire provides excitation voltage for the alternator. If you can get the engine started and then apply 12 volts to the excitation terminal, the alternator will charge. You don't even have to connect the wire. Simply touching the jumper wire to the terminal will cause the alternator to start charging, and remain so as long as the engine is running. If you did connect it, you will need to disconnect it when you stop the engine else it will drain your battery.

Alternator & Starter Applications and Parts. [Dave Stevens] Wood Auto Supplies Ltd. in the Huddersfield, Yorkshire, UK has an excellent on-line alternator and starter reference tool for parts. Visit http://www.woodauto.com to enter their site. They ship worldwide. For alternators/starters, if you know the Bosch (or Marchal or whatever) part number then enter it in the upper right search box. Each major listing will give you the specs, a list of equivalent or similar units, the Volvo part numbers, the years, models and engines in which it was used and a list of the component replacement part numbers and an indication of availability. Many of those components are linked to their own page with further information on the part including a typically long list of all the alternators/starters in which that part was used. If you don't have the alternator/starter number handy then you can use this vehicle search page:

http://www.woodauto.com/woodauto/vehicle.aspx. First, make sure the upper right search box is clear (or you'll come up empty). Select Volvo as the manufacturer and then your particular model and/or engine. You'll then be given a list of the alternators and starts by model year and application. You may need to try a couple of model/engine/alternator/starter configurations to find the appropriate list of alternators/starters. From the list just start following the hotlinks to find the full descriptions and the parts you're interested in. Most are complete with pics. [Jay Simkin] Contact Barsanco in Centerline, Michigan (800-421-3374) for starter and alternator parts (diodes, etc.) to rebuild your own units.

Starter:

Starter and Solenoid Problems.

What causes a starter to fail?

[Tips from Counterman Magazine, August 01 & Underhood Service, May 04] Starter problems can be caused by worn brushes (carbon pads inside the motor that supply current to the rotating armature), by shorts or opens in the armature or field coils or by worn bushings that increase drag or allow the armature shaft to rub against the pole shoes. Continuous and prolonged cranking is very hard on a starter because it generates excessive heat. If not allowed to cool down every 30 seconds or so for at least a couple of minutes, the starter will be damaged by continuous cranking. Other failure modes include:

- "Zero engagement" or "no-clicking" activation of the starter solenoid. This can be caused by an unintentional activation of a vehicle anti-theft system. In other cases, a defective ignition switch, start inhibitor switch, or bad wiring harness/loose wiring connection can cause the problem. The most accurate way to test these components is to connect a DVOM to the primary wire connection on the starter solenoid. Using the min./max. feature found on most professional DVOMs or multimeters, record the voltage at the solenoid terminal when turning the ignition switch to the "crank" position. If battery voltage is recorded, the above components should be considered in good condition. If the starter clicks, but doesn't engage, the problem is usually caused by a faulty starter solenoid that's not engaging the starter drive gear. In most cases, replacing starter solenoids is not a cost-effective procedure compared to replacing the defective starter with a remanufactured unit.
- Starter motor is running but fails to engage the flywheel ring gear or when the engagement is rough and noisy. In most of these cases, the overrun or one-way roller clutch on the starter drive gear is worn or sticking. In the remainder of these cases, the flywheel ring gear itself is either worn, or has broken or missing teeth.
- Low-cranking speed issue caused by worn shaft bushings. The starter's amperage draw will be unusually high for the application. Also, when starter current draw is high, remember that battery voltage will often drop below 9.6 volts. This is enough to affect system electronics, which, in turn, will affect fuel pump operation. Engines must crank at about 200-300 rpm to activate the electronic fuel injection. When the ECU "sees" a strong, sustained signal from the crankshaft position sensor, it will activate the fuel pump relay in order to pressurize the fuel injectors. Without a reliable RPM signal indicating sufficient cranking speed, the ECU may not activate the fuel pump relay, thereby creating a cranking, no-start condition.
- Keep in mind that simply dropping a permanent magnet starter can fracture a field magnet, which may cause a variety of cranking speed symptoms.

Troubleshooting the Starter
In the Shop:

To accurately test a starter, you need a test stand that can measure amp load, voltage and rpm. A good starter will normally draw 60 to 150 amps with no load on it and up to 250 amps under load (while cranking the engine). The no load amp draw will vary depending on the type of starter. If the amp draw is too high, the starter needs to be replaced. The same is true if the starter doesn't achieve the specified rpm.

Sometimes the starter motor works fine but the drive gear won't engage the ring gear on the flywheel. If the drive gear mechanism can be replaced separately, there's no need to replace the entire starter. A bad solenoid can also cause starter problems. The solenoid acts like a relay to route power directly to the starter from the battery. It may be mounted on the starter or located elsewhere in the engine compartment and is usually connected to the positive battery cable. Corrosion, poor ground at the solenoid mount or poor battery cable connections will prevent the solenoid from doing its job.

If the starter tests okay but fails to crank, another possible cause may be a bad

ignition switch, neutral safety switch or clutch safety switch. A low battery and/or loose or corroded battery cables can also prevent the starter from cranking the engine.

On the Car:

When troubleshooting the starter, pay close attention to the wire/cable connections. The starter needs a healthy shot of juice to get going so you need to clean all contacts. Just because they appear OK when the starter is not engaged doesn't mean that they are good enough to do the job. Check ground straps. Make sure your fuses are clean. Check any other device on the starter circuit (if any).

- Make sure your battery is OK - turn your headlights, fan, rear de-mist etc. all on and check the voltage - should be at least 11V. If it's less than 9 or so you may not have enough power to turn the engine over.
- Test the battery terminals - should be clean and tight. If your starter won't turn I'd remove and clean them, then coat them with some Vaseline and put back. Also test the connection between the wires and the terminals - again, should be tight and clean. The usual symptom of loose connections here is that the starter solenoid 'clicks' but the engine doesn't turn.
- Test the + wire (the big thick one) connection on the starter. Again, this should be a good connection. The starter draws several hundred amps, and a connection that's not 100% is quite likely to drop most of the battery voltage across it.
- Make sure the starter is bolted to the engine properly - the current goes through the starter and block. Also make sure the engine is grounded - it should have a big earthing strap, or sometimes the battery - terminal is connected directly to the block - either way, make sure the contacts are good.

If all of the above check OK, simply put a wire from the battery + to the starter - connect it to where the thin wire goes. This should make the engine turn over (but not start unless the ignition is on). If the engine turns, it means that you have a problem in the wire between the ignition switch and the starter; If it doesn't, the starter is faulty: If you don't hear a 'click' the solenoid is to blame, otherwise the starter motor itself.

Starter Will Not Engage: Start Inhibitor Switch.

[Symptoms: I have an 89 740GL that sometimes starts but sometimes does not. When I turn the key the car simply will not turn over: no starter response on key to "start". However, all of the panel lights, the battery level and starter assembly are good. When this happens I usually put the car in Neutral and then back in Park which usually works allowing the car to start.]

[Response:] If your car is an automatic, like my wagon, make sure that the start inhibitor switch located under gear indication panel is not out of adjustment. A simple test is to push the selector forward or back a little in the P position (the only one the car should start in) as you turn the key. If the car starts, crawl under and adjust the rod just a little and the problem should be solved once and for all. Failing this option, check the switch and wires associated with the lockout switch.

[Response: JohnB] Took about 250K and 16 years, but there it was: a potential pattern failure at the start inhibitor (neutral safety) switch. A nice square contact (should be rounded and smooth--the other one was) point due to wear and a relaxed copper alloy arm...the car wouldn't start unless the switch was compressed by hand (a get-home crutch, BTW!). And beware...the Volvo part comes with a new and cheaper connector that the dealer crutches by selling you four terminals and the late model socket for an additional $5.00!! You're supposed to clip the OEM chassis harness clip off and crimp the new male spade terminals on and install the late model socket so the new NSS can plug into it...I just used the old socket and spliced it onto the new NSS. This same NSS is used on the 9xx series....

Removing Starter. The top starter bolt is difficult to remove. Before you go crazy, see the last comment in this paragraph.
Removing Without Lowering the Transmission. You need a 1/2 inch six point 18mm socket (940; 740 may require 19mm) or a swivelling socket, a 1/2 inch universal joint, a large breaker bar, and enough socket extensions (with one about 36"long) to reach back underneath the car to where you can apply the proper leverage to get a firm grip on the bolt head. Use an impact socket if you need to. The breaker bar should be at the rear of the transmission near the crossmember. The higher the car, the better, but I've always done it with the car sitting at jack height. And it's always worked. Unless you are using a lot of extensions and a universal joint, you are going to have a hard time with this bolt. Apply some penetrating oil to the bolt before beginning. You have to get into a position to really, really get on it! Leverage is the key: line up the socket, the uni-joint and the extensions just right, position yourself so you can put your weight into it, then you'll hear it: CRACK! Its not a job for half effort. The placement near the crossmember allows you room to use the breaker bar. While there is usually no need to remove the crossmember and lower the rear of the transmission, if you have problems place a jack under the tranny and remove the tranny support for better access. Do NOT drop the starter, which may fracture an internal motor magnet. Diesel starter: see the FAQ Section.
[Art Benstein] If the above fails, use a 12 inch open end wrench from the topside along the firewall. Apply a piece of oak 1"x1" to lever against the rear engine lift point. You only have room to loosen 1/8 of a turn at time! [Ted Yaffo] Use an impact wrench with requisite extensions to loosen this otherwise impossible bolt.
Removing by Lowering the Transmission.[Adam Stadnick] If you put a jack under the transmission support crossmember, remove the four bolts holding it up, and carefully lower the transmission down a few inches (being careful not to smash the distributor cap if it's a head-mounted distributor) it greatly opens up the access to the infamous upper starter bolt. I was able to remove it using 3/8" drive tools without a breaker bar or torch or anything. I spent about an hour trying to fight that bolt and never even got a tool to seat on it, but as soon as I lowered the transmission it took about ten minutes start to finish.

Diesel Starter Fails: Wiring Fault.

[Inquiry:] I own a 1986 Volvo 740 Diesel. The mechanics have replaced the starter six times from March 1999 to July 1999. The starter itself is still under warranty, but each time I have to pay the installation labor, besides the headache of being stranded, towing, etc. I'm not a mechanic, but even I know that something is wrong, wrong, wrong. Does anyone have any ideas? Even a list of possibilities that

I could have the mechanics check-out.

[Response: Van Audekerce Remi/Brandon] I have seen this quite a few times and it was always a short in the wiring harness that engages the starter when the engine is running. Most likely the place were the wires have rotted is where the wiring harness runs near the diesel pump. Cut the black sleeve open and check the wiring, most likely the wire insulation will fall apart. Check ground connections, the wiring harness, and battery condition. With a diesel starter requiring 2 kilowatts that comes out to 250 amps at 8.0 volts cranking. Any slight resistance will slow things down in a hurry.

[Noel DeSouza]In my case, the grounding wire going from the battery to the engine was bad, so check the obvious first. Use one side of a battery jumper wire clamped so as to ground the starter body (the head of the starter-bolt is a good spot to clamp) and the other side clamped to the negative post of the battery, then try starting again. If it turns over, the ground wire or connections are bad.

Alternator and Charging:

Alternator Mounting Bushings. [Editor] Over time, the three rubber bushings securing your alternator in its engine bracket can compress, allowing the pulley to become misaligned with the crank pulley and accelerating belt noise and wear. You can replace these with OEM rubber bushings or aftermarket polyurethane, which are more robust and do not compress as easily. The latter may be had from IPD. To replace your bushings:

- Disconnect battery negative terminal
- Use penetrant oil to loosen the tension adjusting, securing, and bracket nuts but don't soak the belt
- Unscrew the 10mm tensioner adjusting bolt beneath the side of the alternator by about 1.5 cm. Remove the belt from the pulley.
- Loosen the 12mm bottom securing nut and remove it from the adjusting assembly
- Loosen the top long bolt and nut (12 & 13mm) supporting the alternator in its bracket
- Remove the bottom nut and bolt (12 & 13mm) holding the alternator to the bracket
- Swing the alternator up. Using a screwdriver, push out the old bottom bushing and replace it
- Swing the alternator back down and replace the bottom bracket bolt and nut
- Remove the top long bolt and nut and swing the alternator back to replace the two top bushings
- Replace the top bolt and nut and the securing nut
- Tighten the bracket nuts (not the securing nut!) and retension the alternator belt so you can press it down about 1/4 inch under moderate finger pressure
- Once you tension it, tighten the securing nut firmly and then back off the adjusting bolt so it bears no tension from the belt
- Reconnect the battery negative terminal

If you are interested in replacing the four air conditioning compressor bushings, see the FAQ file.

Alternator Not Charging. When the battery loses charge and the alternator appears not to be charging, here are some diagnostic tips:
Diagnostics. [Response: Danny Halamish] It sounds like it's probably the charging system. Here's what I would check (in this order):

- Battery terminals - clean? Good connection? Corrosion?
- Alternator (thick) wires - both plus and ground (if fitted) - make sure they are OK.
- Alternator brushes - if they are nearly dead, this can cause this.
- Harmonic Balancer: the alternator belt runs off the balancer. If the rubber insert deteriorates, the balancer shell will slip

If all that checks out OK, I would suggest you get a volt meter, and when the voltage reads a little low, measure at the alternator: It should be 14.4V. If it's much less, rev it up a little - does the voltage go up? If not, there is a problem. Also, with the engine running and the voltage low (i.e. when the problem happens) measure the following:

1. Voltage between the alternator power terminal and the battery + terminal should be well under 0.2V
2. Voltage between the alternator body and the battery "-" terminal should be well under 0.2V
3. Voltage between the battery "-" terminal and the engine block should be well under 02.V

Voltage Regulator. If all this checks out but you still have a problem, the alternator voltage regulator may be defective. There are two screws holding it into your alternator. You don't even need to pull the alternator. Remove it and you'll probably find the two brushes (two black square spring loaded shafts) worn out. A good electrical shop can replace these, or a new regulato rfor either Bosch or Nippon Denso alternators is about $60. Install and, get a boost and happy motoring.

[Testing Bosch voltage regulator on 7xx/9xx cars: How can you tell if your voltage regulator has gone bad?. What tests can you do?

[Answer:] The real purpose behind the regulator is to keep the battery voltage from getting too high. When my regulator went bad, voltage would increase with engine speed, going as high as 18-20 V. You can easily test the regulator function by using a voltmeter to test voltage between your battery and ground while the car is running. Look for voltage between 13.8 and 14.6. If your voltage is higher than this, you probably do have a bad regulator. Check the integrity of the regulator diodes on a Bosch alternator by using a multimeter to measure the voltage readings at the D+ terminal and B+ terminal. The voltage reading should be the same at both terminals. A difference of more than one volt would indicate faulty diodes and the need to replace the regulator unit. [Rick Ledbetter] Test the diodes by disconnecting one of the D+ or B+ leads on the regulator and connecting your probes: black is ground (use the alternator case for ground) and red is touched to the D+ and B+ terminals. At the component level, diodes will only conduct one way. They have to be tested out of circuit, so one lead has to be disconnected from

the circuit. A simple continuity test on the meter will do the job. If you have a failure, the Bosch regulator/brush pack unit is easy to replace with the alternator in the car. If your battery has been overcharging, it can boil off electrolyte and may need to be topped off.

Exciter Current Through the Warning Lamp on the Panel. The alternator (charging) warning light in the instrument cluster feeds a small amount of electrical current to the field coils in the alternator when you turn the key on and the engine isn't turning. This excites the coils (electromagnet) and the alternator gets the magnetic field it needs to start charging as soon as the engine runs. When the alternator isn't charging at all (engine stopped) that wire to the alternator also provides a ground path for certain warning bulbs in the cluster, so they light up. Diodes in the network keep current from backfeeding into unwanted circuits. So if you have a bad connection for the alternator warning wire, the alternator won't start charging right away. But most alternators will self-excite once the revs get high enough (say 2000 engine RPM) and then they stay excited and charging, even at idle RPM.

[Editor] To initiate charging upon startup, the small wire going into the rear of the voltage regulator must be at 12 volts. If this is grounded or disconnected (as, for example, through a loose instrument panel or chassis connector), your alternator will not charge. The idiot lights may or may not go on, but if they do and they remain on, then suspect this wire or the panel connector for faults. You can also rarely experience a flexible circuit board failure on the back of the panel. And make sure the alternator warning lamp bulb is not burned out.

[John Randstrom] If you pull the wire off the alternator that comes from the dash board charging lamp and ground it, the idiot light should light with the ignition in the run position. If the lamp does not light then there is a problem with the bulb, the ignition switch, or the wiring/instrument cluster circuit. An easy way to see if this circuit is causing your no charge situation would be to connect a wire from the battery positive terminal through a small spare idiot light bulb(or any bulb with the same wattage and voltage specification) to the idiot lamp circuit connector on the alternator. The alternator should charge and the lamp should light when the engine is off, and go out when the alt. starts charging just like the original dash lamp should do.

[Tip from Paul Golden] I removed my instrument cluster and did the continuity checks, sure enough the solder joints had come loose from the wiring. I fired up the soldering iorn and hit each solder joint with some fresh 50/50 flux core solder. Installed the instument panel and presto, all the lights work once again. Since then I have repaired that same problem in 6 different cars, 760, 3-960, 2-940 so it seems to be a regular problem.

Diagnosing Alternator Exciter Circuit Troubles. [Bruce Young] The Battery, parking brake, brake warning, and bulb failure lamps should all iluminate when the ignition switch applies battery +12 to one side of all 4 bulbs and the other side finds a path to ground via that small red exciter wire from the panel to:

1. alternator D+ terminal, then
2. voltage regulator, then
3. alternator brushes and slip rings, then

4. alternator frame, then
5. Blue wire to engine ground.

These bulbs supply the required pre-excitation current to begin alternator charging:

- Battery light
- Parking Brake
- Brake Warning
- Bulb Failure

You can test for power to and thru the bulbs to the alternator D+ terminal by taking the red wire off the D+ terminal and holding it to any **engine metal** (not the alternator itself) while a helper turns the Key ON and observes the warning lights.

- Lights ON? = all is well to and thru the D+ wire
- No lights = check for battery voltage at disconnected red wire end
- +12V present? = battery=>cluster=>D+ wire path OK (problem is in #1 thru #5)
- No +12V = problem between battery and +12V side of cluster circuit

Installing a Replacement Exciter Circuit to the Alternator. Is it possible - and if so, is it wise - to run a wire from the battery's + terminal to the back of the alternator? Or, does that create a risk of damage in the long-term"? [Steve] This information relates to my experience with the Denso 100 Amp alternator which is on both my wife and son's 940.
It may or may not apply to other model alternators. It's possible, but not wise to make a hard connection from the battery positive to the excitaton circuit on the alternator. You would only do this if the circuit on the back of the flexible instrument cluster PCB failed.

The reason(s) are:
1. You wouldn't have the convenience of a charge light to tell you that your alternator is charging.

2. The excitation circuit (originating in the instrument cluster and going directly to the alternator via the small red wire) powers directly to the internal voltage regulator.
This allows the charge light to illuminate. The voltage regulator provides a circuit to ground to excite the alternator field windings until the alternator begins charging. After the alternator begins charging, the voltage regulator opens this circuit and the alternator continues to provide its own field (excitation) voltage. If you connect a wire directly from battery positive to the alternator excitation terminal, you will have a constant drain of the battery, and probably damage the voltage regulator over time.

On my son's 940, I did run a separate wire to the excitation terminal but not from the battery. I ran this wire from a "switched hot" source under the dash and on to the alternator. Inside the car, I pulled a loop of this wire out of the dashboard, cut it, and soldered a light bulb holder for a standard 1034 12V light bulb into the circuit. The hot wire is soldered to the terminal next to the center contact on the bulb. This did three things: it gave me a "idiot light" to tell me if the alternator

was charging; it provided a dependable excitation voltage source to the alternator that would only be on when the ignition switch is on; and it provided a current limiting device (the light bulb element) to the alternator excitation circuit. The bulb element will handle the current that is required to excitate the alternator field.

Alternator Removal and Replacement. Disconnect battery negative and the wires at the back of the alternator, carefully labeling each so you can replace them at the correct terminals. See the procedure above for removal of the alternator. See the FAQ file under Engine: Mechanical for removal of the alternator pulley.

Installing Rebuilt Alternators.

[Joe Avsec] I just installed a remanufactured NAPA alternator and one of the housing srews vibrated loose after a couple of days. It vibrated to the point where it came in contact with the fins on the alternator pulley, breaking all of them off and making a terrible sound.

[Kevin O'Brien] Had the EXACT thing happen with my last rebuilt alternator: the screw came out, put stress on the pulley, and loosened the main nut on the alternator shaft. [Editor] This suggests you use Loctite on these screws before installation.

Alternator Getting Weak; Regulator/Brush Replacement.

[Symptom:] The alternator on a 740T / B230 engine is getting weaker, slowly but surely. What to do?

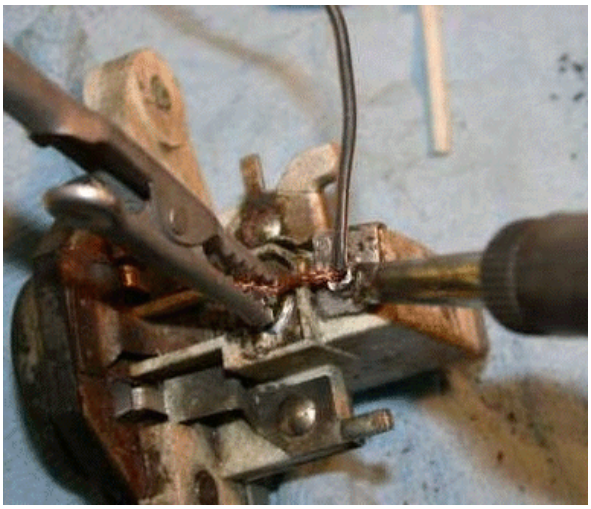
Bosch Alternator:
Regulator/Brush Change. [Editor] You likely need either a new regulator (screwed into the back of the alternator) or new brushes on the existing regulator. Swapping regulators is easy. The regulator has attached to it a set of brushes that contact the commutator. To replace the brushes, you will need to solder the new ones in place according to the instructions below. Also: Often the failure of an alternator is the result of a blown diode or a worn out bearing, etc. These parts are not expensive and their replacement is not difficult with the right tools. ($300+ alternator replacement cost for a burned out $10.00 part, what a scam!) With a little looking, I found a shop in my area that repaired the alternators (new bearings, brushes, leads, whatever else was needed) for about $70. All I had to do was get the alternator out of the car and bring it to them. This may be a way to go for your car. Note: regulators and brushes may be replaced on both Bosch and Nipon-Denso alternators.

Inserting the Regulator Back Onto the Alternator. [Randy Starkie] To keep the new, loger brushes from hanging up on installation, tip the assembly into place to position the brushes before straightening it up. After you push on it to straighten it the brushes are pushed back into the holders. Holding it in that position and then installing the screws usually works for me.

Soldering Tips: Earlier Wires Soldered to Terminals. Drill out the brush wire with a 1/16" bit where it is soldered to the brush holder. Brushes are available from Volvo for less than $4.00 (probably part number 1362710 for your car- they

can check). Solder in the new brushes and replace the regulator/brush assembly.

[Tip from Chuck Jaxel] You should use rosin-core solder specific for electrical or electronic use. DO NOT USE PLUMBER's solder, you will create a bad connection. Solder should have shiny appearance when it cools, A dull gray looking finish indicates a cold joint, another bad thing. Practice on some old wire, find a junk radio or something and practice on that board, its not hard, just takes a couple of times to get it right.



[Don Foster] When you solder the heavier alternator brush wiring, be aware that you might need extra heat if the braid (the wire going to the brush) is heavy, or if the connection is large. I don't know what heat range iron (Wattage) is in your keet, but you might need a soldering gun (150-250 Watts) to deliver the heat. A small iron (25 Watts) may not do it.

[Randy Starkie] There was a question about how to drill out the solder connection to facilitate the installation of the new brushes. I have included an image here that shows the assembly. I use a flat file to file the surface smooth. This gives a little more definition to the target area as well as providing a good surface to get the 1/16" drill started. Since the solder is soft the drill follows the path of least resistance removing the solder/leaving the holder intact (you will be drill towards the brush in each case). Once the solder connection is drilled out the old brush is released and basically pops out due to it's spring load. I apply paste flux to the lead of each brush. If you have trouble getting your solder to stick or flow out it is most likely because of the lack of flux. The new brushes from Volvo (part number 1362710- less than $4) have a solid wire lead on them that makes it easy to thread them into the brush holder. Pull them down far enough that the sides of the brush holder support the brush in an upright position. At that point bend the woven wire at a right angle to the holder to keep each brush positioned properly. Use a clip as shown in the photo to hold the brush gently against the spring. Apply the heat of an iron to the junction of the brush holder and the woven wire. Take a relatively small diameter piece of solder that has been dipped in the flux and touch it to the brush holder where the woven wire exits. Use enough solder so that the drill hole fills in around the woven wire (don't get over zealous here you don't want solder dripping out the backside into the brush holders). Trim the excess wire off and reinstall the assembly. Be sure to tilt the assembly as you position it so that when you press the assembly into place the brushes are pushed back down into the brush holders.

Soldering Tips: Later Wires Crimped and Soldered at Terminals. [Tips from Don "Solder King" Foster] My '90 car has this later crimped-and-soldered connection. First, I flowed fresh, clean solder into the crimped connection. Next, I used a solder sucker to pull the solder out. Then I re-flowed and resucked. And again heated the connection and rapped it on the bench to fling out the remains of the solder. Then I was able to pull the brush out, leaving a tiny, crimped hole. Then I reamed the hole with a tiny ice pick and several jeweler's screwdrivers 'til I

had the hole opened sufficently. Then I threaded the insulation over the new brushes' pigtails. Then I prepared and tinned the wire ends (new brushes) and tack-soldered on a 2' long piece of fine wire to use as a leader. Then I threaded the spring over the pigtail. Then I stuck the end of the leader through the narrow hole, from the brush side, and used it to pull the pigtail through. Once I pulled enough through, I carefully (and gently) crimped the neck with cutters and then soldered the pigtail. I bent it over and solder about 1/8" down the outside and then cut off the excess. (You must pull enough through so that the pigtail will hold the brush properly in the holder but fully extended.) Before installing the VR assembly, I cleaned the internal contacts with a pencil eraser as well as cleaning the contact in the alternator. I also cleaned and shined up the screw ground and mating surface on the alternator case.

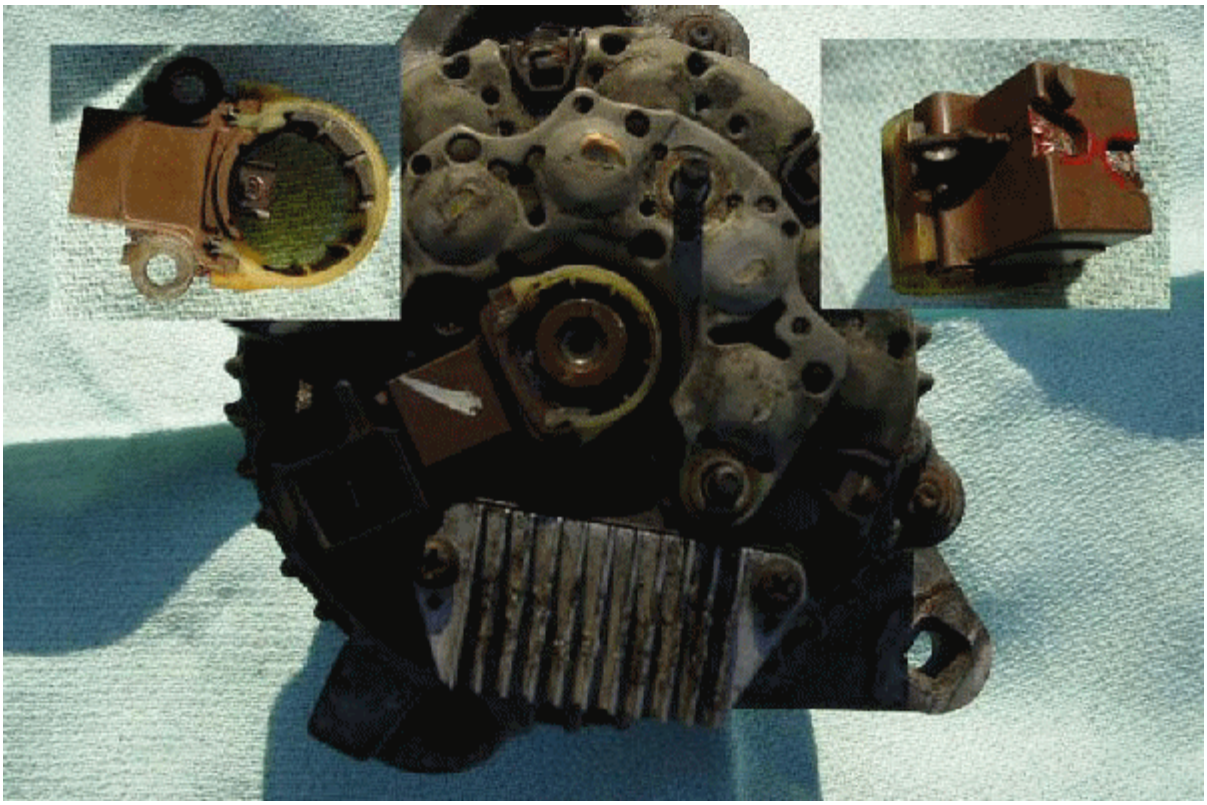
Alternator Regulator/Brush Reliability. [Inquiry] Is it wise to preventatively change out a 10 yrs old voltage regulator now?

[Response: Gary DeFrancesco] The regulators themselves are fairly robust. It is the attached carbon brushes that wear out. If let go too far, the bushes become ineffective and the alternator stops charging eventually. I would pull the regulator/brush assembly out and have a look at it. If the brushes are less than about 3/16", I would go ahead and replace the assembly. An aftermarket assembly costs about $20. A Bosch unit runs about $50. I have installed both in my 2 745Ts this year. So far both are working fine. My gut feel is the Bosch assembly is going to last longer, but time will tell. I know there are those who say the brushes can be replaced and the regulator reused. If you have the tools and want to spend the time, go ahead. However, I do not know how much longer the electronics in the regulator will last. With all the heat under the hood, the electronics will eventually fail. Will they last through a second set of brushes, I don't know. So I just bypassed the question and put in totally new assemblies. Lets face it, $50 in the scheme of things is not a lot of money. Especially when one considers the time involved to solder in new brushes, the cost of the brushes (I know, they're cheap), and the cost of a big soldering iron (if you don't have one). [Response: JohnB] Only if you can't use a soldering gun and wire snips...costs about $10 or less for a brush kit. Prophylactically change out the brushes at 140K miles. Note that some folks have found that aftermarket regulators can cause poor voltage regulation and driveability problems: see Unexplained Driveability Problems: Bad Voltage Regulator . Part numbers: 1988-1991 740 with Bosch 80 amp: Bosch regulator 1197-311-028 .

[Editor] For an older alternator, merely changing the brushes may not help much. You should rebuild it with new bearings and turn the commutator.

If you have flickering instrument panel warning lamps, see Warning Lights Flickering: Bad Alternator Brushes for a solution.

Nippon Denso Alternator:
Brush
and



Regulator Parts.[Jay Simkin] Brushes: 3544588 (MSRP = $43; this number is shown on a VADIS diagram for the 1995 940, but an on-line catalog shows it applies only to NipponDenso units up through 1992). Voltage Regulator: 9128558 (MSRP = $160). Tasca Volvo can confirm numbers; price likely will be below MSRP. These parts may be had from the vendors below and are very inexpensive. Have your alternator part number at hand when you call.

- Barsanco, Inc. (www.barsanco. com; 1-800-421-3374)
  Brushes: 217-510
  Voltage Regulator: 216-043 ; or
- J & N Auto Electric
  10995 Canal Rd
  Cincinnati, OH 45241
  (513) 771-8000
  Brushes: JN50-52003

Brush Installation. [Randy Starkie] See the illustration right and the illustrated file: the brushes in the holder assembly pictured to the right cost $2.45 or as bare brushes for $9.95 for a pack of 50.. Installation is incredibly quick. The white hood slides off for installation giving good access to pushing the brushes back to get the right placement. Then just replace the white hood and reassemble.

Checking Alternator Diodes. [Tip from Corey Glassman, Electrical, Charging and Starting System Tips and Techniques, Underhood Service, Sept 1999]

A Digital Multi-Meter's (DMM's) accuracy and digital display make

regulator/alternator diagnosing and adjusting easy. Be aware that many of the tests mentioned in this article may not work on your specific application. Some alternators can be damaged by full fielding for instance, others have a pulse width modulated field controlling charging. When in question, always follow the manufacturer recommendations.

An alternator generates current and voltage by the principles of electromagnetic induction. Accessories connected to the vehicle's charging system require a steady supply of direct current at a relatively steady voltage level. You cannot charge a battery with alternating current, so it must be rectified to direct current.

Checking Ripple Voltage

Ripple voltage or AC voltage can leak past the rectifier bridge diodes and actually cause the battery to discharge. It can be measured by switching your DMM to AC and connecting the black lead to a good ground and the red lead to the BAT terminal on the back of the alternator. Do not connect the leads to the battery, as the battery will absorb or dampen some of the AC. Run the engine at 2,000 rpm and read the meter's display.

You may want to also load the system by turning on the rear window defogger and headlights. A good alternator should measure less than 500 mV (.5 VAC). A higher reading indicates damaged alternator diodes and may cause problems in the ECU.

Another way to check the integrity of the diodes on a Bosch regulator is to check the voltage readings at the D+ terminal and B+ terminal. The voltage reading should be the same at both terminals. A difference of more than one volt would indicate faulty diodes and the need to replace the regulator.

Use the Vehicle's Radio to Check Alternator Diodes

Have you ever heard a whine from the radio that changes with engine rpm and isn't rap music? You can use the vehicle's radio to test the alternator's diodes. Turn on the radio and select a quiet FM radio station. Turn up the volume and rev the engine from idle to 2,000 rpm and back down to idle. Listen for a small whine or siren noise in the background that follows the rpm change. The noise usually indicates excessive ripple or AC voltage leakage from the rectifier bridge diodes.

Verifying a Good Alternator

The battery must be fully charged before testing the alternator. Run the engine and verify that the no-load voltage is 13.8 to 15.3 V. Next, load the alternator to its rated output current with a carbon pile across the battery. If you don't have a carbon pile, load the alternator by turning on as many accessories as you can. Run the engine at 2,000 rpm and check the current output with a current clamp. You may find that someone has put a number of additional loads on the charging systems increasing current demand from the alternator. Make sure that the alternator is rated to the application.

Where Is the Best Ground?

Technicians ask me this all the time. With the engine shut off, the battery supplies power to accessories and is the source of the best ground. After the engine starts and the alternator takes over, the alternator becomes the source of all power and the battery becomes a load and stabilizer. The best ground now is on the alternator

case, located at the grounding point for the brush set, rectifier bridge and in some cases, the regulator. Where are they mounted? On the rear case half, and how is the rear case half attached to the front? Typically with four through bolts sandwiching the field between them. Most alternators use the front case half as the mount for the belt adjusters and block attachment. With the engine running, it is always a good idea to measure a voltage drop between the front and rear case halves to ensure great connections.

Testing Alternator/Battery Voltage and Amps.

Battery Load Test:

[Motor Magazine, Apr 2002] A load test indicates how well a battery can deliver current while still maintaining enough voltage to operate the ignition system. This is generally the preferred test for any battery in a late-model vehicle. A battery must be at least one-half to three-quarters charged for an accurate load test-preferably fully charged. A load test places a specific current load on the battery to indicate how it will perform under heavier demands, such as cranking. A good battery should deliver the specified current while maintaining a voltage of 9.6 volts or more for 15 seconds at 70 F. As noted earlier, a cold battery delivers less current than a warm one, so the minimum voltage specs must be compensated for temperature. At 30 F, minimum voltage drops to 9.1 volts; at 0 F, it's 8.5 volts. If you have a digital voltmeter with Min/Max recording capability, you can do a fast load test that yields quite reliable results. First, connect your voltmeter across the battery and select the Min/Max recording function. Now turn on the headlights and crank the engine until it starts. Finally, let the engine run for about 10 seconds, then shut it down. The minimum recorded voltage on your meter is the lowest voltage reached by the battery during cranking. The maximum recorded reading is the alternator recovery voltage after the engine started.

Charging Amps:

With the engine idling and no load on the charging system (lights and all accessories off, battery fully charged), the amperage output should be relatively low (typically less than 10 amps). With the headlights and heater blower fan on and the engine running at 2,000 rpm, the output should jump to a higher reading, typically 25-30 amps or more. Charging voltage varies according to underhood temperatures. Room temperature charging voltage is generally about 14.2 volts. As underhood temperatures increase, charging voltage drops down to about 13.8 volts. In very cold climates, charging voltage may temporarily increase to 14.8 or perhaps 15.0 volts.

Voltage Drop in Cables:

Test the voltage drop in the battery cables to ensure that corrosion or internal failures are not preventing a charge. [Tip: Jim Bowers] There should be less that 0.2 volt drop from the alternator to the battery + terminal. My car had a bad crimp on the lug at the alternator and after I bought it I had no-starts due to a depleted battery. After starting the engine while the battery was recharging, I measured 0.5 volts from the alternator stud to the wire just after the lug. I cleaned and soldered the crimp lug and while I was at it also replaced the regulator/brush assembly. I've

had no battery problems for 5 years now.

Cautions:

Don't trust your volt meter in the instrument panel ! Always check voltage at the alternator & battery. If that alternator is weak you'll notice a drop in fuel economy because the fuel system tends to go rich as a battery dies. I replace around 40 voltage regulators in a year, and maybe 2 alternators. Be careful of chain repair operations, gas stations and tow-truck operators: Pep boys technician : "I'll do a quick battery test." Technician disconnects battery with ignition on and engine at high idle . Result: INSTANT $865.00 DAMAGE, blowing five relays, radio and other electrical equip. NEVER disconnect battery with engine running!

Alternator Wiring is Failing. [Editor's Note: See the section on Baked Wiring Harnesses in Electrical: Circuits, Relays for more information.] One quick thing to check is the ground wire that goes from the alternator to the engine block. That broke on me, resulting in my running off the battery with the same symptoms you have. It was not until I pulled the alternator that I saw the broken wire. Would have saved a lot of time to check that first. I have been through this on so many cars that whenever it happens, and the battery proves to hold a charge, I automatically yank the alternator and head straight for the local rebuilder. I couldn't tell for sure at first which alternator I had-turned out to be Bosch internal. I don't remember how much to rebuild, but it was considerably under $100.

[Symptom: idiot lights all go on; also, oil pressure gauge is erratic:] Having all the idiot lights go on at once is not as strange as it might seem. This will happen if the small wire leading to the back of the alternator is grounded. It will also happen if the alternator is not generating any current. When this wire is at ground potential, it is the same condition as before you start the car - hence the idiot lights are on so you can check they are not burned out. The wires for the alternator and also the o/p sender go around the front of the engine under the main crank pulley. (If you get under the front you will see what I mean.) Dripping crank seals often get oil all over these wires. Not to mention it is hot by the alternator. Flaky insulation may be at work. If you really want, you can reroute these wires around the right side of the car instead and splice into the harness at the firewall.

Alternator Interchange. [Randy Starkie] My experience is that there are three different alternators used on the 7/9 series cars. The older ones use the Bosch with the regulator and brush assembly that is also used in the 240's.The two 1994 944Ts we have use the newer Bosch (Denso type) marked as made in Great Britain- part number 9130275 (shown as superseded by 8111115).The 1992 745 has a small 100 amp Denso alternator part number 3544119 (shown as superseded by 8251744).The question (finally) is do these units interchange? Is the mounting hardware similiar enough that if I were to get one of the small 100 amp Denso and its mounting hardware could I install it on amy of the cars mentioned? [John Sargent] They all interchange. The later alternators use a larger stud on the output terminal, and you'll have to carefully ream out the lug on the earlier cars, or replace the lug. The small Nippondenso unit is supposed to have better voltage regulation.

Battery, Terminals, and Wiring:

Slow Battery Discharge. [Inquiry:] I am having an electrical problem with my Volvo. About two months ago the battery went dead--slowly over time. It was an old battery, so I though nothing of it and replaced it. All was good for a month and a half, then it went dead again. With the car running I measured 14volts across the terminals of the battery (12 when stopped) and 14v off the main positive lead of the alternator. What is the problem here?

Resources. See this useful site for diagnostic ideas.

[**Battery Drain Diagnostics**: Response: Ross Gunn] To check to see if there is something draining the battery while the ignition key is removed, remove the positive battery terminal, and with a digital electronics meter set to "amps", measure to see if there is any current flowing between the battery terminal and the cable end. For more accuracy, use a low-amp induction probe ammeter to measure current flow through the battery cables. If there is anything more than a couple of milliamps, re-connect the cable and remove fuses one at a time to see if you can identify the circuit that is causing the drain. If this pins down a problem, a little more sleuthing through the offending circuit should tell you what needs to be done.

If there is no drain showing with the above test, the charging system is suspect. Try measuring the voltage at the alternator output terminal and battery pos terminal with all utilities (headlights, rear window heater, fan etc.) on high. Any difference in reading indicates a poor connection somewhere in the red cable from the alternator. Don't assume that a crimp connection of a terminal on the cable is good. Corrosion can introduce enough resistance to prevent proper (any?) charging when there is a significant load on the system (cold, dark, wet/snowy winter evenings). I have experienced this on a 20 year old Brick.

[**Battery Drain Diagnostics**: Chris Bowne] I agree with Ross Gunn that the best way to trouble shoot a discharging battery is to find the source with the engine shut down and a multimeter (set to measure DC current) in series with the positive battery terminal lead. Other places to check besides the fuse block for drain paths are the alternator and voltage regulator (if not internal to the alternator).

Disconnect/reconnect the connections on them, one at a time, and monitor for drain. I had a problem on a Ford Taurus once where the voltage regulator had shorted, and was the cause of the drain. You may or may not find a source of a drain like this merely by pulling fuses. In fact, you could end up with all the fuses pulled, and still have the drain, like I did!
Someone on an earlier posting of this thread mentioned checking to see if his alternator was providing output by lifting the battery + terminal connection WITH THE ENGINE RUNNING. DO NOT DO THIS! Many solid state regulators will be damaged/destroyed by this condition. (And in turn may compound the causes of the battery drain you are troubleshooting!)

Battery Tips. [Tip from JohnB] Check the specific gravity of the cells...if they're accessible. With a fully charged battery, either from your battery charger or the alternator, disconnect the battery and measure the voltage, measure it again 12

hours later and it should be virtually the same, maybe .1v less, no more. Reconnect the battery to the car and turn on the headlights on full bright for 10 minutes and every accessory in the car...if the battery dies in 10 minutes replace the battery. Otherwise, battery voltage should remain above 10.5 volts or so after this test. There are load testers available in auto parts stores for about $30 or so that will do a higher load test (couple hundred amps through a resistance load bank) in about 10-30 seconds against a red/bad yellow/weak green/good voltage scale. If these tests still have you with a good battery, then you just have to trace down the current drain, circuit by circuit.

Tool Tips for Short Circuits. See the Special Tools section of the FAQ for suggestions on tools capable of rapidly locating shorts in wiring harnesses. [George Downs] Take a fuse, remove the element, and solder an instrument light bulb across it. With the engine off, plug it in to each circuit in turn at the fuse panel and find the one that illuminates it. That is the circuit which is grounding your battery and causing the drain.

Starting Problems and Battery Cable/Terminal Corrosion.

Terminal Corrosion and Starting Problems:

[Inquiry:] Car cranks strongly but will not start.

[Response 1: Jim Rothe] I've been discounting -- actually, completely ignoring -- any possibility of battery terminal corrosion, mostly because I've always had strong cranking power. But in light of last night's incident (and the prior one time occurrence) of starting with the help of a jump start, I'm going to re-check these things. I'm reminded of incidents with my RX-7 last year, when I was able to crank it strongly and it wouldn't start. I replaced the battery a few weeks later when the starter motor started sounding weak, and then my intermittent no-start condition miraculously disappeared. I've since found out that early rotaries tended to be a bit more susceptible to weak sparks (compounded by old, low compression, engines) than other cars. Food for thought.

[More Battery Cable Tips from Paul Grimshaw] The battery grounding cable on Volvo 700-series cars fitted with the 2.3 litre engine is constructed of braided steel, crimped to lugs which secure it in place. Over time, chassis and engine bay vibrations may weaken the grounding wire. This often breaks at the block connection. Furthermore, the effects of salt-induced corrosion can adversely affect the crimped portion at the lugs--resulting in a poor electrical contact. Any ground failure, whether total or partial, can play havoc with electronic systems and can lead to the failure of the car's engine management computer and/or mass airflow sensor. Given the risk of failure of this part, it's advisable to regularly inspect the ground cable.

Preventive Maintenance. [Eric Anderson] . I work for Lockheed and spent years chasing micro-corrosion. MicroC exists everywhere and is aggravated by substantial temperature changes. It is a microscopic or larger film of corrosion that can build up on both positive and ground connections with a preference to the ground connection, however auto's positive connection are just as susceptible. Have you thoroughly cleaned the battery connections, tightened and applied an anti-corrosive

(exide cro-guard, etc)? removed the starter B+ (positive cable) and brush the lug and the stud it attaches to plus all washers and mounting points. retightend and apply antiC? Same applies to ground connections. [Editor] For years, I have used the little colored fabric washers (red/green) that go under the battery terminals to prevent corrosion. They really do work, especially when combined with an anti-corrosion spray (the little cans of red spray you can buy at Walmart). Never, ever had a corroded battery terminal or wire set.

Diagnosing Corroded or Malfunctioning Cables and Wiring Using the "Voltage Drop" Method:

[Motor Magazine Mar 04] Measuring the resistance from one end of the cable (the battery) to the other end (the starter) will not reveal a problem. That's because your Digital MultiMeter places an almost unmeasurable load on the cable when it measures its resistance. Because the load is so small, the DMM will show a very low resistance reading, as long as even just a few of the strands in the battery cable are still good. The DMM can't tell the difference between a good cable and a bad one with this test. What's needed is a test that will reveal the cable's performance when it's in operation and under a load. To test the negative battery cable, attach the DMM's negative lead to the negative battery terminal. Don't attach it to the terminal clamp; we want to test the whole circuit from end to end. Attach the positive DMM lead to the starter motor body or the engine block. Set the DMM to the 0-40 volt DC scale, then have an assistant crank the engine while you watch the DMM display. Any voltage reading shown represents the voltage that has been dropped between the battery and the starter motor. Typically, a ground cable that's in good condition will drop .1 volt or less. Don't accept a voltage drop that's greater than .3 volt. A cable that's causing starting problems may be dropping far more than even these modest amounts. Voltage drops may occur at any point in a circuit. It may not be practical to replace all of the suspect wiring, so it will be necessary to pinpoint exactly where the voltage drop is occurring. It's relatively easy with something like a battery cable because there are only a few joints or connections in the circuit. If there's a voltage drop, the likely suspects are the cable itself or the terminals at each end. Cleaning the connections and replacing the cable should take care of the problem.

When a circuit is longer and more complicated than a battery cable, save time and keep your diagnosis focused by using the split half method. Divide the circuit in half, then perform a voltage drop test on one half at a time. Find a convenient connector somewhere in the middle of the circuit to mark your halfway point. Conduct a voltage drop test on the front half of the circuit while it's under load. If no significant voltage drop is found, move to the rear half of the circuit, then retest. Keep dividing the remaining segments of the circuit in half until you've narrowed it down and have conclusively located the voltage drop. Many circuits on today's vehicles are designed to carry very low voltage and amperage. Ohm's Law reminds us that any added resistance in these circuits will have a direct effect on their ability to perform as designed. Voltage drops measured in tenths or even hundredths of a volt can be significant and will cause problems.

Cleaning Battery Posts and Connectors:

[Editor] You can clean the battery posts and cable connectors safely by:

- Disconnecting both cables and keeping them clear of the battery
- Mixing a baking soda solution in water
- Wiping that on the surface of the battery and on the connectors, then rinsing (this removes acid). Rinse the tray as well.
- Cleaning grease off with rubbing alcohol and a rag
- Polishing up the posts with either fine sandpaper or a metal brush
- Cleaning the terminals with a metal brush and fine sandpaper
- Inspecting them and the cables for damage, broken strands, etc. Replace if needed.
- Reassembling with the little red and green battery anti-corrosion washers (they really work!) under the terminals and then, once the cables are secured, spray the post, connector and exposed part of the cable with anti-corrosion spray (a red lacquer you can buy in the battery section at KMart, Walmart, etc.)

Your biggest problem will be corrosion damage inside the cable, which is tough to fix. See battery cable connector repair for procedures.

Connector Under Battery Tray?

[Inquiry] Whilst cleaning up (minor) corrosion under the battery tray on my '85 765T I found a rubber device (inserted into the tray) with a cable which leads off to a (disconnected) 2-wire plug. Where does it go? What does it do?

[Response: Abe Crombie] It is a temperature sensor that affects the voltage regulator activity. The idea was to alter the voltage as battery temp changed. The voltage needed to charge battery without overdoing it and risking electrolyte evaporation varies with the temp of battery. This noble engineering feat was fraught with troubles though as the sensor could (and most times did) get attacked by acid and the temp value would be wrong. The result was exactly the thing the sensor was there for, i.e., it would overcharge. There was a service bulletin 13 years ago saying to disconnect the sensor plug on back of alternator. The voltage regulator would revert to internal temp regulation when the sensor resistance went infinite.

Unexplained Drivability Problems: Failing Battery Wiring Harness

Rotting Battery Wiring Harness or Insulation.
Rotten Harness. Last weekend, I uncovered the 1989 780T to show a friend. The car ran well, but seemed a little ''late''. After glancing at the gauges, I noticed the volt meter reading low. I don't trust the volt meters in Volvos, but felt the need to check alt. output anyway. At the battery (new OE), the output (input, actually) was 12.9V. No good. I could hear the alternator charging, but checked the regulator/brushes anyway. No problem. I checked the output at the alt. and the output was 14.1V Good. This car has a battery cable ''Harness''. After cutting it open, I found the insulation to be gooey and loose. Current was flowing between + and -- through the insulation. After replacing the harness, everything came back to ''like new!'' The car's acceleration was impressive, not just ''good''. The ECU said thanks, and the slight drop in fuel economy went away. The problem was wiring this time, but sometimes just changing the battery returns life to a Volvo. Check your electrical system thoroughly.

Failing Insulation. [Beth M.] I've had a hot no-crank no-start problem with my 1989 740 GL and had replaced all the usual suspects (RSR, FIR, crank angle/RPM sensor) and the ignition switch, but still had the problem recurring. Testing showed large intermittent voltage drops across the positive battery cable, so I decided to replace the cable. This evening we pulled off the positive and negative cables and slit the sheath binding the two together. Lo and behold, the insulation on both cables was worn almost all the way through (to the point that the wiring was showing in a few spots) and the positive cable had a large crack in the insulation at the bend. The positive cable also showed signs of wearing through at the point where the cable comes off the cross member under the A/C compressor. I had initially intended to only pull the positive cable since it was showing signs of wear and cracking at the crimps on either end, but now I've got to get a new negative cable as well. These were most likely the original cables and the car currently has 325,000 miles on it.

I'm just glad that I found this out before I had a car fire.

[Editor's Notes:] See the 960 section for a detailed discussion of battery cable connector repair procedures.

Loose Connector Nut. [Klaus Clark] If your positive connector is the same as mine, there is a smaller wire piggybacked onto the connector. The nut that keeps the smaller wire on is not the same nut that tightens the cable to the battery. What feels like a nice snug terminal can have one loose nut. It caused an intermittent stall during bumps or turns on my 740.

Replacement Harness. [Editor] You can buy a replacement battery wiring harness from a dealer or from a custom maker such as Custom Battery Cables.

Car Battery Failure: Diagnostics.

Service and Diagnostic Tips:

[Motor Magazine, April 2002] The most basic battery services are simple inspection and cleaning. Following are some fundamental steps:

- If the battery has removable cell caps, check the electrolyte level. It should be above the tops of the plates or at the split-ring indicator in each cell. If electrolyte is low, add mineral-free drinking water or distilled water. Do not overfill.
- Check battery terminals, cable connectors and metal holddowns for acid corrosion, and clean as necessary.
- Check cables for broken or corroded wire strands, worn insulation and defective connectors. Replace defective parts.
- Look for cracks in the case and loose terminals. Replace a battery with these defects.
- Check the battery tray and holddown parts for looseness, corrosion or other damage. Clean, tighten or replace parts as needed.
- Inspect the battery case and cover for dirt, grease or electrolyte condensation, and clean as necessary. You can clean a battery with a solution of baking soda

and water to remove corrosion and electrolyte deposits. Make sure to keep corrosion and the cleaning solution off painted surfaces. Remove heavy corrosion with a stiff-bristle brush. After removing corrosion, clean the battery with a detergent/water mixture, then rinse with clean water. Disconnect the battery cables and clean them with the baking soda solution. Scrape battery posts and the inside of cable terminals with special brushes or scrapers. After cleaning the battery and cables, dry them with a clean cloth or low-pressure compressed air.

[Inquiry:] My battery died at 40 months; is this normal? [Response: Tim Curry] This could be a normal failure of the battery, but check a few things first.

1) Battery cables. Positive side will be more likely to have a build-up of crud or bad connection, but check both cables. Is it clean at the connection? Is there corrosion at the cable/end where it joins the clamp itself (grey stuff at the wire insulation or a thickening/bulge of the cable somewhere in the insulation). Remove both cables, clean the terminals (wire brush), use the red & green felt rings under the cables to preserve the connection. Tighten both cables.

2) Get a multi-meter and measure the voltage between the battery terminals with the engine off. If it is less than 12 volts, you have a battery or charging system problem. Use jumper cables and get the car started. After you remove the jumper cables, check voltage with the car running and no lights, AC, radio playing. Should be over 12.7 volts and 14 plus volts if the idle speed is raised a little. If this is the case, your charging system is good, but your battery (or cable) is bad.

3) If you don't show an quick increase in voltage, check the fan-belt. If it is tight, check the voltage regulator at the back of the alternator. It would be easier to work on it with the alternator removed on some cars (turbo especially). There are 2 screws that hold the regulator in place on the back side of the alternator. These screws hold a brush assembly in place against the internal shaft of the alternator, carbon blocks on a spring assembly attached to the holder. The carbon brushes wear down with time and do not put enough pressure against the armature to make good contact. Often the alternator is good, while the brushes have worn out. The part costs less than $30 (US) and is available from shops with a decent electrical parts supply.

4) It could be the battery. Here in Tucson, the average life of a battery is 28 months (from the Exide corporation). Our problem is not cold cranking ability, it's the heat. If the plates inside the battery are exposed to heat, subjected to constant cranking, or given a quick charge there is a lot of heat generated inside the battery. The metal grid expands due to heat, the paste inside the grid is loosened and begins to fall to the bottom of the battery or swells in place. This will eventually cause a build-up of metal in the bottom of the cell which can short out the cell.

A break in the grid or swelling, a loose plate, an old battery, too much heat (or cold) and a dead battery is the result. Don't buy a lifetime battery. It will cost $100 and still fail before your life is over. Buy a moderately priced battery with 4 years of life for $35-$40 and you will be spending $10/year, not $30/year. Plan on setting your clock at 4 years and start saving for the next $40 battery.

Car Battery Replacement Tips.

Purchasing Tips:

Sourcing US Batteries. [Consumer Reports] Most auto batteries are made by just three manufacturers: Delphi, Exide, and Johnson Controls Industries. Each makes batteries sold under several different brand names. Delphi makes ACDelco and some EverStart (Wal-Mart) models. Exide makes Champion, Exide, Napa, and some EverStart batteries. Johnson Controls makes Diehard (Sears), Duralast (AutoZone), Interstate, Kirkland (Costco), Motorcraft (Ford), and some EverStarts.

[Tips from Rich:] Being involved in the telecommunications power business since Mr. Bell was a pup, I have some knowledge about batteries. If there were any additives that are useful in the long term they would be commonly used. There are not. As to size, buy the biggest heaviest battery that will fit. Typical car batteries are around 50 amp hours and weigh around 45 pounds. Some parts chain may sell you a cheap, light battery with a warranty, but they are counting on you not owning the battery when it goes bad. Since batteries do not like to be used a small battery is stressed more when cranking and when charging. Sure, a low charging rate is best for a battery, but you have no control over that. At some speed your alternator puts out 70-100 amps. Deducting 20 amps for fuel pumps and ignition the rest is going into the battery.

Car batteries are designed for high-rate discharge (cranking) and a reasonable life of 5 years. Other designs optimize other types of service. Marine Deep Cycle batteries accept repeated full discharge conditions. Telcom batteries are designed to sit there for 10-20 years with charging voltage applied and ready for the very infrequent discharge when AC power fails. UPS batteries are similar but due to the competitive consumer market they will not last very long.

Design considerations include a space at the bottom of the case so that material that falls off the plates can accumulate. Eventually it piles up enough to short out the plates. Longer life batteries have more space but they also have less lead and therefore less Amp-Hour capacity in a given size. The 20 year batteries have a lot of extra space added for a long life seal where the post comes out of the case. It is the nature of a battery to eat away the post seal. When it does you get the white powder. Felt washers and grease do not keep the acid from eating the seal away. The white stuff is the end result of the seal failing and efforts to remove the white powder do not cure the problem.

It is useful to remember that there is no magic in batteries. Every manufacturer understands the chemistry perfectly. The only difference is in the PR and advertisment depts. The biggest battery you can fit has a chance of having more space below the plates and a better seal. When Johnson Controls made the Die Hard batteries they were good. Now that someone else makes them they are not so good. Since Interstate distributes J. C. batteries that is what I buy. You will not hurt the alternator with a bigger battery. I always had good luck with OEM Volvo batteries but I understand that the 850s had a battery vith frequent failures. Sounds like the Purchasing Dept saved the company a buck or two but gave the reliable cars a bad name. This is not the first time that has happened, and will not be the last.

[BatteryTips from Tim Curry:] I talked to Exide here in Tucson a while ago and found out a bunch about batteries. Basically, here in the heat, they last an average of 28 months. If you buy a lifetime battery for $100 and it lasts 3 years (heat is bad for batteries) you spent $33.00 per year. Pro-rated? Oh yes, that saves you (you pay some every three years). If you need cold cranking amps, the plates are thinner and there are more of them to make more juice in a limited container. They also heat faster under a load. Heat them once without enough electrolyte (low on water) and you get the dreaded China Syndrome, cooked plates. They distort, shed some of the lead and it settles to the bottom of the container of the low cells. Get enough and the plates ground out internally to each other if the level reaches the bottom of the plates. Hot weather batteries? They use smaller plates and more electrolyte (it acts as a coolant inside) to cover them so a low water condition isn't as bad. Trade off is cold cranking amps (who needs it at 115 degrees, the car is always warmed up). Best buy? A commercial battery (truck fleet types) that you keep charged and full of electrolyte. 5 or 6 years at $65. How long do most people keep their cars? $33 / year or $10 / year? Next bet is a 4 or 5 year wonder from Wally's World for $29.95. It will last for as many years as stated and you will buy another, so its cheap. Oh yes, the battery, alternator and starter are a SYSTEM! Don't buy an 18 wheeler battery to start your VW or the alternator may be unhappy. Don't buy a motorcycle battery to start your Volvo, the starter pulls too many amps, the alternator will cook it from charging too fast and the starter will poop out from not enough current to get the job done because of heat $$$$$. Now you need one of each.

Battery Explosion; Wiring Chafing. Received panic call from wife that '88 740 Volvo just went completely dead on road and smoke was pouring out from under hood. When I arrived, all electrolyte boiled out of battery and battery cable insulation melted. Turns out was a direct short where cables pass under engine. Volvo neatly bundles both cables in a plastic sheath. Unfortunately too tight against bottom of engine and cut through, often at the clamp securing them. This is all too frequent in pre-1990 cars. A new battery and cables cured the problem. Volvo later issued a recall for battery cable chafing.

[Technical Note from UK Volvo Club, 700 Section] On 700's the front suspension crossmember has the heavy battery-to-starter cable running over its nearside front edge. These were the subject of a recall some years ago as they chafed, leading to a big electrical short (and under-bonnet fires in some cases). Apparently, most cars were caught, but the odd unmodified one must still be about. The recall modification involved fitting a sheathed clip, which lifted the lead away from the cross-member. It's screwed to the nearside front cross-member inside the fixing point of the lower suspension arm.

Volvo Maintenance FAQ for 7xx/9xx/90 Cars
