



SWANSEA METROPOLITAN UNIVERSITY

PRIFYSGOL FETROPOLITAN ABERTAWE

Emissions Control and Diagnostics

Positive Crank Case Ventilation (PCV)
Secondary Air Injection (SAI)

Purpose

- PCV and SAI are designed to reduce both CO and HC emissions
- Due to the non full proof sealing capabilities of piston rings, some *blow by* of unburned fuel past the rings and onto the crankcase will occur
- This vapours need to be vented but not directly to the atmosphere
- Similarly to EGR, PCV has been developed to recirculate this gases into the engines induction system
- Unlike EGR, PCV vapours will be burned in the cylinders

- All use a valve, a calibrated orifice or separator, a air filter and connecting hoses
- An oil/vapour or oil/water separator is used in some systems instead of valve
 - Particularly in turbocharged systems
 - The oil/vapour separator allows the oil to condense and drip back into the crankcase
 - The oil/water separator accumulates moisture and stops it freezing in cold weather engine starts
- The air for the PCV system is drawn after the air cleaner filter, that acts as PCV filter too

PCV System



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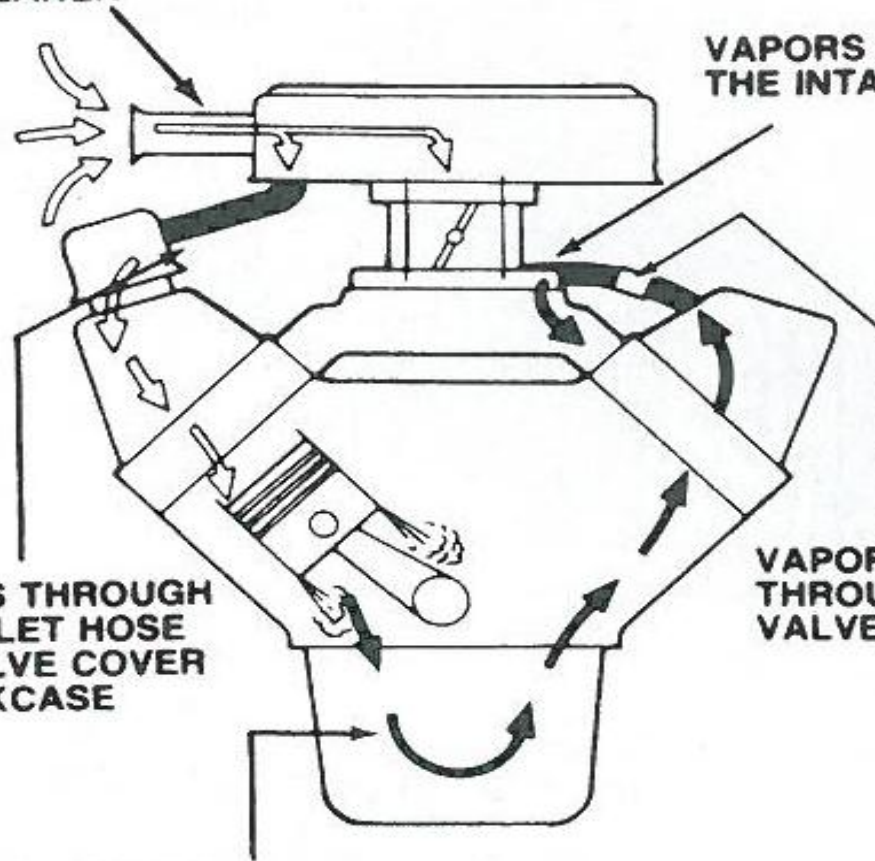
**FRESH AIR ENTERS
THE AIR CLEANER**

**VAPORS PASS INTO
THE INTAKE MANIFOLD**

**AIR PASSES THROUGH
THE PCV INLET HOSE
TO THE VALVE COVER
AND CRANKCASE**

**VAPORS THEN PASS
THROUGH THE PCV
VALVE AND HOSE**

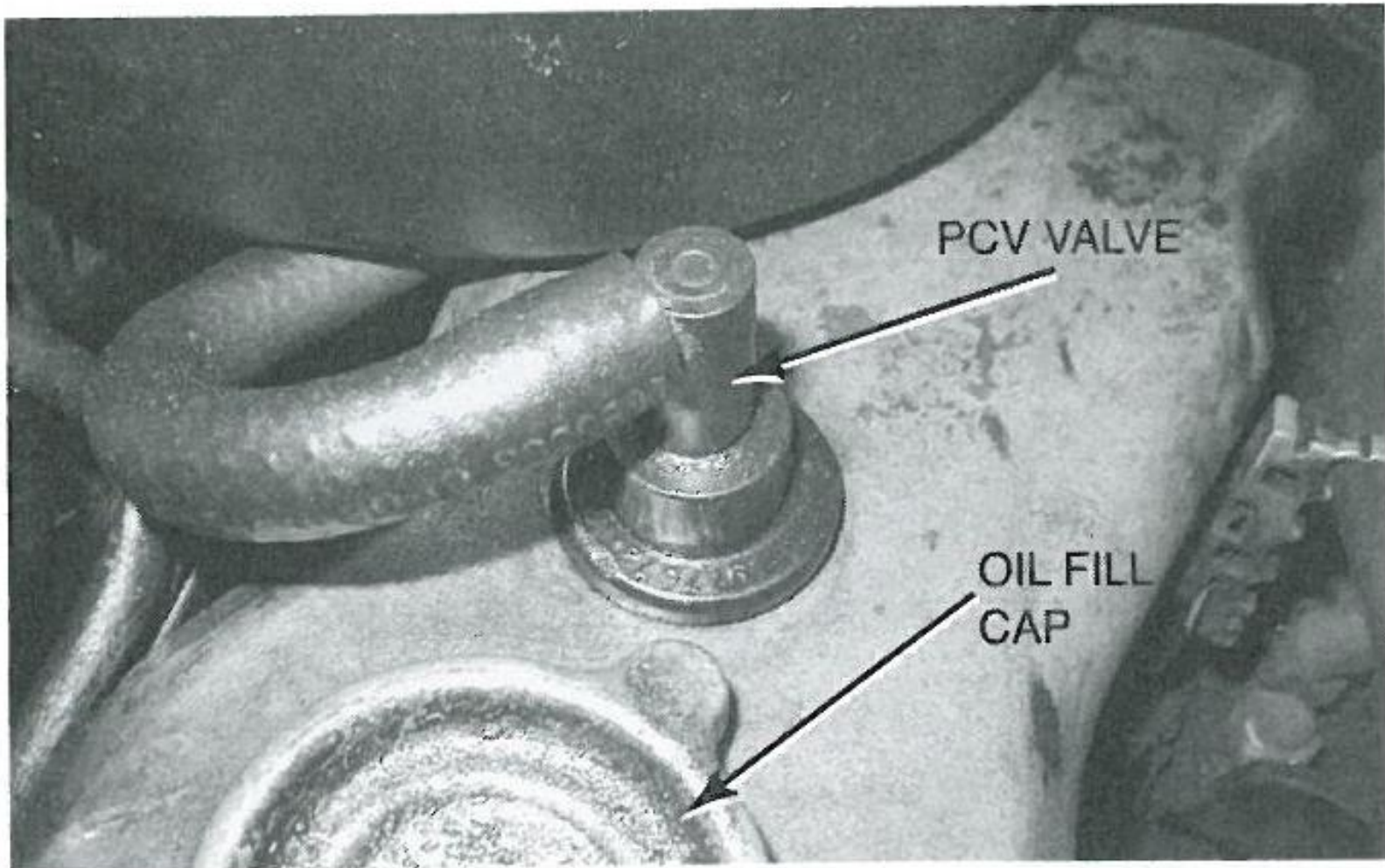
**FRESH AIR MIXES
WITH BLOWBY GASES
IN THE CRANKCASE**



PCV Valve



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- PCV valve is of the one way type with a spring operated plunger that controls flow rate
- Engines are calibrated for individual engines
 - Therefore only like for like should be replaced
- Usually located in the valve cover or intake manifold
- It regulates air flow through the crankcase in all driving conditions
 - When manifold vacuum is high (idle, cruising) it restricts air flow
 - Also stops inlet vacuum sucking oil into the fuel mixture
 - Under high speed and heavy load the valve opens to allow maximum air flow
 - If engine backfires valve closes to prevent crankcase explosion!

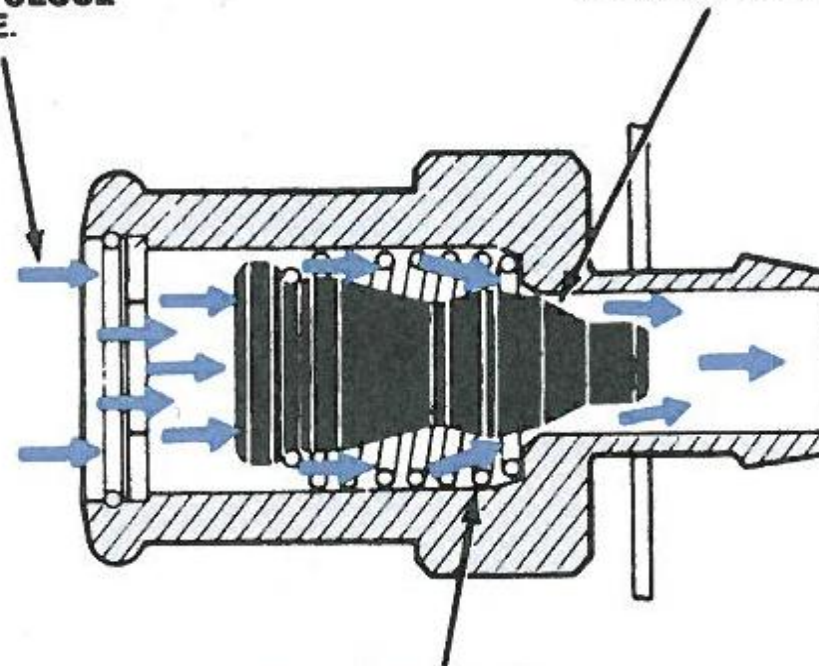
PCV Valves



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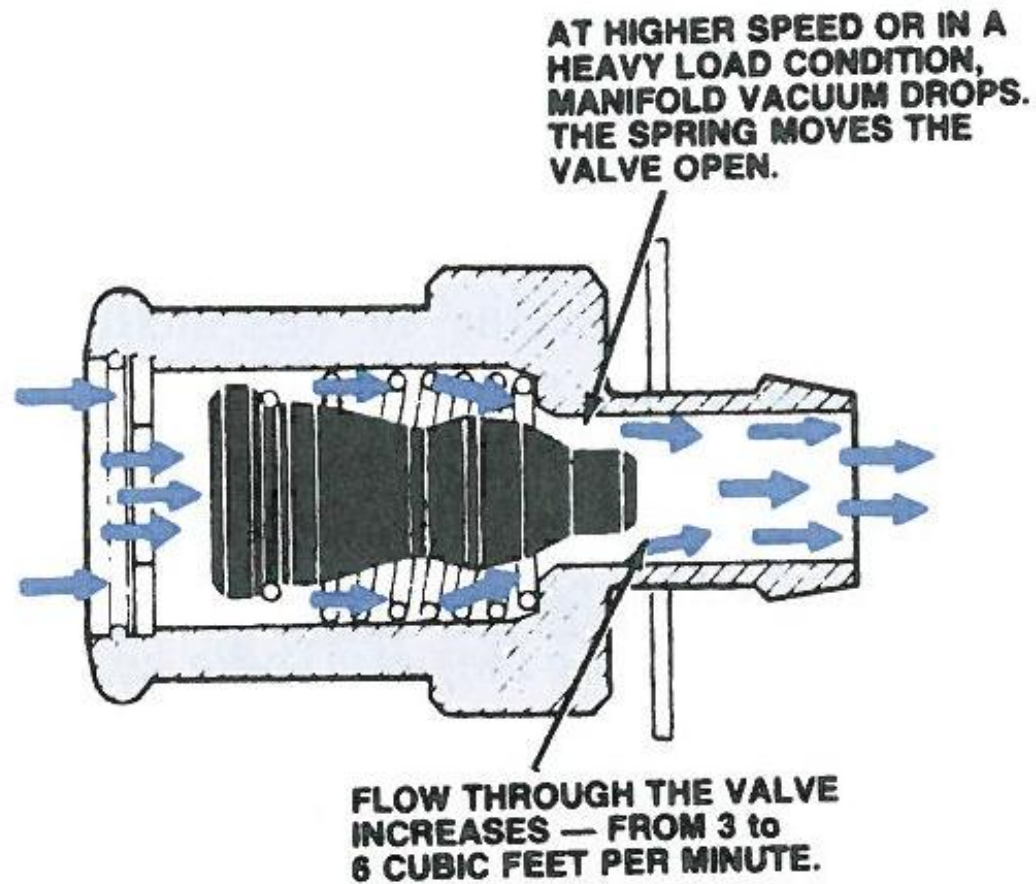
THIS END OF THE PCV VALVE IS SUBJECT TO CRANKCASE PRESSURE THAT TENDS TO CLOSE THE VALVE.

THIS END IS SUBJECT TO INTAKE MANIFOLD VACUUM THAT TENDS TO CLOSE THE VALVE.



THE SPRING FORCE OPERATES TO OPEN THE VALVE TO MANIFOLD VACUUM AND CRANKCASE PRESSURE.

PCV Valves

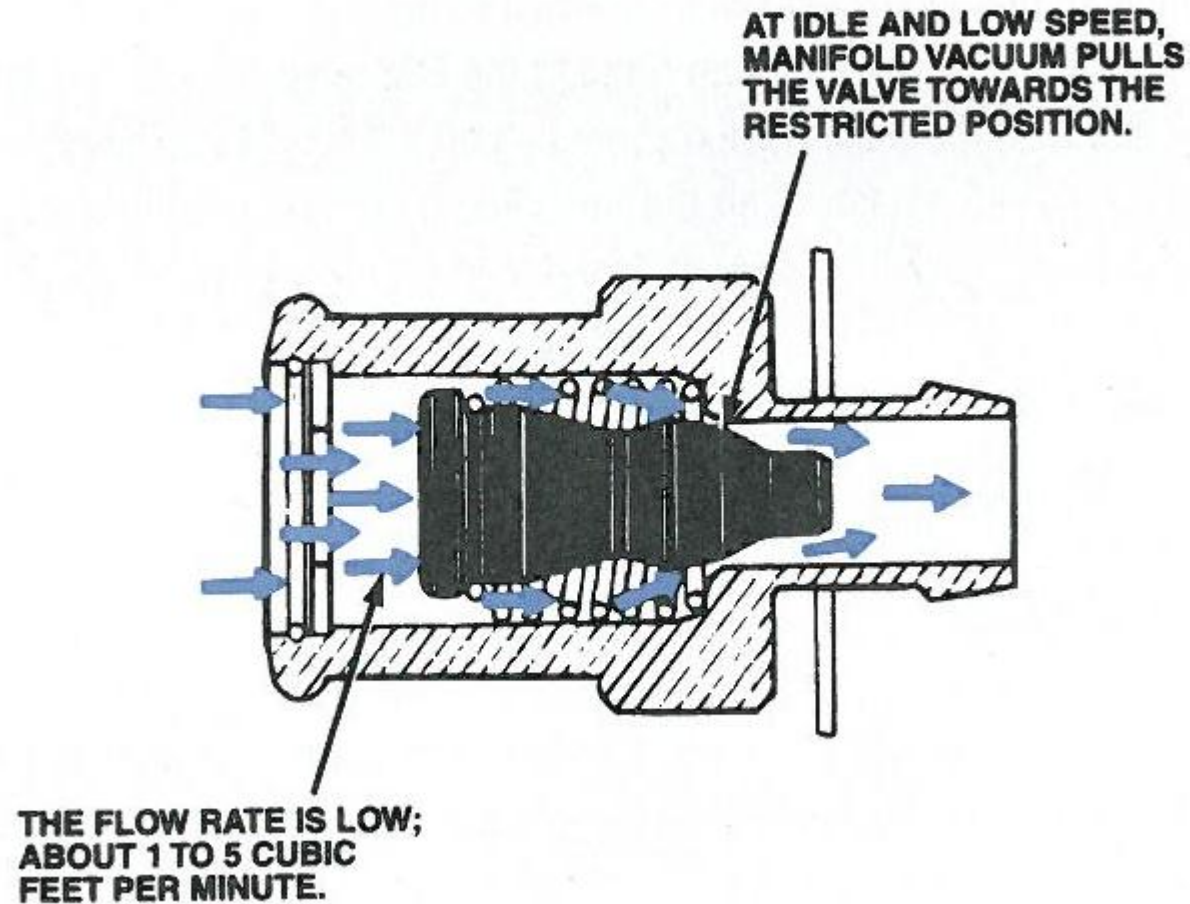


PCV Valves



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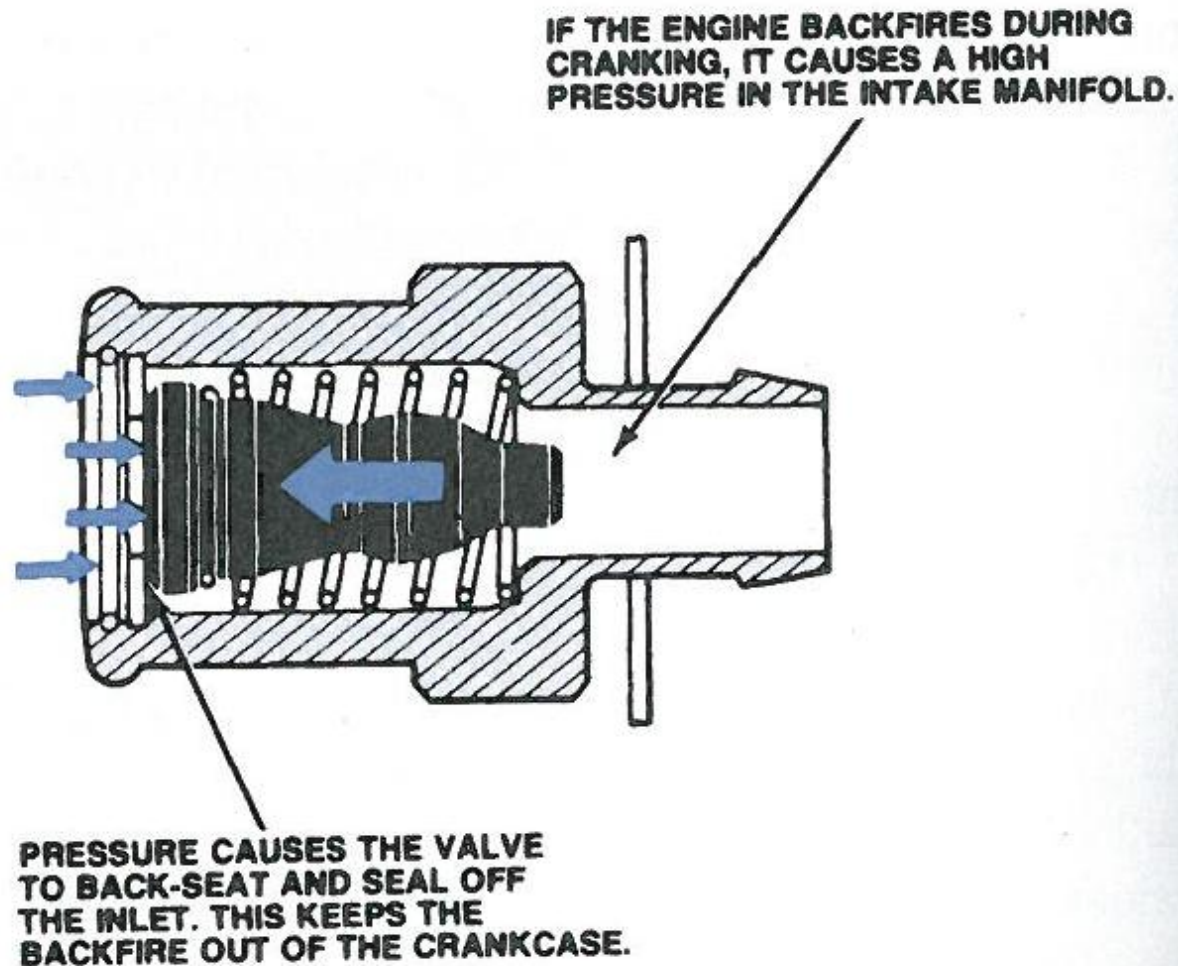


PCV Valves



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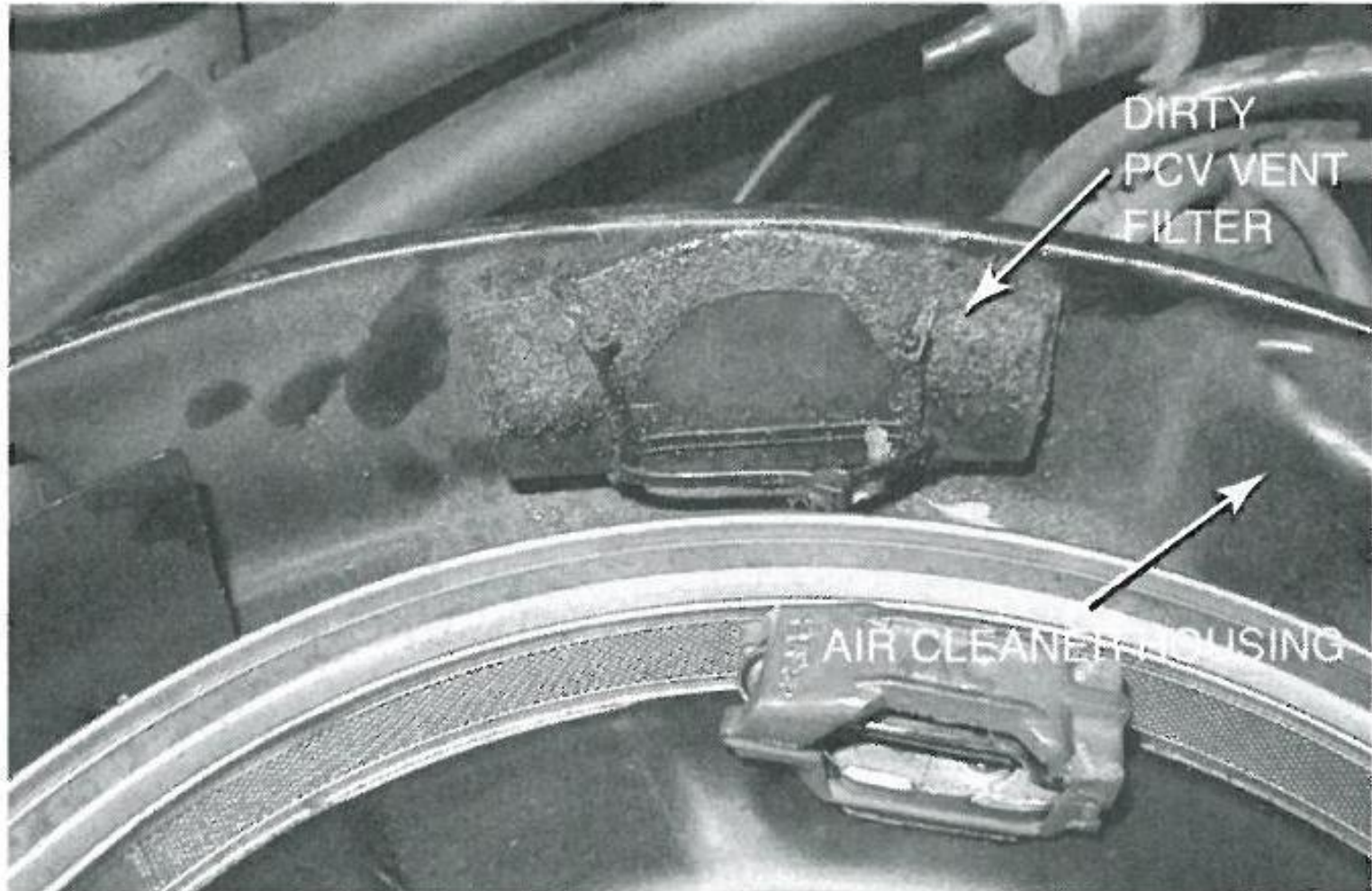
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PCV and air filter



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- Common in four cylinder engines
- Systems contains an orifice instead of a valve
- Located in the valve cover, intake manifold or in a hose connecting those two with the air filter
- Vapours are drawn into the intake in a calibrated manner based on orifice size and inlet pressure.
 - If vapours are small (idle) air is drawn into the vapour
 - Small orifice
 - During non idle operation vapours are sent to the air filter as crankcase pressure raises
 - This is achieved by a vacuum controlled spring loaded valve allowing flow to pass through larger size orifices

- PCC in good working order is essential mainly for good idling since in some cases 30% of idle air comes from PCV
- To check the system works correctly a test of the vacuum the engine is generating at the valve cover can be conducted
 - Place a small card of bank note over the oil cap and it should be held in place by the small vacuum
 - Use a vacuum tube to measure vacuum at the dipstick
- From 2004 all vehicle have to monitor the PCV
 - Pressure sensor in the PCV system
 - Fuel trim characteristics

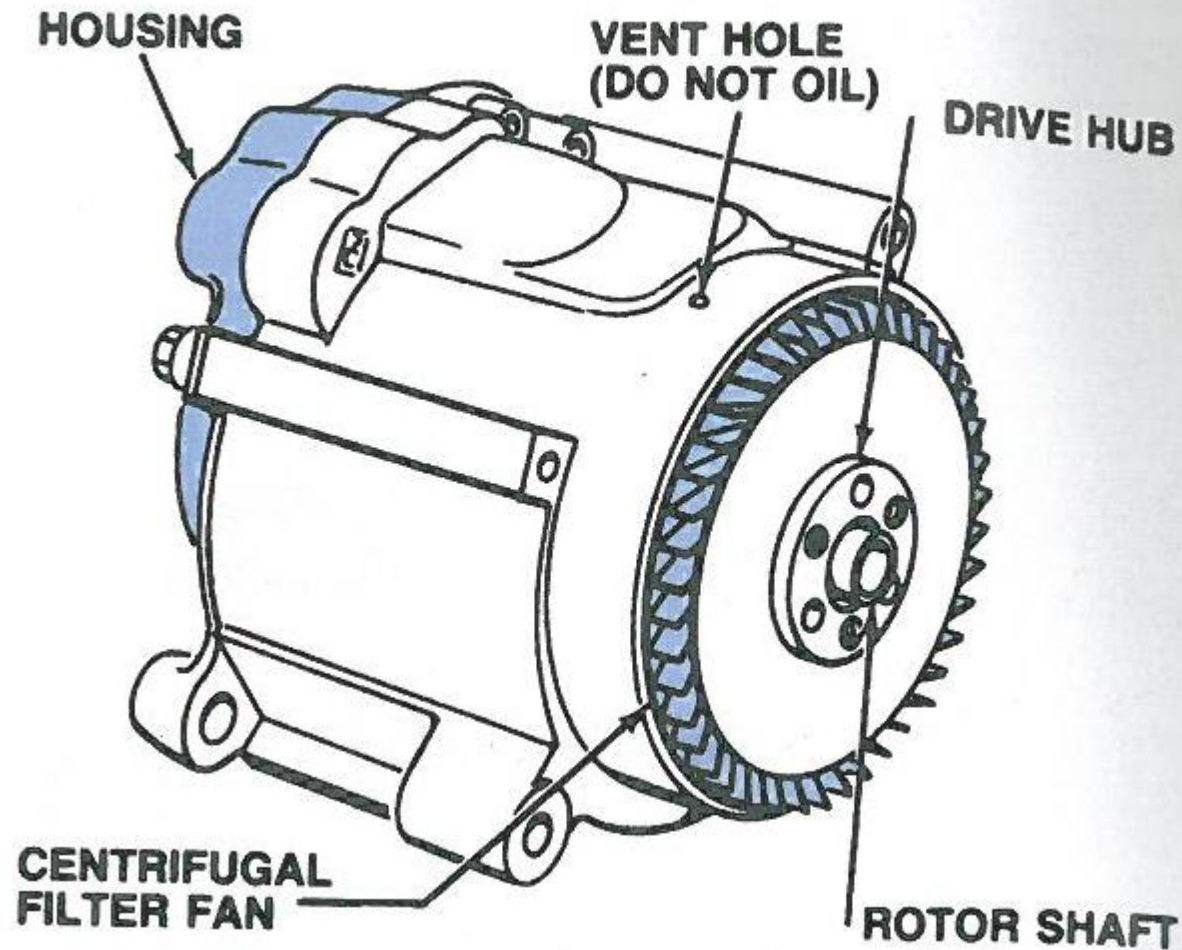
Secondary Air Injection SAI

- A pump provides air to the exhaust system to help the catalytic converter to oxidise HC and CO into H₂O and CO₂
- Also known as smog or thermactor pump used to be mounted of the crank pulley. Newer models use an electronic pump.
- Systems also comprises of
 - air manifolds and nozzles
 - Exhaust check valves
 - Connecting hoses
 - Air controlling solenoids on most recent systems

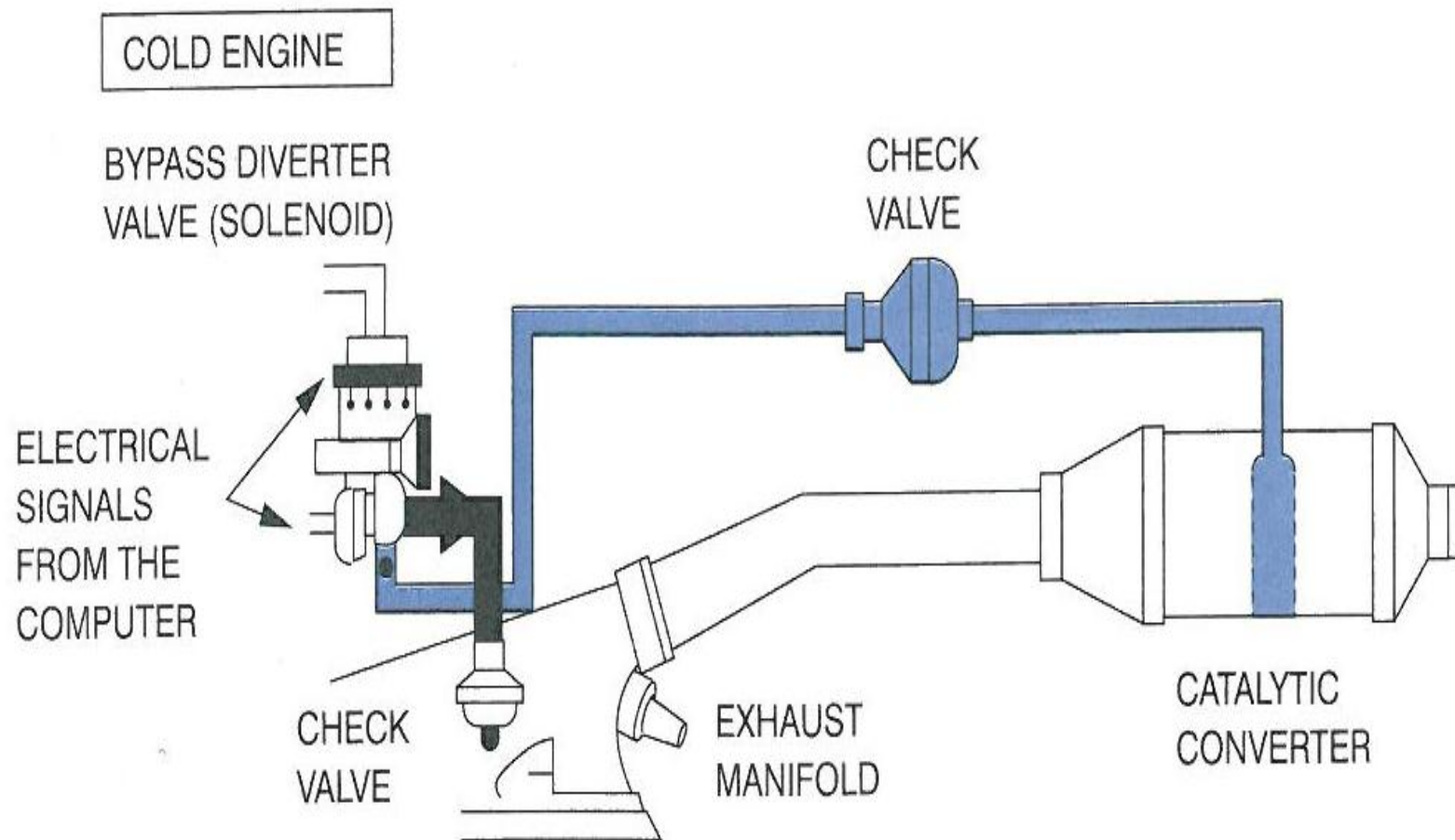
SAI pump

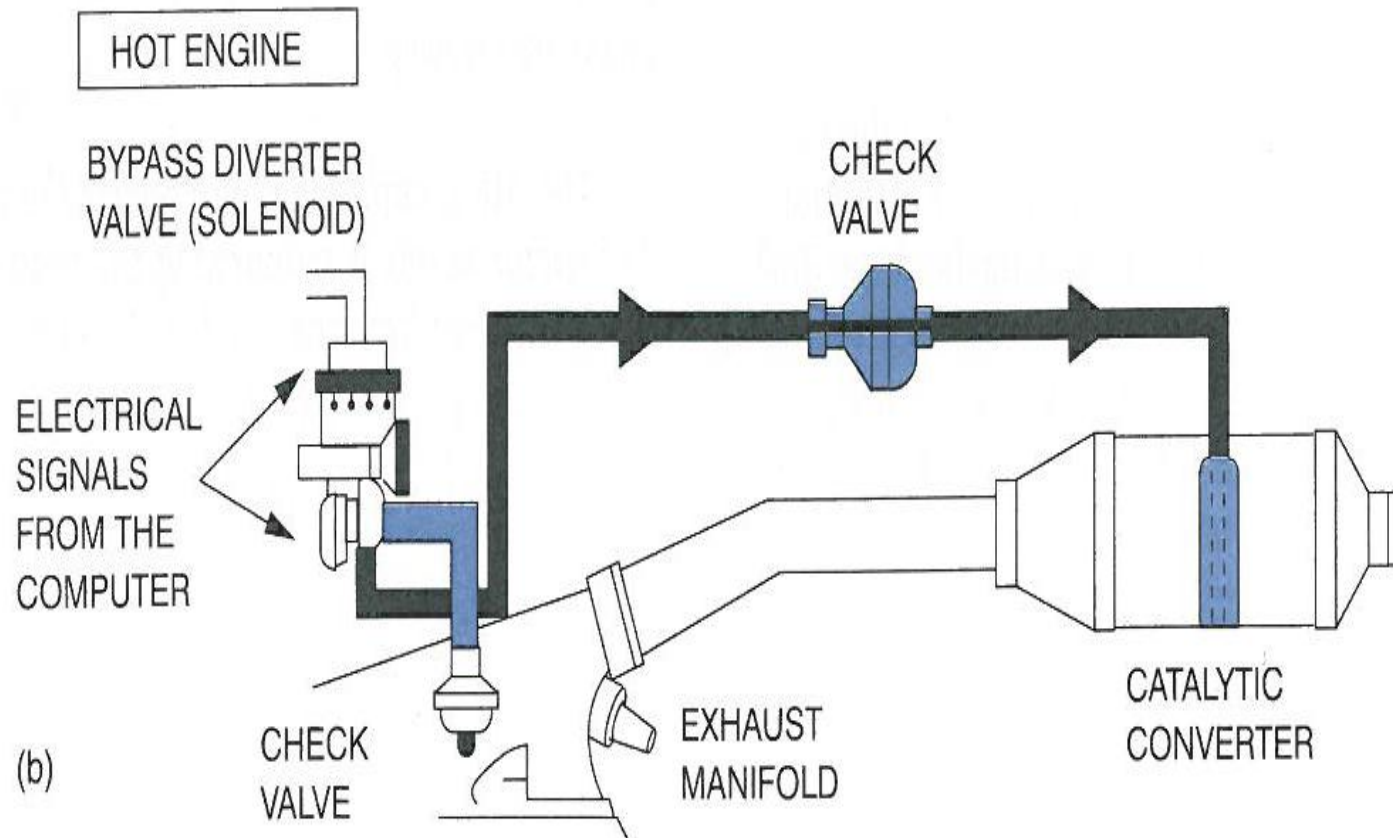


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- ECU controls the air solenoids
- When engine is cold air is supplied to the exhaust manifold to help oxidise HC and CO
- When engine is warm and running in closed loop the ECU controls the solenoids so that air is sent to the Catalytic Converter directly
- An increase in vacuum over normal idle level, as in rapid deceleration, the ECU diverts the air to the air filter to avoid backfire



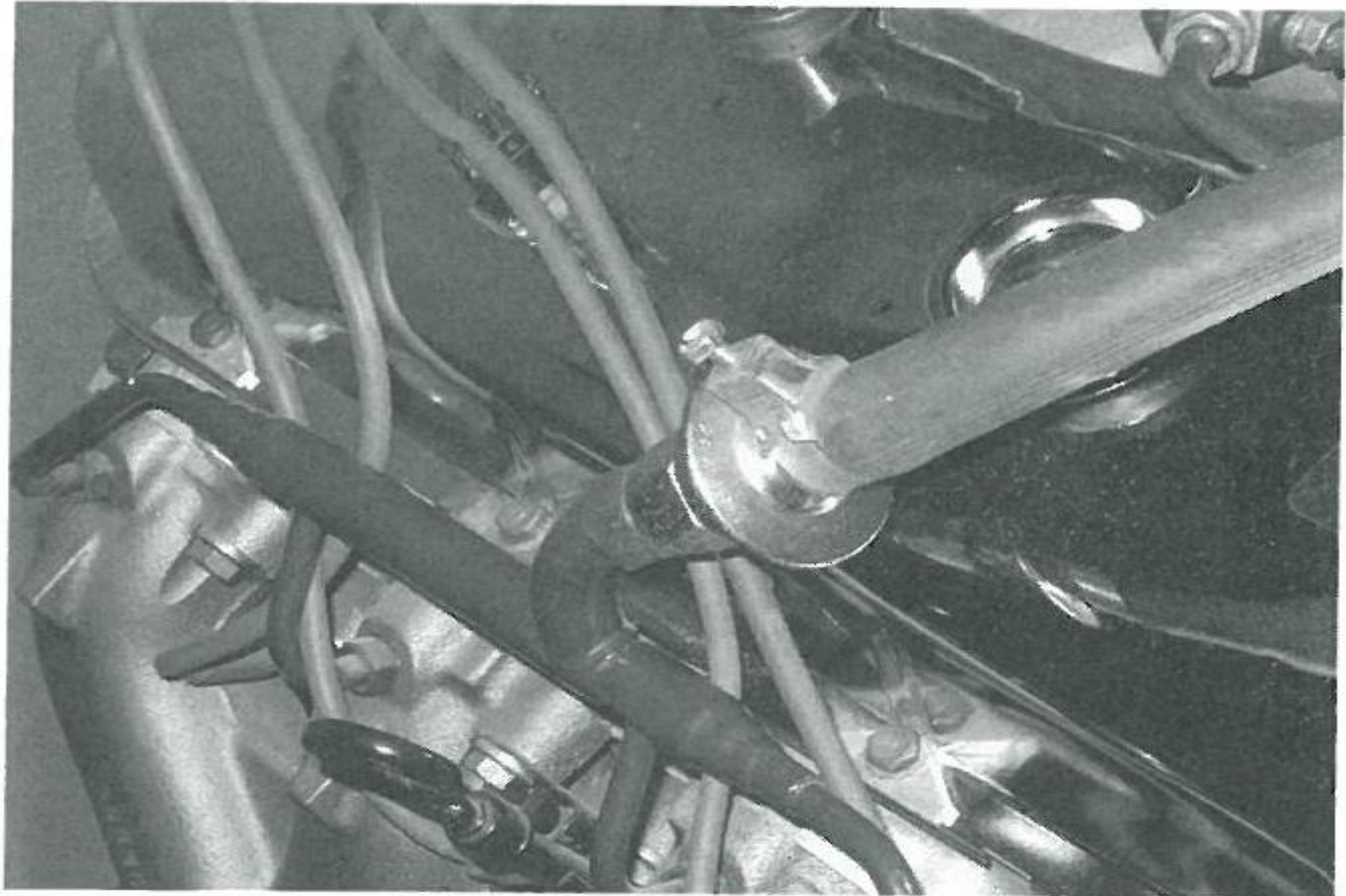


- The air injection system takes the pressurised air from the pump to the nozzles in the exhaust manifold of each cylinder in two ways
 - External air manifold with stainless steel nozzles in the head or exhaust manifold close to the exhaust valve – smaller engines
 - Internal manifold cast into cylinder head distributes air to each exhaust manifold – larger engines
- All systems have a series of Exhaust Check Valves to protect the air pump from exhaust back pressure
 - If exhaust pressure higher than pump or pump failure check valves closes

SAI Check Valves

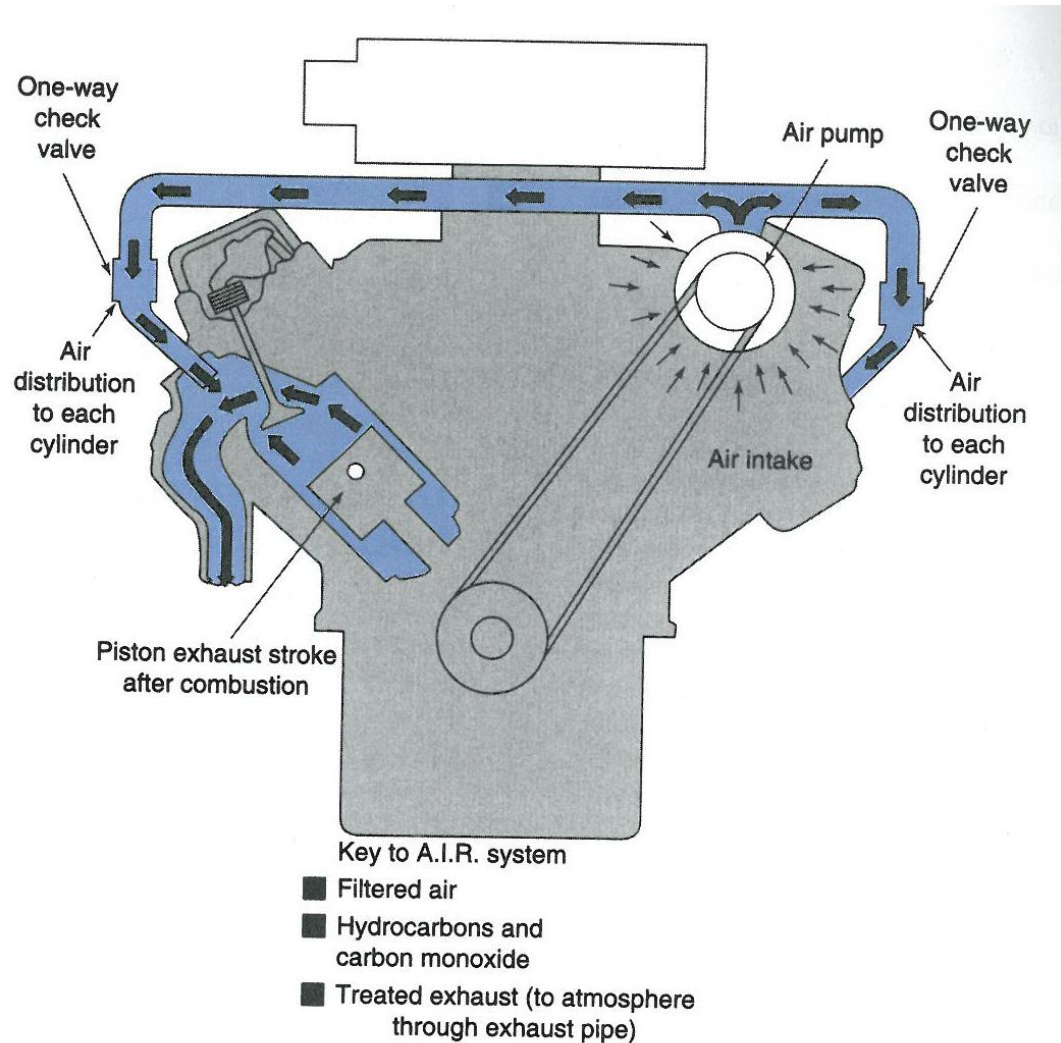


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- Belt driven are now less common
- Electric motor driven pumps are now the norm
 - Are ECU controlled and inject air to the manifolds in cold engine conditions
 - Also used to warm up Catalytic Converters quicker on start up
 - Built in one way valve to avoid backfire
- Pulse Air-Driven pump
 - Uses the exhaust system pulses to draw in the compressed air
 - After exhaust valve closed there is a period – pulse – of low pressure behind the valve and the pulse valve lets fresh air in
 - Works best at low engine speeds when air is most needed

Pulse Air Driven



- Is system fails it may cause poor running due to excessive exhaust in inlet
- This can be checked using a 4 gas exhaust analyser
 - Start engine and allow to warm to running temperature
 - Connect the analyzer probe and record reading os HC and CO
 - Shut off the air flow from the system with pinch pliers
 - Observe the new readings of CO and HC – they should go up
 - Record the level of O₂ with the system cut off
 - Remove the pliers and record new readings of O₂
 - In a functioning system the reading should go up by 1 to 4%