Rover SD1 Efi System – The Plenum Chamber

Introduction

- A subtext to the above title might be "And all the nasty things it can do!"

- Why so?? Well, if the ECU is the brain of the Rover SD1 Efi System then the plenum is its heart, but whilst the ECU is hard wired, reliable, pampered and cool, the plenum is exposed to any amount of dirt, abuse and heat, both inside and out.

- Yes! It's only a lump of aluminum but it has five different services plumbed into it and each of these demand that the plenum is in good order.

    - **Water** flows through the hot spot below the air intake tunnel. No water leaks or internal corrosion needed here thank you!

    - **Air**, after being measured for volume and temperature by the air flow meter, enters the plenum through up to five locations. Via the throttle discs in the air intake tunnel, the extra air valve, the overrun valve, the air conditioning anti-stall valve (*) and the auto transmission anti-stall valve(*). (* if fitted).

    - **Petrol** is regulated by eight injectors situated below the plenum and one connected to its rear face but not before the fuel rail and its multiple collection of pipes, hose clips and the ubiquitous fuel pressure regulator play hide and seek in its shadow.

    - **Vacuum** is felt, and used, by no less than seven external functions. The overrun valve, the brake servo, the fuel pressure regulator, the automatic transmission modulator valve (*), the air conditioning control system (*), the distributor vacuum advance and the crankcase ventilation system. Each of these is dependent upon clear suction pathways with no leaking pipes and reciprocally, the plenum itself is even more dependent upon the integrity of all the connecting pipe-work. (* if fitted).

    - **Electrical** connections wander all around the plenum to six key functions fixed to its body or the adjacent inlet manifold. The throttle potentiometer, the Efi temperature sensor, the thermotime switch, the cold start injector, the main injectors below and the extra air valve.

- Clearly, the plenum is the heart, and is at the heart, of everything that happens to the Rover SD1 Efi System. Only the driver is more important so to paraphrase Trigger the road sweeper (with his ubiquitous broom) in 'Only Fools and Horses': "Look after your Plenum and your Plenum will look after you!"

- What follows are my personal observations how to care for the plenum and the standard tests required to keep it in "good heart".

Location and Operation

- The plenum, a completely passive unit with no moving parts, located at the highest part of the engine is mounted on top of the trumpet housing which in turn is mounted above the inlet manifold.

- The volume of air entering the plenum controlled by the throttle disc(s) in the input tunnel(s) swirls around awaiting the opportunity to be sucked down one of the trumpets by a descending piston on its induction stroke.

- Let's be clear about this? The engine does all the sucking and the throttle only regulates the total amount of air allowed in. So the plenum is simply storing air until demanded by the induction down-strokes.

- The ECU is of course calculating the appropriate amount of fuel to match the air flowing through the air flow meter. The wider open the throttle discs, the more air; the more fuel; the bigger the bangs; the faster the pistons move and the more rapidly air is sucked from the plenum.

- That's the process, and it's as simple as that.

- Under normal cruising conditions there is no significant amount of fuel in the plenum because the injectors squirt directly into the inlet manifold runners just prior to the intake valves where the gasping engine is waiting to breathe it in.

- Having said that, the injectors do not squirt in sequence with the induction strokes, so fuel also hangs around in the inlet manifold, mixing with the air already there until it is inducted, in turn.

- It's different at idle where the low speed of the intake air-flow will allow a certain amount of atomised fuel to migrate into the plenum area. This is aided by the fact that the plenum, as a unit, generates high depression (vacuum) at idle so there is an obvious tendency for some of the unburned mixture waiting its turn in the runners below the trumpets to migrate upwards towards the highest vacuum.

- Also, at start up, fuel may be injected into the plenum from the cold start injector directly opposing the incoming stream of air. This is a very rich mixture process and if for some reason the engine does not fire and run, then it leaves considerable evidence of unburned fuel in and around the plenum and its inlet tunnels which can be strongly smelled when investigating the non-starting engine.

- In addition to the fresh air rushing into the plenum there is a small quantity of foul air containing unburned hydrocarbons and other gasses sucked up from the crankcase via the flame trap and breather hose connecting the RH rocker cover to a pipe and gallery adjacent to the throttle pot.

- The very nature of this impurity laden air has a detrimental effect on the breather gallery eventually blocking it with crud after tens of thousands of miles.

- There is another small gallery controlled by the idle adjustment screw which can also get blocked by impurities. At first sight it would seem that it should be passing only filtered air but there are two reasons why it is vulnerable.

- First, it can get dirty is because minute amounts of unfiltered air from the engine bay leaks down the threads of the unsealed idle adjust screw and into the gallery.

- Second, mostly on the single plenum system, foul air scavenged from the crankcase by the breather system crosses over the tunnel area into the idle air gallery which can eventually become completely blocked.

- Either or both of these galleries being blocked will have a detrimental effect on the performance of the Efi system and because the plenum is removed so infrequently, the job of clearing the galleries is mostly overlooked.

- This leads to all sorts of difficulty when these actual faults are attributed to other components and the diagnostic process goes off on a wild goose chase, seeking causes that don't exist.

Testing for Air Leaks

- If during the process of fault finding its is established that all the ignition, fuel and sensor components are working correctly but engine performance is still not up to standard, then obviously there remains a fault as yet undiscovered.

- With so many pipe connections to the plenum affecting what happens at the inlet manifold there is a high probability of rogue air leaks into the system.

- The following mode of diagnosing the location of any air leaks will also prove if the extra air valve and the air-con anti-stall valve (if fitted) are working correctly

- Run the engine until it attains normal working temperature and "try" to set the idle speed to somewhere near its normal level. Now attach a suitable external tachometer, connected as per the manufacturer's instructions, to a spark plug lead, the negative side of the coil or an injector, as appropriate, and stop the engine.

- Begin by disconnecting the vacuum pipe ('A' in fig.1) to the fuel pressure regulator and suck on the open pipe to check the integrity of the regulator and the pipe. If the vacuum generated by sucking does not hold, check the pipe. If the vacuum still won't hold, the regulator is definitely faulty. This test can also be performed using a vacuum pump working at no more than 15 inches of mercury.

- Thoroughly check the inlet hose(s) between the air flow meter and the throttle butterfly housing to ensure the laminations have not separated, there are no holes in the hose(s) and the hose clips are secure.

- Restart the engine and allow it to come up to operating temperature again. Reset the idle speed with the help of the external tachometer to an easily remembered level (say 800 rpm) and make a note for future reference. Stop the engine.

- Disconnect all air/vacuum related systems joined to the plenum which can affect performance and seal off all the inlets marked **X** with patches of self-adhesive tape (badge tape is good) as follows:

1 Disconnect the brake servo, and seal the union connection at the plenum
2 Disconnect the pipe to the ventilation system reservoir and seal the port
3 Disconnect the extra air valve "U" shaped hose and seal the port
4 Disconnect the air rail hose from the pipe next to the throttle and seal the port
5 Disconnect the breather from its pipe near the throttle pot and seal the port
6 If fitted, disconnect the air-con valve hose from its stub pipe and seal the port
7 Disconnect the air supply to the overrun valve and seal the input to the valve
8 If fitted, disconnect the vacuum pipe to the automatic transmission and seal the port.

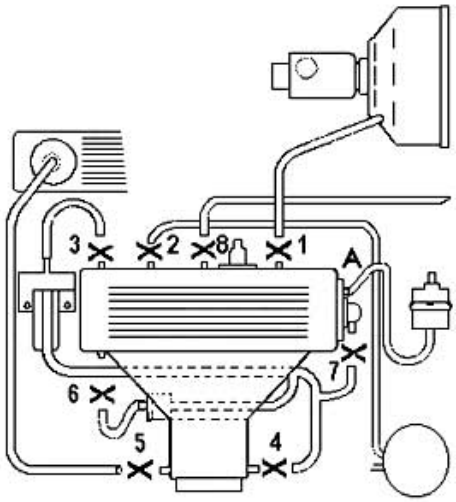

Fig.1. Plenum Air Connections

- With the exception of the pressure regulator connection, all the air/vacuum connections at the plenum have now been sealed off, as illustrated in Fig.1.

- Start the engine (if necessary depress the throttle to raise the engine rpm), run it to attain normal operating temperature then allow it to idle. Check and record the idle speed, and compare with that recorded earlier.

- If there is no change in idle speed, this proves that all the disconnected systems are sound as far as air leaks are concerned. On the other hand if the engine speed has altered significantly (say 100 rpm or more), this indicates one or more of those systems is faulty and must be found by a process of elimination.

- Air leaking into the vacuum connections or blockage of a permanent air feed into the inlet system can cause the engine speed to increase or decrease by as much as 200 rpm or as little as 10 rpm if, for example, the crankcase ventilation oil separator is blocked.

- Faults which cause small changes in idle speed are often overlooked or are erroneously rectified by readjustment of the idle screw. Over time these minor faults can build up and interact so they should not be disregarded when they can be detected and analysed by the following tests.

- So if idle speed changed, record the readings at this and each subsequent stage as they are required for ongoing comparison to pinpoint which of the disconnected pipes or components is at fault during the remainder of the tests:

    - No.1. Unseal and reconnect the brake servo pipe. Restart the engine and compare with the idle speed just recorded. If it has changed a fault lies in the brake servo hose, the non return valves (Yes, there are two on Efi cars!) or the brake servo itself which must be investigated and resolved.

    - No.2. If fitted, set air-con controls to “on” then unseal and reconnect the pipe to the ventilation system vacuum reservoir. Restart the engine and measure the idle speed. Any change from the previous figure indicates an air leak into the vacuum control system. To isolate a fault, first move the controls to “off” and recheck the idle speed. If still affected the fault is in the vacuum reservoir or connecting pipes. If the idle speed is restored the fault lays in the vacuum distribution unit, one of its associated vacuum servo units that operate the flaps or their associated pipes. Investigate and resolve.

    - No.3. Unseal and reconnect the extra air valve hose at the plenum. Restart the engine and check if there is a change in the idle speed. Assuming that the “U” shaped hose itself is sound, and remember, the inlet hose is open at the throttle end, any change indicates that air is leaking through the extra air valve mechanism into the plenum and therefore the fault lies in the extra air valve itself. If when the hose is reconnected there is no change in the engine speed then the extra air valve is proved to be sound with respect to air leaks.

    - No.7. Unseal the input pipe to the overrun valve and restart the engine. If the idle speed is unchanged the valve is not leaking. If the idle speed changes there is a fault in the valve that must be corrected. A common cause is debris between the valve head and the valve disc preventing it from closing properly.

    - Nos. 4 & 6. Unseal and reconnect both the air-con air valve connection at the plenum (if fitted) and the air hose at the throttle butterfly. Restart the engine and measure the idle speed. If no change is detected this proves that the air hoses and the air-con air valve are sound. If the idle speed has changed, air is entering the plenum either through a faulty air conditioning air valve or the associated pipes. Investigate and resolve.

- No. 5. Unseal and reconnect the crankcase breather pipe and check the idle speed. Any change in engine speed indicates a possible air leak in or around the oil separator or the pipe itself which can be easily checked by visual inspection. However, the crankcase ventilation system is complex and interactive with several seals and gaskets which should be carefully inspected if problems are indicated. It may be that there is a problem with the engine itself regarding how much gas is able to bypass badly worn pistons into the crankcase and subsequently affect the idle speed. If such a condition exists then chasing non existent air leaks will be a fruitless exercise.

- No. 8. Unseal and reconnect the vacuum control pipe to the automatic transmission modulator valve (if fitted). Restart the engine and check the idle speed. Any change will indicate a leak in the rubber connecting elbows at each end of the metal pipe or the transmission modulator valve itself. If the modulator valve is faulty then manifold vacuum is able to suck transmission fluid into the plenum where it enters the engine and burns with a dense white smoke. Such a fault would surely have been previously observed?

- Having checked all the connections and components mentioned there remain a number of other ways in which rogue air can enter the system. It can leak past the plenum/trumpet housing joint, the trumpet housing/inlet manifold joint, the cold start injector seal, any of the injector seals or even the inlet manifold gasket.

- The plenum to trumpet housing joint is particularly vulnerable to poor sealing because the metal to metal face is only 1/4” wide over an aggregate length of 30”.

- To check for leaks in any of these inaccessible areas, restart the engine and squirt very thin oil, WD40 or Plus-Gas around the mentioned joints and gasket locations in turn. Any ingress of fluid into the manifold can usually be heard or seen.

- Repeat the test around all the injectors to ensure each has an airtight seal. Fluid gaining access to the inlet manifold may also be indicated by a change in engine rpm and/or by changing colour of the exhaust gasses.

- If leaks are found they might be temporarily sealed using a brand of Damp Start Lacquer (i.e. Holts). Use it when an area to be sealed is dry and free of grease. Sprayed from an aerosol around the suspect area of leakage, it forms a plastic latex film which can seal the most inaccessible of leaks into the air inlet system.

- This type of sealant should be only used when the engine is switched off as during application, it gives off a flammable propellant. Bear in mind that such a cause temporarily cured by this method would still need to be permanently corrected.

- After fixing any air leaks idle speed and CO level must be reset as per the manual.

Inspection and Maintenance

- It's debatable whether the following recommendations should be performed before or after the air leak test program. There is no doubt that the plenum and its attachments are vulnerable to heat and dirt, but there are other factors to consider.

- First there is "Idle Speed Hang-up", a phenomenon almost always caused by unwanted friction in the throttle mechanism although a badly soiled intake area gummed with sticky goo can have a similar effect. Obviously, if idle speed is impossible to regulate then performing the specified tests is a hopeless task.

- Also, as mentioned earlier, the idle air gallery is susceptible to blockage by crud and if idle speed cannot be adjusted for that reason, the tests would be very difficult to perform.

- A different problem occurs with a blocked breather gallery. The engine cannot ventilate unwanted gas from the crankcase and pressure builds up which can have severe adverse effect on engine performance. In such circumstance finding air leaks using a process depending primarily on reliable idle speed is difficult.

- Another situation of note is that if any or all the above three conditions exist this might indicate long term neglect and the whole of the inside of the plenum, the trumpet housing and the trumpets may well be contaminated with all sorts of stuff from foul oil deposits to rock hard carbonised encrustations.

- On the other hand, if these three conditions are known to be OK, then the following plenum maintenance plan can be foregone.

- The only satisfactory way to deal with the conditions mentioned is to remove the plenum and take it to the workbench. If the trumpet housing needs attention then remove it too.

- If possible use a parts washer to clean off loose dirt and oil and blow the assembly dry. Dismantle the throttle assembly, clean all the parts, check for damage and fettle them as needed to eliminate all possibility of friction in the assembly.

- Locate the idle air and breather galleries, then use lengths of bent wire, pipe cleaners or acidic cleaning to remove all traces of crud. The idle gallery is best cleaned from within the plenum housing using a torch and mirror to locate the exit hole blinded by the rear plenum wall. Rod out any dirt using a tool fashioned from a wire coat hanger. The breather gallery has a right angle bend which can be accessed from the intake tunnel.

- Both the plenum and trumpet housing are susceptible to encrusted deposits which can be removed with suitable tools, perhaps a high speed air drill with suitable wire brushes, a miniature high speed "Dremel" or even appropriate chemicals.

- Whatever the favoured method, the aim is to return the interior of both assemblies to a good clean condition ready to receive their ancillary components such as the throttle mechanism, which can now be refitted and adjusted to ensure all unwanted friction is eliminated.

- Most owners will be familiar with their throttle assembly but eliminating "Idle Speed Hang-up" particularly on twin throttle plenums is very difficult. For further information on that specific subject, read the discussion available from here:

- http://www.vintagemodelairplane.com/pages/Downloads/Rover_Tasters/Idling01.html

- That articles' discussion and detail applies to the twin throttle plenum fitted to later Rover SD1 Vitesses but specific information related to air leakage, friction in the throttle assembly and cleanliness of the air intake system may be laterally applied to single plenum systems fitted to the earlier Vitesse and the VDP Efi.

- When everything is cleaned, inspected and reassembled as desired the two units can be refitted to the inlet manifold. As mentioned, the plenum to trumpet housing joint is particularly vulnerable to poor sealing because the metal to metal face is typically only 1/4" wide over an aggregate length of 30".

- The effective way to close it is with a light smear of silicon gasket sealant applied to one face, quickly and accurately mated. Too much sealant can be squeezed to the inside of the joint where it may eventually break off and make its way into the engine. Too little sealant, and joint integrity will be compromised.

Conclusions

- Whichever sequence of maintenance/testing is chosen, the end result of this program of tests will be to remove all possible sources of rogue air leaks into the plenum and inlet manifold system. Correctly applied, it is capable of eliminating problems often wrongly diagnosed as faulty components elsewhere in the system.

- Indeed, rogue air leaks together with wiring/connector faults are the two most common causes of problems encountered with the Rover SD1 Efi System.

- Inspecting and attending to them on a routine basis can go a very long way to keeping the system in good order and prevent unnecessary purchase of expensive components to replace items that are NOT faulty. As previously observed:-

- "Look after your Plenum and your Plenum will look after you!"

Ramon
Website: http://www.vintagemodelairplane.com.
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