



# SUPERCHARGER

## DESCRIPTION

The supercharger, like the turbocharger, is a kind of air pump which forces much more air into the cylinders than in the case of an ordinary engine.

The Roots type supercharger used on the 4A-GZE engine for the MR2 (AW11) is explained here.

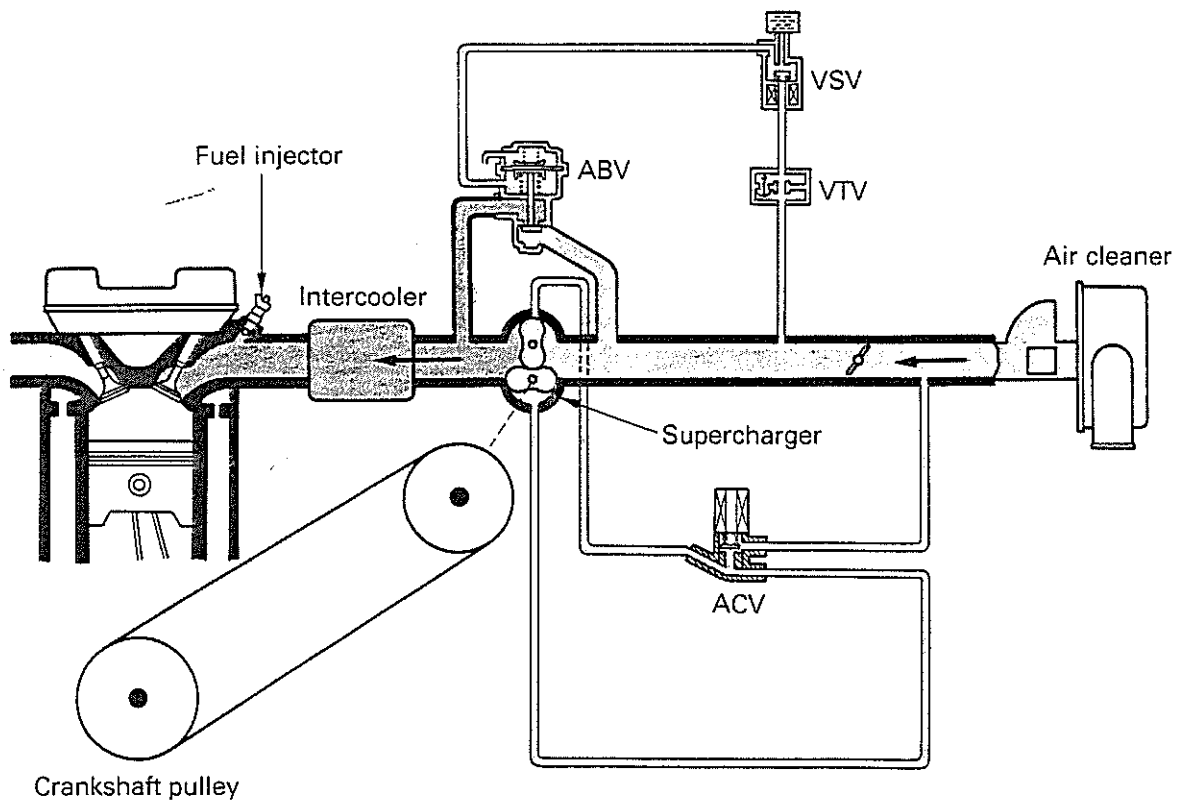
To activate the supercharger, engine output is transmitted by a V-ribbed belt, via a crankshaft pulley, to the magnetic clutch, and finally to the two cocoon-shaped rotors inside the supercharger housing.

Since it is driven directly by the engine via a crankshaft pulley and a V-ribbed belt, the supercharger starts providing strong torque at a lower speed range than turbochargers. Furthermore, its time-lag is less, thus ensuring a quick response.

The magnetic clutch is engaged and disengaged by a signal from the Engine ECU according to the running conditions of the engine.

In the supercharger system, there is an air bypass valve (ABV), which controls the amount of intake air bypassing the supercharger, and an air control valve (ACV), which controls the introduction of atmospheric air into the ventilation pipes to prevent the leakage of the supercharger oil and bearing grease. These are also controlled by the Engine ECU.

An air-cooled type intercooler is provided to improve charging efficiency. Operation of this intercooler is the same as for the turbocharger intercooler (see page 13 for details).



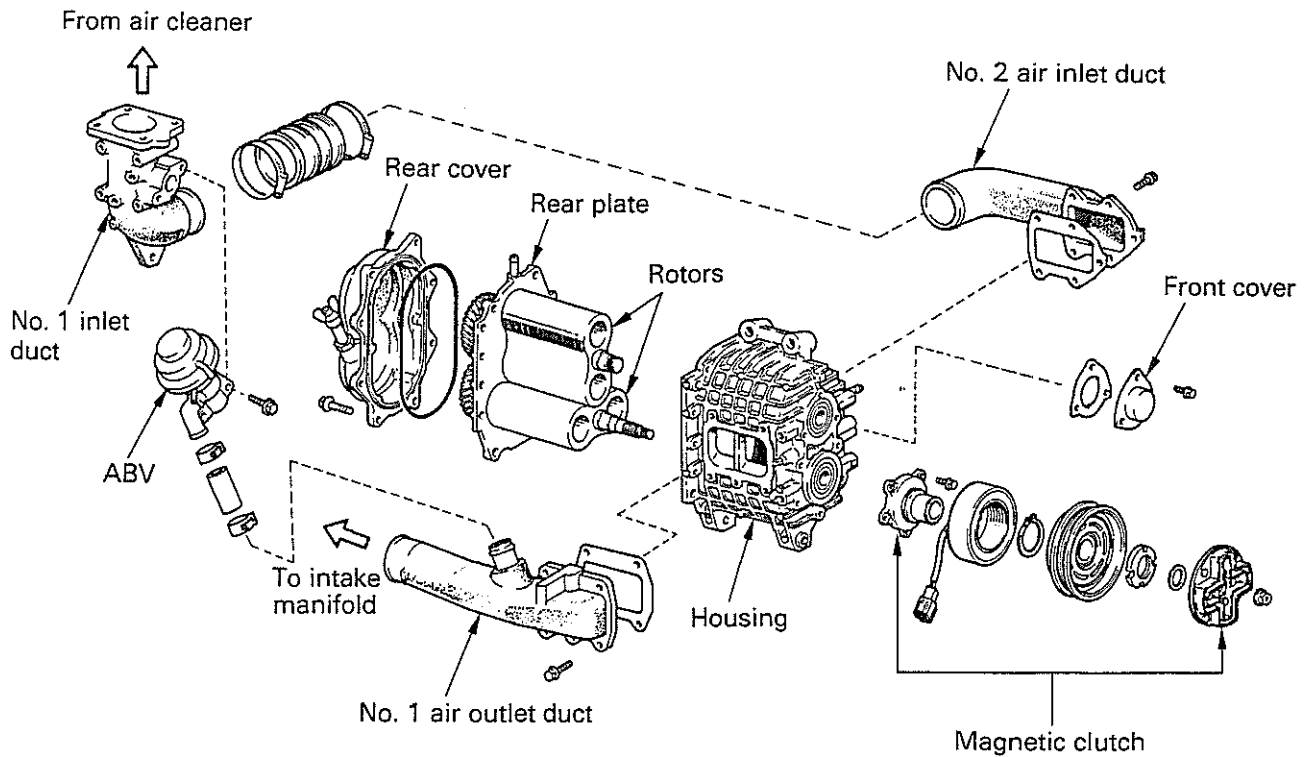
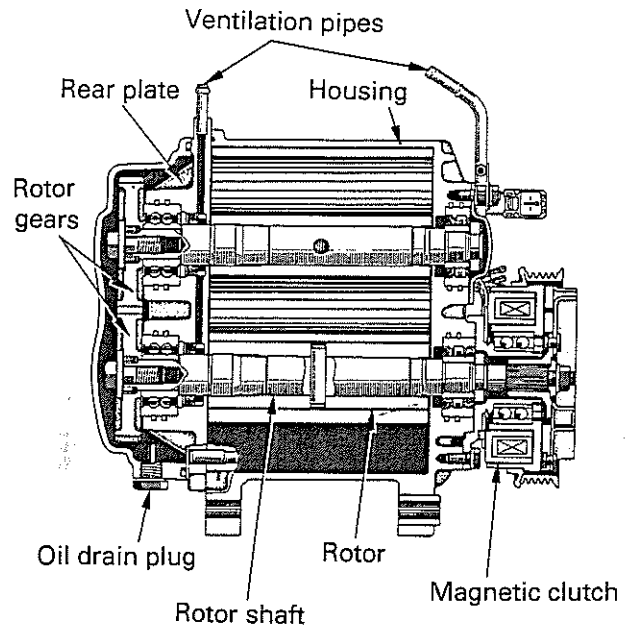
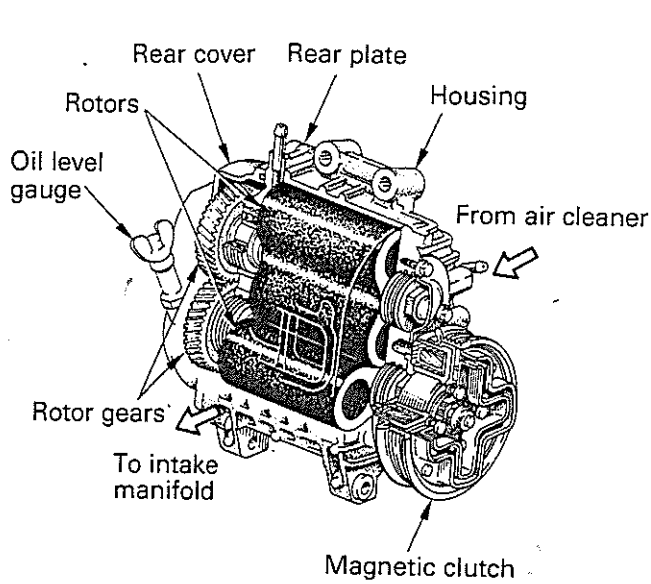
**SUPERCHARGER SYSTEM**  
(4A-GZE on MR2 [AW11])

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# SUPERCHARGER

The supercharger consists of a magnetic clutch, two rotors, two rotor gears, a housing, a rear plate, a rear cover, etc.



CONSTRUCTION OF SUPERCHARGER



## 1. MAGNETIC CLUTCH

The magnetic clutch is turned on and off by the Engine ECU. It is turned off to stop the supercharger when the engine is running under a light load.

The magnetic clutch consists of the clutch stator, the clutch pulley, and the clutch hub.

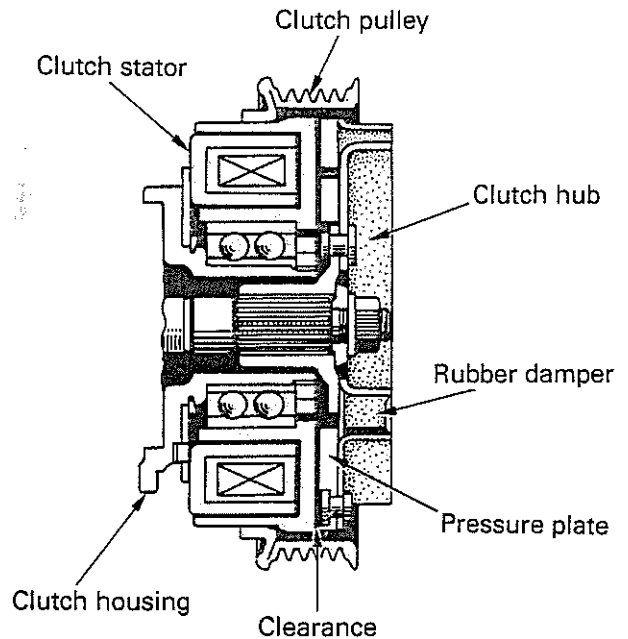
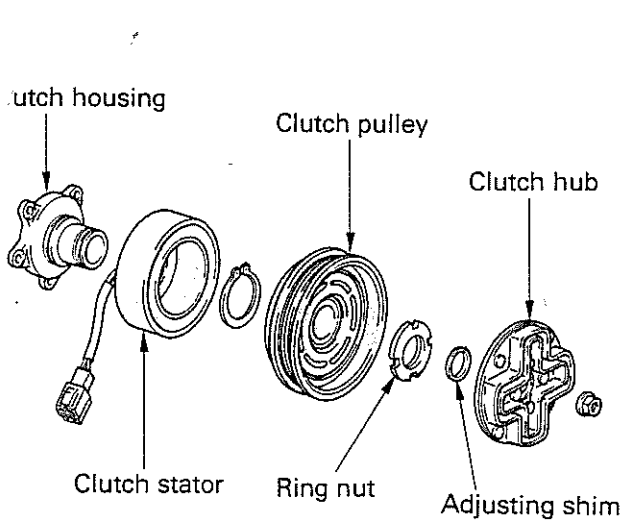
The clutch pulley turns around the clutch housing on a bearing incorporated in the pulley.

The clutch hub is splined with the rotor shaft and turns as one complete unit. There is a rubber damper between the boss of the clutch hub and the pressure plate to allow the plate to move in

the axial direction. When the magnetic clutch turns on or off, the rubber damper absorbs the shock that is created by the movement of the plate.

The clutch stator is a solenoid. When the magnetic clutch is turned on, the pressure plate is pressed against the clutch pulley.

Normally, a 0.5 mm (0.0197 in.) clearance is provided between the clutch hub and clutch pulley, as shown. A larger clearance due to wear, etc., may cause noise. The clearance is adjusted by changing the thickness of the adjusting shim.

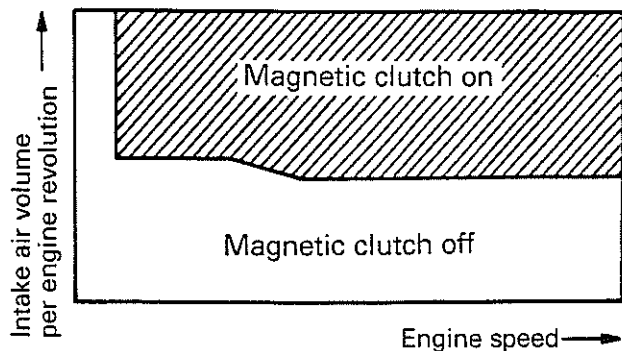


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### MAGNETIC CLUTCH CONTROL BY ENGINE ECU

The Engine ECU turns the magnetic clutch on under the following conditions:

- Throttle valve opening angle is more than a certain angle (that is, during acceleration).
- Engine speed and intake air volume per engine revolution are in the shaded area in the graph to the right (engine under heavy load).



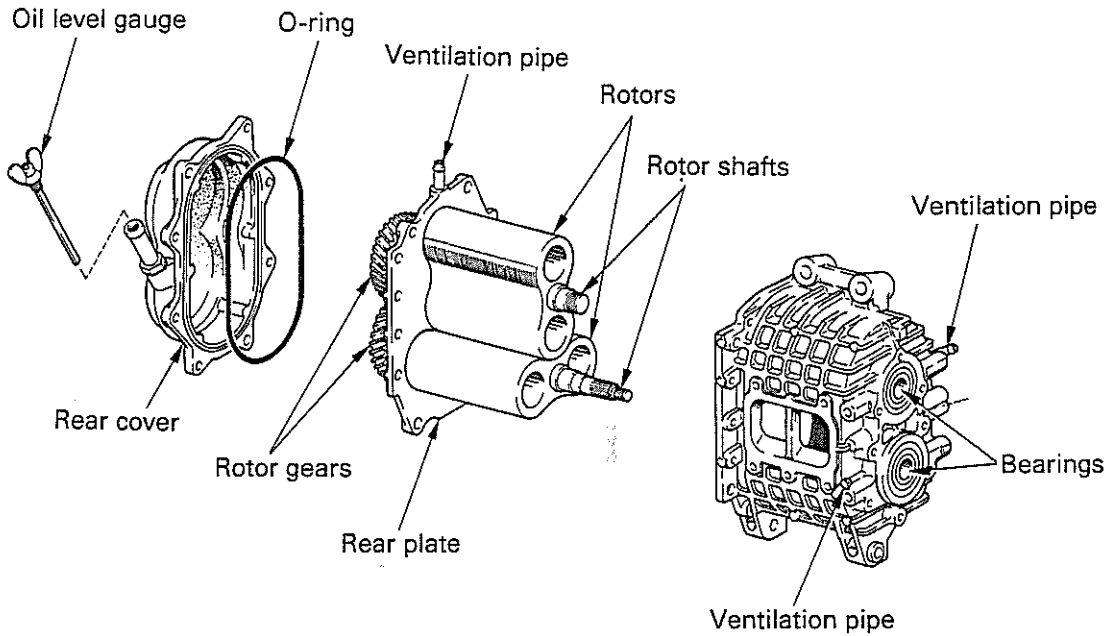
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## 2. ROTORS AND HOUSING

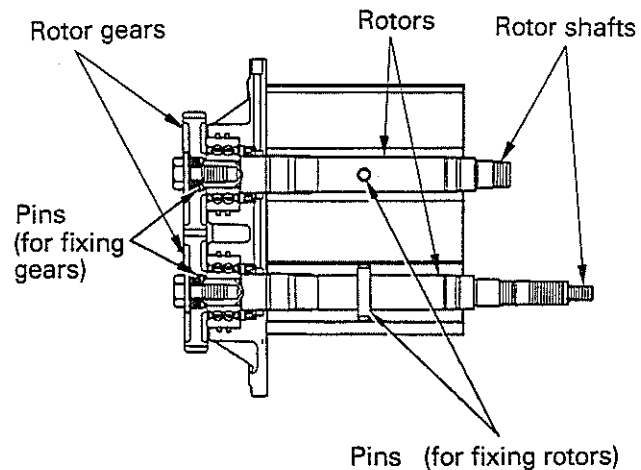
A rotor and gear are fitted to each of the two rotor shafts, which are in turn fitted to the rear plate via bearings. The rotors are made of aluminum, which is coated with a special fluoro-resin.

The housing is made of aluminum. An air inlet duct is connected to the right and an air outlet duct to the left. Bearings are located in the front of the housing to support the rotor shafts.



### IMPORTANT!

The pair of rotors are press-fit onto the rotor shafts and then fixed in position by pins and serrations. The gears are pinned integrally to the rotor shaft so that the original rotor-to-rotor orientation will not be lost. For this reason, they cannot be disassembled. Component parts are therefore supplied as an assembly, with rotors and gears fitted to the rear plate as illustrated.

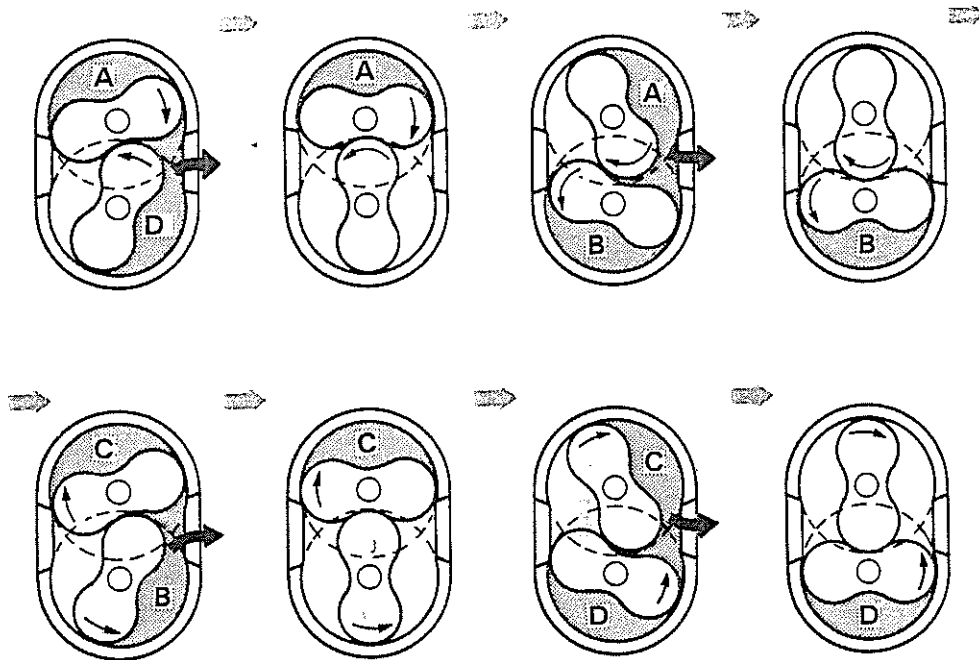




### PUMP ACTION OF ROTORS

Power is transmitted from the engine crankshaft pulley to a V-ribbed belt and the magnetic clutch, and finally to the lower rotor shaft. The upper and lower rotor shafts are geared together. The two

rotors turn in opposite directions and force air between the housing and rotors as they rotate. Air is pumped out four times per rotor revolution.



PUMP ACTION OF ROTORS (viewed from rear)

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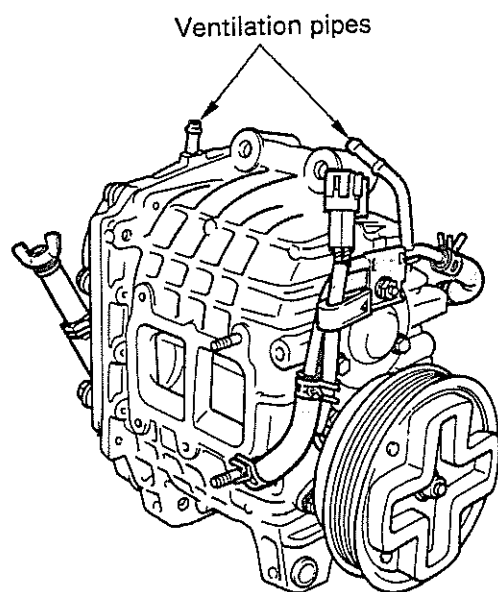
### 3. VENTILATION PIPES

The gears and rear bearings are lubricated by Toyota brand supercharger oil. The front bearings are lubricated by grease.

The pressure in the housing varies while the engine is operating. Ventilation pipes are provided to prevent oil leakage from the rear cover or grease leakage from the front bearings due to pressure fluctuation. Introduction of atmosphere into the ventilation pipes is controlled by the opening and closing of the air control valve (ACV). (See page 38 for operation of the ACV).

**IMPORTANT!**

- Check oil level periodically (every 48,000 km [30,000] miles) or 36 months).
- Use Toyota Supercharger Oil (Part No. 08885-80108) or equivalent.





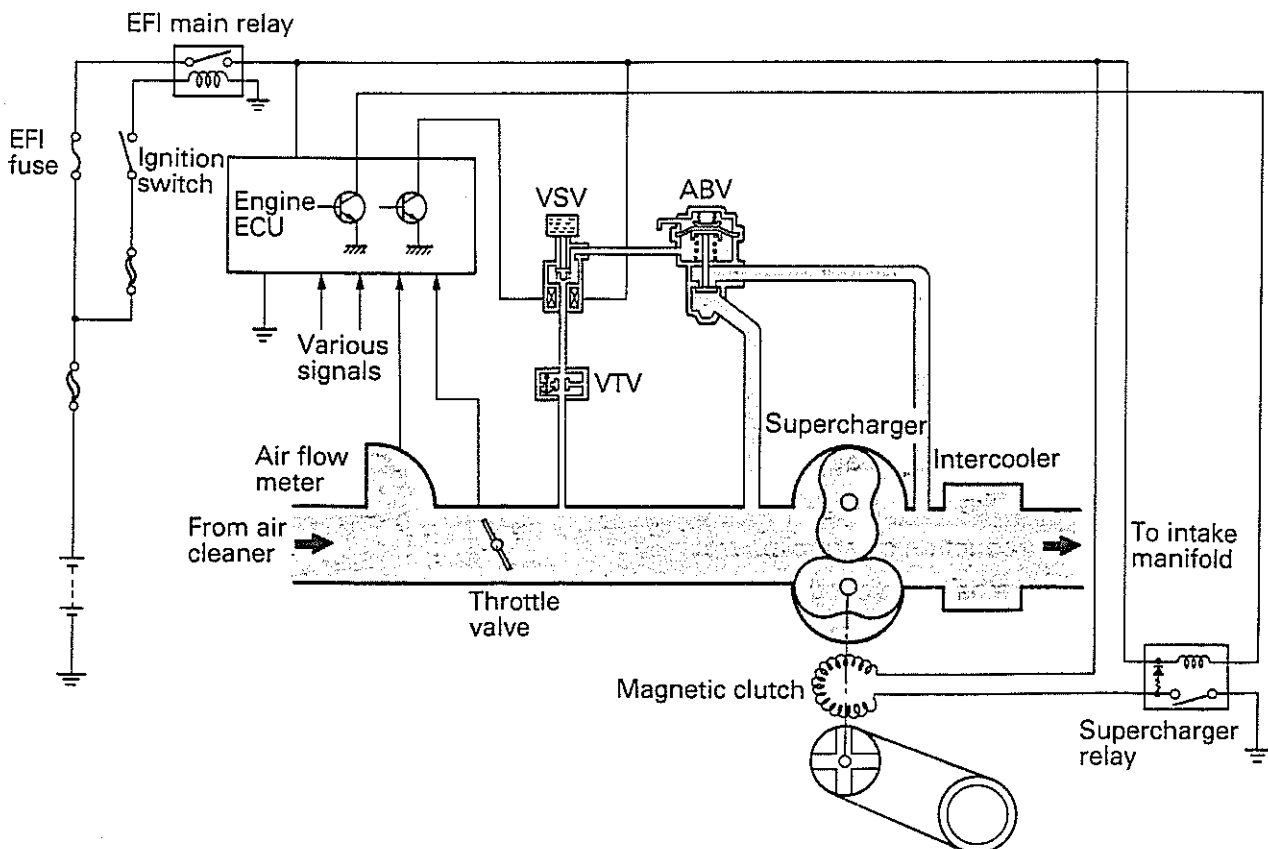
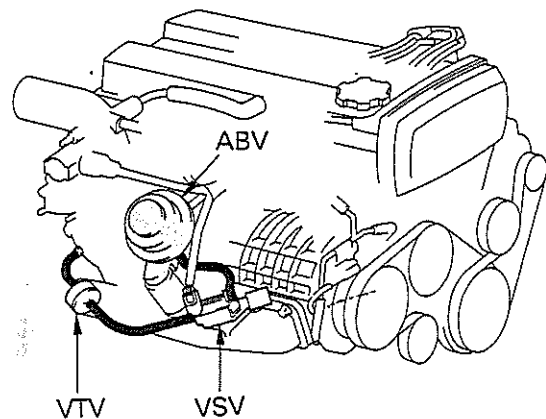
## AIR BY-PASS VALVE (ABV)

### 1. DESCRIPTION

An ABV is installed in the No. 1 air inlet duct. The passage bypassing the supercharger is opened and closed by it for the following purposes:

- While the engine is idling or operating under a light load (i.e., when the supercharger is off), the supercharger will generate significant resistance to the flow of intake air. The ABV prevents this by opening to ensure the unimpeded flow of air in this situation.
- When the engine is accelerating (magnetic clutch turns on), the rotors must be made to start rotating slightly in advance of supercharger operation to prevent sudden charging.
- While the engine is operating at high speed, the maximum boost pressure must be controlled to prevent overcharging of the intake air.

The ABV opens and closes when the pressure applied to the diaphragm of the ABV is shifted from atmospheric pressure to vacuum and vice versa by the VSV. The VSV is turned on and off by the Engine ECU.



AIR BY-PASS VALVE SYSTEM

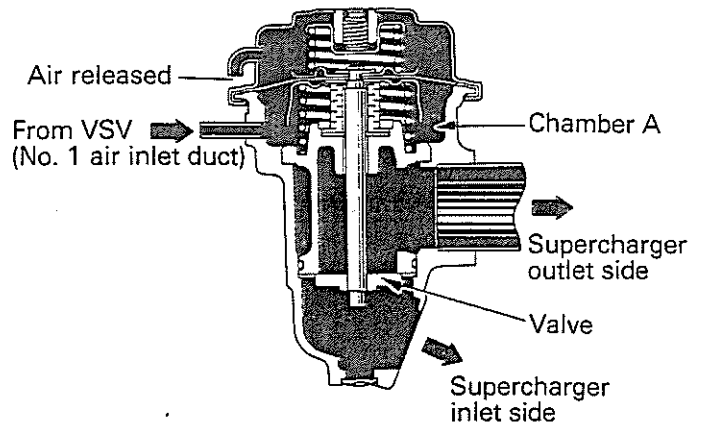


## 2. CONSTRUCTION

The ABV consists of a valve that opens and closes the bypass passage, and an actuator that opens and closes this valve.

When atmospheric pressure is introduced from the VSV into chamber A, this valve is closed by the diaphragm spring.

When vacuum is introduced from the VSV into chamber A, the diaphragm shortens the diaphragm spring, thereby opening the valve.



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## ABV CONTROL BY ENGINE ECU

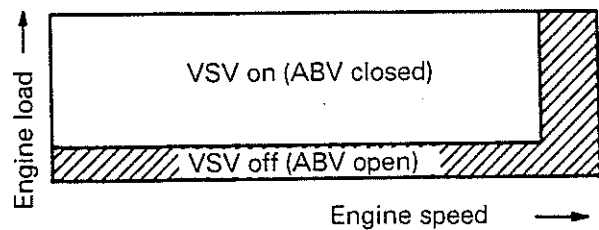
The VSV for the ABV is turned on and off by the Engine ECU, in accordance with operation of the supercharger magnetic clutch, engine speed, throttle valve opening angle and opening speed, etc. When the VSV is turned on, atmospheric pressure is introduced into the ABV and closes the valve.

The Engine ECU turns the VSV on under the following conditions:

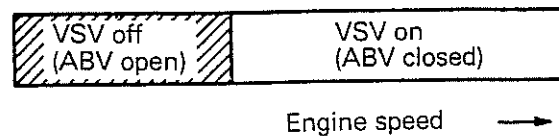
- When the magnetic clutch is on, engine load is more than an intermediate level, and engine speed is a little below the maximum speed.
- When the magnetic clutch is off, and engine speed is greater than medium speed.

When the starter signal is detected or the coolant temperature is low, the VSV is turned off automatically regardless of the above conditions.

### SUPERCHARGER MAGNETIC CLUTCH ON



### SUPERCHARGER MAGNETIC CLUTCH OFF



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## SUPERCHARGER — Air By-pass Valve

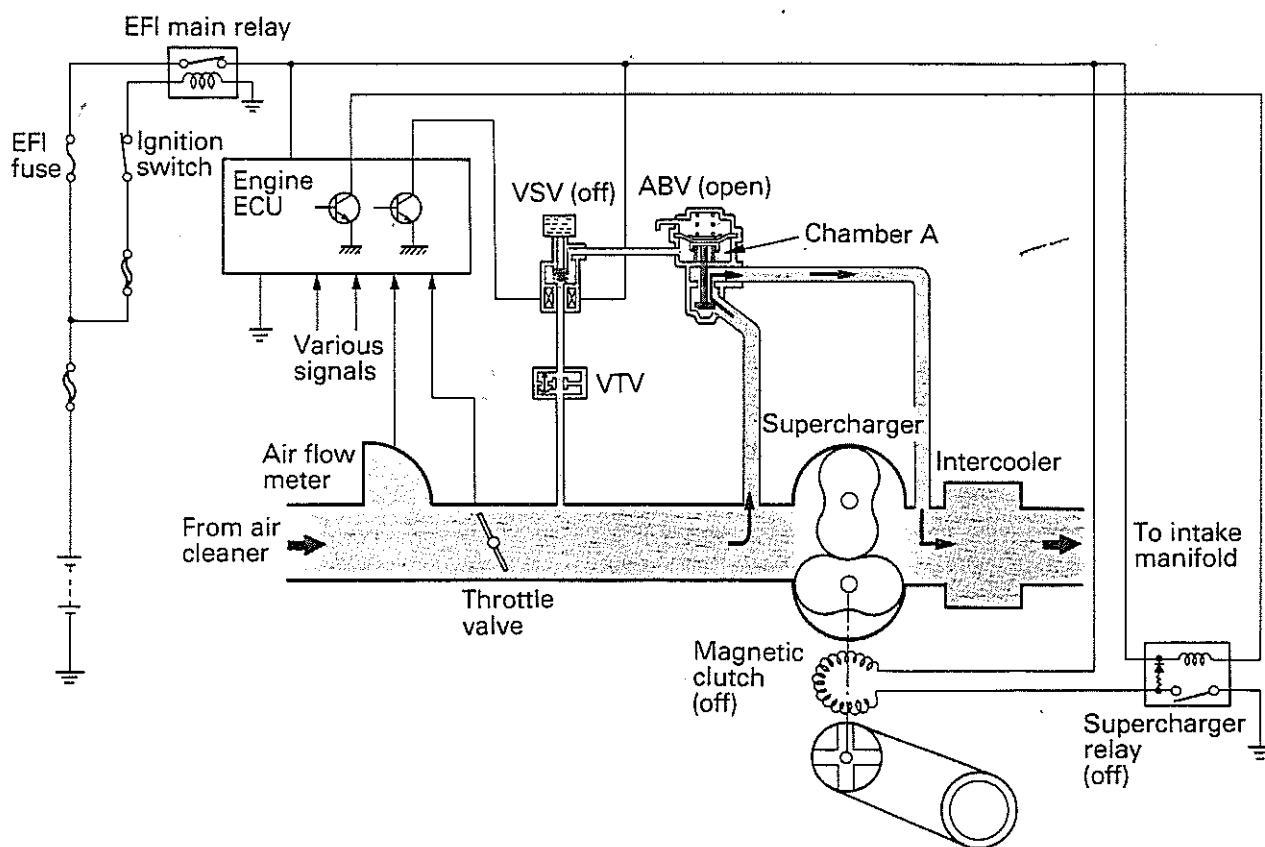
### 4. OPERATION

#### ① SUPERCHARGER OFF (PHASE 1)

The supercharger is off while the engine is idling or operating under a light load.

Since the supercharger magnetic clutch and VSV are turned off by the Engine ECU, vacuum acts on

chamber A of the ABV and opens the valve. Therefore, most of the intake air bypasses the supercharger and is introduced into the intake manifold through the ABV.



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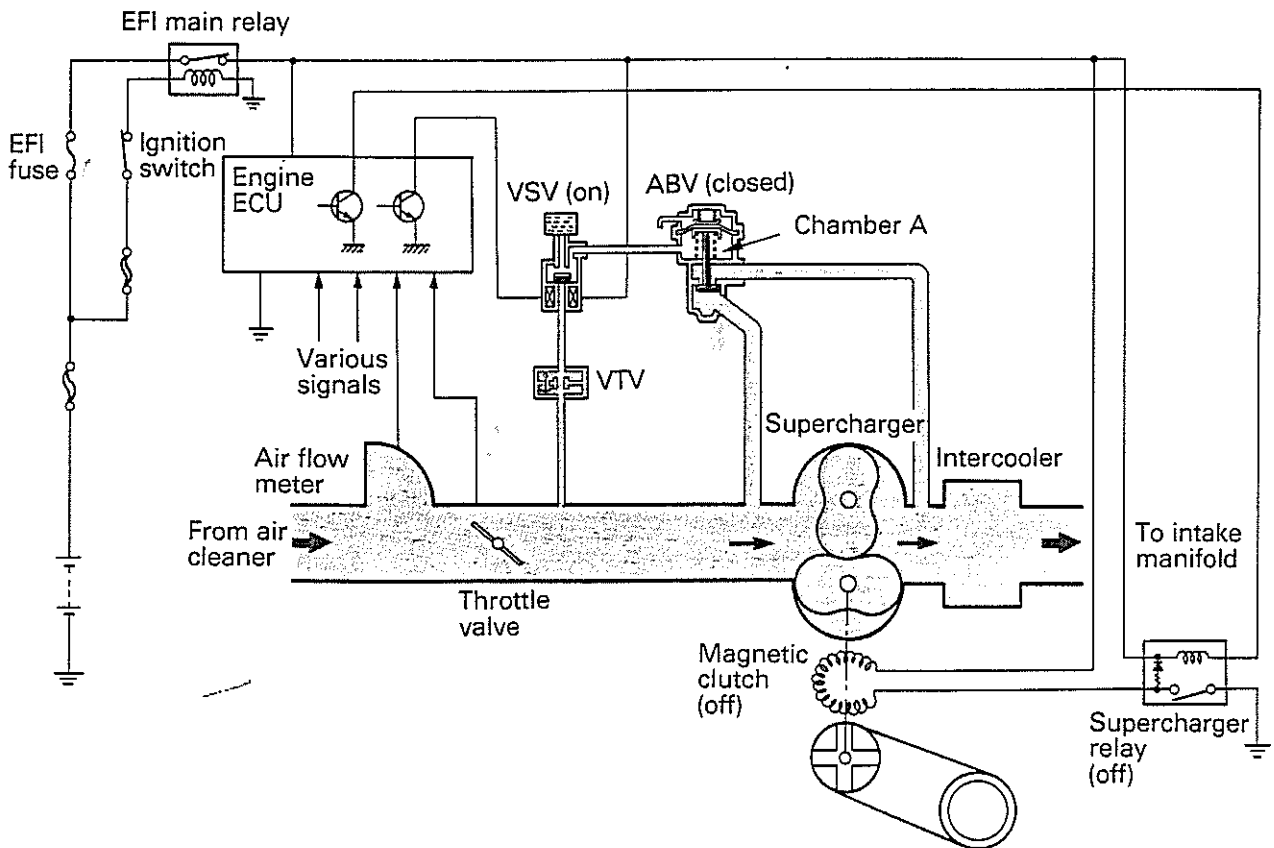




② SUPERCHARGER OFF (PHASE 2)

When the engine is running under a light load and above medium speed, the VSV will go on while the supercharger magnetic clutch remains off. In this event, since the VSV is on, atmospheric pressure is introduced into chamber A of the ABV and closes the valve. Therefore, intake air causes the rotors to spin, after which it is introduced

(without being compressed) into the intake manifold via the supercharger. This prevents, for example, sudden operation of the supercharger just before the magnetic clutch turns on when the engine begins accelerating. (This is to reduce the operating shock of the clutch.)



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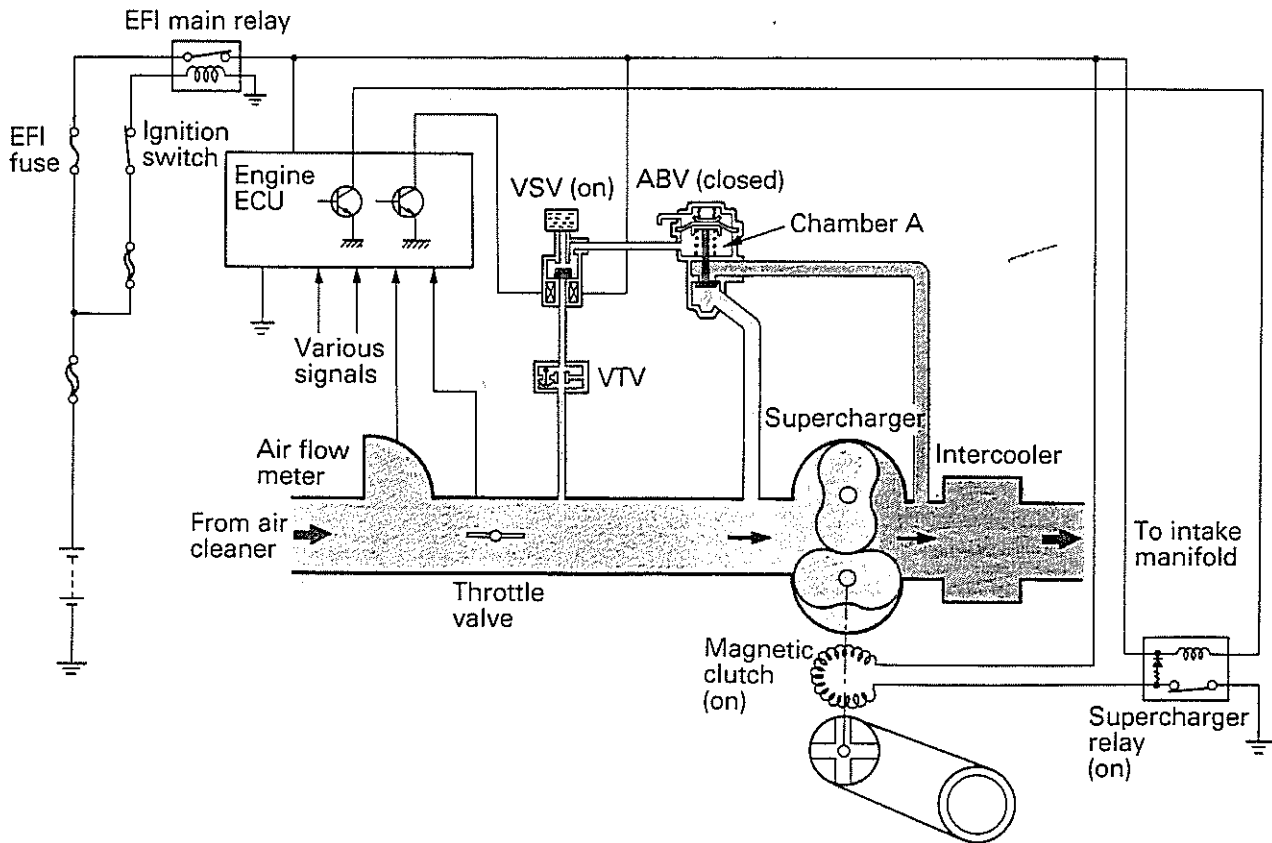
## SUPERCHARGER — Air By-pass Valve

### ③ SUPERCHARGER TURNED ON

The supercharger is on as long as the engine is accelerating or operating under a heavy load.

Since the supercharger magnetic clutch and the VSV are turned on by the Engine ECU, the ABV closes because atmospheric pressure is intro-

duced from the VSV into chamber A of the ABV. All intake air is sent to the supercharger and pressurized there before being introduced into the intake manifold.



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#### REFERENCE

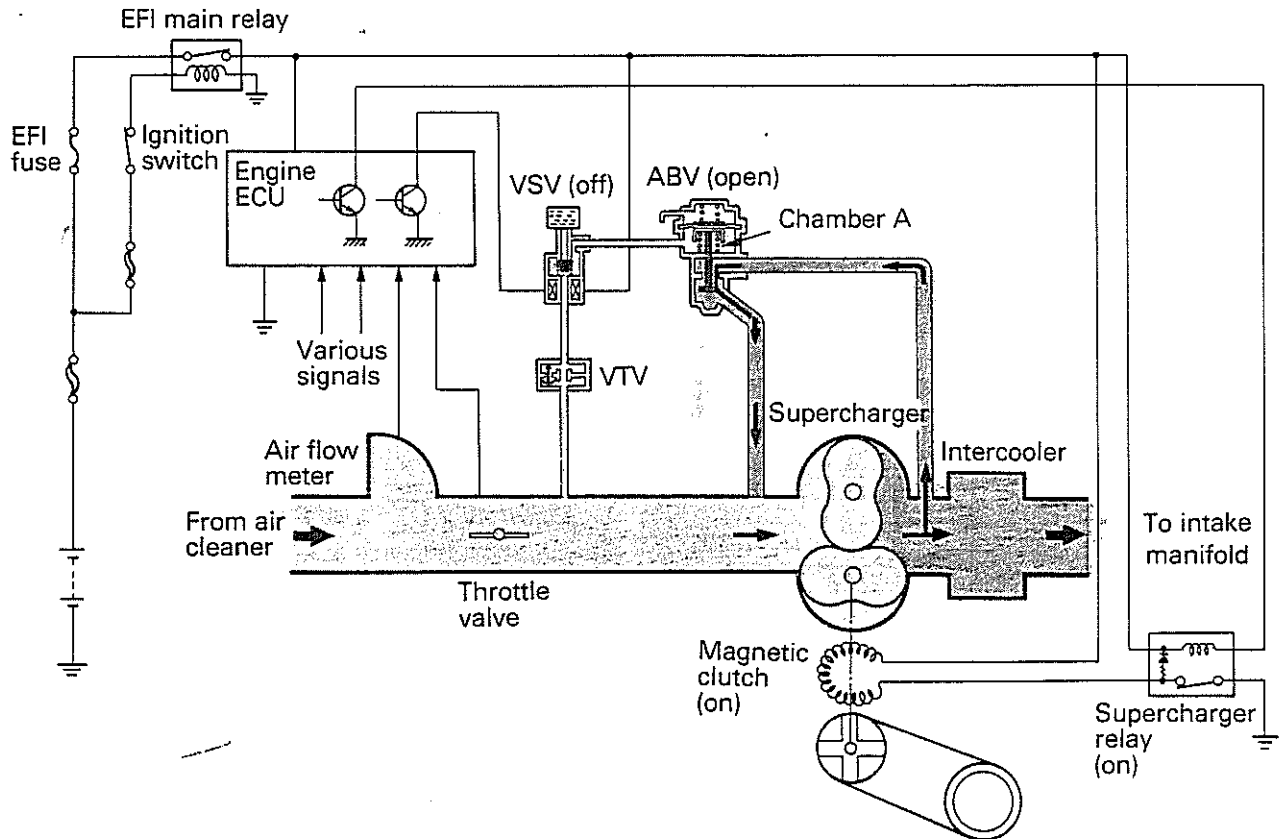
During sudden deceleration, the Engine ECU turns the VSV off, and the ABV opens. This causes unnecessary supercharged air to be returned to the inlet side of the supercharger.



④ DURING OVER-CHARGING

As the engine speed increases, the supercharging pressure rises. When the engine speed increases to around maximum rpm, the Engine ECU turns the VSV off and a weak vacuum acts on chamber A of the ABV. At the same time, part of the

supercharging pressure acts on the upper side of the ABV valve and attempts to push it open. The valve is finally opened by these two forces and part of the supercharged air returns to the air inlet duct. The result is that boost pressure is lowered.

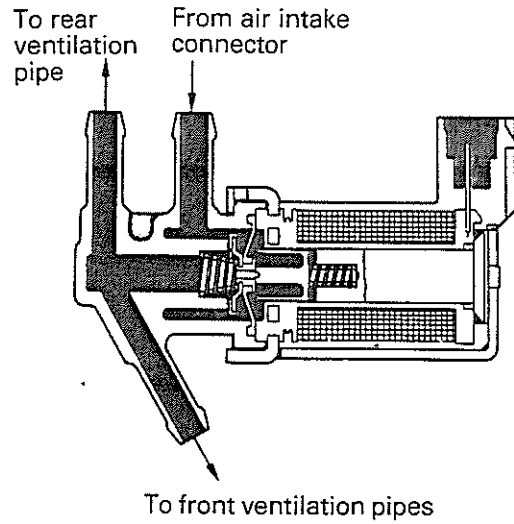


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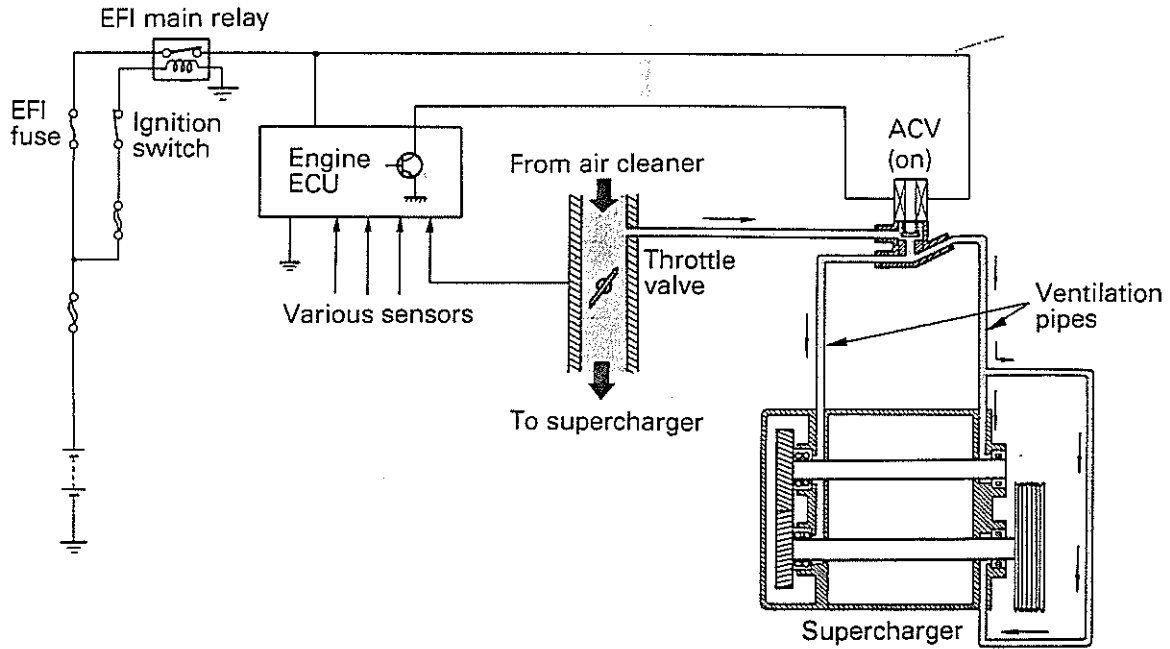


### AIR CONTROL VALVE (ACV)

The ACV is turned on and off by the Engine ECU. When it is turned on, atmospheric air is sent into the ventilation pipes located in the front and rear of the supercharger. As a result, the pressure near the front and rear bearings becomes close to atmospheric pressure. This prevents grease for the front bearings and oil for the rear bearings and gears from leaking out due to pressure fluctuations inside the supercharger housing.



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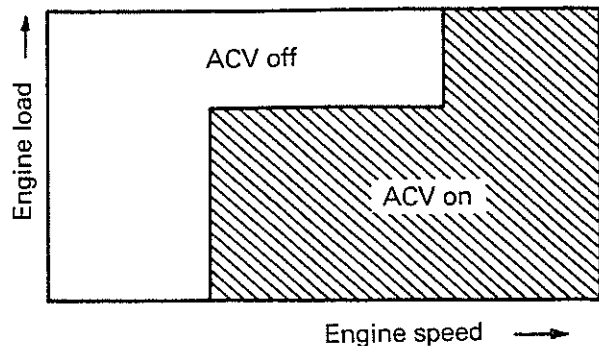
AIR CONTROL VALVE SYSTEM

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### ACV CONTROL BY ENGINE ECU

The Engine ECU turns the ACV on under the following conditions:

- Engine speed and engine load are in the shaded area in the diagram to the right.
- The engine is starting.



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