Supercharge! Chapter 4

Supercharging Your Volvo
Chapter Four:
"Plumbing 101"
by Greg Sievert

Is everyone still following the saga? Well, it may take a long time on paper, but I can assure you that the results of the project have been quite rewarding, with more tweaking to come for even more extra power! But I digress. The last chapter left us with the Mother of All Brackets complete. At that point, I had a supercharger bolted to the engine block, but that was the only physical connection to the car. The two other main issues to be addressed with the supercharger are the plumbing and the belt drive. Chapter 4 will concentrate on the plumbing issues, hence the title "Plumbing 101".

When I purchased the supercharger, I made sure I grabbed the pipes and hoses that connected it to the intake manifold of the engine and to the outlet side of the air filter housing. Actually, I didn't go right back to the air filter housing because on the Toyota in-line 6 engine that the supercharger came from, there was no air filter box. (The engine was bare and ready to be sold as a complete unit, with the donor vehicle nowhere in sight.) What I was mainly concerned with was getting as much of the large-diameter rubber hoses, clamps and cast aluminium pipes as possible, knowing I'd have to be doing a lot of custom modifications to fit the system to the Volvo.

The key part of the plumbing that I knew I'd be using from the Toyota parts bin is the small cast manifolds that are bolted to the inlet and exhaust ports of the supercharger. The supercharger has large rectangular ports on the sides, and the manifolds re-direct the air from a horizontal flow direction to a more vertical flow and also present round pipe ends to connect to the rest of the plumbing. (See Figure 1 & Figure 2) If you didn't have these small manifolds, you'd be trying to figure out how to hook up a large (60-80 mm) diameter hose to the rectangular ports on the supercharger, and you'd be stuffed.

When I was setting up the position of the supercharger in the engine bay, I made sure that the inlet and exhaust manifolds on the blower could be used intact because I felt this was one thing that I couldn't safely modify and still retain an air-tight system. Luckily, the hose routing and position of the supercharger on the Toyota engine is very similar to the chosen location on the Volvo, so naturally the nice cast manifolds pointed in roughly the right direction to draw air in from the air filter and to blow air out towards the engine inlet manifold. Of course it wasn't quite as easy as just hooking everything up! Filling the gaps proved to be quite an exercise.

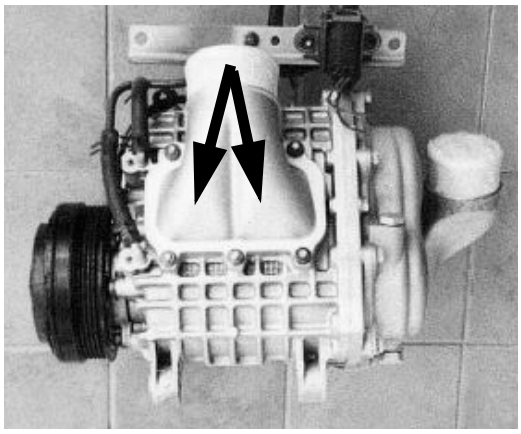

Figure 1: Supercharger with Inlet Manifold (Arrows indicate flow into Supercharger)

Figure 3: What to do with all these Hoses & Pipes?

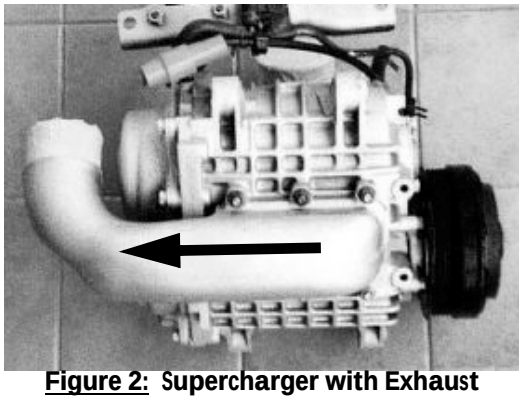

Figure 2: Supercharger with Exhaust Manifold (Arrow indicates flow out of S.C.)

Luckily, about the time I was starting the plumbing job, VolvSaab had their big garage sale. Because they break up heaps of cars, and because many of these cars are turbocharged Volvos and Saabs, there was quite a selection of various turbo hoses and pipes to choose from. I spent quite a while browsing through the bins of parts, and ended up with a wide assortment of plumbing that I thought I could use to finish up the project quite easily. I also found some power steering reservoir hoses from a 940 in new condition to tidy up the plumbing for that unit, which complemented the high-pressure side hoses that I found at Pick-a-Part. There were also several Bosch compressor bypass valves, so I grabbed one of those as well. I'll talk more about that later.

When I got home, I set out all the hoses and pipes and started trying to figure out which bend would go here, and which pipe there. (See Figure 3) It didn't take long to realize that I had a lot of pipes and hoses that simply wouldn't do the job. For the most part, the turbo Volvo and Saab aluminium intercooler pipes were much too small in diameter, so many of those were unsuitable for use in this project. One of the best parts was the 120-degree rubber elbow that fit the throttle body diameter and also had a small 25 mm

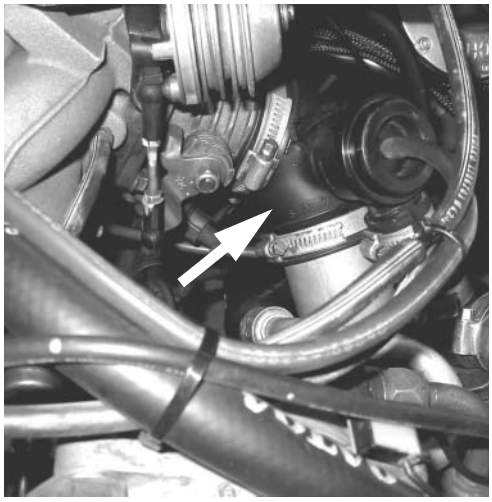

Figure 4: 120-degree Elbow Pipe

port for the bypass valve. (See Figure 4) I believe this came from a Saab 9000T. From a Saab 900T, I was able to use an aluminium pipe that had a large diameter on one end, then a 45-degree bend, then small diameter. I cut this into several pieces and used one between the 9000T rubber elbow and the existing Toyota output pipe/hose on the supercharger exhaust side. I used the other short piece between the supercharger inlet hose and a used Volvo 740 Turbo rubber inlet hose that I had from my old 740 project car. (See Figure 5) The hose had a bad end where it had melted near the turbo, but I cut that off anyway because it was too long. The final bit of my VolvSaab cache was the short rubber coupling (I think also from a Saab 900) that connected the mass airflow meter to the Bunnings-sourced PVC drain pipe piping headed towards the air filter. (See Figure 6)

I was pretty happy with the end result, especially since the Volvo turbo hose had the necessary fittings on it to connect the PCV vent hose and the compressor bypass valve hose neatly, giving an almost-stock look. For the bypass valve and idle speed control plumbing, I went to Super Cheap and picked up several 25 mm radiator hoses (must be from an old Toyota or Datsun being that small) with various bends, and I positioned and cut them as required to get the bends where I needed them. A word about hose clamps - I never use the "cheese grater" clamps, the ones with exposed slots cut completely through the clamp band. Instead, always try to find clamps that provide a smooth surface contact to the hose. This will avoid chafing the hose and causing damage.

I forgot to mention earlier that I had to make some changes regarding the air filter. Early in the project, I found that there wasn't going to be room to utilise the stock air filter box (which sits just to the left side of the radiator). The box just took up too much room and interfered with the front pulley on the supercharger. I toyed around with the idea of modifying the box and using a smaller filter, but decided instead to use a conical K&N filter on the end of the air inlet pipe. To make things easier for the purposes of getting the car going, I didn't plumb the air duct out to the front of the radiator, so the situation isn't ideal. (See Figure 7) I do plan to re-route the duct to draw in cool air, either from below the battery area or in front of the radiator. Another option would be to build a custom air box where the battery is currently positioned, and move the battery to the boot. That could be the topic of another article - maybe Ash Davies would care to contribute that one as he's done such a modification on his red-hot 240GL.

Figure 6: Short Rubber Coupling from Saab 900T

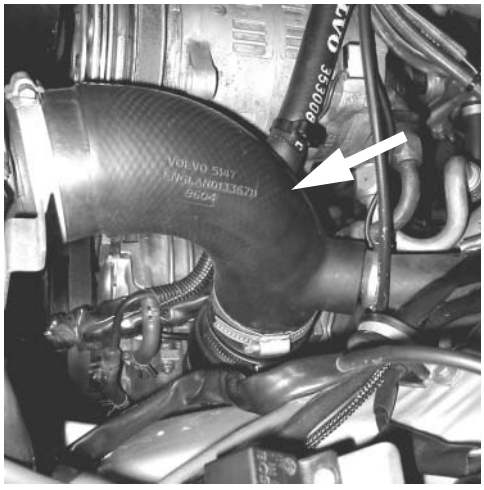

Figure 5: Modified 740 Turbo Hose

Now for a little commentary regarding bypass valves. With a positive-displacement supercharger like the Toyota SC14, and especially if the supercharger is upstream of the throttle plate, a bypass valve is absolutely

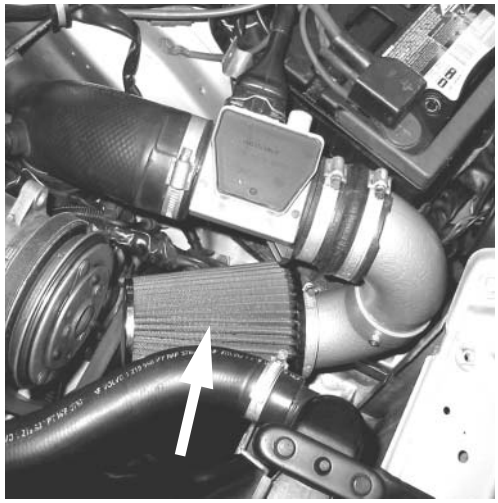

Figure 7: K&N Air Filter - Not Ideal

mandatory! If you don't have one, when the throttle is closed during shifts or deceleration, the supercharger keeps pumping against the throttle plate and you'll likely either blow all your hoses or damage the supercharger. The bypass valve I'm using is actually a "compressor bypass valve" made by Bosch. (See Figure 8) It has a sensing hose that runs from the valve to the inlet manifold, and when vacuum occurs in the inlet manifold, the valve is drawn open. It's often used on turbo cars, but for a slightly different function. On the turbo cars, the bypass valve allows some recirculation of air when the throttle is closed. With a bypass valve, during shifts the compressor wheel doesn't slow down as much, so when you get back on the throttle, the boost builds up quicker than it would have without the bypass valve. The Volvo 240 turbos (sorry, not available in OZ, except for a few "special" cars!) didn't have a bypass valve, but the 740 turbos with LH Jetronic injection did. Those are the only Volvo turbo models I've owned, so I can't speak about others. Obviously the evolution from 240 to 7-series included

Figure 8: Compressor Bypass Valve

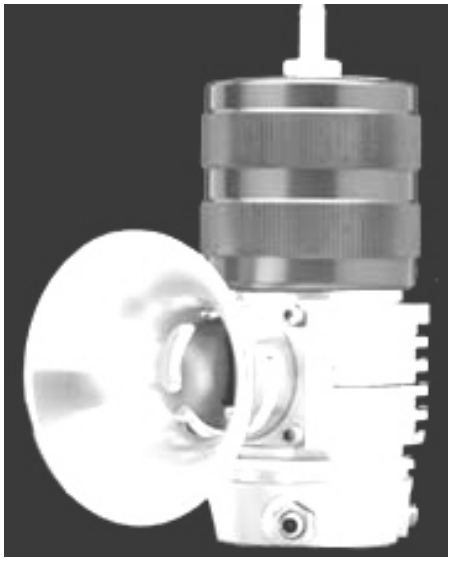

Figure 9: **Blow-off Valve**

more advanced features.

There's another commonly used name, blow-off valve. From what I can tell, these are exactly the same as a compressor bypass valve, but many are not plumbed back into the intake system. Hence, when you close the throttle between shifts, you hear a hiss or rush of air as the turbo keeps pumping and the bypass valve opens, dumping air into the atmosphere. This is OK depending on your fuel injection system (and if you like the obnoxious noise it makes! See Figure 9) It's NOT OK if the computer has already measured that air that you're dumping into the atmosphere. If this is the case, the computer will dump in the appropriate amount of fuel as well, but won't have sufficient air to mix with it, so you'll have a very rich mixture any time the blow-off valve is open to atmosphere. In the Volvo systems with K-Jetronic (the 240 Turbo) and LH Jetronic (240's from 86 on in OZ, and all 740 Turbos), the fuel injection measures the air close to the air filter, so you wouldn't want to use a blow-off valve that's not plumbed back into the intake system. The FI systems that use a manifold absolute pressure (MAP) sensor are not adversely affected by open blow-off valves because they only look at the inlet manifold conditions. They don't physically measure the air going into the engine like the Volvo FI systems. Most of the aftermarket FI systems use a MAP sensor, as do many GM cars & trucks, and probably many other manufacturers. It's a little hard to describe all that without writing a dissertation! Maybe it's a good subject for a future tech tip or article.

To finish up the plumbing job, there were a few loose ends to connect. The bypass valve had to be plumbed back into the large Volvo 740 turbo hose, downstream of the mass airflow meter. The idle air bypass system also tees into this line. Also, the crankcase ventilation system needed to be connected, again to the Volvo turbo hose. Finally, the sensing line for the compressor bypass valve was fitted to the inlet manifold. At this point, I was able to start the car and drive it, even though I didn't have the supercharger belt drive hooked up. If you were at the Dandenong display day in 2003, you would have seen the car in this state. So, the next step, and the topic of Chapter 5: "Holy Pulleys, Batman!" is the belt drive and pulley set-up. I hope you enjoyed this installment. Any questions or comments, feel free to Email me at gsievert@tpg.com.au.

Regards,
Greg