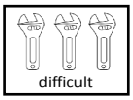
Replacing a Faulty Hall Sensor* Cable

(Cause of No-Start)



$6 donation requested. bytewrite LLC, P.O. Box 2635, Bellingham, WA 98227.

1987 740 TURBO, LH-JETRONIC 2.2, EZ 117K IGNITION SYSTEM

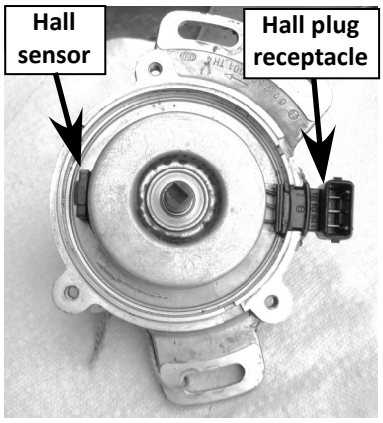


Figure 1. The distributor base-plate with Hall sensor and Hall plug receptacle.

Symptoms: Engine hiccupped, then intermittently died over a period of months. Sometimes it restarted right away, other times not. Eventually engine stayed dead (but cranked). Ran tests. Got 0.25 VDC at ignition "On," instead of 12 VDC, when testing #3 red wire of Hall plug. Found bare hot wires in Hall plug, which caused a short circuit. What caused worn insulation? Engine heat and *lots of oil* leaking past large O-ring of distributor into and around Hall plug.

Result: The short circuit will have killed the Hall sensor (Figure 1), necessitating a replacement Hall sensor *and* a fix of the short circuit.

One Solution for short circuit: Replace the Hall cable, which runs from the distributor to the Ignition Control Unit (ICU). *THIS DIFFICULT TASK INVOLVES WORKING IN CRAMPED SPACES AND CONTORTING YOUR BODY UNDERNEATH THE DASH TO ISOLATE AND FREE THE HALL CABLE. NOT EASY!*

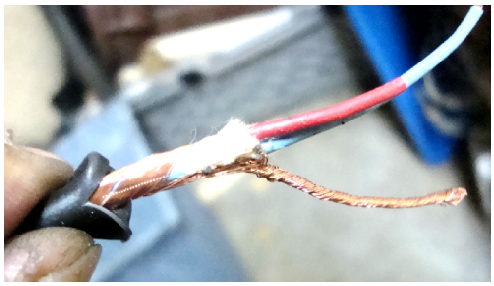
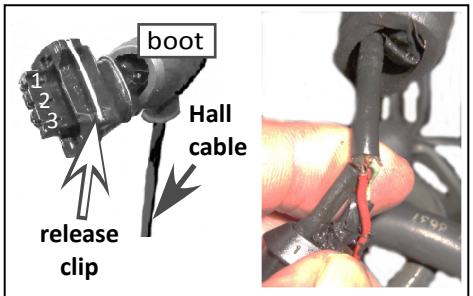


Figure 2. The ground wire of the Hall cable is the twisted end of the cylindrical copper sheath. Note red and blue hot wires.

At times you have to go above and beyond the normal pale of the average do-it-yourself mechanic. In fact, sometimes you may go beyond even what a *professional* mechanic would attempt to do! Because it's your car and you like a challenge.

Such a time would be replacing the Hall cable that runs from the distributor alongside and through the firewall to the ICU under the driver's side dashboard (above the gas pedal).

Why do this? Well, after several weeks of chasing red herrings again and buying the wrong part (fortunately, used and cheap), I traced one aspect of the no-start. It was a short circuit between exposed wires at the Hall plug (**Figure 3a**), located at the bottom of the distributor. *There are three wires in the the shielded Hall cable that end at the Hall plug:* #3 (red, 12 VDC at Ignition "On,"), #2 (blue, 5 VDC at Ignition "On,") and #1 (black, ground). The two hot wires have rubber insulation, and the ground wire is the twisted end of the copper sheath that forms the shielding for the whole (**Figure 2**). The ground wire is usually bare at the terminus of the shielded cable and insulated going into the plug. The problem was the insulation of the two hot wires had worn away. The exposed wires created a short circuit (**Figure 3b**). [A short circuit is a short unintended path for current to go from a hot wire to another wire or ground, rather than traveling its designed path through the device in question—in this case, the Hall sensor.]



(a) **(b)**

Figure 3. (a) The Hall plug showing the connector terminals, rubber boot, cable, and release clip. Terminal 3 faces passenger side when plug is connected. (b) Exposed strands of the Hall plug wires, where the insulation had worn away from oil, heat, and handling, led to a short circuit.

*In 1988, Volvo replaced the Hall sensor with an RPM sensor.

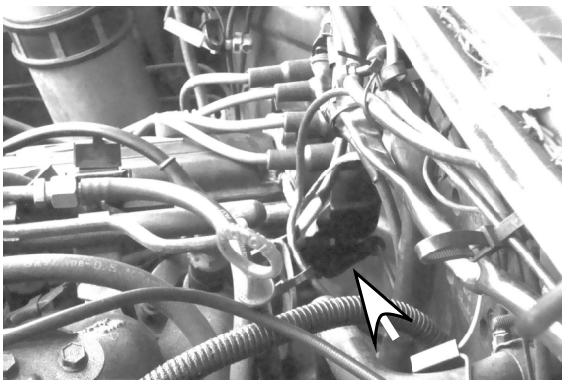


Figure 4. The arrow shows the location of the Hall plug, at bottom of distributor and close to firewall. Unplug it from receptacle.

There are three ways to attack this problem. **(1)** Pull the connectors out of the Hall plug (using technique similar to **Figure 20**) one at a time, clean, and slip heat shrink tubing over the connectors beyond the insulation break. (You may have to cut some of the cable back.) The problem is that you need a big enough diameter tube to get it over the connector ends. *Once heated, the larger diameter tube, in my experience, doesn't shrink enough to give good coverage over the insulation break, thus making this fix temporary.* But, you may be able to weave some good electrical tape in there to help. This is not a good way to go if any of the copper strands of the hot wires have broken. **(2)** The second way is to use a good replacement Hall plug and splice the wires and the shielding at a point in the cable somewhere along the firewall. I didn't go this way because I was unsure about the quality of the splicing of the shield and its ability to repel electromagnetic interference (EMI). One website suggested just soldering the shielding as two wires (once you open up the cable and shielding to splice the hot wires, your only good recourse is to braid the shielding into wires) and then encasing everything in heat shrink tubing. This suggests, as some other websites have, that a grounded parallel wire works well enough to mitigate EMI. (If this technique works for you, please let me know: fred@bytewrite.com.) I believe unraveling the cylindrical sheath defeats its purpose, as it acts as a Faraday shield for everything within—which are the two hot wires. [Wrapping aluminum foil over the exposed section of insulated hot wires, then encasing everything in heat shrink tubing, may work.] **(3)** To preserve the cylindrical shield, I did it the hard way. I removed the old cable, retrieved a good used one, added extra insulation at the Hall plug end of the replacement cable, and then installed the replacement Hall cable on my car.

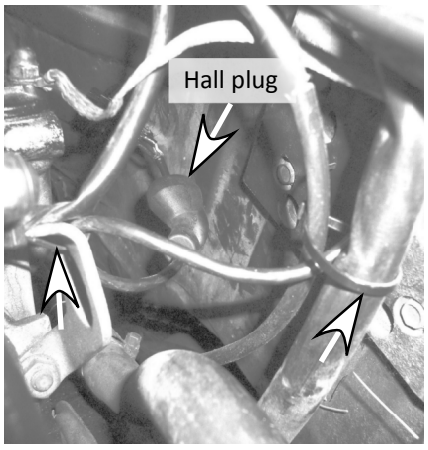


Figure 5. Cut the zip ties (uncaptioned arrows) holding the Hall cable. Note these points for installation of the replacement Hall cable.

The rest of this article illustrates method **(3)**. The greatest difficulties lie in opening up the wire bundles going through the firewall and underneath the dash, as well as exposing and following the Hall cable under the dash. You will spend hours trying to get to that Hall cable on your car and the junk car. At the junkyard, ask the manager if you can cut other wires at the firewall and possibly under the dash (it's a morass there) so you can more easily locate and pull the replacement Hall cable through the hole in the firewall.

Before beginning, disconnect the battery ground cable. If you haven't removed the Hall plug, do so now. It is on the bottom of the distributor against the firewall (**Figure 4**). Feel for the spring clip at the bottom of the Hall plug; press it up while pulling the plug backward to release. Once the Hall plug is released, cut the zip ties holding the cable per **Figure 5**.

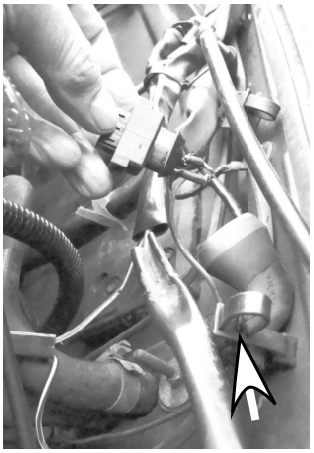


Figure 6. Push the Hall cable alongside the firewall. The arrow shows the release tab for the reversible zip tie.

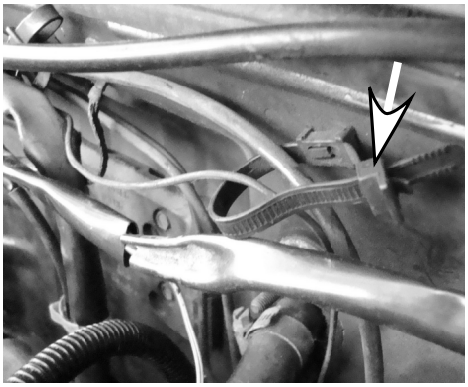
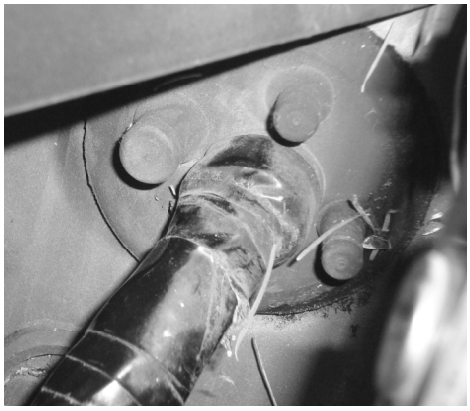


Figure 7. Release the reversible zip tie by pulling its end free and then pressing down on the short tab (see *Figure 6*) while pushing the end through the lock block (arrow).

(a)



(b)

Figure 8. These photos show the taped wire bundle behind the left (driver's side) suspension tower. (a) The arrow shows the Hall cable wrapping around the wire bundle before being incorporated by it to go through the firewall (b).

Figure 9. Cut the zip tie shown in *Figure 8a* and use a one-sided razor blade to lightly score the electrical tape along the length of the wire bundle. Then peel the electrical tape off to expose the wires as shown. You should now be able to isolate the Hall cable going into the hole of the firewall.

If you haven't done so already, remove the trim from underneath the driver's side dash. On some models, all you have to do is rotate plastic fasteners 90° and remove a Phillips screw; on other models, I recall removing 10 mm screws. Then, for more access, lower the radio amplifier (**Figure 10**) out of the way.

Figure 10. Remove the two 8 mm screws holding the amplifier and lower it to floor. Mark the background holes for easy replacement.

Figure 11. Inside view of the wire bundle of *Figure 8b* coming through the firewall. Getting a good view and feel (for cutting away the electrical tape) entails pushing a lot of other wire bundles out of the way. A good headlamp is handy for illumination under the dash.

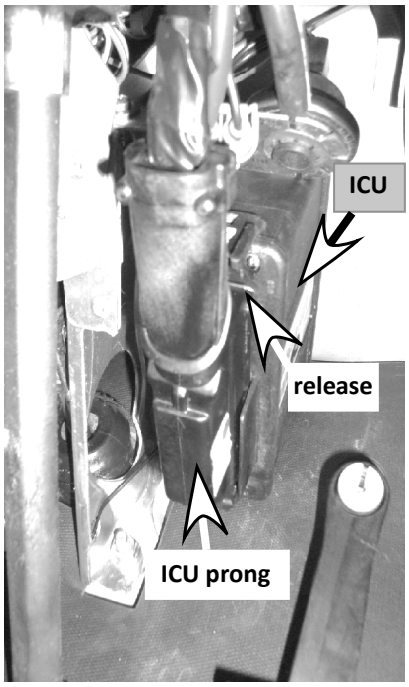
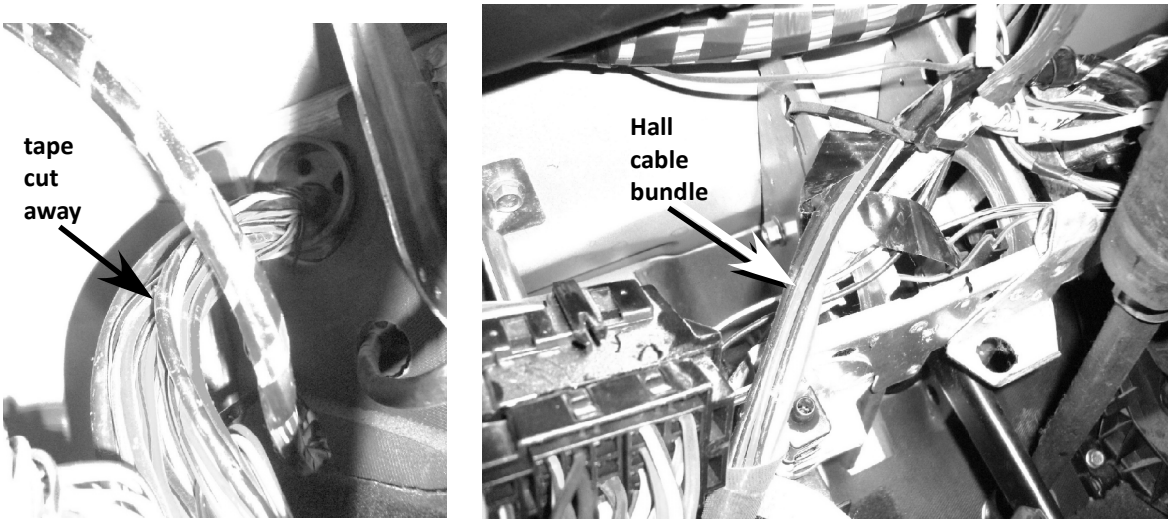


Figure 12. Locate the boxy Ignition Control Unit (ICU, arrow) above the gas pedal. The feed wires are contained in the ICU prong (arrow). To disconnect the prong, start by pressing on the brass release tab (arrow). This frees the tail end of the prong. To release the front end you need to lift the prong wire bundle off the black hook (right arrow, *Figure 13*) and cut the zip tie (left arrow, *Figure 13*). Then, pivot the whole prong forward ~90° to an almost vertical position to be able to unhook the forward latch. Next, push the vertical prong rearward to release.

Figure 13. The Hall cable bundle is labeled in the photo. It is hung to the underframe by the zip tie and the black hook (both arrowed).



(a) (b)

Figure 14. Under the dash, score and then peel away the electrical tape from the wire bundles, near the firewall (a) and closer to the ICU prong (b) to expose the Hall cable.

Figure 15. Remove the small Phillips screw from the top (forward end) of the ICU prong. Use #1 Phillips screwdriver, as the screw is tight and its slots are easily rounded (same caution for *Figure 16*).

Figure 16. Remove the two Phillips screws at the tail of the ICU prong. Pull the back cover off to expose the wires at the tail. Score and cut away any electrical tape holding the tail wires together. Identify the Hall cable.

Figure 17. Insert a pick into the hole in the tail end side of connector socket and exert pressure toward tail on end of pick handle to pivot the connector socket free from the ICU prong housing.

Figure 18. Pull the wire connector socket out of the ICU prong housing as shown to expose the wiring.

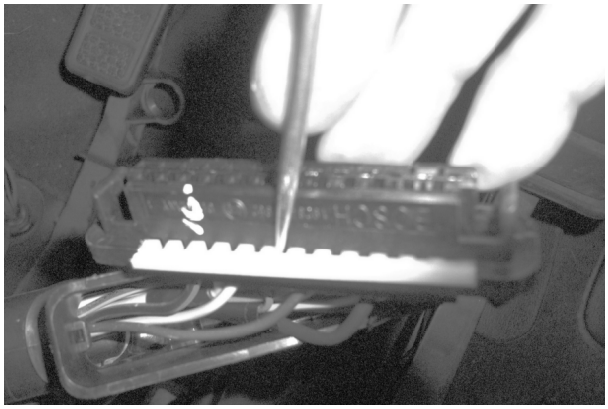


Figure 19. Use a pick to pry out the two plastic inserts on the sides of the socket. These inserts help hold the electrical connectors in place.

(a) **(b)**

Figure 20. (a) I used the smallest head (0.94 mm, slightly larger than 1/32") of my jeweler's screwdriver set to remove the Hall cable wires from the prong socket. Another suggestion was a finely ground pick. (b) To free a connector, insert the miniature blade into the channel shown by the arrow (which is back side of connector) while gently pulling on the wire from the back. Make sure that the plastic inserts of *Figure 19* have been removed. (In this photo, the inserts are still present.)

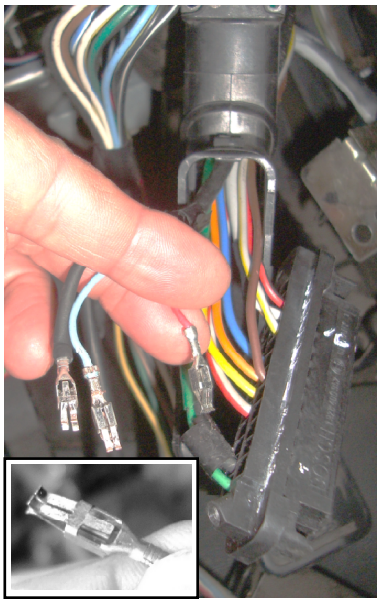


Figure 21. The three wires of the Hall cable have been released from the ICU prong connector socket. They are the red wire from the #4 terminal of prong, the blue wire from #24, and the black wire from #10. (See the EZ 117K wiring diagram for reference.) Inset: Close-up of terminal connector. Fragile! Note locking tab on back.

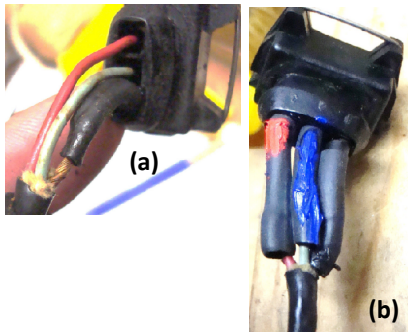


Figure 22. Gently pry out each connector terminal, one at a time, from the Hall plug using the small screwdriver of *Figure 20a*. Insert the screwdriver on the back side of the connector. (a) Photo of replacement Hall plug, as is. (b) Additional insurance against a short circuit is achieved by slipping heat shrink tubing over each wire all the way to the terminus of the cable housing. After shrinking the tubing, mark the #3 wire with red paint and the #2 wire with blue paint. Let dry.

After you've removed the three Hall wires from the ICU prong connector socket as shown in **Figure 21**, cut the terminal connector ends off and pull the whole cable back through the firewall into the engine compartment. You may have to work the cable a bit from under the dash and through the wire bundle at the firewall. (**Figure 21 inset** shows a close-up sample of the terminal connector. The Hall plug and ICU prong terminal connectors are identical.)

At the junkyard, remove the candidate Hall plug from the distributor and peel back the rubber boot to check the condition of the feed wires. The #3 and #2 wires should still have their insulation in good condition. The #1 wire is ground (braided from the shielding) and will most likely have a gap, showing bare wires, next to the terminus of the outer cable housing. B**efore beginning the tedious process of dismantling the wire bundles, use an ohmmeter to probe the terminals from the replacement Hall plug to the terminals at the ICU prong socket.** You should get continuity (and low resistance, ~0.3 ohm) between #3 at Hall plug and #4 at the ICU prong, between #2 of Hall plug and #24 of ICU prong, and between #1 of Hall plug and #10 of ICU prong. (Check your ignition system wiring diagram for correct terminals.) Only when you've confirmed continuity and low resistance should you then proceed to dismantle the wire bundles and free the Hall cable. Ask the junkyard manager for permission to cut wires of the wire bundle at the firewall. Pull those cut wires free to make room to pull the Hall cable through. **Tape the ICU prong terminal ends of the Hall cable, as they are fragile, before pulling the cable through the firewall.** I also highly recommend buying the ICU prong off the junk car. If so inclined, release the ICU prong by cutting the wires about four inches from its tail. This prong has backup terminal connectors, which can be useful if you break one on the Hall cable. (Replacing terminal connectors is difficult because of their miniature size, but it can be done. You could also splice the wires.)

Once you have the replacement cable back home, consider adding additional insulation to the wires, per **Figure 22**. This acts as additional insurance against short circuits.

Now you're ready to install the replacement Hall cable. Don't fight going through the old hole in the firewall with the original wire bundle. Volvo has conveniently provided additional holes **(Figure 23**).

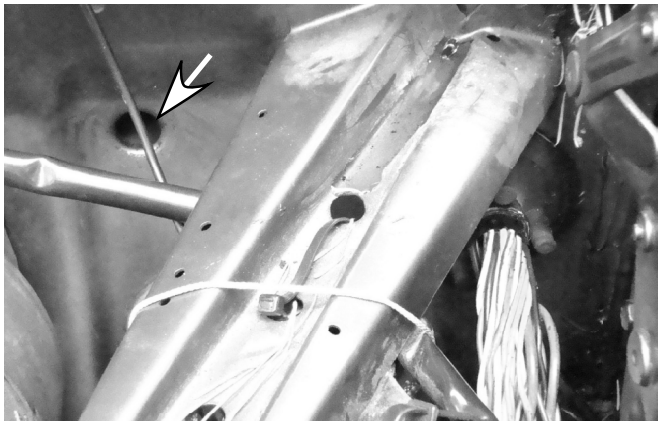


Figure 23. Pry out the rubber plug, medial to the exposed wire bundle, to open up a new hole (arrow) in the firewall.

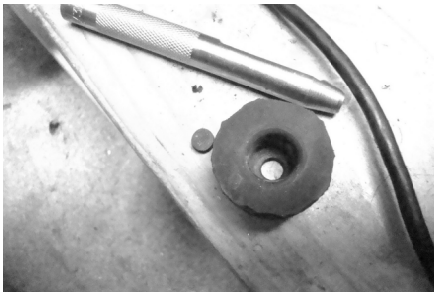


Figure 24. Use a 5/16" hole punch to cut a hole in the rubber plug. Insert plug over Hall cable, being careful not to damage the terminal connector ends. *The narrow diameter end of the rubber plug faces the ICU prong terminal ends*.

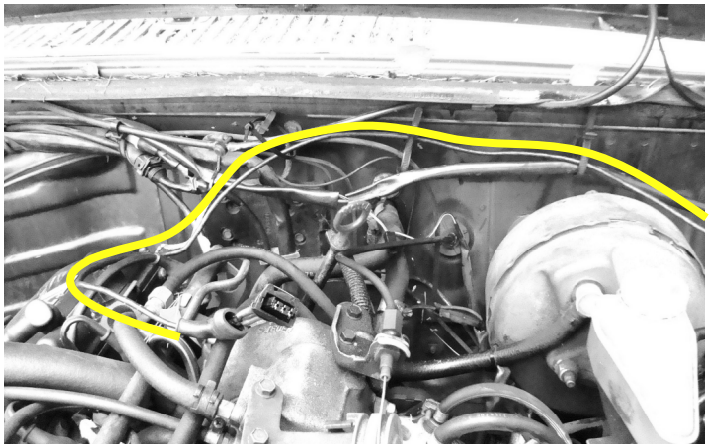


Figure 25. Wrap the ICU connector end of the Hall cable with masking or electrical tape to protect the terminal ends, which can be easily damaged. Run the Hall cable (visible next to yellow line in photo) through the reversible zip ties you opened during removal and zip tie the cable loosely to zip points noted earlier (*Figure 5*).

Figure 26. Push the taped ICU connector ends of the replacement Hall cable through the new hole in the firewall. Go under the dash and pull the cable in.

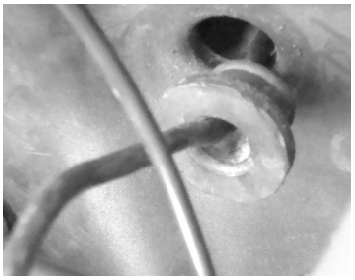


Figure 27. Take up the Hall cable slack within the engine compartment by pushing the cable through the hole in the firewall. Set the rubber plug into the firewall.

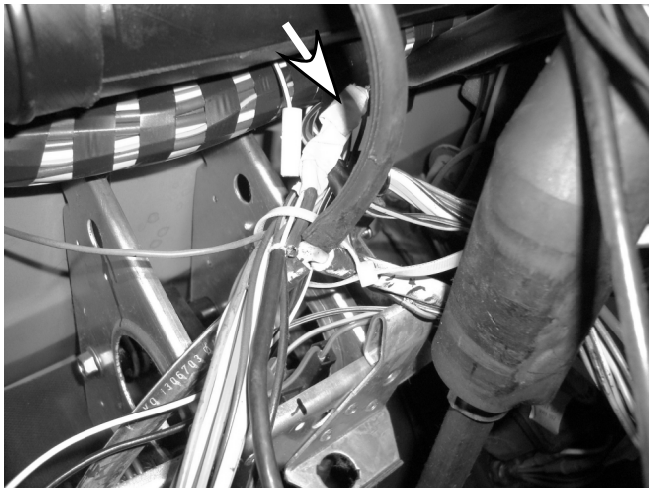


Figure 28. Under the dash, take up any slack on the Hall cable and run it alongside the ICU wire bundle. The arrow shows the taped end of the Hall cable. Fit the cable through any zip ties and over the black plastic hook (*Figure 13*) for the ICU wire bundle. Then run the cable through the tail housing of the ICU prong.

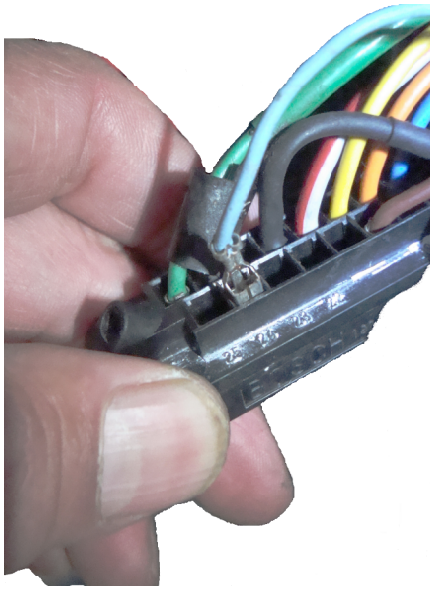


Figure 29. Remove the tape from the connector ends. Insert the connectors into the back of the ICU prong socket with the locking tab of each connector facing medial. Here, the blue (#2 of Hall plug) connector terminal is being inserted into the #24 position of the ICU prong socket. Insert the red (#3) connector into the #4 position of the ICU socket and the black (#1) connector into the #10 position of the ICU socket. (Double-check the correct position for your ignition system.)

After inserting the terminal connectors of the Hall cable into the back of the ICU prong socket (**Figure 29**), push the white plastic strips of **Figure 19** into the holes on the side of the socket. These strips hold the terminal connectors in place. Use good electrical tape to wrap the wires going into the tail of the prong (**Figure 30**). (I like 3M Super 88 electrical tape.) Next, push the connector socket back into the prong shell, snapping it in place so that socket face is flush with the prong face. Put the tail tab on the prong and secure with the two Phillips screws (**Figure 16**). Then, secure the head of the prong with one Phillips screw (**Figure 15**). Under the dash, wrap wires with electrical tape all the way back to the firewall—no need to wrap every square inch; feel free to leave gaps of unwrapped wires (**Figure 31**).

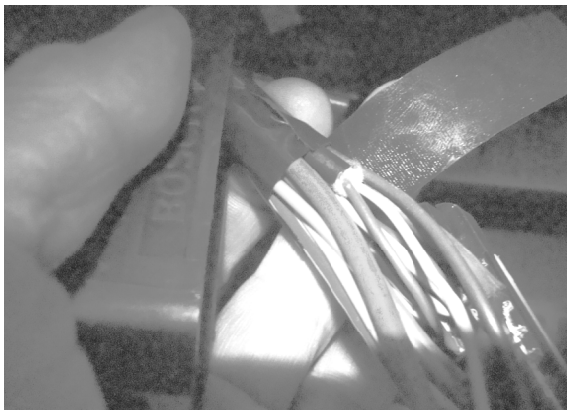


Figure 30. Wrap electrical tape around the ICU prong wires at the tail end of the prong. Then push and snap the connector block back into the prong housing, and secure with screws per *Figures 15 and 16*.

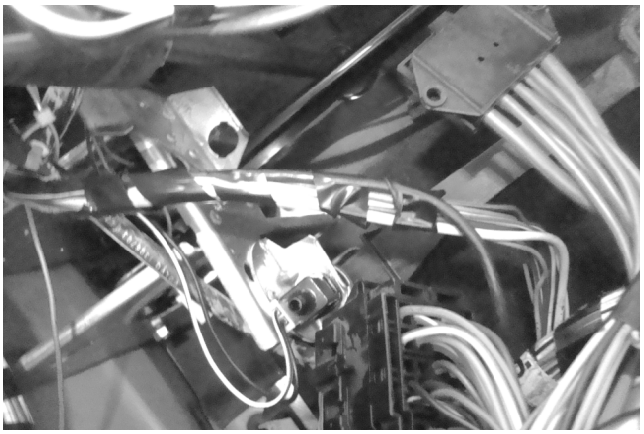


Figure 31. Under the dash, you can leave gaps when you wrap the wire bundles with electrical tape.

In the engine compartment, because of exposure to oil and heat, completely rewrap the wires going into the firewall (**Figure 32**). Back under the dash, carefully insert the front end of the prong into the ICU, making sure the appropriate pins and connectors line up. Then pivot about the front end to insert the rear of the prong into the ICU and snap in place, so the whole assembly looks like **Figure 12**. Hang the Hall cable bundle under the dash onto the black plastic hook (**Figure 13**). Zip tie, where needed, to support the wire bundle.

On the other end of the Hall cable, in the engine compartment, zip tie the Hall cable where needed. Slip the rubber boot over the back of the Hall plug. Connect the Hall plug into the distributor's Hall receptacle (**Figure 4 and 1**).

Reconnect the battery ground cable. Start engine.

Congratulations! You've completed a difficult task. The reward is a better running, more reliable engine.

Figure 32. In the engine compartment, rewrap the wire bundle going through the firewall. This is the wire bundle that previously held the old Hall cable.

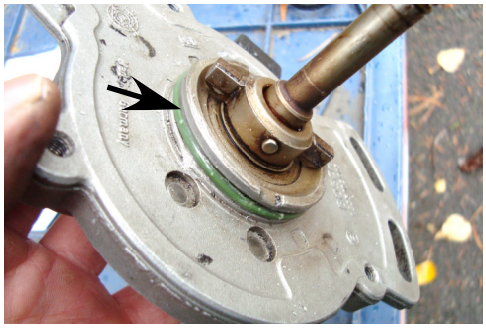


Figure 33. Photo showing distributor's green large O-ring (arrow), which should be replaced if excessive oil is found on the Hall plug. Doing so may save your Hall sensor.

Postscript. It is unusual to have two faults occur simultaneously, but my most current no-start occurred from a Hall plug short circuit *and* a faulty Hall sensor. Turns out that the short circuit in the Hall plug between the signal wire (blue, 5 VDC) and power wire (red, 12 VDC) fried the sensitive electronic circuits inside the Hall sensor. It has been 15 years and 58,400 miles on that Bosch Hall sensor, which would have lasted longer had there been no short circuit. Before this current no-start, I noticed, over a period of many months, that the Hall plug was soaked in oil. I foolishly ignored the situation. If you find gobs of oil on your Hall plug, consider pulling the distributor (see "Replacing/Repairing the In-Line Distributor") and replacing the large green O-ring on the distributor baseplate (**Figure 33**). Doing so may well save your Hall sensor and prevent you from becoming stranded on the side of the road.