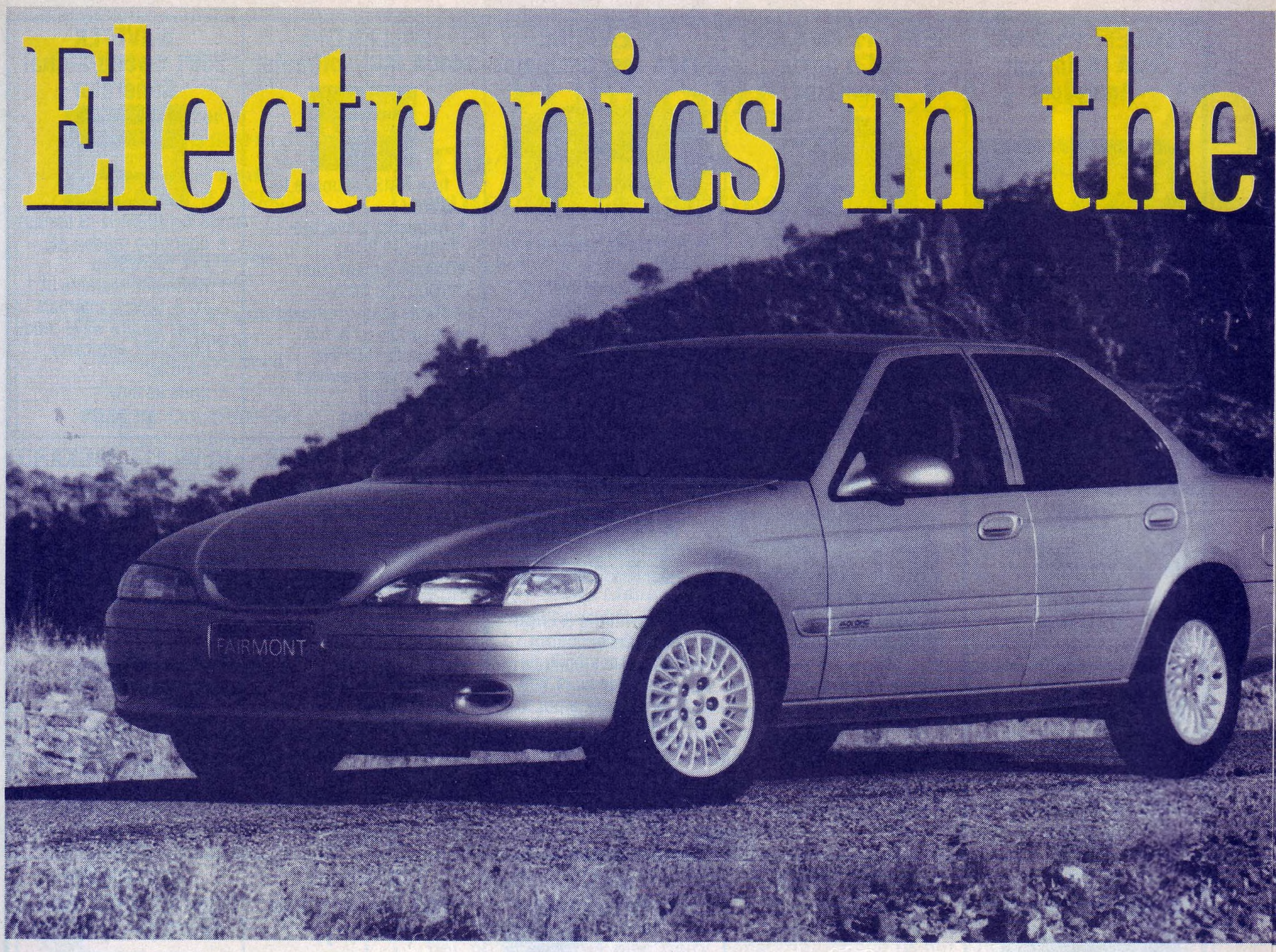


Electronics in the

Electronically controlled fuel injection & ignition timing is now common but the engine management system can also be used to control other functions. The latest Falcon range also uses electronic control for the radiator cooling fans & the variable intake manifold.

To meet styling and aerodynamic criteria, the new EF Falcon was designed to draw all of its engine cooling air from an opening positioned under the front bumper. This required the design of a new intake duct, with the opportunity also taken to develop dual electronically controlled electric fans.

The design of the new intake duct was undertaken using CAD techniques, with numerical modelling of the airflow being used to plot streamlines. In particular, the shape of the duct was tuned so that only attached (ie, laminar) airflow was present for the majority of the duct system. This design was then tested at the Ford Lara Proving Ground and in an environmental testing room. The results indicated a 32.7% improvement over the cooling system intake used in the previous model.

In addition, cooling test comparisons between a conventional engine-driven fan and electric fans showed that the latter configuration gave better cooling performance. This showed up in two ways: (1) increased headroom between the coolant temperature and its boiling point; and (2) a reduction in the airconditioning refrigerant pressure (due to more efficient condensation).

However, the new duct's 32.7% improvement in heat rejection over the previous design was reduced to only 19.8% with the electric fans fitted and operating in their "off" mode. This reduction in free-flow 80 km/h heat rejection was due to the obstruction posed by

Pt.2: engine management secondary control

By JULIAN EDGAR

new EF Falcon

the fans and their shroud. Even so, it still represented a significant improvement over the EA Falcon's non-ducted radiator and engine-driven fan design.

As can be seen from the photos, the Fairmont model has slightly different front-end styling to that of the Falcon. The "grille" located between the headlights is actually a fake and has no bearing on engine cooling airflow. However, the "styling bar" placed across the lower intake was found to have a potentially adverse effect on cooling air intake – if it was angled at four degrees from the horizontal, it degraded engine cooling by 8%! For this reason, production line assembly of this component must be very accurate.

Supplementing the improved intake duct is the twin electric fan package. This was also designed to give greater air flow through the radiator. One fan is a single speed unit, while the other has two speeds.

These fans are controlled by four relays linked to the EEC-V engine management computer. These relays operate the fans by means of series and parallel circuits – see Fig.1. Although seven fan-speed combinations are possible, only four are used in practice. Potential problems with NVH (noise, vibration & harshness), caused by fan beats and a whirling noise, precluded the use of all speed combinations and, in any event, proved unnecessary.

The fans may be operated by the engine management system at idle, depending on engine coolant and airconditioning refrigerant temperature. In fact, in hot environments, the airflow provided by low-speed driving and during city driving is insufficient to cool the airconditioning condenser.

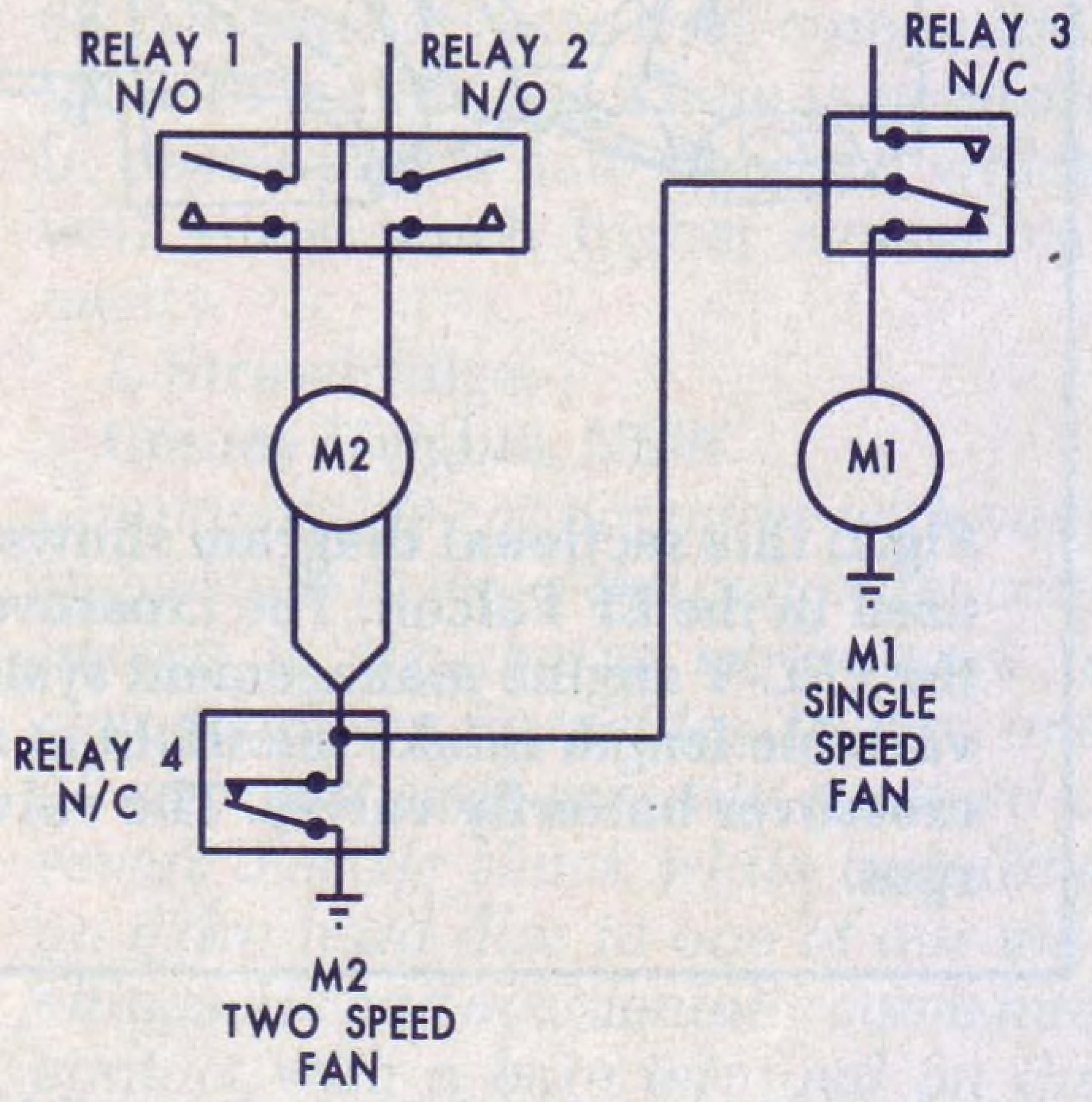
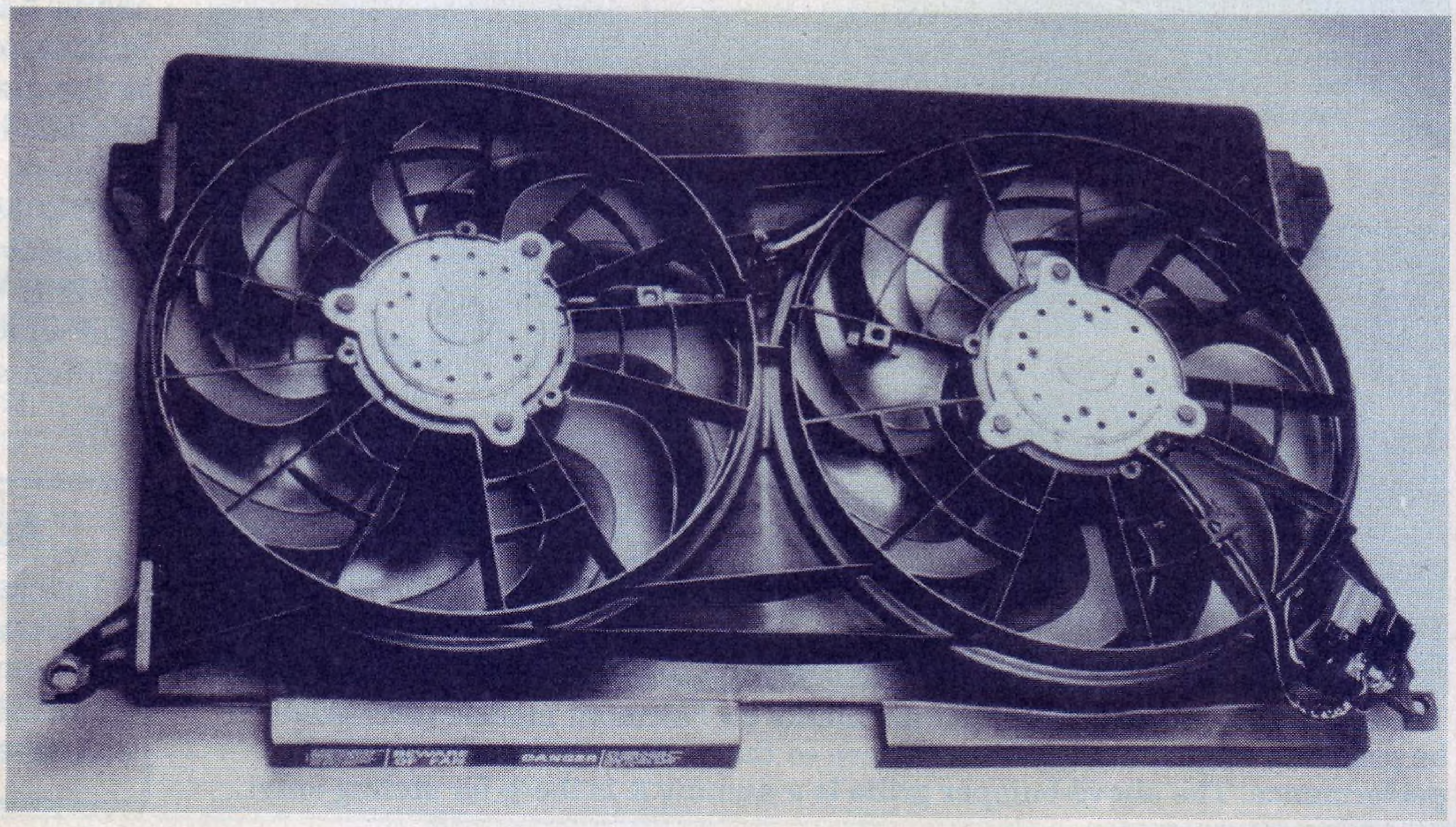


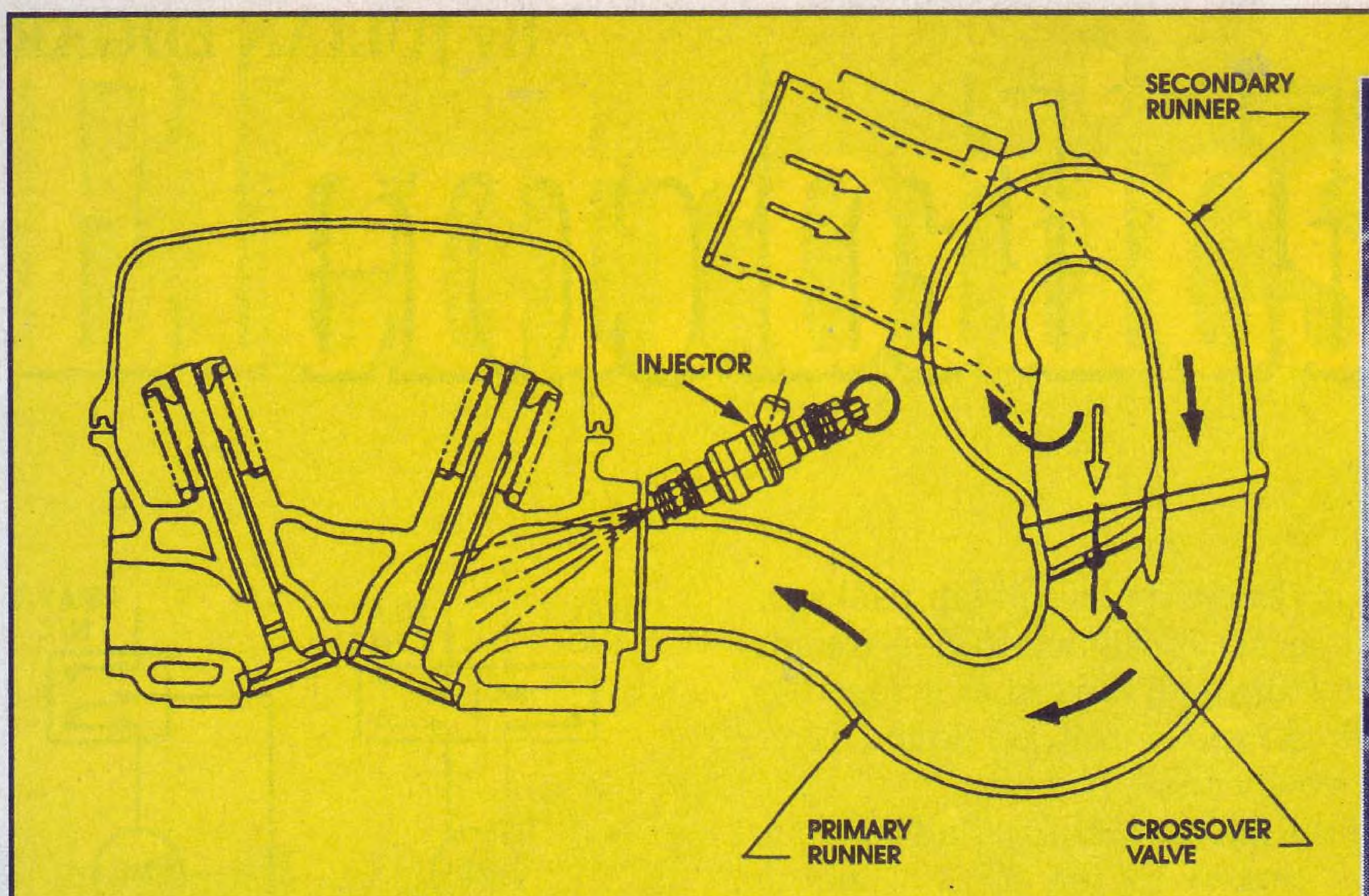
Fig.1: the dual electric fans are controlled by the EEC-V engine management system via relays. Four different fan speeds can be selected, depending on engine coolant temperature; airconditioning head evaporative temperature; engine speed; transmission temperature; & heater fan speed.

The EEC-V module controls the fan speeds using the following inputs: (1) engine coolant temperature; (2) airconditioning head evaporative temperature; (3) engine speed; (4) transmission temperature; and (5) heater fan speed.

Relay operation of the fans was de-

Dual electric fans have replaced the engine-driven fan of the previous model. These are controlled by the EEC-V engine management computer on the basis of five inputs.





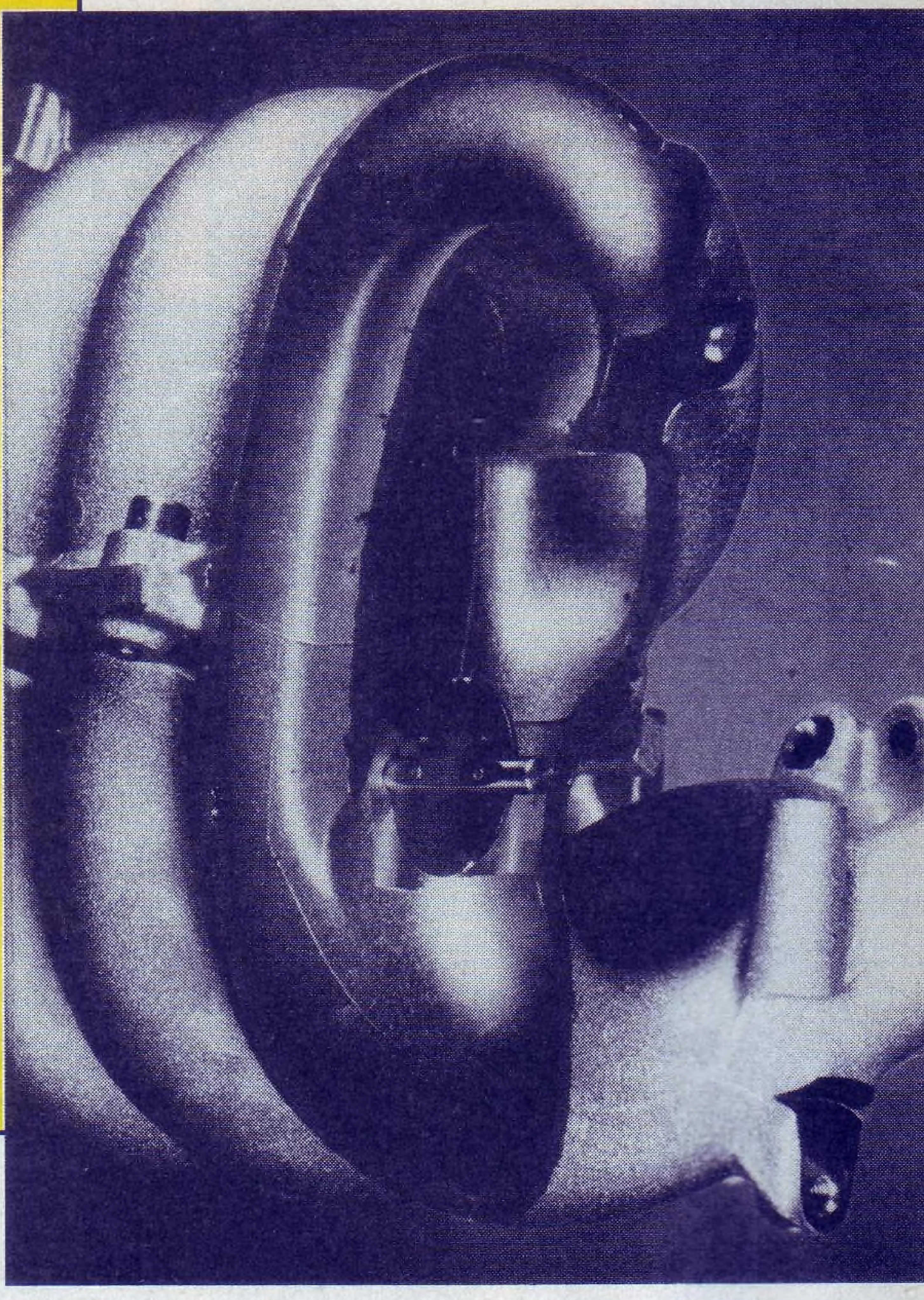


Fig.2: this sectional diagram shows the dual-resonance intake system used in the EF Falcon. The crossover butterfly valves are controlled by the EEC-V engine management system. The cutaway view of the variable length intake manifold at right clearly shows one of the crossover butterfly valves. The valve operation is dependent on engine rpm.

cided on after evaluating a pulse width modulation (PWM) system. The PWM system had the advantage of allowing stepless variable fan speed control but it was not selected because it was not sufficiently proven to meet Ford in-service durability criteria.

Intake manifold control

The new EF Falcon features a clever and compact dual intake runner system for the manifold. Depending on the movement of six internal crossover butterfly valves, the intake air is either forced to flow through a short primary runner only or to take a longer path through a secondary runner. Fig.2 shows a cross section of the intake system.

The different resonance characteristics of the dual length runners means that the volumetric efficiency of the engine is boosted at two different rpm points, rather than at a single point as for a single fixed length runner. By using dual-length runners, the resonant behaviour of the intake system can be tuned to provide maximum torque at low engine speeds and maximum power at high engine rpm, without one compromising the other.

Engine dynamometer testing by Ford indicated that a transition between short and long runners at 3800rpm gave the best results for the Falcon's engine. In particular, the new engine has worthwhile improvements in both power and torque compared to the previous single length manifold ED design.

Engine rpm is the single control criteria used to activate the manifold changeover. This is achieved by using the EEC-V module to control a solenoid which, in turn, directs an engine vacuum source to actuate the butterflies. **SC**

The bar across the under-bumper air intake on Fairmont models (left) needs to be precisely angled during manufacture so that it doesn't degrade cooling performance. The above-bumper grille is a dummy & is there for styling only!

Acknowledgement

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