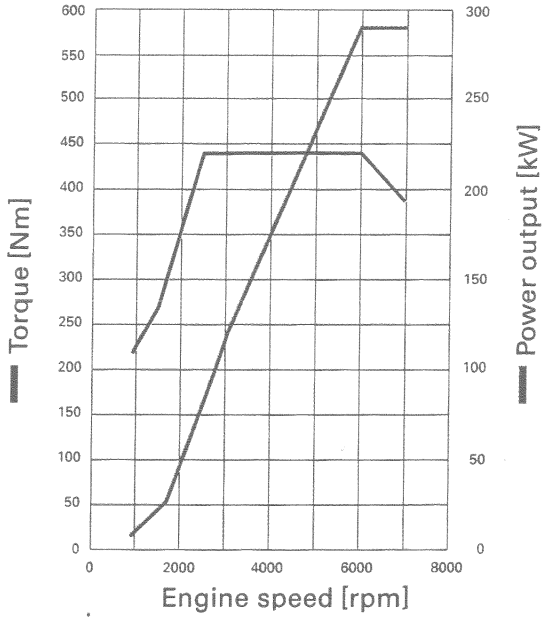
The power of the RS4

PAUL HARRIS looks at some of the technical features which set the RS4 apart from its less-powerful sisters . . .



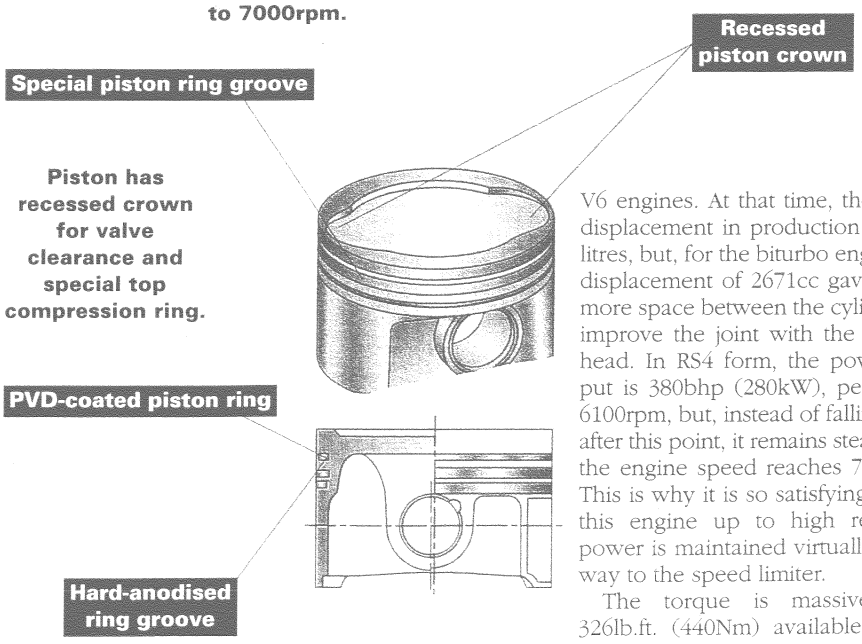
The graph shows that the power output of the RS4 engine remains steady from 6000 to 7000rpm.

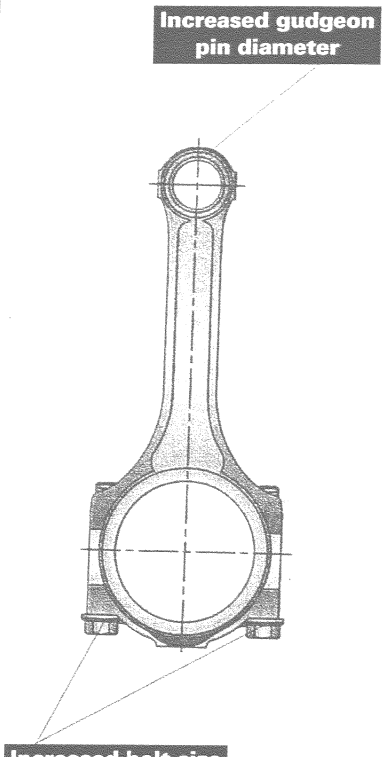
THE biturbo engine of the RS4 develops tremendous power and torque, setting this Avant apart from any other Audis with the biturbo engine. The basic biturbo unit was first introduced for the S4, but the gestation period took longer than anyone had expected, largely because of overheating problems in the engine compartment. The S4 version, which developed 265bhp (195kW) and offered maximum torque of 296lb.ft. (400Nm), was soon followed by a detuned version for the A6 2.7T and a third variant for the allroad quattro.

Audi knew that special measures were needed to push the output up to the levels demanded for the RS4 and much of the development work was carried out by Cosworth Technology, in Northampton, a division of the Audi empire since the late Nineties. Not only did Cosworth develop new cylinder heads and carry out development work on the rest of the engine, but the RS4 engines were manufactured at the nearby Cosworth engine assembly plant in Wellingborough. It was quite a circuitous chain, with the crankcase and associated parts arriving at Wellingborough from Germany, the cylinder heads coming from the Cosworth casting plant in Worcester and the completed engines going back to the quattro GmbH assembly line at Neckarsulm.

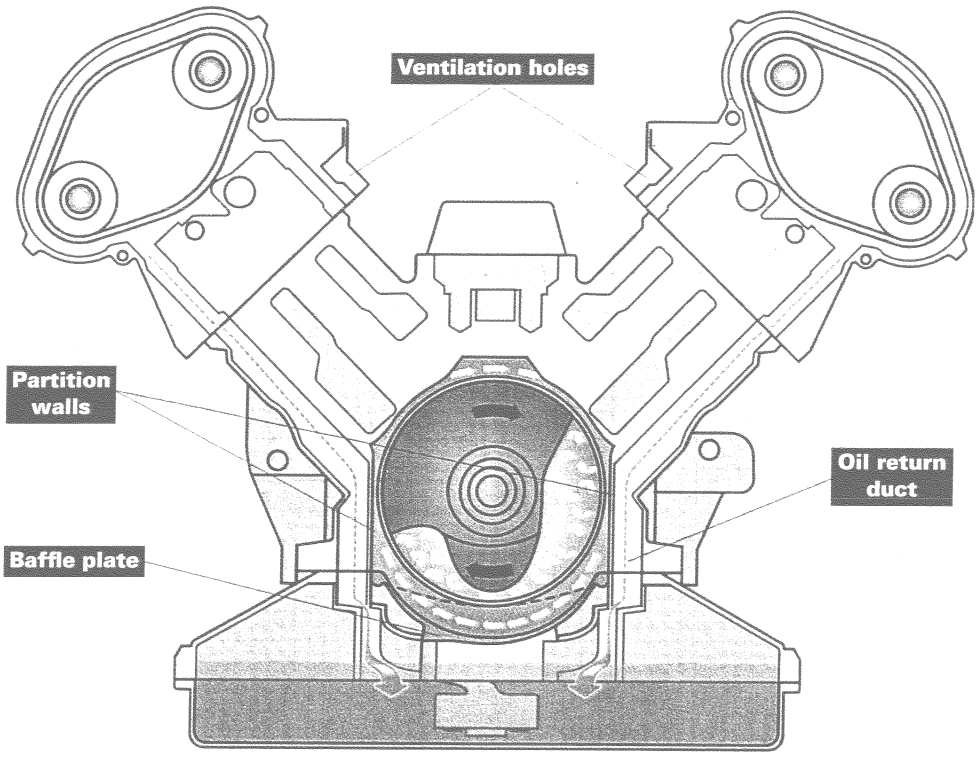
The biturbo engine has much in common with the whole range of 90° V6 engines. At that time, the largest displacement in production was 2.8 litres, but, for the biturbo engine, the displacement of 2671cc gave a little more space between the cylinders to improve the joint with the cylinder head. In RS4 form, the power output is 380bhp (280kW), peaking at 6100rpm, but, instead of falling away after this point, it remains steady until the engine speed reaches 7000rpm. This is why it is so satisfying to take this engine up to high revs: the power is maintained virtually all the way to the speed limiter.

The torque is massive, with 326lb.ft. (440Nm) available all the





Con-rods have bigger small end and thicker bolts.



Oil draining from the cylinder heads is guided to the sump by partition walls and a baffle plate which prevents oil churning.

way from 2500 to 6000rpm. This explains why the RS4 is so tractable, pulling smoothly from moderately low engine speeds.

To cope with the extra output of this engine, the cast-iron crankcase was strengthened, the ventilation apertures in the bearing seats reduced in size and the bearing caps made of cast steel. The depth of the threads which take the cylinder head mounting bolts were increased so that tension was transmitted over a wider area. The steel used for the crankshaft had a 10 per cent higher load capacity, the connecting rod bolts were reinforced (M9 instead of M8.5) and the piston pins were both longer and had a larger diameter. The pistons had a stronger crown and the bushes for the piston pins were reinforced. The inner surface of the first piston ring groove was hard-anodised and the high-strength piston ring had a wear-resistant material applied to it by vapour deposition.

The cylinder heads, made by Cosworth's unique sand-casting process, had better coolant flow around the exhaust valves and a new material for the exhaust valve seats allowed heat to be conducted away more rapidly.

With high-output engines like this, cooling is of paramount importance and it is not just the cooling system itself which plays a part. Much of the heat is removed by the flow of oil round the engine, so effective oil cooling is essential. Audi engineers designed the engine so that the maximum oil temperature would be 135°C.

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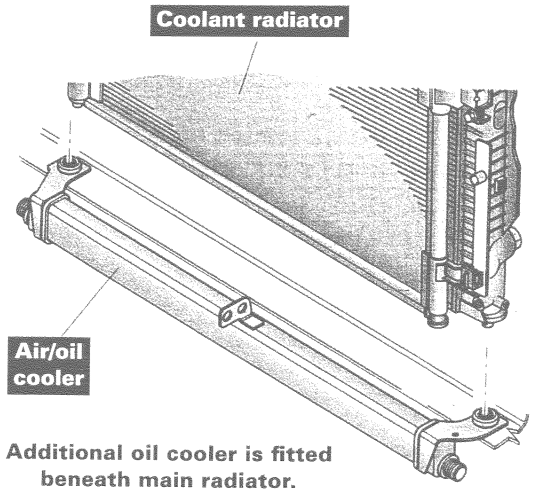
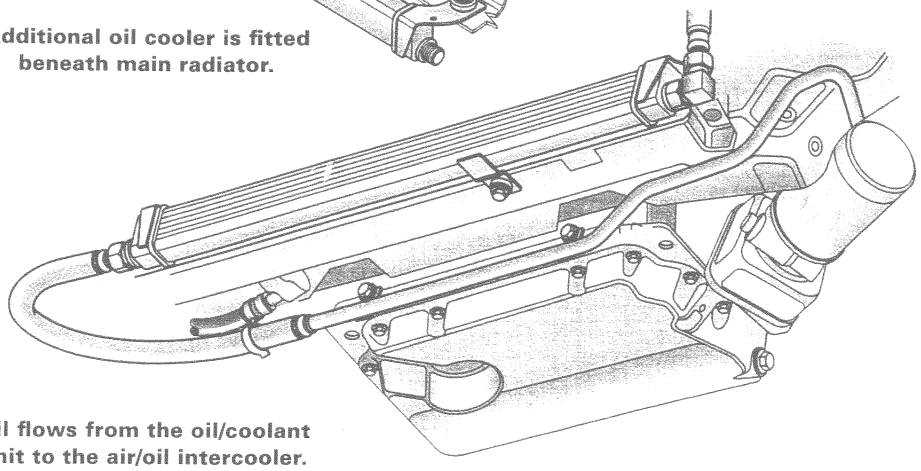
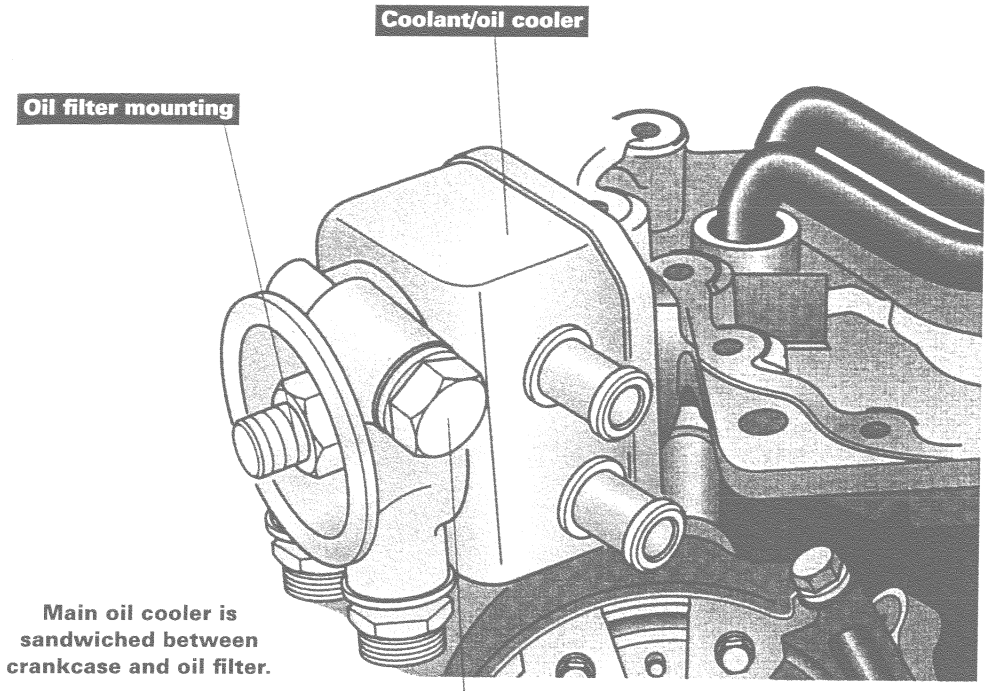


Additional oil cooler is fitted beneath main radiator.

As the oil drains away from the cylinder heads, it is guided down to the sump by partition walls inside the crankcase and by a baffle plate which prevents the crankshaft webs from churning the oil. The gears in the oil pump have wider teeth than those in the S4 so that the oil flow is always adequate, even at idling.



Oil flows from the oil/coolant unit to the air/oil intercooler.



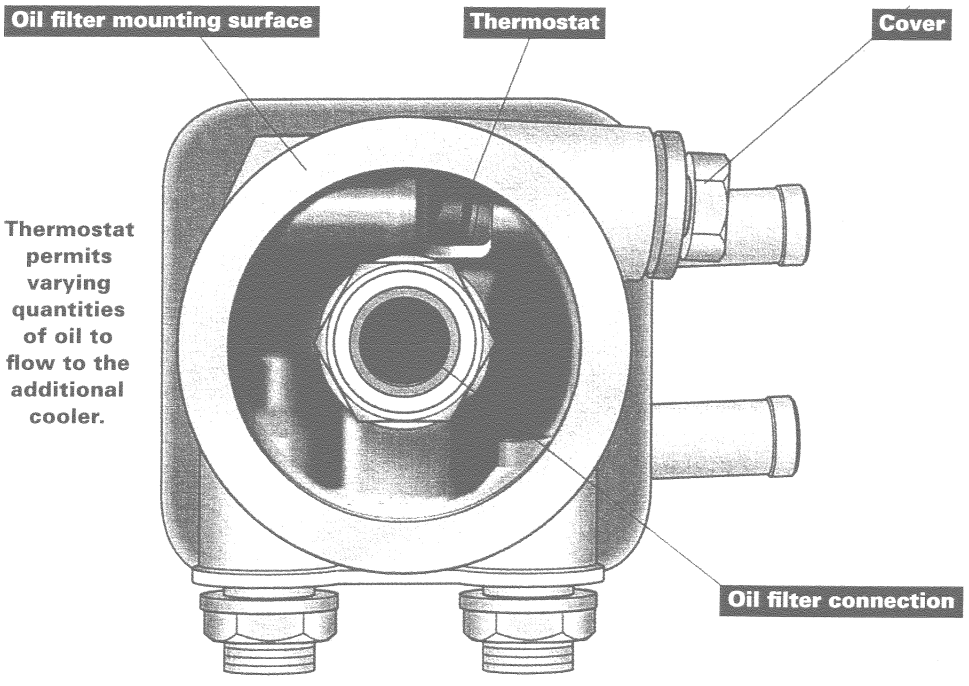
Main oil cooler is sandwiched between crankcase and oil filter.

'Another cooler is mounted beneath the main coolant radiator'

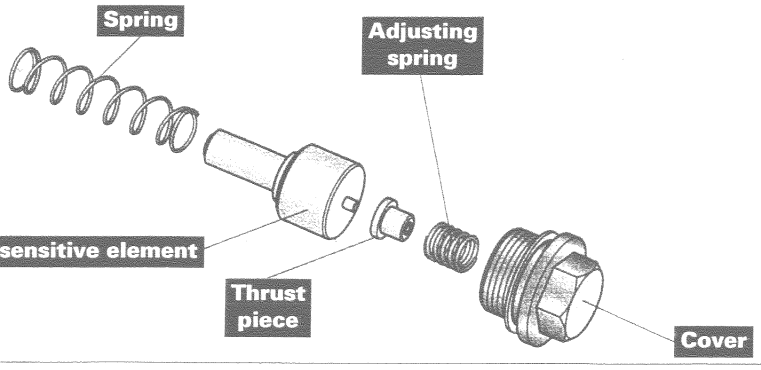
Two oil coolers are used. One is of the type used almost universally by Audi, a unit sandwiched between the block and the oil filter, with both oil and coolant flowing through it in separate tubes. It is very effective at keeping the oil temperature down, but cannot achieve all the necessary cooling, so another cooler, this time an oil/air intercooler, is mounted beneath the main coolant radiator. A thermostat, built into the coolant/oil cooler, ensures that there is a small flow of oil through the air/oil intercooler even when the vehicle is stationary with the engine idling, but as soon as the oil temperature exceeds 120°C the thermostat opens to allow full flow.

Because of the 40 per cent increase in power output, the intake air requirement of the RS4 engine is much greater than that of the S4, so the air cleaner box was provided with an additional intake tube. When the engine control unit detects that the road speed is in excess of 50kph and the load on the engine is increasing, it operates a solenoid which, in turn, opens the flap valve in the additional air intake tube, allowing more air to be sucked in.

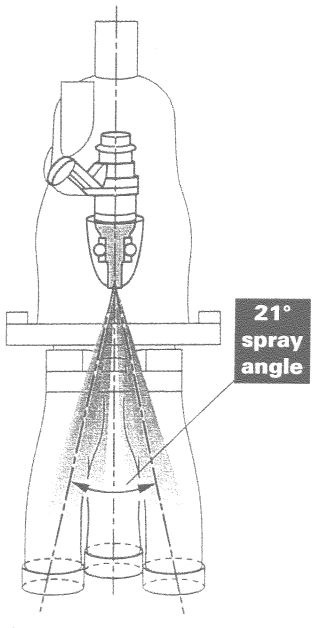
When the engine is starting up from cold, the mixture is excessively rich and this creates an excess of



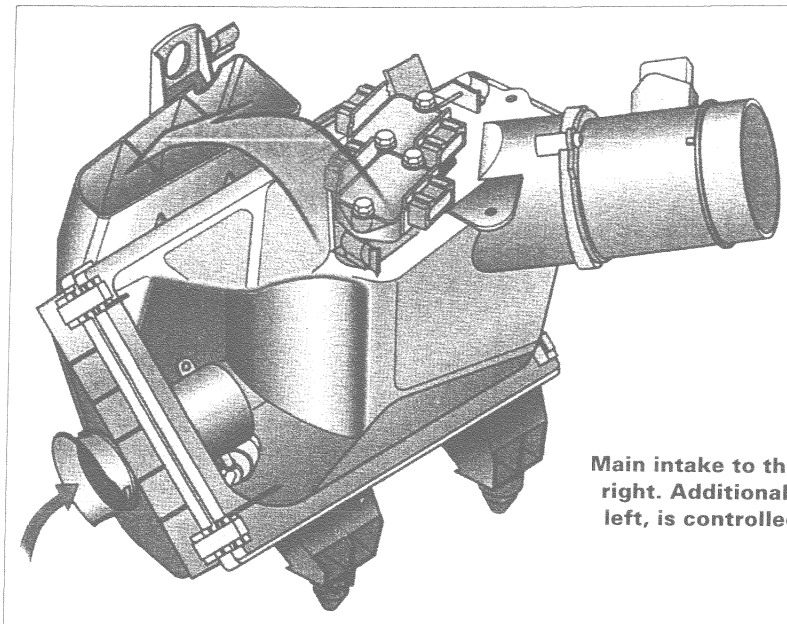
Thermostat permits varying quantities of oil to flow to the additional cooler.



Thermostat assembly.



Injector spray pattern is designed to cover the width of the triple valve port.



Main intake to the air box is top right. Additional inlet, bottom left, is controlled by the ECU.

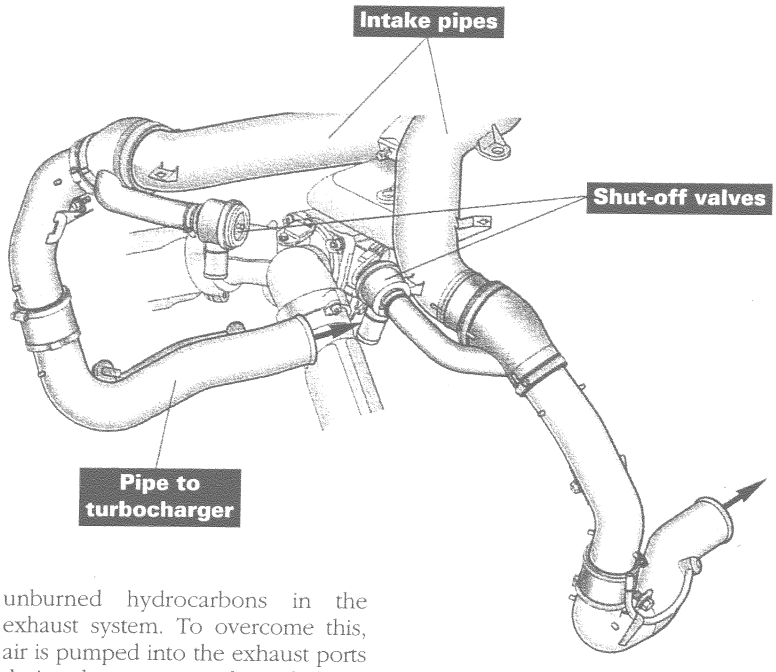
'The intercoolers were enlarged by 37 per cent compared to those of the S2'

so that, as far as possible, fuel droplets do not adhere to the walls.

Just as the intake system had to be modified to get more air in, the pipes leading to and from the intercoolers, and the intercoolers themselves, had to provide greater air flow. The intercoolers were enlarged by 37 per cent compared to those of the S2 and the surfaces cooled by the flow of air were increased by 16 per cent. The upper and lower sections of the intercoolers, where the pipes are attached, were made of aluminium, and this material was also used, instead of plastic, for the main air ducts because of the increased pressure.

It was necessary for the turbocharger to be able to push more charge through the intake system, so the compressor wheel was increased from the 46mm employed for the S2 to 51mm. The turbine wheel, which is driven by the exhaust gases, was increased from 45 to 50mm and the material used for the turbine housing was changed to cope with higher temperatures.

It will be interesting to see if this is the ultimate derivative of the biturbo V6. Audi now has a 3.0-litre V6 in production and perhaps there is room for even greater power output, but the indications are that a V8 engine will be used for any future high-performance versions of the A4, just as with the A6.

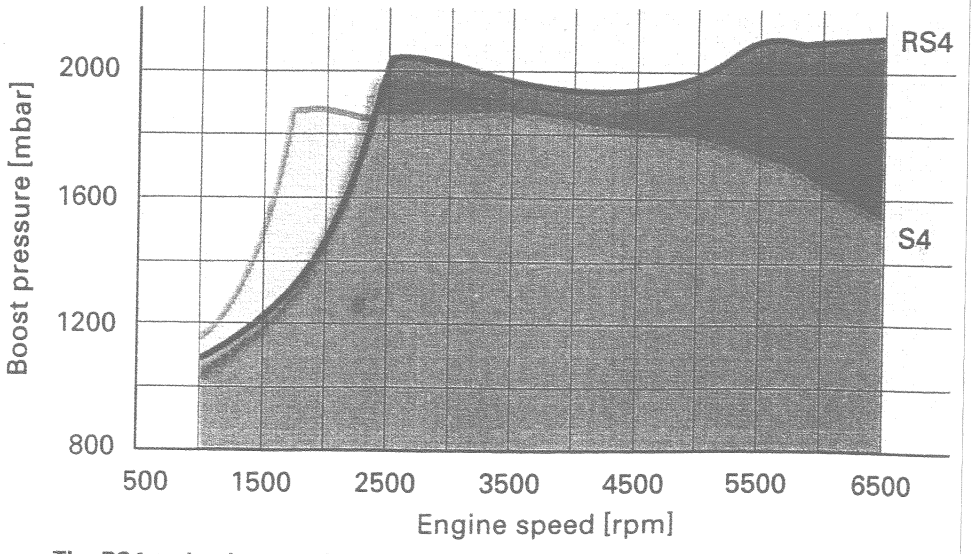


Intake pipes are of aluminium rather than plastic.

unburned hydrocarbons in the exhaust system. To overcome this, air is pumped into the exhaust ports during the warm-up phase, helping to burn the unwanted gases in the manifold.

As with conventional engines, the content of the exhaust gases is monitored by lambda probes. For the RS4 engine, four probes were employed, one upstream and one downstream of each of the two catalytic converters. These probes can be replaced only if the gearbox is lowered.

The fuel is injected into the exhaust ports by dual-jet injectors, set at 13° to the axis of the inlet valves. Because each section of the inlet manifold feeds a triple inlet port, the spray pattern from the injectors is arranged so that it covers an angle of 21° across the width of the port and 15° in the other direction. The shape of the inlet ports creates the same tumble effect as with the S4 engine, but the dimensions allow for greater air flow and the injectors are placed



The RS4 turbocharger gives higher boost pressure at engine speeds above about 2300rpm.