

# Diagnosing No-Starts on Some 740/940 Volvos

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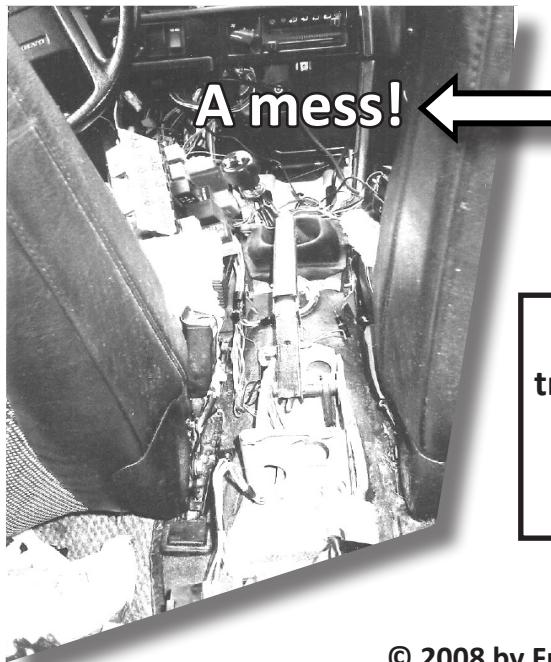
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1987 740 Volvo, with B230FT engine and Bosch LH-Jetronic 2.2 Fuel Injection System

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. . . from chasing after red  
herrings when my car died.  
Learn from my mistakes!

Use this step-by-step guide to  
track down the *most likely suspects*  
for no-starts on some  
**740/940 Volvo models**



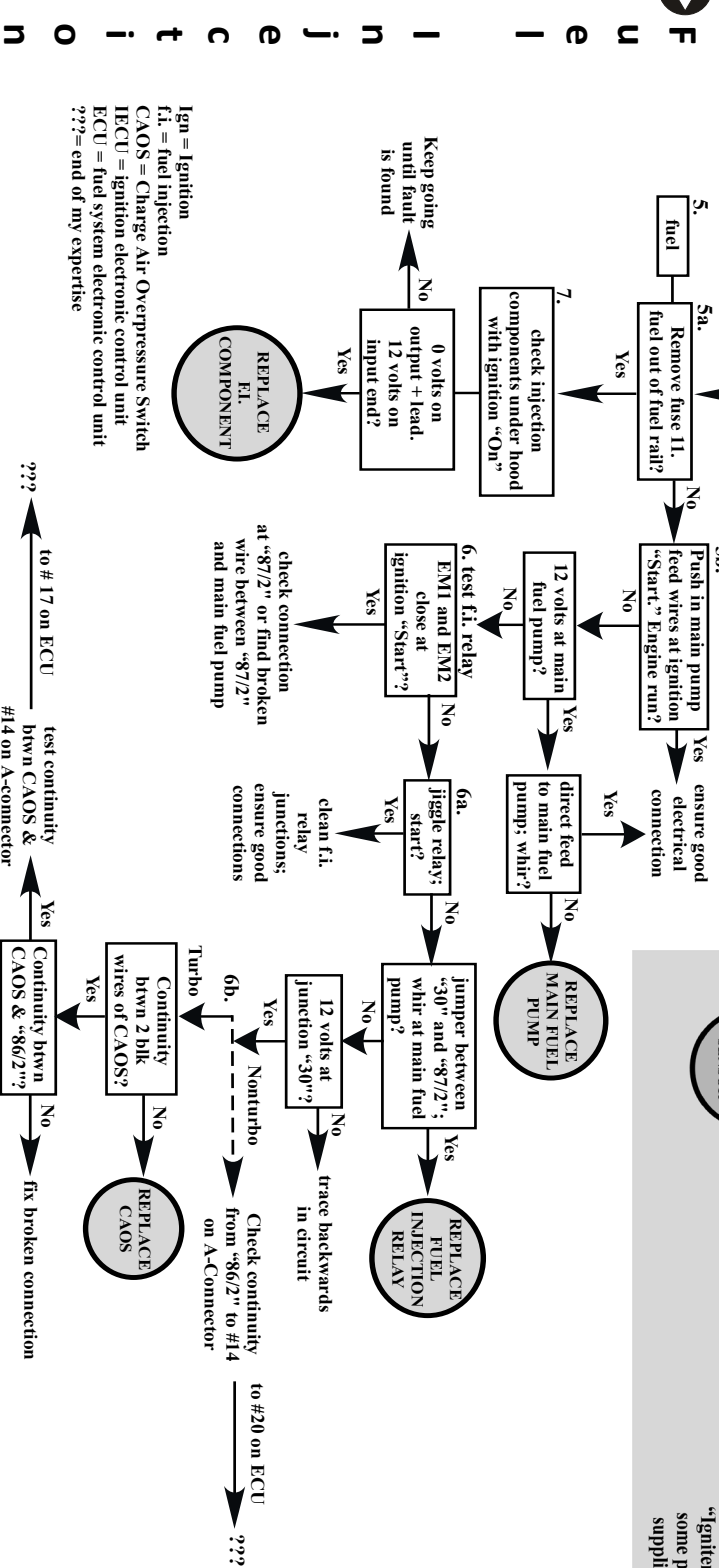
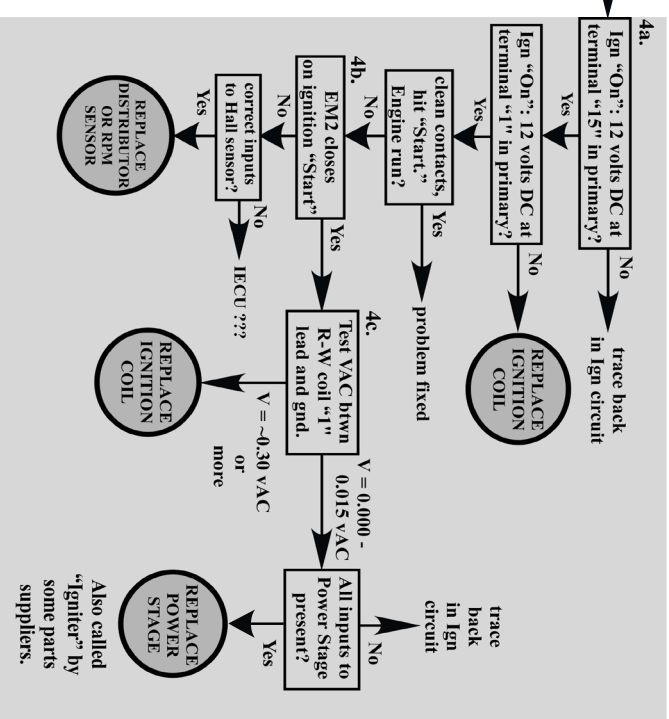
# 740/940 No-Start Flow Chart

(mainly B230FT, LH-Jetronic 2.2)  
[read accompanying text of how-to article;  
follow safety precautions!]

## Quick Tests:

## Involved Tests:

## No Spark





This guide is a best-faith effort provided by someone who is not a professional mechanic. Users assume all risks and liabilities, including material damage and costs that may be caused by incorrect information and injury and/or death caused by not following safety precautions. Use of this article is an agreement that parties shall hold harmless the author and bytewrite LLC. Observe all safety precautions!

**T**here are many possible causes for a no-start. While not exhaustive, this manual covers the *most likely suspects* right up to the fuel system Electronic Control Unit (ECU) and ignition Electronic Control Unit (IECU), where my expertise ends. Having chased red herrings (and needlessly spent money) as a do-it-yourselfer, I now adhere to the motto: “Be informed. Check twice, buy once.”



**Figure 1.** Test for spark. Pull coil high tension wire from distributor. Use *plastic grip* to hold end 1/8” from metal on engine block while an assistant cranks engine. Don’t overdo cranking.

Diagnosis is done without the use of fault codes or an oscilloscope. How so? In the end, a computer delivers certain voltage or current values to components under certain conditions, and a lot can be discerned by testing for those end results.

My Volvo is a 1987 740 turbo, B230FT, L-H Jetronic 2.2. So, instructions are mainly for this model, but advice here may help you with other models and variations. Exceptional wiring diagrams are available for different fuel injection and ignition systems at [www.autoelectric.ru/auto/volvo/740/1989/740-89.htm](http://www.autoelectric.ru/auto/volvo/740/1989/740-89.htm) for the 740 and <http://www.autoelectric.ru/auto/volvo/940/1993/940-93.htm> for the 940.

**A dead engine has three possible culprits: mechanical, electrical, or fuel.**

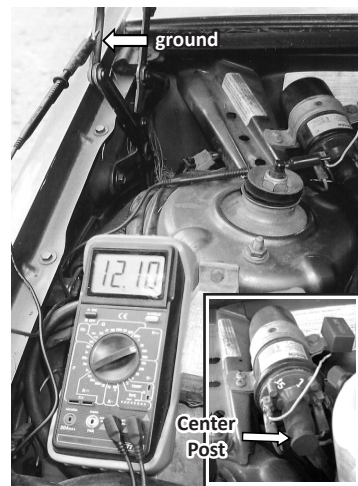
**1. No or little noise on ignition “Start” (engine does not turn over or crank) or grinding screech.** Check for 12 volts DC at battery terminals (note: a faulty battery will quickly drop to 9-10 volts when under load). Also clean battery cable ends and battery posts. Other possibilities are the starter solenoid and starter (grinding screech) and ignition switch and circuit.

**2. Engine cranks but doesn’t run on ignition “Start”—the symptom for all following tests.** Be sure you have gas (and not water; I once had that problem!). Then check that fuse 1 (main fuel pump and fuel injection system) is intact.

**3. Mechanical.** Check timing belt. Lift oil filler cap to view overhead camshaft while an assistant cranks engine. If camshaft rotates, the timing belt is fine. If the camshaft doesn’t rotate, your timing belt is likely broken.

**4. Electrical.** Pull the coil high tension wire from the distributor and hold its end about 1/8” from metal on the engine block (**Figure 1**). (**Danger! Use a plastic grip or tongs, never “insulated” metal pliers or your bare hand! Perform test in dry environment.**) With someone cranking the engine for 2-3 seconds, check for good spark. (Don’t overdo cranking, as some manuals warn it could damage sensitive electronics.) If no spark, go to **Step 4a**. If good spark is present, go to **Step 5a**.

**4a. No spark.** In olden days, no spark from the ignition coil usually meant it was faulty or the coil primary contacts “1” and “15” were corroded. These days, other possible culprits include the Hall sensor or Power Stage—and they cannot be discounted. (Parts suppliers also call the Power Stage an igniter, ignition amplifier, etc.) With ignition



**Figure 2.** Check for 12 volts DC between “15” terminal on ignition coil and ground with ignition “On.” (Ground is sanded bare metal on hood hinge.) 12 volts between “1” and ground implies that the primary winding is fine. Inset: Shows ignition coil leads and center post (high tension wire = secondary winding) to the distributor.

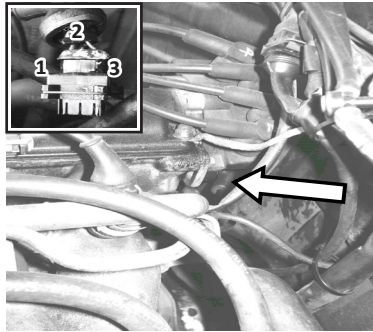


## Sidebar 1: Notes, Hints, and Observations



- For purposes of this guide, the key in the || position of the ignition switch means ignition “On” or ignition “Run.” The key in the ||| position is ignition “Start.”
- An old battery (>5 yrs) may give spurious results because it quickly runs down in tests. Recharge as necessary. Subsequently, if it fails to hold charge, replace it.
- The diode tester (beep mode) on a digital multimeter is great for continuity tests, but it cannot discern a short circuit (~0.1 ohms)—use lowest ohmmeter setting, instead. Also, digital multimeters have different resistance ranges over which they will beep for continuity checks. For instance, my old Fluke 73 Series multimeter beeps for resistances < 210  $\Omega$ s; my Cen Tech model beeps for resistances < 60  $\Omega$ s.
- Realize that a probable cause for a no-start may be a broken wire, which can be confirmed by a null continuity test. Breaks are more likely within the engine wiring harness—which is exposed to oil, heat, and in some cases, chafing—rather than, for instance, wiring in the passenger compartment. Continuity and resistance tests are run with the key out of the ignition.
- Doublecheck multimeter leads are solidly connected when running tests. Your wallet depends on it.
- Once diagnosed, some faults are easy to fix, such as replacing a faulty fuel injection relay, ignition coil, or Power Stage. Others are more involved, such as replacing a timing belt or main fuel pump.

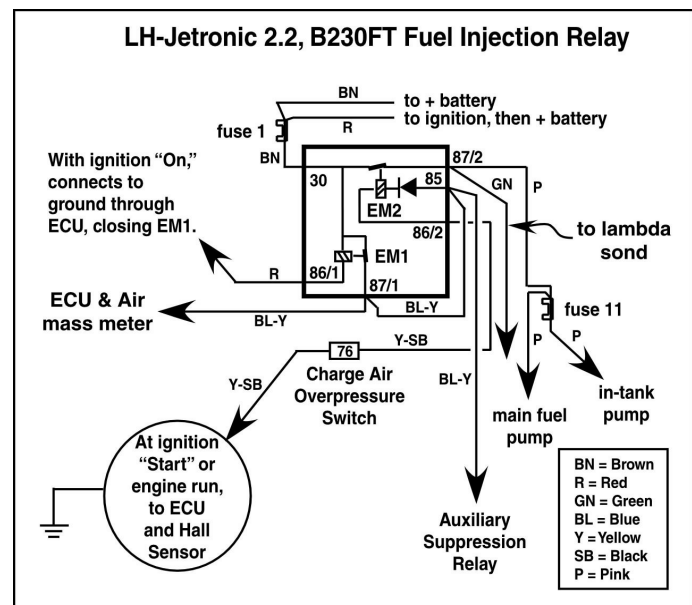
“On,” check for 12 volts DC at the primary lead of the coil (between “15” and ground—see **Figure 2**). If no 12 volts, trace back in ignition circuit. Also check for 12 volts DC between “1” and ground—if null, replace ignition coil. Otherwise, clean “15” and “1” terminals and leads and high tension lead



**Figure 3.** Arrow points to Hall sensor connector beneath in-line distributor on back of engine near firewall. To test inputs per Step 4b, unplug connector by pressing up on spring clip at bottom and gently pulling back. Inset: Numbers denote Hall sensor terminal leads. Probe terminals for proper inputs (Sidebar 2). Terminal 3 is red wire.

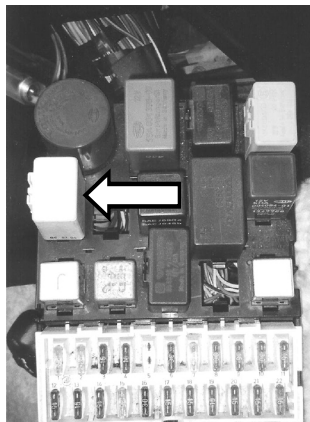
and center post contact. Attempt restart of engine. Start? Problem is fixed. If no start, go to **Step 4b**.

**4b. No spark.** A malfunctioning Hall sensor, located on the overhead distributor near firewall (**Figure 3**), also means no spark from the ignition coil. (Starting in 1988 Volvo switched over to an RPM sensor instead, located on the bellhousing (see **Sidebar 5**), that runs off the crankshaft. Functions of the Hall sensor and RPM sensor are supposedly identical, but I cannot personally vouch for that fact. In this article, any mention of the Hall sensor also implies the RPM sensor.) A properly functioning Hall sensor also closes electromagnetic switch 2 (EM2) on the fuel injection relay (**Figure 4**), feeding current to the main fuel pump. To observe EM2, release then lift and

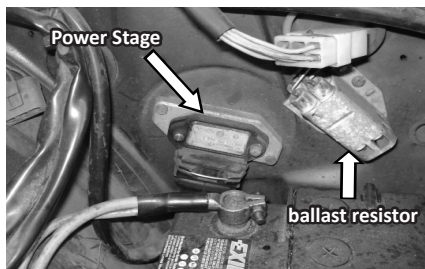


**Figure 4.** Schematic for the fuel injection relay. 12 volts is always present at junction “30.” Ignition “On” closes EM1 by providing a path to ground through the ECU. EM1 then feeds current to EM2 through junctions “87/1” and “85.” But, EM2 does not close until the Hall Sensor detects camshaft rotation (ignition “Start” or engine running) and completes the circuit to EM2 through the Electronic Control Unit (ECU) and, for turbos, through the Charge Air Overpressure Switch connector. When EM2 closes, it feeds current to the main fuel pump through junction “87/2.”





**Figure 5.** Pull out ashtray and fuse cover plate and remove the cigarette lighter shelf (Phillips screw beneath plastic snap-off cover plate). Release and lift tray out. The fuel injection relay (arrowed) has a white housing and is leftmost, second row behind the fuse tray.



**Figure 7.** The Power Stage, located near battery, is a transistor current amplifier that switches direct current on and off in concert with the IECU and Hall sensor. In effect, it provides an alternating current to the primary winding of the ignition coil to induce high voltage in the secondary. Note ballast resistor and, directly above it, its connector. Also see Figures 14 and 15 (and Sidebar 5 for 940 location).

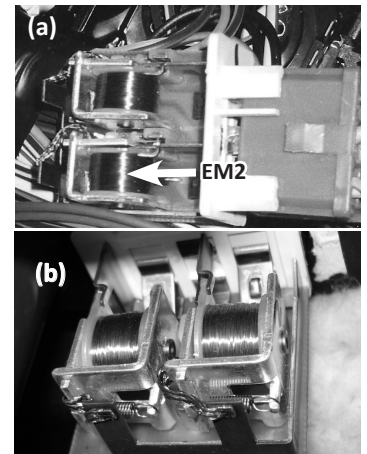
If you get  $V > \sim 0.30$  VAC between Red-White lead and ground, this implies the Power Stage is working properly. Replace the ignition coil.

**5. Fuel System.** Good spark implies a problem in the fuel injection system. Consult the wiring diagram available at autoelectric, listed earlier. Their schematics also show locations of various components on the car.

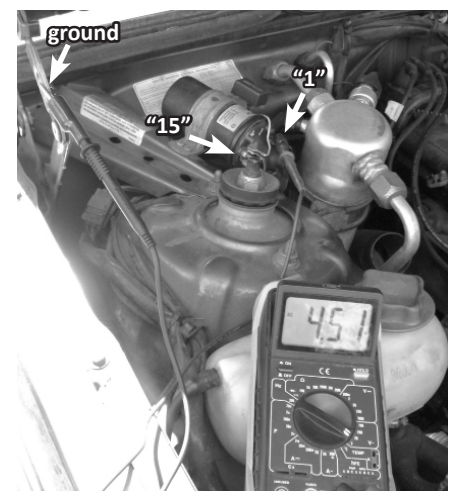
**5a. Test Fuel delivery.** Open the fuel rail (**Danger! No smoking!**) and

work the relay tray into the open (**Figure 5**). Remove relay from its tray socket and gently pry whitish cover off to expose the two switches, EM1 and EM2 (copper coils). Reinstall the relay sans cover into its blue female socket in tray. Turn ignition to “Start.” EM1 (frontmost in tray) and EM2 should both close (**Figure 6**). If EM2 closes, then the Hall sensor works and either the ignition coil or Power Stage is bad (**Step 4c**). If EM2 is open, then the Hall sensor or RPM sensor is most likely bad. First check for proper inputs to Hall sensor (**Sidebar 2**). If inputs are there, replace distributor. If inputs are not there, the problem could lie with the IECU (**Figure 13**). End of my expertise. [A new RPM sensor is no longer cheap. And replacing it, because of the confined space, is no walk in the park. Breaking it may necessitate pulling the transmission. Visit [http://www.volvoclub.org.uk/faq/EngineSensors.html#Crank\\_Position\\_Sensor](http://www.volvoclub.org.uk/faq/EngineSensors.html#Crank_Position_Sensor) for instructions. (Yes, they misspelled “Position.”)]

**4c. No spark.** The presence of 12 VDC between “15” and ground does not exonerate a faulty Power Stage. [The Power Stage (**Figure 7**) uses a transistor to amplify and switch the battery direct current on and off—essentially sending an alternating current—to the primary winding of the ignition coil, thus stepping up voltage in the secondary winding to fire the spark plugs.] Instead, use the AC (alternating current) voltage setting on your multimeter (**Figure 8**). Isolate the Power Stage by disconnecting the Red-White lead from terminal “1” on the ignition coil and test VAC between Red-White lead and ground at ignition “Start.” If you get 0.000 - 0.015 VAC, check for correct inputs to the Power Stage (see **Sidebar 2**). If Power Stage inputs are present (within reason), replace the Power Stage.



**Figure 6.** (a) The two relay switches (fine copper wire) are shown. EM1 is topmost (and frontmost when installed in vehicle) and EM2 is shown below it in photo. In this case, EM1 is closed (ignition is “On”) while EM2 is open. (b) At ignition “Start” or engine “Run,” both switches should close, as shown here.



**Figure 8.** Disconnect the Red-White lead from “1” on ignition coil. Use the AC (alternating current) voltage setting on your multimeter and test voltage between Red-White lead and ground at ignition “Start.” A reading of 0.000 - 0.015 VAC implies a faulty Power Stage or a fault feeding the Power Stage. In this photo, 4.51 VAC across “1” and ground (with all leads connected, of course) represents a properly running engine. (On the 940, I got 2.6-2.8 VAC with engine running.)



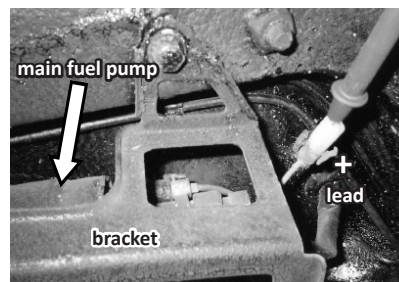


**Figure 9.** Pull fuse 11. Use 14-mm and 17-mm wrenches to break open the fuel rail. Insert the 17-mm inlet into a container to check for fuel flow while an assistant cranks the engine (ignition “Start”). Careful! Fuel can come out fast! The connectors are arrowed.

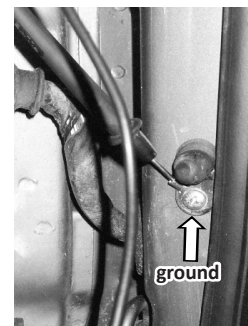
insert 17-mm inlet into a jar or can (**Figure 9**). Pull fuse 11 for the in-tank pump (to exclude it in this test) and hit “Start” for a couple of seconds. (If you had left fuse 11 in, a functioning in-tank pump would still deliver fuel, falsely implying a working main fuel pump. The engine will not start with a faulty main fuel pump and cannot start relying on a functioning in-tank pump alone.) If no fuel is delivered, go to **Step 5b**. If you get fuel, the main fuel pump and fuel injection relay work. Go to **Step 7**. Re-insert fuse 11.

**5b. No fuel delivery.** No fuel means a faulty main fuel pump, fuel injection relay, or their circuits. Test the main fuel pump first. (**Danger! Set car up on good jackstand on flat surface, transmission in neutral, wheels blocked, handbrake set. Use jack as backup support.**) Go under car and push on both feed wires to the main fuel pump while an assistant cranks the engine. A functioning main fuel pump emits a whiney, tinny whir at ignition “Start” or engine “Run.” (FYI: on the other hand, a functioning in-tank fuel pump emits a soft hum at ignition “On.”) If there is no whir from the main fuel pump, check for 12 volts DC across the leads when engine is

cranked (**Figure 10a**). Also, make sure negative lead is grounded. If 12 volts is present, because a main fuel pump is not inexpensive, doublecheck by running a long positive lead probe [Caution! Sheathe positive probe so it doesn’t touch metal (ground) while setting up and only unsheathe for test!] directly from the battery + post and a ground lead from the door buzzer terminal of **Figure 10b** and probe the main fuel pump contacts directly. (You’re doing this test because sometimes the electrical leads don’t seat properly.) If no whir, replace main fuel pump. If whir is present, then clean all electrical contacts as best as possible (they’re recessed), reconnect, and push leads into pump while an assistant cranks engine. (I had to grind down the plastic housing of the positive lead by 2 mm to ensure a better fit into the pump connector.) If engine starts, then it was a bad electrical connection to the main fuel pump. If 12 volts is not present, go to **Step 6**.

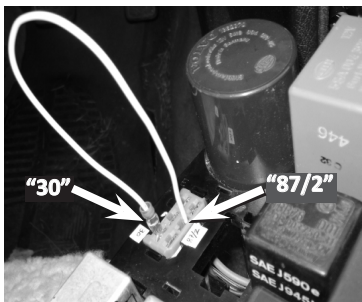


**Figure 10a.** Underneath the vehicle, insert positive probe of multimeter into the positive lead to the main fuel pump and insert the negative probe of the multimeter to ground of (b). Have an assistant crank engine (ignition “Start”) while you check for 12 volts DC.



**Figure 10b.** Set up a convenient ground by screwing an electrical connector onto the driver’s side door buzzer switch. Note multimeter probe inserted in connector.

## 6. Fuel injection circuit. Electrical. Lack of 12 volts



**Figure 11.** In Step 6a, with key out of ignition, jump the connections “30” and “87/2” on the blue female connector. If you hear a whir from the main fuel pump, then the fuel injection relay is faulty.

at the main fuel pump implies a fault in the fuel injection relay or its feed circuit. With ignition “Start,” does EM1 and EM2 close? If yes, check connection at “87/2” or fix broken wire between “87/2” and main fuel pump. If no, go to **Step 6a**.

**6a. Fuel injection relay circuit. Electrical.** If EM1 and EM2 do not close at ignition “Start,” first try jiggling the relay as you hit “Start.” It could just be poor electrical connections. If so, clean the contacts. If still no go, pull the upper (male) relay out and use a jumper wire to momentarily connect “30” and “87/2” at the blue (female) socket of the fuel injection relay (**Figure 11**). As “30” is always “hot,” i.e., always at 12 volts DC, do this test with the key out of the ignition. You should be able to hear a whir within the passenger compartment. If you like, have an assistant listen underneath the car. If there is a whir, replace the fuel injection relay. If there is no whir, check for 12 volts at “30.” If no 12 volts, trace back in that circuit. If 12 volts is present at “30,” in non-turbos, check



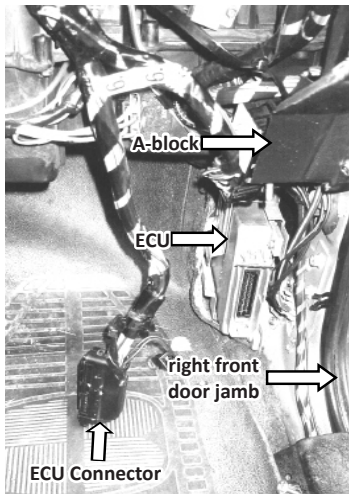


Figure 12. The A-connector block and ECU are located behind the trim, by the front passenger's right foot. Gently pry open hold-down latches on A-connector to expose contacts, which are numbered. Test continuity between #14 on A-block to correct yellow-black wire of Charge Air Overpressure Switch or, for nonturbos, to "86/2" on f.i. relay. My expertise ends here.

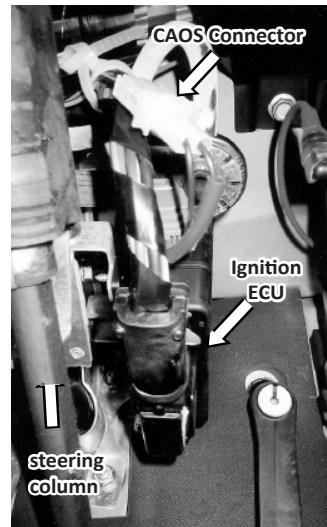


Figure 13. In turbocharged engines, the Charge Air Overpressure Switch (CAOS connector, top arrow) turns current off to the fuel injection relay if boost pressure is too high, thus interrupting fuel supply to the engine. It is located above the driver's knees next to steering column. Remove trim. Unclip the translucent connector and check for continuity per text.

continuity between "86/2" of fuel injection relay and #14 on block A-connector (Figure 12; end of my expertise). In turbos, find the Charge Air Overpressure Switch (CAOS, Figure 13). Pull connector apart and check continuity across CAOS (the black wires in one half of the connector). If no continuity, replace the Charge Air Overpressure Switch. On the other half of the connector, check continuity to "86/2" through one of the yellow-black wires. The other yellow-black wire runs to #14 on the block A-connector and then on to ECU. End of my expertise.

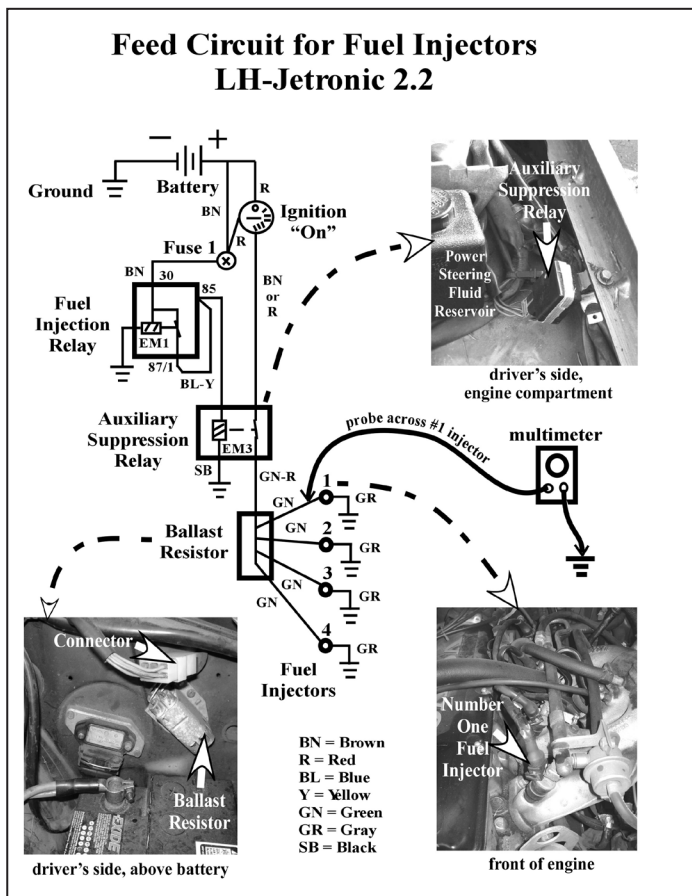


Figure 14. With ignition "On," first check for 12 volts DC (normal) between Green lead and ground at fuel injector 1. Next, work backwards through the connector at the ballast resistor and then the auxiliary suppression relay. A null result on output + connection of a component and 12 volts on the input end identifies that component as faulty. See Sidebar 3.

**7. Fuel injection component circuit. Electrical.** If you get spark and fuel, then use Figure 14 to run voltage tests across each of the other fuel injection components. First check for 12 volts DC across the #1 fuel injector (green wire and ground) with ignition "On." Next, work backwards through ballast resistor connector and then the auxiliary suppression relay. A null reading on a positive outlet of a component and 12 volts on the input side identifies that component as faulty. And, make sure there are no broken wires by checking for continuity from one component to the next. (See Sidebar 5 for location of auxiliary suppression relay on 940.)

One of the little joys in life is isolating and diagnosing a no-start fault in an automobile engine. I hope this guide has helped you make informed choices. Remember, check twice, buy once. Good luck!



## Sidebar 2: Normal Readings

(Author's results in parentheses, for an engine that runs)

### Hall Sensor (Figure 3 inset)

*test (?) between:*

(voltage) Terminal 3 (red) & Ground: 12 VDC, (11.14 VDC), ignition "On"

(voltage) Terminal 2 (blue) & Ground: 5 VDC, (5 VDC), ignition "On"

(resistance) Terminal 1 (black) & Ground: 0 ohms, (0.2 ohms), key out of ignition



Figure 15. Remove the Power Stage connector (also see Figure 7) by depressing the spring clip and gently tugging the connector down. The numbers identifying the pin connectors are exposed by pulling the rubber boot back.

### Power Stage (Figure 15)

*test (?) between:*

(voltage) Pin 1 & Ground: 12 VDC, (12.17 VDC), ignition "On"

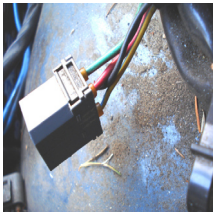
(voltage) Pin 4 & Ground: 12 VDC, (12.18 VDC), ignition "On"

(resistance) Pins 1 & 4: match primary coil resistance, ~1 ohm (13.3 ohms)

(resistance) Pin 2 & Ground: 0 ohms, (0.2 ohms), key out of ignition

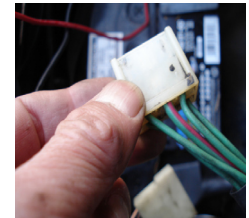
(voltage) Pin 5 & Ground: 2 VDC, (2.13 VDC), leads disconnected from coil terminals "1" & "15" at ignition "Start"

## Sidebar 3: Test the Auxiliary Suppression Relay (LH-Jetronic 2.2)



Connector for auxiliary suppression relay.

For instance, to test the auxiliary suppression relay, pull the relay apart and test the BN or R lead of connector (left) for 12 VDC (should always be present, even with key out of ignition switch). If no 12 V, check back in the feed circuit. If you get 12 V, put the relay back together and pull the ballast resistor connector apart (right). At ignition "On," check for ~11- 12 VDC at the ballast resistor connector by probing the GN-R lead coming from the auxiliary suppression relay. If you get 0 VDC or otherwise low reading, then replace the auxiliary suppression relay.



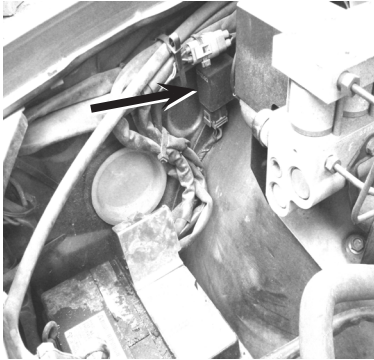
Connector for ballast resistor.

## Sidebar 4: The Ballast Resistors

The ballast resistors in the LH-Jetronic 2.2 system, as far as I understand it, act as shunt resistors. The Bentley manual claims that their main purpose is to limit current to the ignition coil at low engine speeds. The Haynes manual claims the resistance of the ballast resistor (total) should be 1 ohm. (There have been misprints in the Haynes manual, particularly when they said the resistance of the secondary windings of the ignition coil is "6.0 to 9.5 ohms," when it should be 6.0 kohms - 9.5 kohms.) I don't know what they mean by total. There are 4 resistors with 2 each connected in series. I have tested ballast resistors on three 740 Volvos, and I always got 12 ohms for the two resistors in series (adjacent terminals).



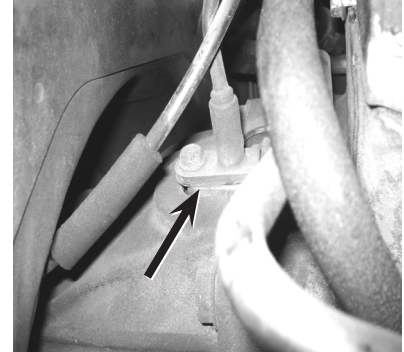
## Sidebar 5: Auxiliary Suppression Relay, Power Stage, and RPM Sensor Locations on the 940 (LH-Jetronic 2.4)



The auxiliary suppression relay (arrow) is on the passenger side front wheel well, near battery. There are no ballast resistors.



Removing the top of air filter box exposes the Power Stage (arrow) on the driver's side front wheel well.



The RPM sensor (arrow) sits atop the bellhousing (behind engine, low against firewall). Very confined space! Step 4b lists website with instructions for careful removal.

### Spare parts to carry in case of breakdown

A lot of the spare parts can be found at junkyards. I recommend carrying the following:

**(1) ignition coil** (test at junkyard; should meet following specs: 1-2 ohms between primary windings "1" and "15," 6 kohms - 9 kohms between "1" or "15" and center post); **(2) Power Stage**; **(3) auxiliary suppression relay**; **(4) fuel injection relay**; **(5) distributor with Hall sensor or rpm sensor (new)**; **(6) spare timing belt and at least one fan belt**; **(7) extra fuses**, especially 25-amp fuse 1 for the main fuel pump; **(8) tools** to handle above jobs; **(9) this how-to guide**; and possibly, **(10) main fuel pump**. The main fuel pump is expensive. At the very least, carry information for ordering one so you don't get ripped off. With overnight freight, it will probably be cheaper than buying through a local dealer who may take advantage of your situation. I can't imagine trying to replace a main fuel pump yourself while on the road. It's a tough, smelly job, difficult enough to do at home. Also, you want a *new* main fuel pump because you don't want to have to replace a used one in a few years.

### Other helpful sources:

- 1) [www.autoelectric.ru/auto/volvo/740/1989/740-89.htm](http://www.autoelectric.ru/auto/volvo/740/1989/740-89.htm)
- 2) [www.autoelectric.ru/auto/volvo/940/1993/940-93.htm](http://www.autoelectric.ru/auto/volvo/940/1993/940-93.htm)
- 3) Haynes manual *Volvo 740 & 760*
- 4) Bentley *Volvo 240 Service Manual*
- 5) <http://www.volvoclub.org.uk/faq/ElectricalIgnition.html#BasicOperationandTroubleshootingoftheEZ>
- 6) [www.swedishbricks.net](http://www.swedishbricks.net)
- 7) Google searches on Volvo specific topics

Comments? Email [fred@bytewrite.com](mailto:fred@bytewrite.com); please write "Volvo" in the Subject line.

Fred is a physicist turned writer who works on his Volvos when he has to. In his award-winning novel, *An American Sin* (ISBN13: 978-0-9711206-0-0, price \$15), the protagonist's 1970 145 Volvo breaks down outside Missoula, Montana, leading to a meeting with a pivotal hero of the Vietnam War. More info at [www.bytewrite.com](http://www.bytewrite.com). *An American Sin* can be ordered at your local bookstore (or, see next page).



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<input type="checkbox"/>	<i>An American Sin</i> (regular price \$15; with above paid download, it's 20% off)	\$12.00 U.S.	x	_____	=	_____
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