



AIR INTAKE MANIFOLD REMOVAL (SECOND EDITION)

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The following is a step-by-step procedure for removing the engine intake manifold on a model year 1987 or newer Porsche 928.

When attempting the procedure please keep the following in mind:

1. This article is provided solely as friendly advice; neither the author nor the 928 Owners Club takes or accepts any responsibility for the outcome of any work done by those reading this article. No attempt is made to represent or supersede any third party, specifically Porsche Cars North America or Porsche AG.
2. This procedure is not a replacement for the Workshop Manuals. Before attempting this procedure you should become very familiar with the components and factory procedure. Study the following manual pages:
 - 24-116 through 24-118
 - 24-223 through 24-224
 - 25-01

Also, study the exploded diagrams of the various systems in your parts manual.

3. You will be dealing with the fuel delivery system of your 928. Fuel can be dangerous. Take appropriate safety precautions.
4. Assume that removal of the intake manifold will require on the order of 5 to 20 hours. Exercise patience. No part of the process requires bending of, breaking of, or hammering on any components. If you get tired or frustrated, call it a day.



5. Once you've opened up some part of the intake system, ensure that foreign objects don't find there way into the openings. Clean rags, old T-shirts, and sandwich baggies secured by rubber bands work well.

You should ensure that foreign objects do not find their way into:

- the engine cylinders
 - the fuel injector engine inlets
 - the Mass-Air Sensor housing
 - the fuel rails, dampers, and fuel lines
6. This procedure, while not overly complex, is long. You will be disconnecting a large number of components. Take notes - especially if you stray from the procedure to replace or repair other components in the vicinity of the intake. Also, while the description and pictures of the procedure may seem adequate after a first read, when you actually perform this procedure use masking tape and a marker to label the various things you disconnect.
 7. Also, carefully note the precise routing of hoses, vacuum lines, and electrical wires you disconnect; You'll want to re-connect them precisely as they were originally connected.
 8. When removing bolts and/or nuts place the nuts and bolts in a labeled bag. Sandwich baggies and masking tape for labels work well. Put the label on the inside of the bag.
 9. If you are going to perform the entirety of this procedure you will need the following parts during reassembly:
 - 2 rubber engine intake gaskets (part number 928.110.580.02)
 - 2 throttle housing / intake gaskets (part number 928.110.637.04)
 - 10 rubber pressure rings (part number 928.110.691.01)
 - a small torque wrench (3 to 30 Nm range)
 - Vaseline (or equivalent)

You may be able to do without replacing the gaskets listed above. However, as the newest 928 is now almost 10 years old, those rubber gaskets are very likely hard and in need of replacement. As these gaskets are all on the output side of the Mass-Air Sensor any air these gaskets allow through will be unmeasured air. Unmeasured air can cause erratic idle, lean combustion during acceleration, emissions-related problems, etc.

10. During disassembly, in addition to an assortment of hand tools, you may require:
 - Bosch Electrical Connector Tool (part number 000.721.926.60)
 - Magnetic retrieval tool. (See note 11 below.)
 - Sandwich bags
 - Rubber bands



11. You will be removing a large number of nuts and bolts. You will likely drop at least one into the engine compartment. If your 928 is equipped with an undertray consider removing the undertray before you begin this procedure; It's easier to retrieve a lost nut or bolt from the ground than it is from the top side of your still-attached undertray.
12. Take note that there are many minor variations from model-year to model-year. (In particular the configuration and routing of crank case breather hoses has several variations.) While this procedure may highlight some model-year variations do not assume that all variations are covered. If you run into a variation not covered herein take note during disassembly so that you can reassemble correctly.

The procedure is broken into six sub-procedures:

- I. Gaining access to the fuel delivery system
- II. Removal of fuel rails and injector
- III. Removal of other intake related components
- IV. Removal of the air intake
- V. Additional "While You're in There" Tasks
- VI. Re-installation.

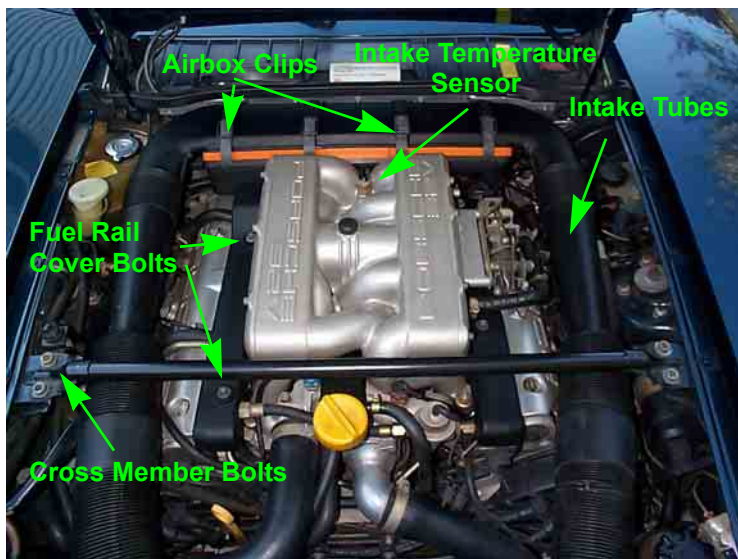


FIGURE 1

GT Engine Compartment



I Gaining access to the fuel delivery system.

- a. Disconnect the battery.
- b. Remove the engine compartment crossmember.

Make certain that the 928 is in the location and state you want it in for the rest of the procedure. The cross member helps distribute forces on the chassis. Once you remove the cross member you should not move the car. Also, once the cross member is removed raising or lowering the car with jacks may cause your windshield to crack. Thus, if you're going to remove your undertray, do so before you remove the cross member.

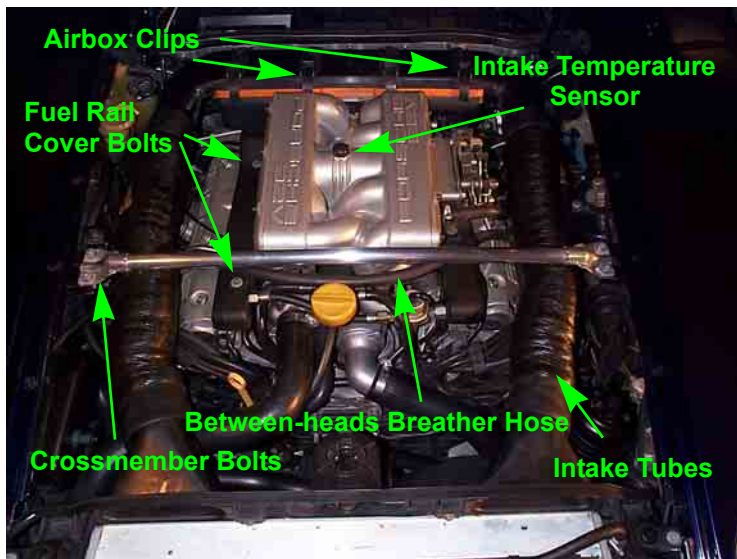
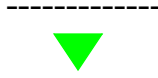


FIGURE 2

GTS Engine
Compartment

- c. On GTS models remove the breather hose that connects to the front of the left and right cam covers.
See Figure 2.



- d. Remove the fresh air induction components. *See Figure 1.*

Remove the fresh air intake tubes. They should come off easily with a tug at each end. Note that the front of each tube has a hole in the bottom which fits over an inlet to the distributor assembly.

Release the retaining clips on the top of the air box. Remove the top of the airbox and expose the air filter.

Remove the air filter. Remove any debris in the airbox.

Two nuts secure the airbox to its supports. Unscrew the nuts and remove the airbox. The airbox makes a tight fit with the Mass-Air Sensor (MAS).

Once the airbox is removed cover the MAS opening with a sandwich baggy and secure it in place with a rubber band. Be careful not to allow any foreign objects to enter the MAS. The MAS operates by sensing the resistance of several ultra-thin wires as air passes over them - and those wires are very delicate.

Also, screw the two nuts you removed back onto the airbox supports or bag and label them.

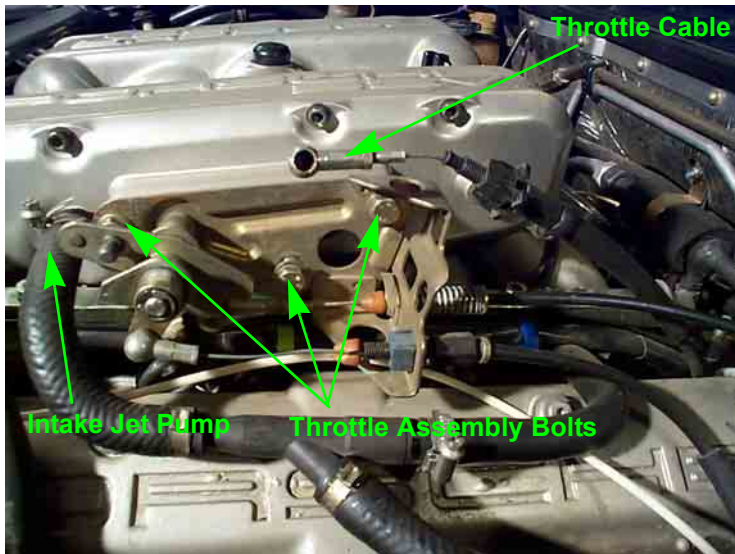
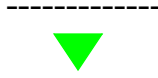


FIGURE 3

Throttle Cable Assembly

- e. Disconnect the thick vacuum line from the driver's side of the air intake. This line is called the "Intake Jet Pump." *See Figure 3.*
- f. Disconnect the throttle plate cable guide from the assembly bracket and withdraw it from the assembly. The cable guide is retained in the bracket by small plastic barbs on each side. Use a small flat screw driver or other small tool, depress each barb and wiggle to the guide out. Do not unscrew the cable



guide or you will need to readjust the cable tension later to ensure that both the idle contact and wide-open-throttle contacts are closed during idle and WOT respectively.

- g. Once the throttle plate cable is withdrawn from the cable bracket, access to the bracket's bolts is simplified. Unbolt the throttle cable assembly on the driver's side of the air intake. See *Figure 3*. Once you have the assembly disconnected from the intake replace or bag the bolts. Leave the throttle plate cable disconnected from the assembly.

Once you have the cable assembly disconnected from the intake you can tuck the assembly behind the intake to allow access to the fuel injector rails.

- h. Remove the insulated fuel rail covers. See *"Figure 1" on page 3*.

Two bolts secure each cover in place. The covers are bolted directly to the fuel rails. You may find that the covers have been 'baked' into place. Also, on older 928s the insulating material may have partially or totally disintegrated and it may be time to replace them.

Screw the cover bolts back into the fuel rails or bag and label them.

- i. Disconnect the fuel rails. See *Figure 4*.

Each fuel rail holds about 6-8 ounces of fuel. Improvise a means of catching the fuel that will escape when you disconnect the rails. A soda bottle and a small funnel work well for this task.



FIGURE 4

**Driver's Side Fuel,
Vacuum and Electrical
Connections**

To disconnect the fuel rails from their fuel lines, use a flare wrench on the coupling nut and counter-hold with another wrench. The front of the engine compartment has enough room to get your funnel



and bottle contraction under each fuel line nut, so unbolt the fuel lines at the front of the engine compartment first.

Place a shop rag under the fuel line nuts at the rear of the fuel rails to catch any remaining drops of fuel and disconnect the rear fuel connections. *See Figure 5.* (Rear driver's side coupling not shown.)

- j. Disconnect the right-side knock sensor harness connector. *See Figure 5.* On later-model 928s, in particular the GTS model, the knock sensor harness connector may be underneath the fuel rail and difficult to disconnect. If this is the case leave the sensor connected but make sure that the harness routing will not interfere with removal of the fuel rail.

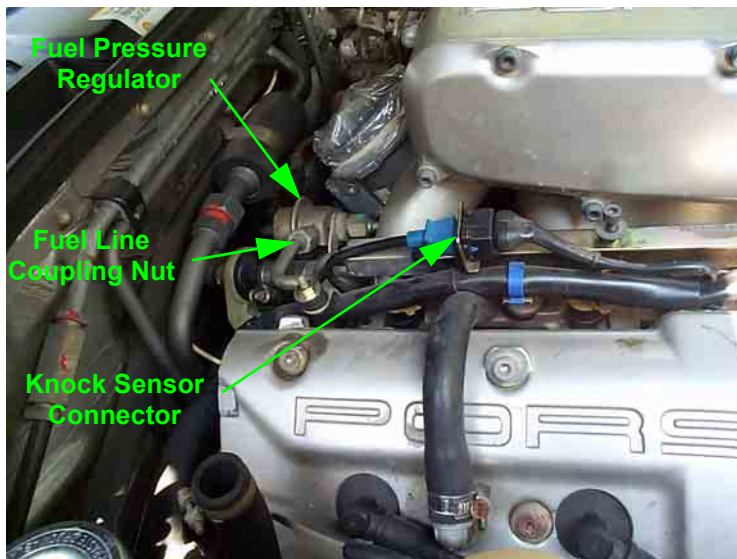


FIGURE 5

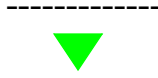
**Right-Side Fuel, and
Electrical Connections**

- k. Disconnect driver's side knock sensor harness connector. *See Figure 4.*

You may not need to make this disconnection if the injector wiring harness has enough slack to allow a inch or two of upward movement.

- l. Detach the harness connection to the vacuum valve for the dual resonance intake flap, the vacuum feed line to the actuator, and the vacuum line to the fuel pressure damper. *See Figure 4.*

Again, you may not need to disconnect these if the harness and vacuum line have slack. You may find that you want to disconnect them when you remove the fuel rails or detach the harness from the rails.



m. Unbolt the fuel rails.

Two nuts secure each fuel rail to the air intake. Be very careful when you remove the nuts or they may fall into the 'V' of the engine.

If you do lose a nut you can try to retrieve it with a magnetic extraction tool. If you cannot extract a lost nut, don't despair - you'll find it when you've removed the intake.



II Removal of fuel rails and injectors

Removal of the fuel rails and injectors may be the hardest part of this procedure. This procedure will direct you to disconnect the injector harness connections, then to disconnect the injectors from the fuel rails followed by removal of the rails and lastly, removal of the injectors from the intake.

The first step is to disconnect each injector from the wiring harness and to detach the harness from each fuel rail.

- a. Disconnect the injectors.

The injectors are connected to the harness with a standard Bosch two pole electrical connector. The special Bosch Electrical Connector tool makes disconnection of the injectors easy.



FIGURE 6

**Bosch 2-Pole Connector
Tool**

The box end of the tool fits over the female end of the connector. Page 24-224 of the 928 workshop manuals shows the proper positioning of the Bosch tool. Once fitted over the connector, a tug on the handle of the tool will complete the disconnection. Disconnect each injector. See *Figure 7*.

Inserted into the female end of each connector is a square clear rubber gasket. Examine each connector as you make the disconnection and make sure that the gasket remains where it should - as opposed to falling in to the 'V' of the engine or onto the ground.

- b. Detach the injector harness from the fuel rails by pressing the barbed ends of the harness clips together and working them out of attachment points on the fuel rail.

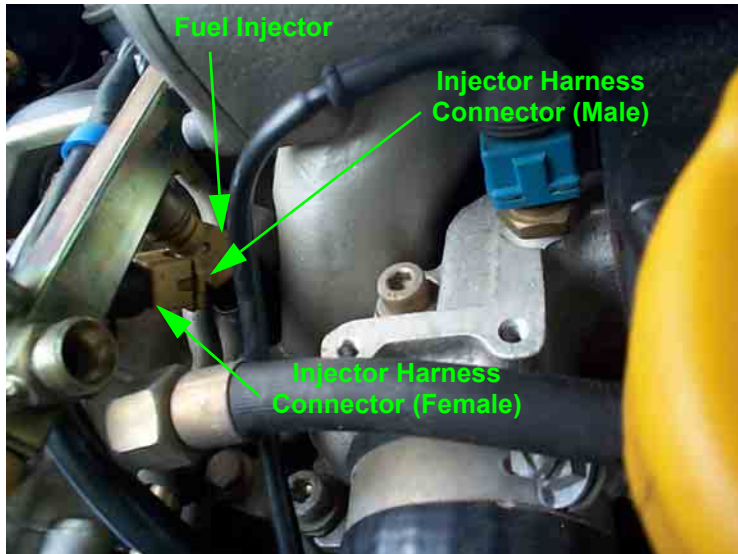
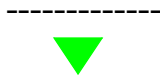


FIGURE 7

Fuel Injectors

- c. Remove the fuel rails and injectors.

Removal of the rails and injectors is greatly facilitated by lubrication. Once you are ready to remove the rails and injectors apply lubricant to both o-rings on each injector.

The amount of force necessary to pull the rails out with the injectors attached is quite high. If you attempt this method, be very careful that you do not rip part of the injector wiring harness out with the rails. Also, use even pressure on as much of the fuel rail as possible when lifting it out.

An easier method is to pull the rail out without the injectors. An o-ring seals each injector into the fuel rail. In addition, a square metal clip retains each injector in place. Pull the clip off of each injector - needle-nose pliers work well for this.

With the injector retaining clips removed, pull the fuel rail straight up. Apply even pressure as much as possible. You may find it useful to wiggle the rail around as you pull up.

If, after application of WD-40 and more upward wiggling, the fuel rails still won't budge, employ two or three small pry bars. Use a rag or towel to protect the cam covers and carefully avoid the injectors and wiring harness. Be absolutely certain of where and how you apply pressure with any prying devices you employ.

Use liberal patience along with a little force. It may take up to an hour of careful tugging and wiggling to get the rails out. When they do come out, the rails come out suddenly. Be prepared to cease the



application of force the instant the rails pop off; you really don't want anything else coming out with them.

Once the fuel rails have been removed, you'll need to remove any injectors that did not come out with the rails. When you attempt to remove them, be careful to pull them straight up. Wiggling the injectors through with a circular motion is effective and the wiggling allows the lubricant you applied to work past the o-rings. As with the rails, the injectors will pop out suddenly, so be prepared to check your upward motion.

If you have difficulty removing the injectors proceed with the removal of the intake. The injectors will come out with the intake and can be more-easily removed once the intake is on the ground.

The yellow injector end-caps can be accidentally damaged during removal. Check each end-cap, both o-rings and the rest of the injector for cracks or other damage. The caps are an essential part of the injector. So, if you damaged any end-caps or the injectors themselves during the removal process, you'll need to have them repaired.

If your 928 is more than a few years old, having your injectors refurbished is something to consider - especially since you have all eight of them in your hands at this point.

Marren Motor Sports (www.injector.com) will clean, balance, repair, and refurbish your injectors for about \$225. They'll send you a nice report detailing the 'before' and 'after' condition of your injectors. If your injectors are old, dirty, or damaged before you send them to Marren, when you get them back they'll be as good as or better than new. You may notice improved throttle response and possibly better acceleration.

If you plan to send your injectors to Marren, you should number each one with the number of the cylinder from which it was removed. This will allow you to match up any seriously negative reports from Marren with the bad cylinder.



III Removal of other intake related components

At this point you've removed a good portion of the fuel system. Now you need to disconnect and/or loosen a few other components before actually removing the intake. In particular, there are a number of vacuum lines and breather hoses that are attached to the intake and/or throttle housing. You now need to disconnect some of them from the intake and/or throttle housing or disconnect them from the other end.

Since access to the intake and throttle housing is very limited, this procedure directs you to disconnect as few of the connections as possible. You'll disconnect some of the hoses and vacuum lines from the other end and pull them out with the intake rather than disconnect them from the intake.

- a. Examine the intake bolt on the driver's side closest to the firewall. In some cases the fuel pressure damper may block access to this bolt. If access is blocked, loosen the Allen bolt that retains the damper. The "speed wrench" from the 928's tool kit is the perfect tool for this. Other more common tools may be too large. See *Figure 8*.

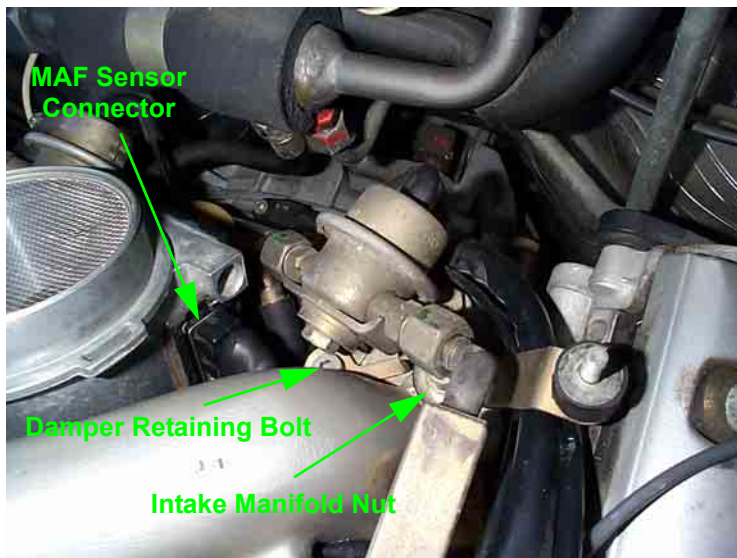


FIGURE 8

**Rear Fuel Damper and
MAF Sensor**

- b. Examine the fuel damper at the front driver's side of the engine.
Determine if it will limit access to the intake bolts. Loosen the damper if necessary.
- c. Examine the brass fuel line that runs over the front passenger side cam cover. See *Figure 9*.
Loosen the retaining bracket for the line if it limits access to the intake bolts.

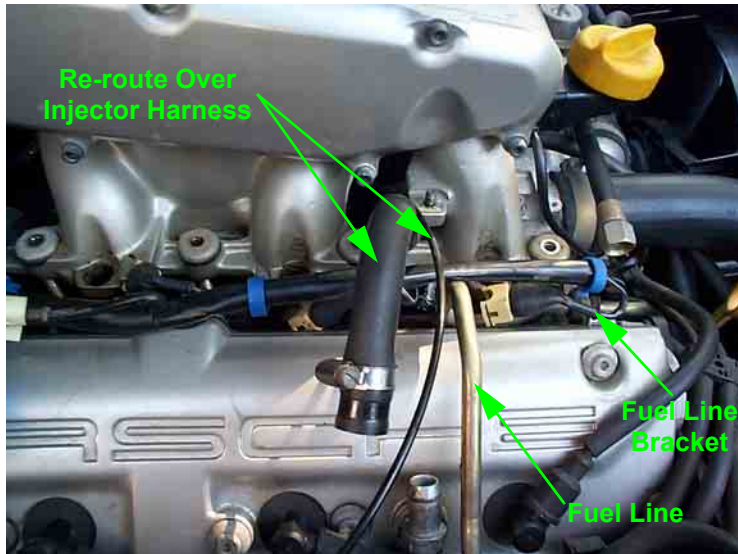
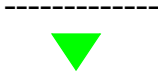


FIGURE 9

Passenger's Side Hose and Fuel Connections

- d. Remove, bag, and label all ten intake bolts. Remove and bag any compression washers, rubber gaskets, and bolt guide sleeves that are loose and might get lost when the intake is removed.

You will likely have to use a variety of tools to access all the bolts - box-end wrenches, sockets, crow-foot wrenches, etc.

- e. Disconnect the cam cover breather hoses on the passenger side from the cam covers. See *Figure 10*. On a GTS the front-most hose was removed previously.



FIGURE 10

Breather and Vacuum Hoses



- f. Disconnect the two vacuum lines on the passenger side. *See Figure 10.*

Carefully note how these lines are routed around the cam cover and intake. They are attached to the throttle housing and should remain so when you remove the intake. Thus, you'll need to know how to re-route these lines when you re-install the intake.

- g. Re-route the passenger-side breather hoses over the injector wiring harness. *See Figure 9.*
- h. Re-route over the injector harness the vacuum line that runs over the passenger-side cam cover and underneath the intake. (This is one of the lines you disconnected in step f above.) *See Figure 9.*
- i. Remove the Mass-Air Sensor. Disconnect the MAS's harness connector. *See Figure 8.* You may need to use one or two jeweler's screwdrivers to move the spring wire that retains the connector. On a GTS the connector is much-improved; the spring wire can be pressed down to disengage the connector.

Loosen the hose clamp that secures the MAS housing to the throttle housing. Remove the MAS and cover the throttle housing opening with a baggy. Secure the baggy with a rubber band. Place the MAS in a safe place so that its sensitive wires are not damaged.



FIGURE 11

Mass-Air Sensor Clamp

- j. Pop the throttle cable off of the throttle assembly. You'll have to reach under the back end of the intake and do this by feel. You may need to use a small screwdriver for leverage.



- k. Disconnect the vacuum line that runs under the intake from the resonance flap electronic actuator. Once again, note carefully how this line is routed under the intake as it too will come out with the intake. See *Figure 4*.

Disconnect the breather hose from the oil filler neck and from the secondary vacuum valve.

This disconnection is optional. You may find that you need to perform this disconnection in order to gain enough slack in the breather hose to perform the final disconnection of this hose from the throttle housing.

- l. Disconnect the electrical connection to the idle actuator using the Bosch special tool.

Make use of the inspection hole in the top of intake and a flashlight and/or inspection mirror. You will be doing this almost entirely by touch, so be careful. See *Figure 12*.



FIGURE 12

Throttle Assembly

- m. Disconnect the vacuum line from the top of the throttle housing that feeds to a 5-way splitter near the firewall. See *Figure 12*. See *Figure 13*.
- n. Disconnect the electrical connection on the top of the intake to the air intake temperature sensor. Re-route the wires so that they will not get snagged when you lift off the intake. See *Figure 1*.

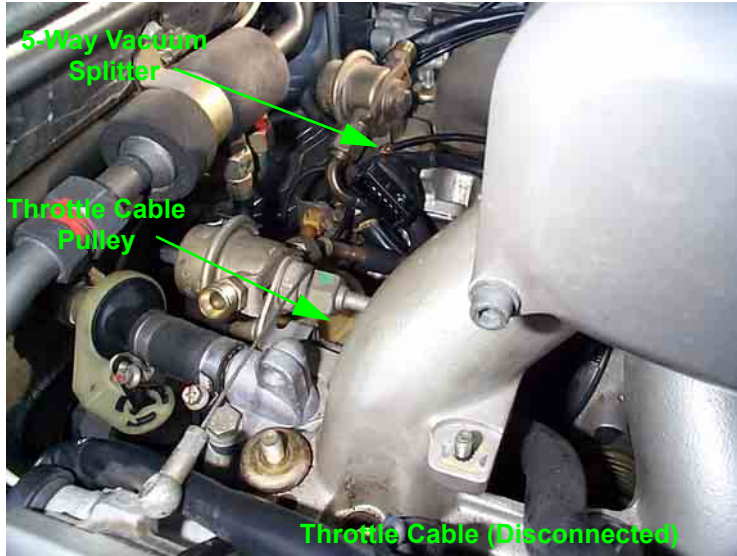


FIGURE 13

**Detail with Mass-Air
Sensor Removed**



IV Removal of the air intake

At this point you've disconnected and re-routed almost everything necessary to allow the intake to be lifted off the engine block. For the remaining disconnections, you'll be lifting up one side or the other of the intake to gain access. A junior assistant helping to keep the intake off your forearms may be helpful. Alternatively, a few pieces of hard foam rubber placed carefully under the intake will also work well.

- a. Lift the intake on the driver's side.

Disconnect the oil filler neck breather hose from the intake/throttle housing. You may find that you need to disconnect the other ends of the breather hose to allow the intake to be lifted or to allow sufficient access to the breather hose. (See step III.I above)

- b. With the intake lifted up on the driver's side, disconnect the throttle position sensor harness connector. See *Figure 14*.

Depending upon the size of your hands and arms you may be able to disconnect the sensor without lifting the intake.

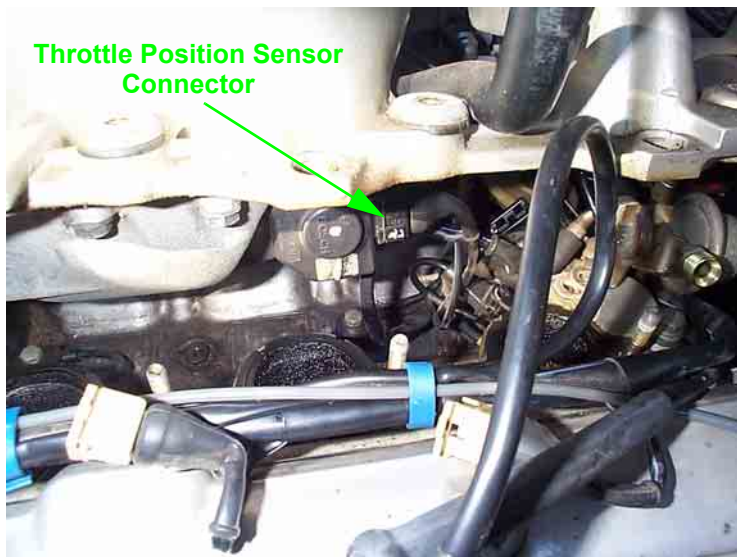


FIGURE 14

Throttle Position Sensor

- c. Lift the passenger side of the intake. Disconnect the breather hose from the rubber elbow of the throttle housing. See *Figure 15*.

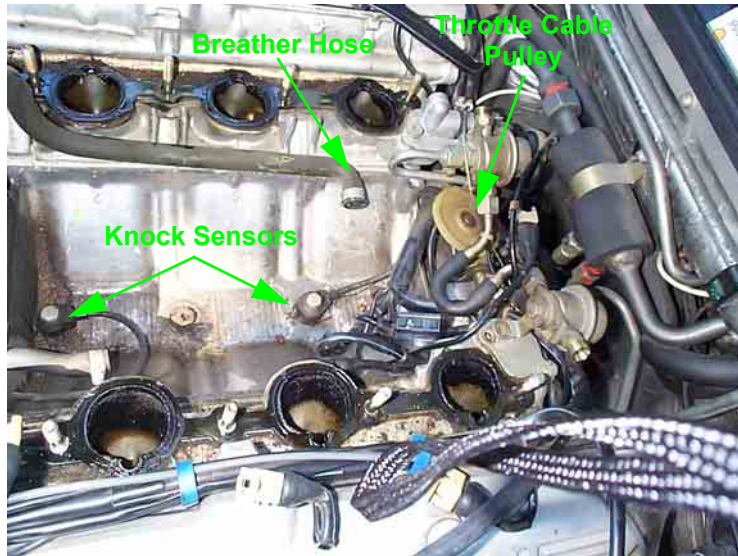


FIGURE 15

Block without Intake

- d. With the intake lifted up on the driver's and/or passenger's side, note the position and routing of the white vacuum line connected to the underside of the throttle housing. See *Figure 16*.

This is one of the vacuum lines you previously disconnected from the other end. When you re-install the intake you'll have to re-route this vacuum line.



FIGURE 16

**Throttle Assembly
Vacuum Connection**

- e. Lift the intake straight up and off the engine block. Lift slowly and ensure that all remaining hoses and vacuum lines come away safely.



V Additional “While You're in There” Tasks

With the intake manifold removed you have access to quite a few hoses, gaskets and other components that may fail over the expected lifetime of your 928. Since you have access you may wish to do some of the following “While You're In There.”

- a. Breather hoses. Hoses should be uncracked, soft, and pliable.
- b. Oil filler neck gasket. Check the gasket for leakage.
- c. Coolant bridge o-rings.
- d. Knock sensors. No matter what, you should carefully clean the 'V' of engine and ensure that the area around and under the knock sensors is free of foreign matter.
- e. Vacuum lines and vacuum elbow joints.
- f. Flexible fuel lines.
- g. Vacuum actuator for the dual resonance intake flap. See Figure 17.

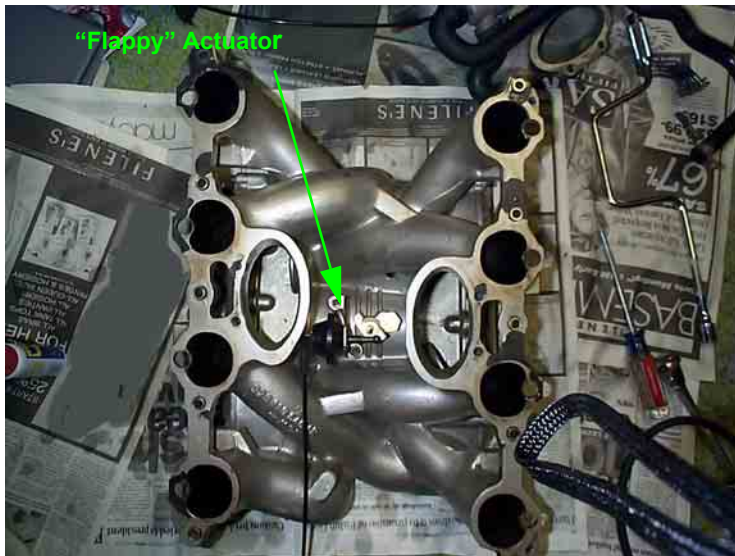


FIGURE 17

“Flappy” Actuator

- h. Rotary Idle Actuator a.k.a the idle stabilizer. There is no better time to clean your idle stabilizer and to make sure it works. A 12-volt power supply can be used to actuate the stabilizer through its full rotation.
- i. Mass-Air Sensor rubber elbow - check the elbow for cracks etc.



VI Re-installation

Re-installation of the intake and the other components you have removed is essentially the reverse of the removal process.

While reassembly is straightforward, the following is of paramount importance:

When re-installing the fuel injectors coat the outside of each o-ring with a thin layer of Vaseline or other lubricant. The Vaseline will make it easier to install the injectors in the manifold and in the fuel rails. If you don't coat the injectors, the force necessary to seat the injectors may cause one or more of the o-rings to "roll"; i.e., to fail to properly seal. The result of a poorly sealed injector will be a fuel leak followed by a fire in your engine bay followed by a very, very large bill and mostly likely the loss of the use of your 928 for some time - perhaps forever.

Also, after re-assembly, when you start your engine for the first time, have your junior assistant standing ready with a fire extinguisher. Have your assistant carefully watch the fuel rails and injectors while you crank the engine. If the slightest leak is noticed, you must immediately stop the engine and tend to the leak.

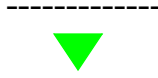
When replacing the intake manifold a few pieces of hard foam rubber (or other suitable devices) placed under the manifold will enable easy reconnection of the various hoses and vacuum lines that need to be reconnected. Once the connections are made to the intake manifold, the foam can be removed and the intake set in place.



FIGURE 18

Air Intake on Stilts

When reinstalling the manifold nuts and reconnecting the other various couplings, use a torque wrench wherever possible. The workshop manual lists specific torque values for tightening almost everything you've loosened.



There are several problems that can occur due to improper reassembly:

- a. False Air. False air is air that enters the induction system but has not been measured by the Mass-Air sensor. The result of false air will be a too fast or erratic idle. The most common causes of false air are improperly tightened intake bolts, bad manifold or throttle body gaskets, or a leak around the Mass-Air sensor.
- b. Problems with the throttle cable. The throttle cable is threaded around a pulley. *See Figure 13. See Figure 15.* Make sure that you properly thread the throttle cable around the pulley when you re-attach it to the linkage on the throttle body. Also, make sure that the cable is correctly threaded through the cable guide at the firewall.
- c. Bizarre throttle response and/or rough running. Check all the vacuum lines, especially to the fuel pressure dampers and fuel regulator. Make sure all the electrical connections you disconnected are properly reconnected (e.g. intake temperature sensor, both knock sensors, Mass-Air Sensor, throttle position sensor, idle stabilizer.).