DEALER TRAINING

Delanair Mk. IV Air Conditioning System

JAGUAR

The New
Jaguar and Daimler

DELANAIR MK IV AIR CONDITIONING UNIT

The new air conditioning system has been designed to give a far greater level of control and comfort. This has been achieved by the use of advanced electronics, which control the operation of the system by means of a control unit containing a microprocessor.

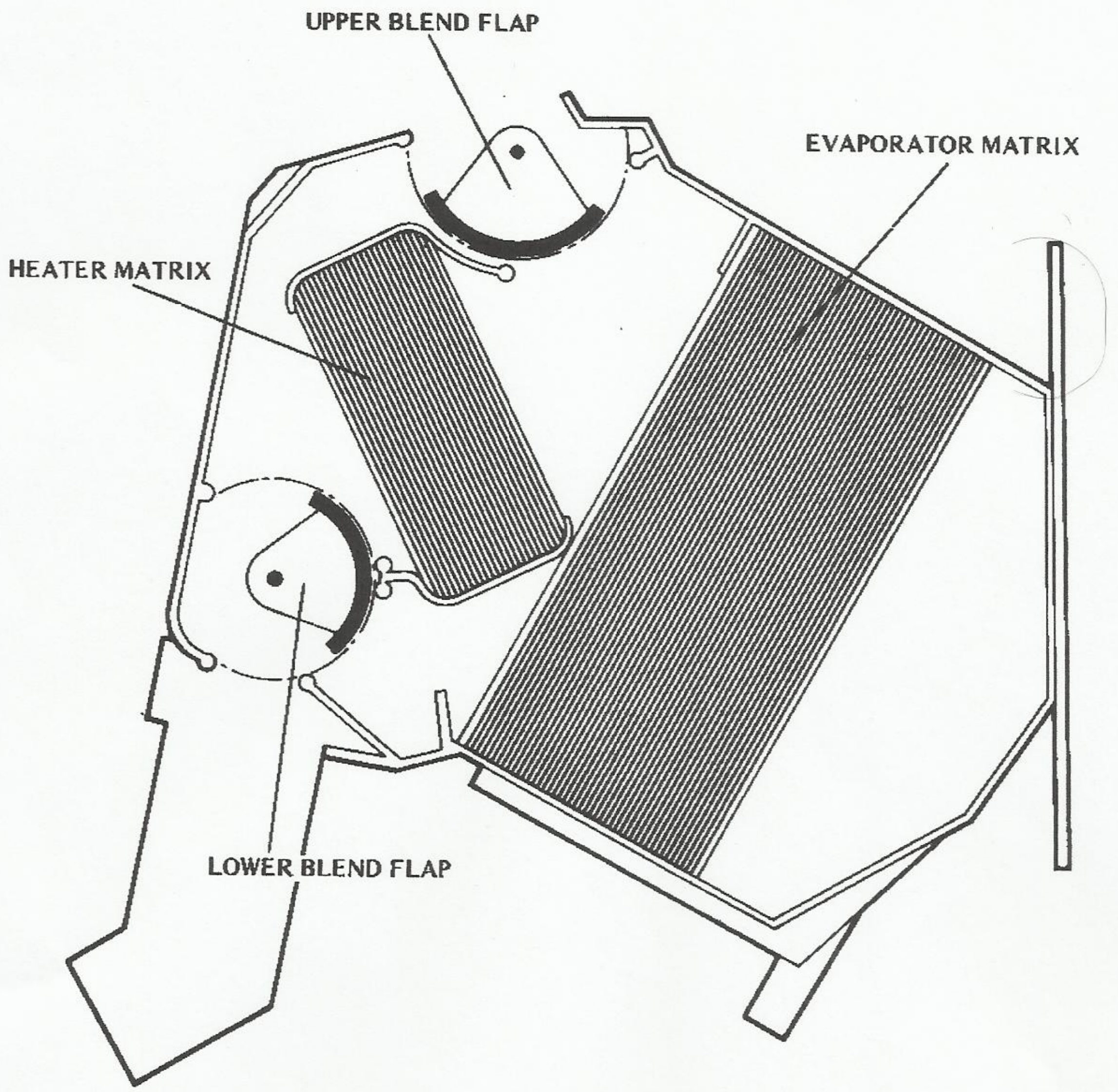
Its comparison with the Mk II unit can be assessed from the list below:—

1. Increased heating capacity — larger matrix.
2. Increased cooling capacity – evaporator capacity increased.
3. Temperature control in car can be maintained within a closer tolerance.
4. Stepless air flow control.
5. Weight reduction due to modern materials.
6. The ability to vary the difference in temperature between face level and footwell outlets.
7. The inclusion of humidity control used to vary the amount of moisture in the air as it enters the vehicle.
8. The ability to switch off the air conditioning function and use the system as a heater only.
9. The ability to switch between fully automatic and manual modes.

PRINCIPLES OF OPERATION

The unit is constructed from high density plastics giving rigidity and weight reduction. The case is constructed in three parts, the rear section houses the evaporator matrix, the front is divided into two halves housing the heater matrix and the two rotary blend flaps.

The air from the two blower motors (situated under the dashboard either side of the unit) is passed through the evaporator matrix (Fig. 1) which removes heat from the incoming air and, depending on the position of humidity buttons, moisture (See Fig. 2). Depending on the position of the two blend flaps, one for upper level, the other for footwell level temperatures, the cold air either passes directly to the distributor outlets within the vehicle, or is passed through the heater matrix (Fig. 1) to be reheated and then to the vehicle outlet vents. The amount of air passing through the heater matrix is infinitely variable depending on ambient temperature and temperature selected within the vehicle. This information is passed to the control unit which in turn controls the position of the rotary flaps. The rotary flaps are driven to the position required by a motor and gearbox, one on each flap, and the flaps are monitored by feedback potentiometers and are connected to the control unit. (See Figs. 3 and 4).



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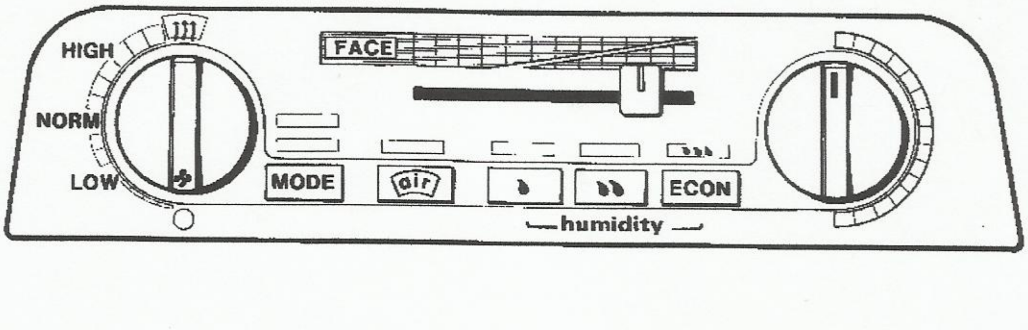
SECTIONED AIR CONDITIONING UNIT



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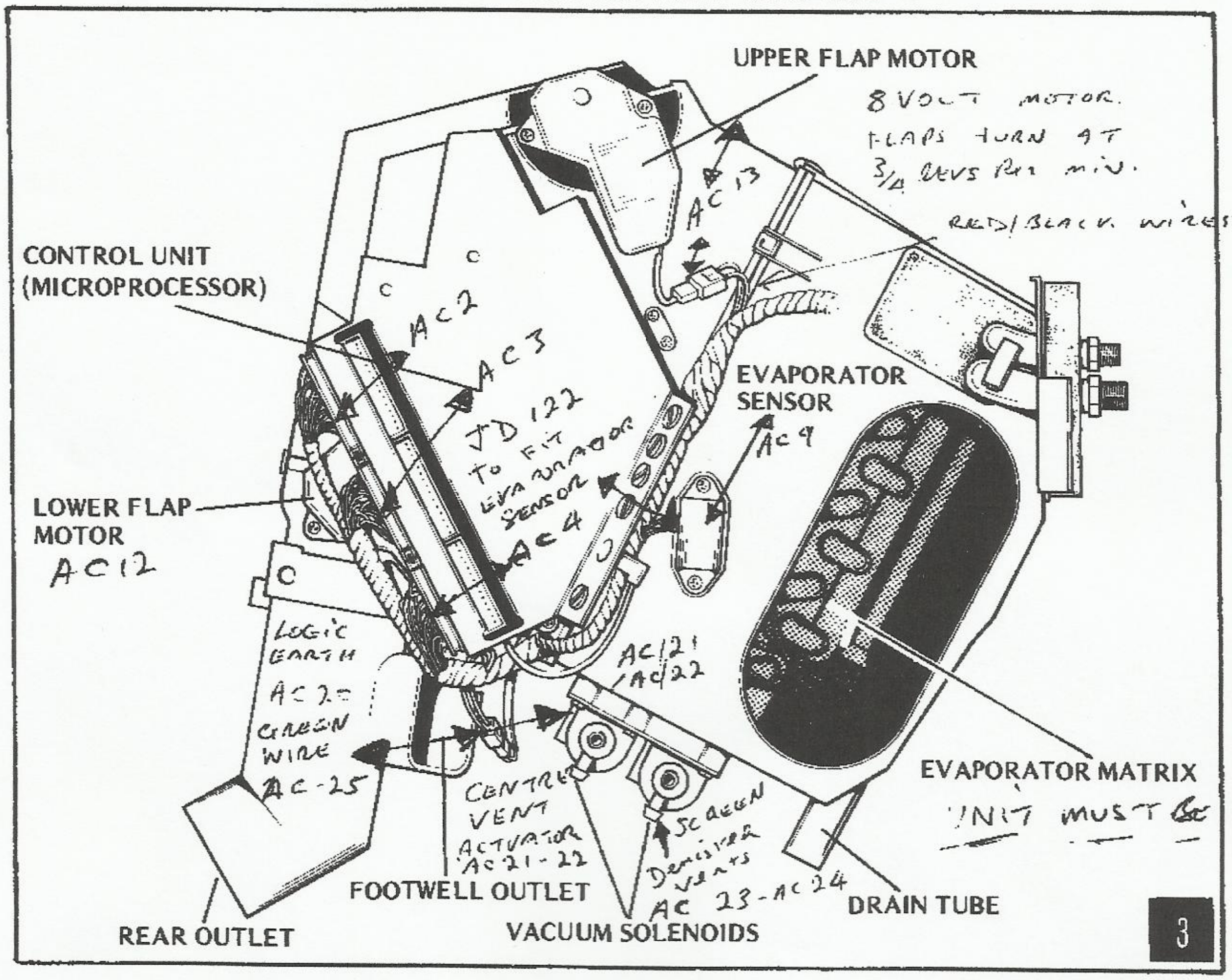
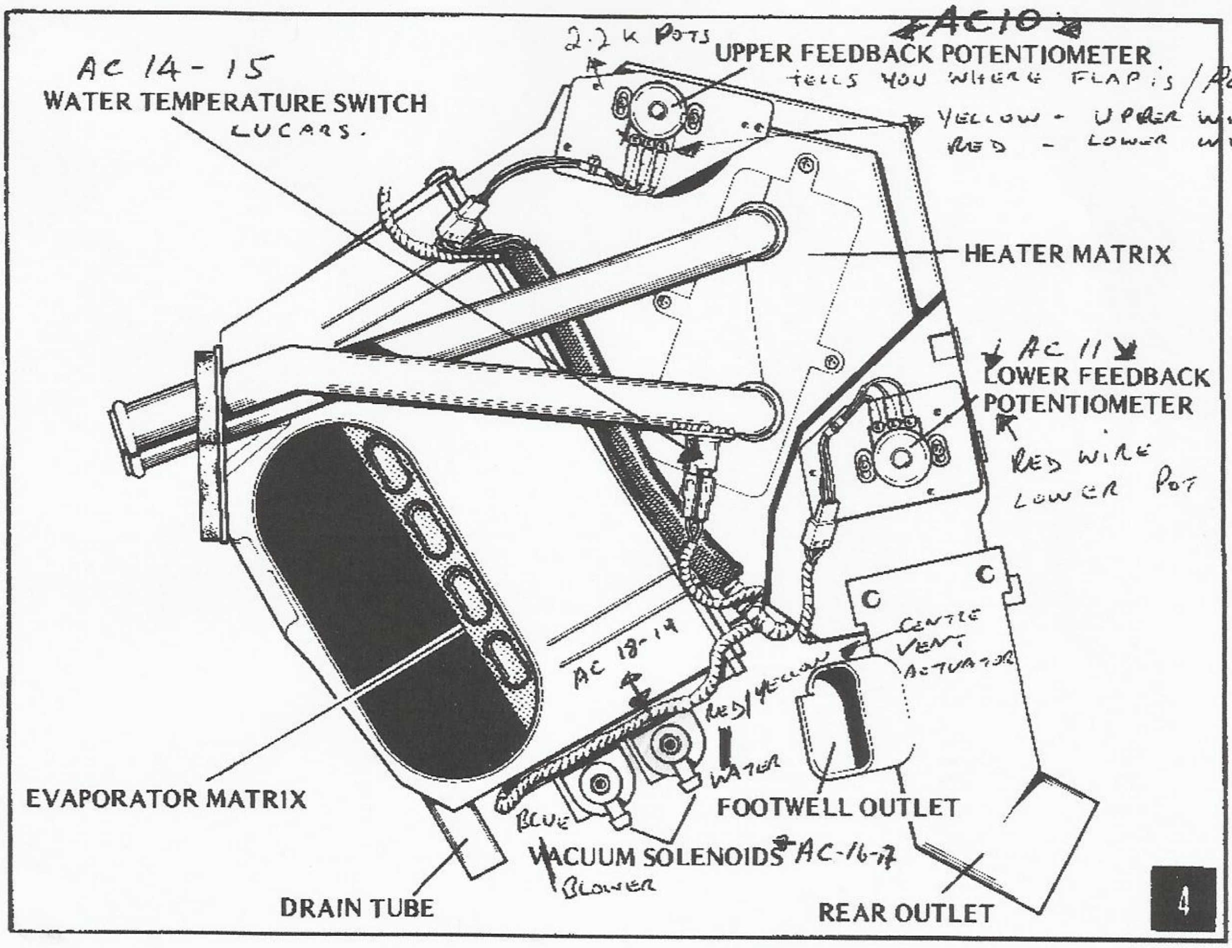
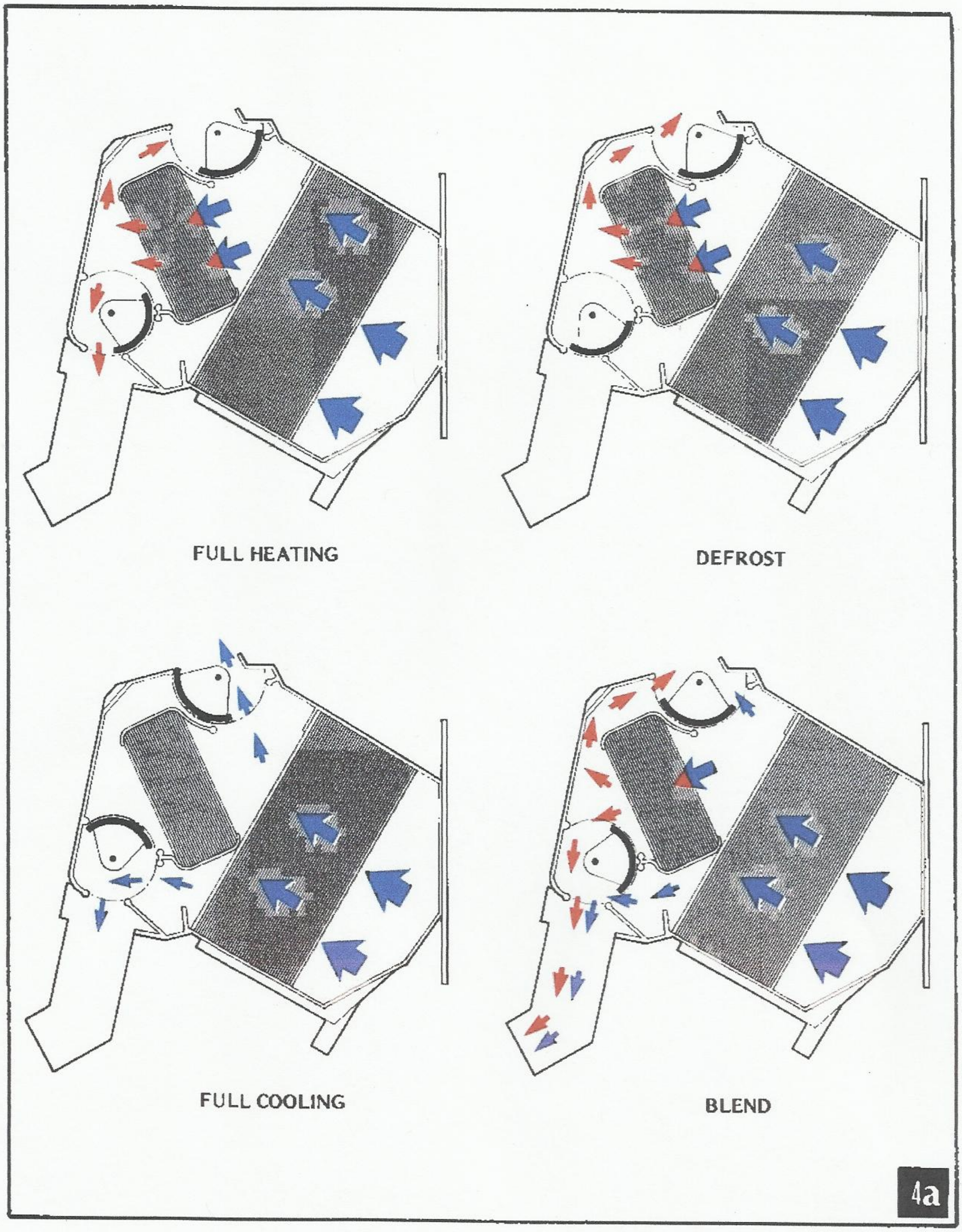
DRIVER'S CONTROL MODULE

* AIR CONDITIONING UNIT RIGHT HAND VIEW * JS7 *

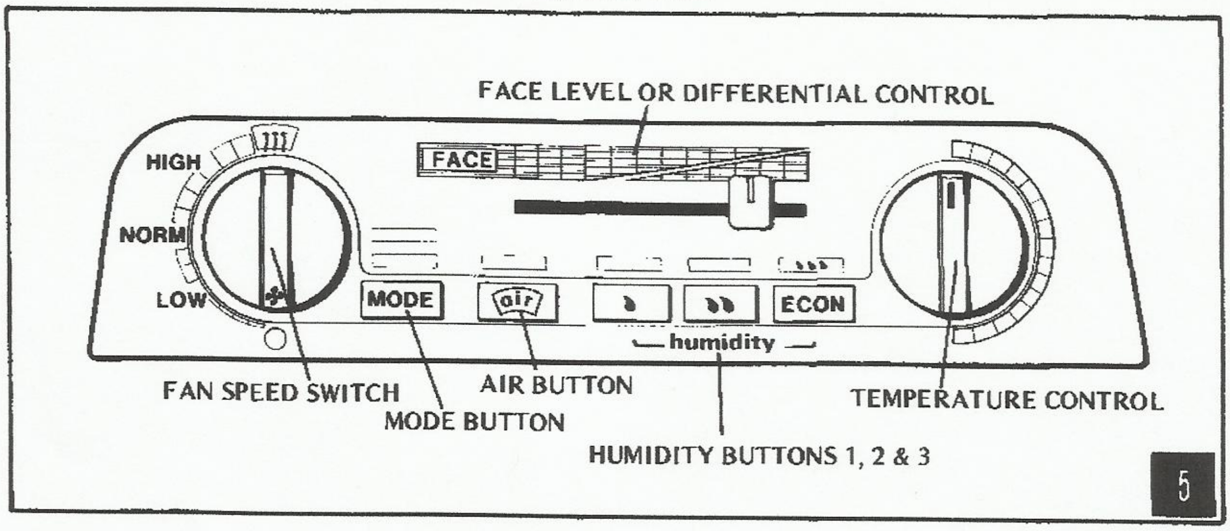






Shown above are positions taken up by the flaps and the air flow through the unit in four possible situations.

FIG. 5 – AIR CONDITIONING DRIVER'S CONTROL MODULE



SYSTEM CONTROL

The complete system can be sub-divided into separate sections:

1. Function control system.
2. Sensing system.
3. Temperature and distribution control system.
4. Airflow control system.
5. Vacuum system.
6. Heating and refrigeration system.
7. The control module (micro).

SECTION 1 – FUNCTION CONTROL SYSTEM

This system covers all the inputs to the microprocessor from the visible controls.

L/H Switch (Fig. 5) Blower Fan Switch

This switch has five positions and is used to control the amount of air distributed by the blower fans.

Off (O)

The control module is not operating, but a signal is sent to close the flap in the blower assemblies so that air cannot enter from the outside. This function is controlled by the recirulation vacuum solenoid.

Low, Normal, High

Information regarding fan speeds is fed to the control unit. There are no steps between "Low" and "Normal" fan speeds as they are electronically variable depending on demand. "High" speed is a fixed fan speed.

Defrost

This position is used to defrost or demist the screen as quickly as possible. When this position is selected, the system moves to "High" fan speed, opens the screen vents, goes to full heating and also closes the lower level fully (this can take a maximum of 30 seconds).

R/H Switch

Temperature selection switch. This is used to select the desired in-car temperature.

Mode Button (Auto)

When this button is in the "auto" position the control system maintains the interior of the vehicle at the desired temperature. Information supplied by the sensors is fed to the control unit which compensates for exterior ambient condition and then decides which fan speed and flap position is required.

Mode Button (Manual)

In this position information from the sensors is overridden and the system will maintain the output air at the temperature selected regardless of ambient conditions.

Air

When this button is pressed during normal operation of the air conditioning system there will be an increase in the amount of air delivered to the screen via the screen flaps.

Face (Fig. 5)

When this slider control is positioned fully to the right the air being delivered to the face and footwell outlets will be at the same temperature. Moving this control from right to the full left position reduces the temperature of the air being delivered to the face level vents.

Humidity Control

The three buttons illustrated in Fig. 5 control the interior humidity of the vehicle.

They work by regulating the evaporator temperature, via the evaporator sensor.

Button 1 (Fig. 5)

Button 1 is identified by one teardrop, if switched to its "on" position a red indicator is illuminated, if pressed again the red indicator will go out.

Button 2 (Fig. 5)

Button 2 has two teardrops, and is switched on and off as above. This switch also has a red indicator.

Button 3 (Fig. 5)

Button 3 is marked "Econ". When pressed three teardrops will illuminate above the switch and this indicates that the compressor is switched off. Pressing this switch once more will extinguish the indicator and re-engage the compressor.

When there are no teardrops or red indicators illuminated,the interior humidity of the vehicle will be at its lowest.

To recap then:

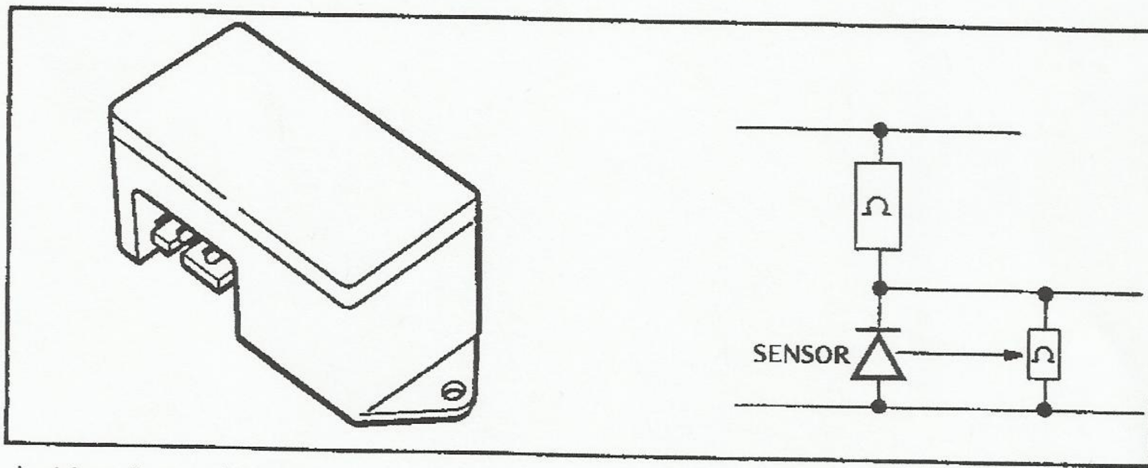
1. No teardrops or red indicator – humidity level at its lowest.
2. One teardrop – humidity a little higher.
3. Two teardrops – humidity a little higher still.
4. Three teardrops - humidity level the same as incoming air because the compressor is not operating.

SECTION 2 – SENSING SYSTEM

This section covers the inputs into the control unit from the sensors, etc.

In-Car Sensor (Fig. 6)

This sensor is located above the glove box. The sensor is a semi-conductor device and is far more accurate than the older thermistor type.



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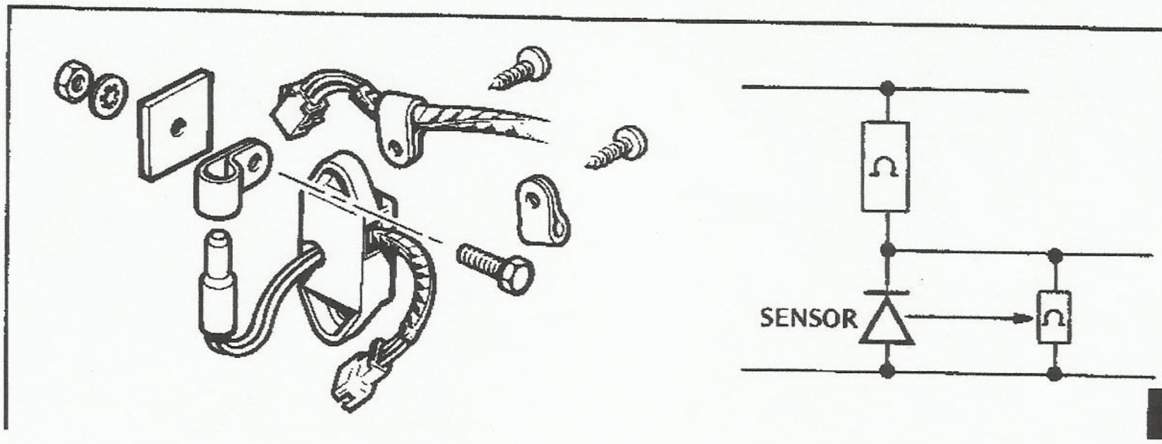
Ambient Sensor (Fig. 7)

The ambient sensor is located on the R/H blower motors recirculation/fresh air flap. It will measure the temperature of the incoming air. However its effect can be regarded as one tenth of the effect of the in-car sensor.



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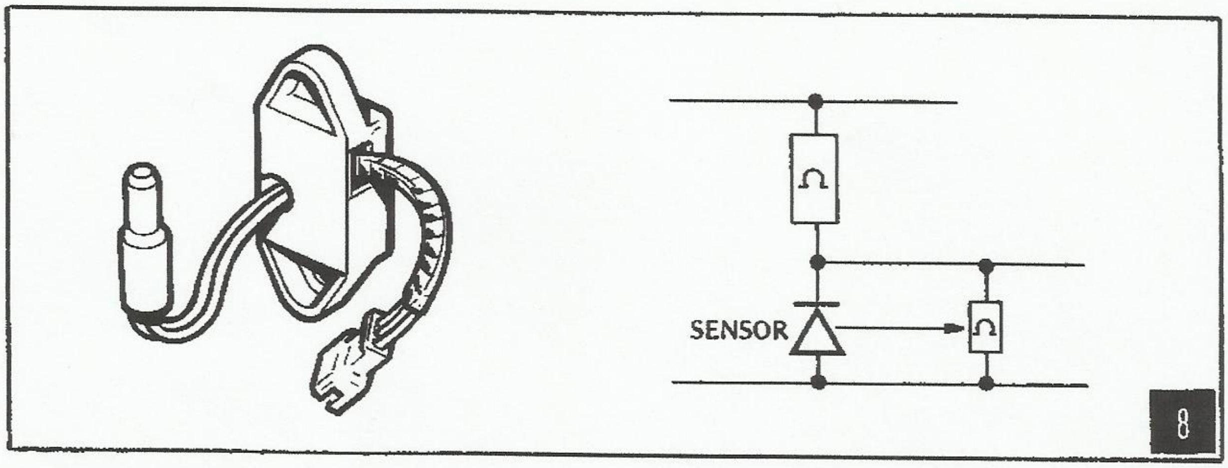
Evaporator Sensor (Fig. 8)

The evaporator sensor has its temperature sensing semi-conductor housed in a bullet which is inserted into the evaporator core. The sensor will send the appropriate signal to the control unit when the evaporator temperature falls to a certain level. The control unit will then switch off the compressor. The sensor's operating range is controlled by the humidity buttons mentioned earlier.

With no buttons operating, evaporator temperature will be regulated at 0°C ± .25°C.

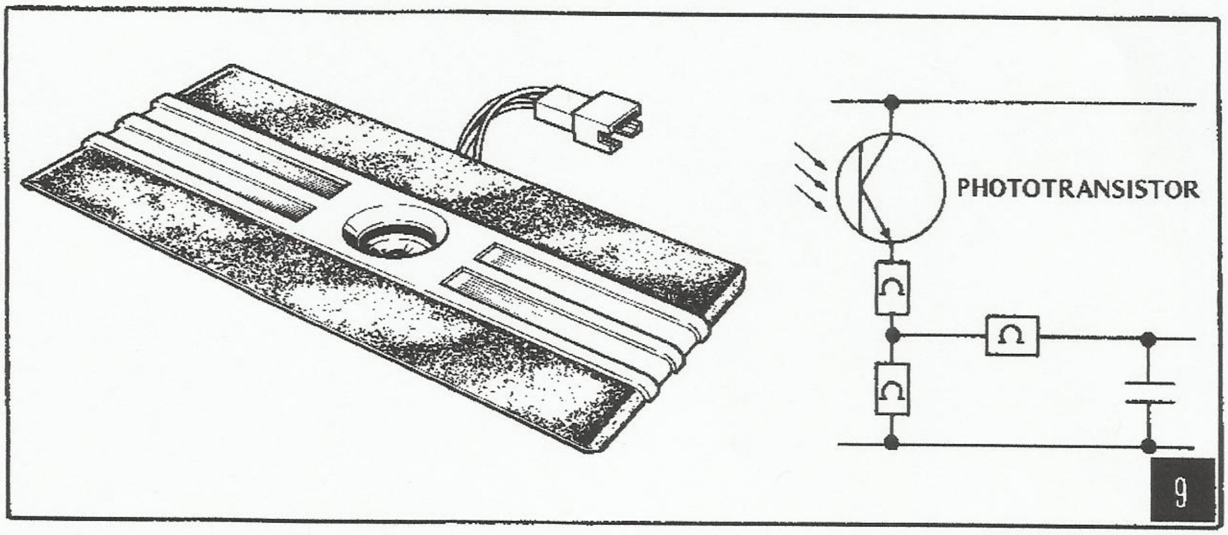
With button number 1 activated, evaporator temperature will be regulated to 3.0°C ± .25°C.

With button number 2 activated, evaporator temperature will be regulated to 5.5°C ± .25°C.



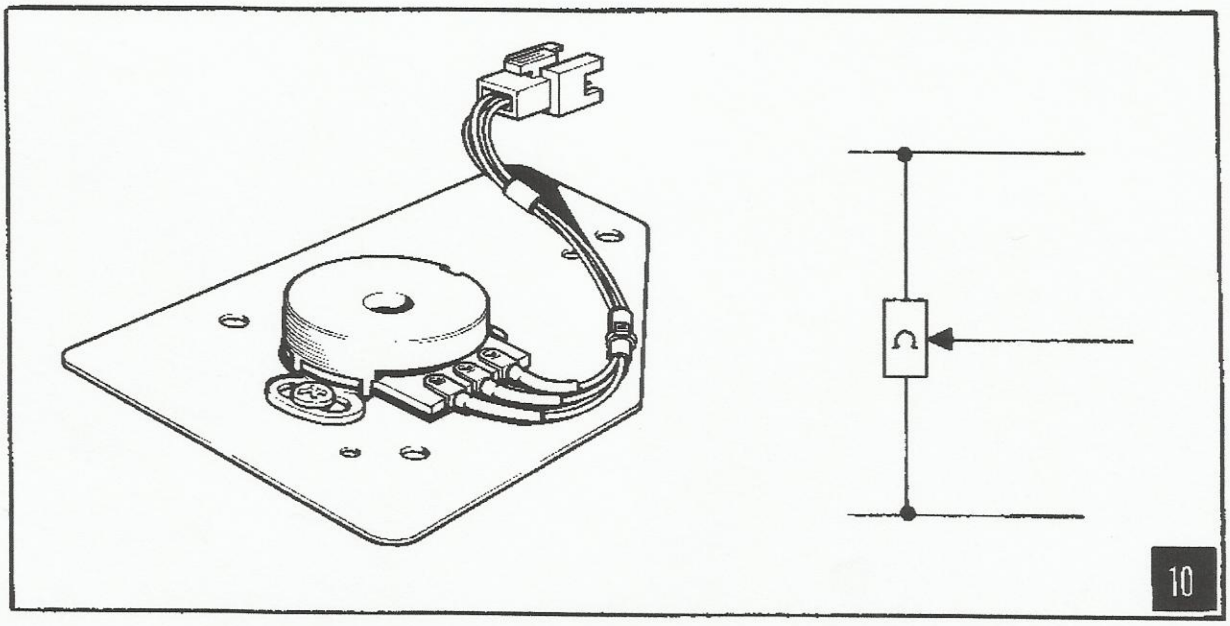
Solar Sensor (Fig. 9)

This sensor is different in construction from the other three sensors in that it is constructed around a photo-transistor. It is mounted on top of the dash, in between the screen outlets. The photo-transistor will measure the direct sun light and reduce the temperature demand by 2°C. This will effectively leave the in-car temperature stable whilst reducing outlet temperature to compensate for increased solar load.



Feedback Potentiometers (Fig. 10)

Lower and upper flap feedback potentiometers relate information to the control unit regarding the exact position of the flaps. These potentiometers are fitted to the bracket and are factory pre-set. They are mounted on the left hand side of the unit, one to each flap.



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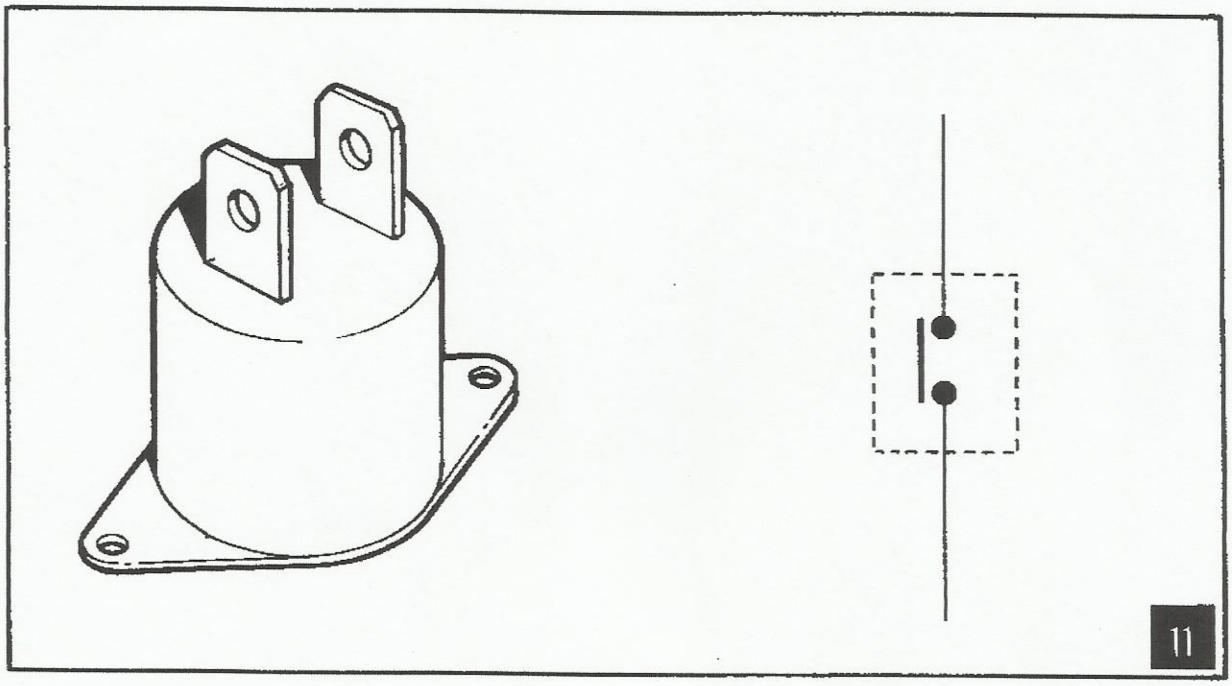
Water Temperature Switch (Fig. 11)

This switch prevents the fans from operating when the system is demanding heat, until relatively hot water (i.e. approximately 30°C) is flowing into the heater matrix.

However, like the previous system, fans will operate if cooling is demanded and also when defrost is selected.



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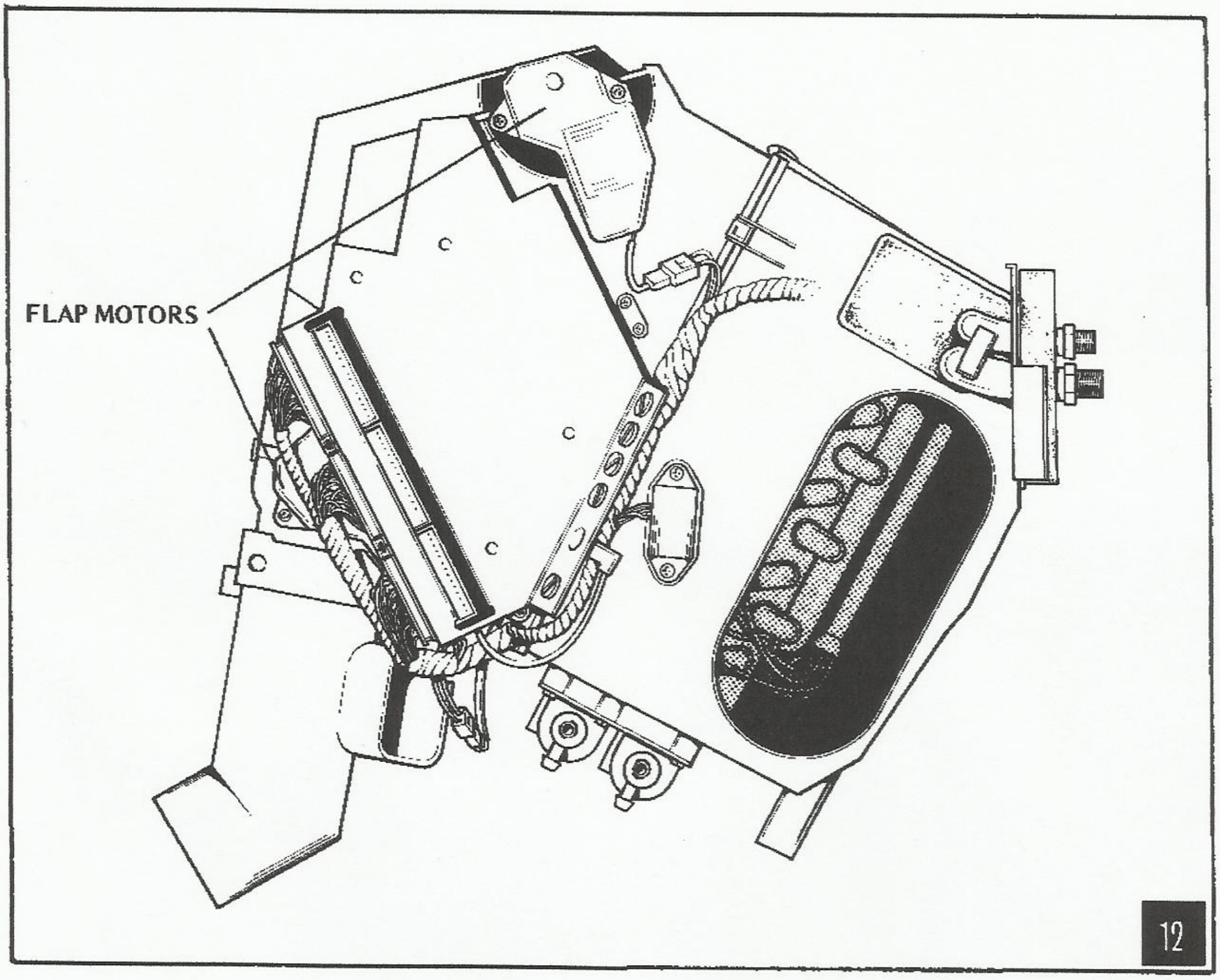
SECTION 3 – TEMPERATURE AND DISTRIBUTION SYSTEM

The control unit gathers all the information contained in sections 1 and 2 and decides the position each rotary flap should be in. It then compares, via the feedback potentiometers, desired position and actual position and moves the flaps by sending signals to the flap motors. The control unit can also select one of three speeds in order to move the flaps, this will depend on how far the flaps are from the desired position. Finally, it inches the flap into position at the slowest speed

Flap Motors (Fig. 12)

The two flap motors are identical, with a reduction of 1500:1 and having a maximum speed of 0.75 r.p.m. connecting directly to each flap and secured by two screws.



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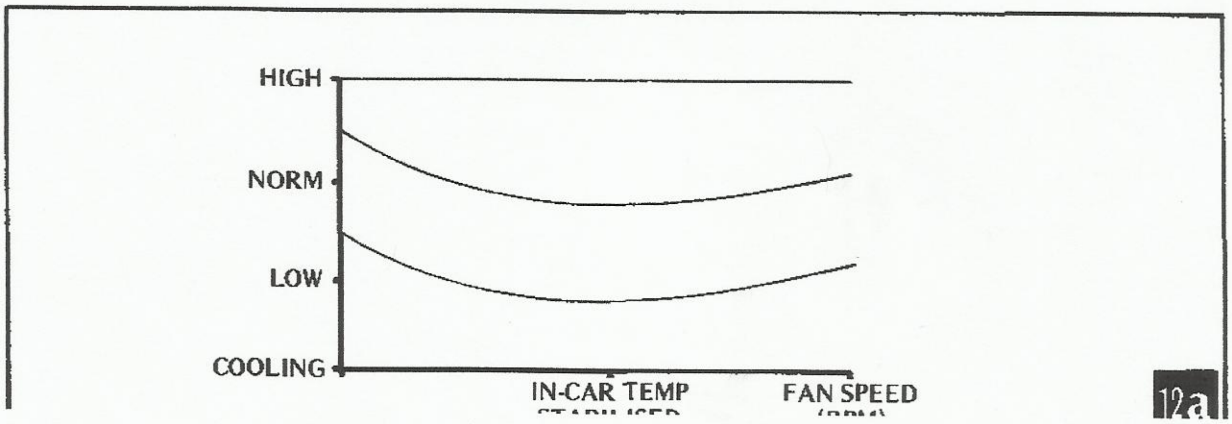
SECTION 4 – AIRFLOW CONTROL SYSTEM

This system governs the fan speeds on the "Low" and "Norm" positions. The control unit has a program written into its memory which supplies data concerning fan speeds. When the system has eliminated the temperature error in the car, the fans will be running at their slowest speed for the range selected. When there is a slight error the fans will run faster, the larger the error the higher the fan speed will be within the selected range, i.e. "Low" or "Norm". Selecting "High" will produce a fixed high fan speed as will selecting "Defrost". When "High" or "Defrost" is selected a relay is operated in each fan casing to achieve high fan speed. See graph below.



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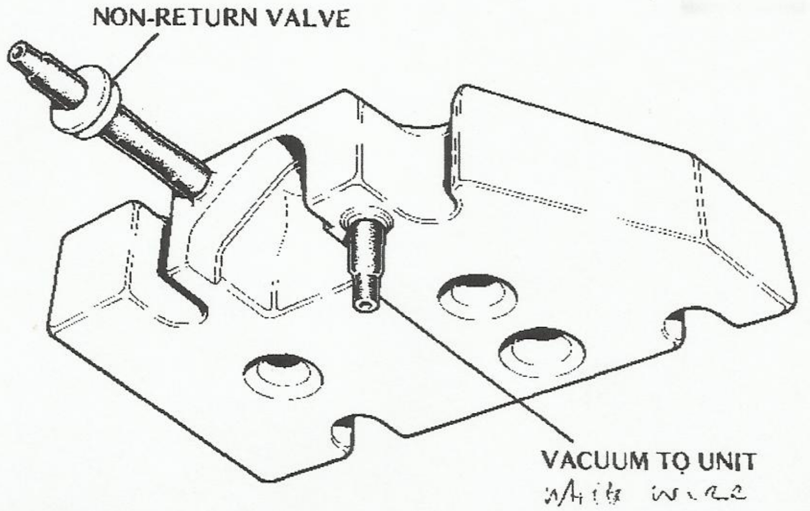
SECTION 5 – VACUUM SYSTEM

Vacuum for the system is supplied from the inlet manifold, via a non-return valve and a reservoir (Fig. 13). This reservoir supplies four vacuum solenoids mounted on two plates which are located behind the front footwell outlets.



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The vacuum solenoids are operated by the microprocessor and control the following:–

Defrost Solenoid (Fig. 14)

The green coloured vacuum pipe operates demist/screen flaps when mode switch is in defrost position. Flaps are held closed with vacuum. This solenoid is also operated when the "Air" button is pressed, if the mode switch is not in the defrost position.

Centre Vent Solenoid (Fig. 14)

The black-coloured vacuum pipe operates the centre vent actuator by applying vacuum. This will partially open the centre vent.

Recirculation Solenoid (Fig. 14)

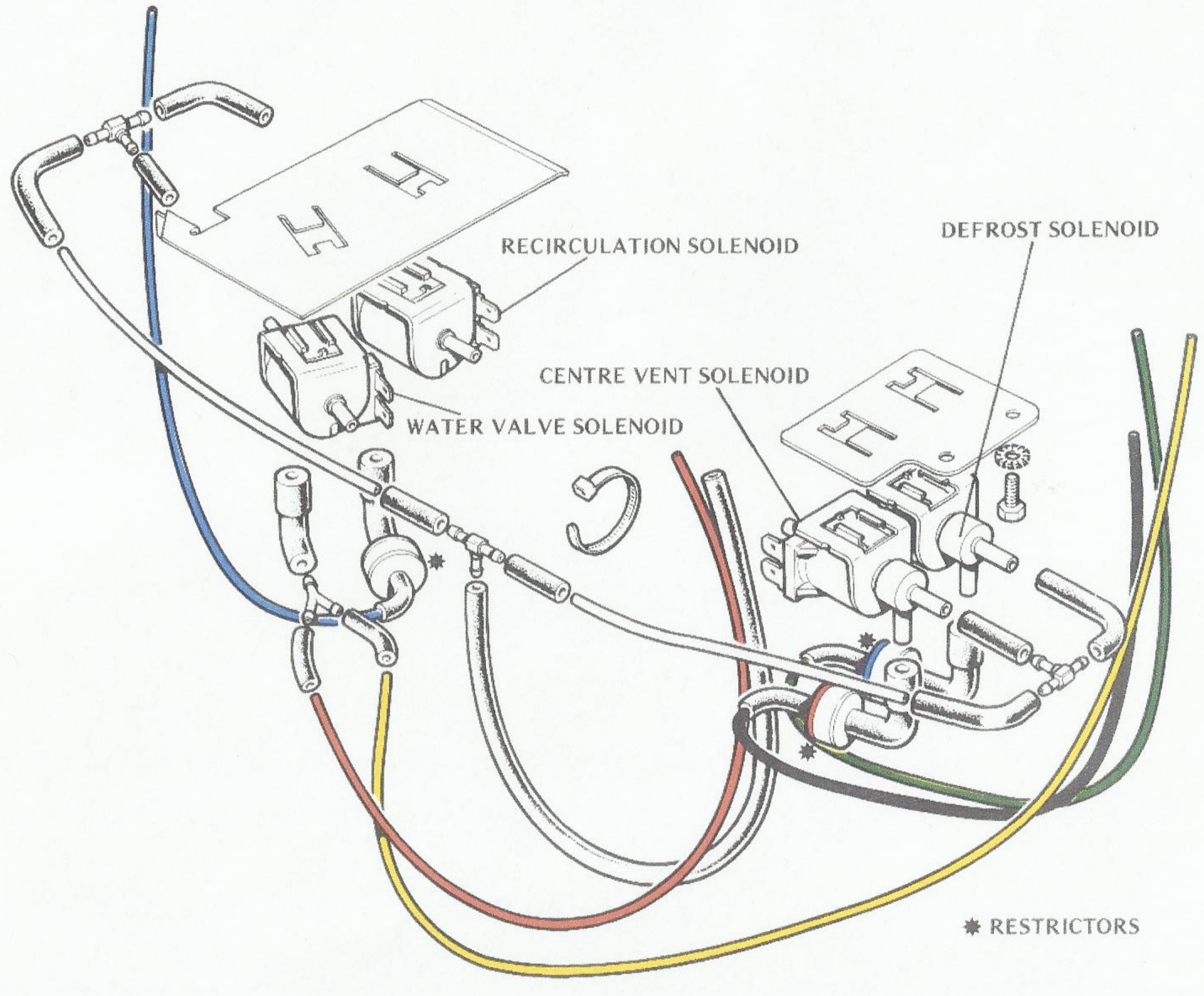
The blue-coloured vacuum pipe operates the recirculation/ambient flap. When this solenoid is operated the flap is held closed to ambient air.

Water Valve Solenoid (Fig. 14)

A red and a yellow vacuum pipe are connected to the water valve solenoid.

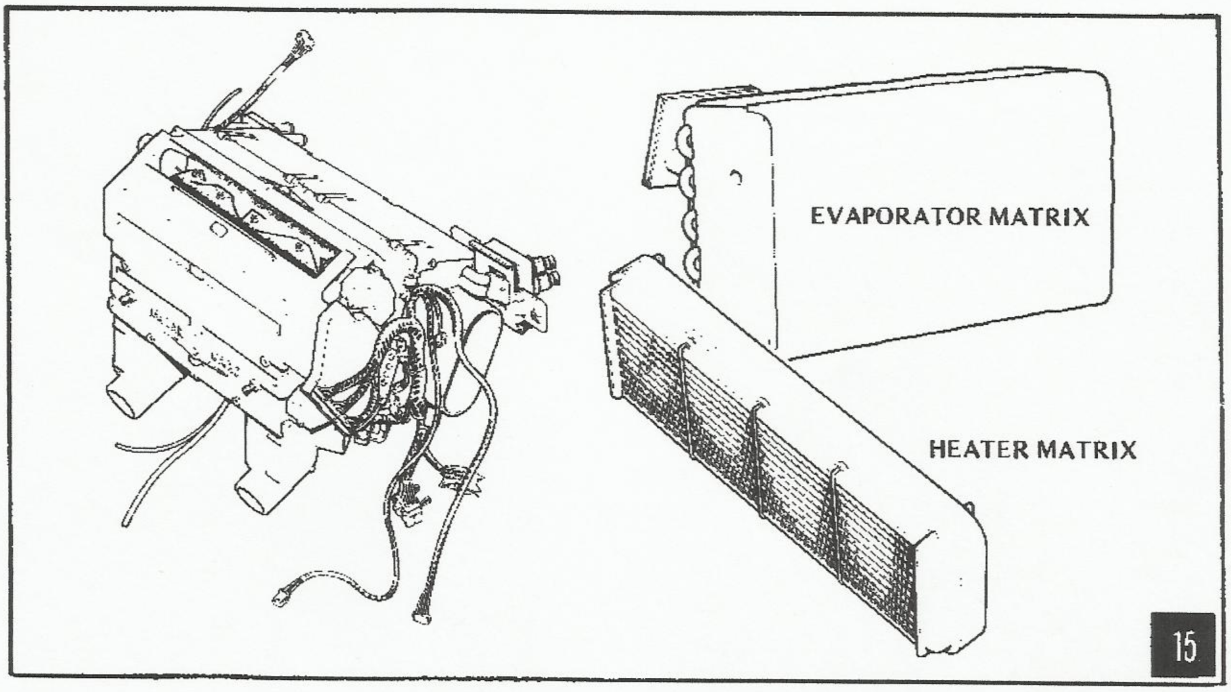
When the solenoid is operated vacuum is applied to the water valve to close it via the red pipe. The yellow pipe is taken to the centre vent actuator and operates in conjunction with the vacuum from the centre vent solenoid to fully open the centre vent.
The vacuum supply pipes to the recirculation/ambient, defrost and centre vent actuators have restrictors built into them (Fig. 14). These restrictors slow the operation of the flap to avoid the risk of the system hunting due to quick movement of the flaps causing sudden changes in temperature. NOTE that these restrictors are also colour coded and must be fitted to the appropriate vacuum solenoid.

The solenoids are similar in operation to the previous ones (Delanair III) and they only require a small current to operate. They are controlled by the microprocessor.


RECIRCULATION SOLENOID
DEFROST SOLENOID
CENTRE VENT SOLENOID
WATER VALVE SOLENOID
* RESTRICTORS

SECTION 6 – REFRIGERATION SYSTEM

The refrigeration system is similar to previous systems used by Jaguar Cars, but the cooling capacity has been improved by increasing the size of the evaporator. The heater has also been improved by increasing the efficiency and size of the heater matrix (Fig. 15). Refrigerant and oil quantities are the same as previous systems.

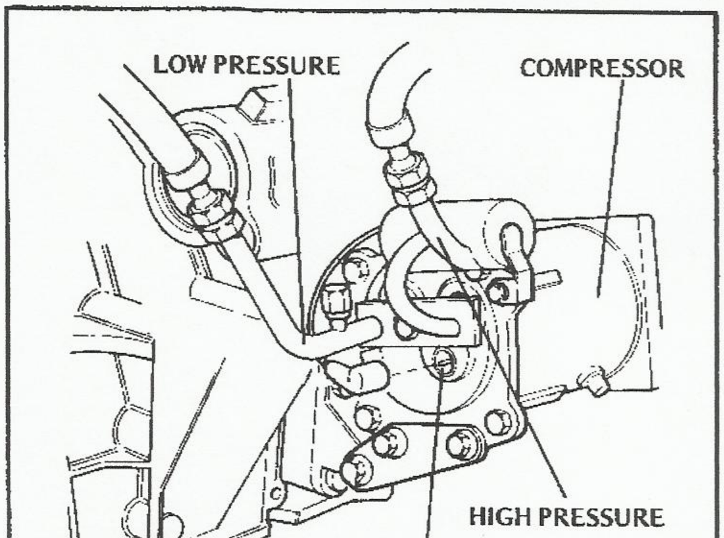


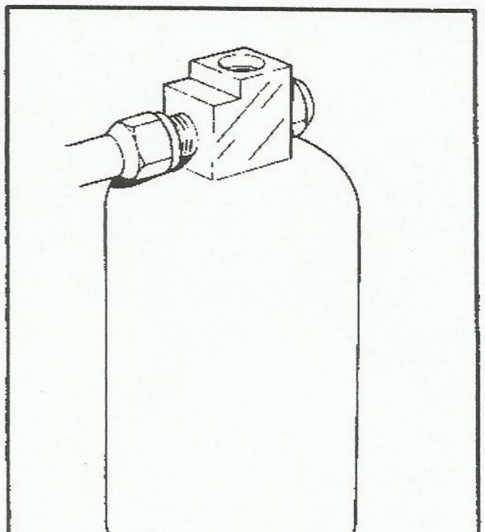
The system is operated by a belt driven compressor (Fig. 16) to draw the low pressure refrigerant from the evaporator. The compressor then raises the pressure and also temperature of this vapour and passes it to the condenser where heat is given off to the outside. As this heat is given off the high pressure vapour changes into a lower temperature, high pressure liquid. It is then passed on to the receiver/drier (Fig. 17). The receiver/drier has three functions:–

1. It acts as a storage tank for the evaporator (the quantity required by the evaporator varies widely).

2. The filter inside the receiver/drier removes foreign particles from the refrigerant.

3. A sachet of dessicant (silica gel crystals) removes any water particles.

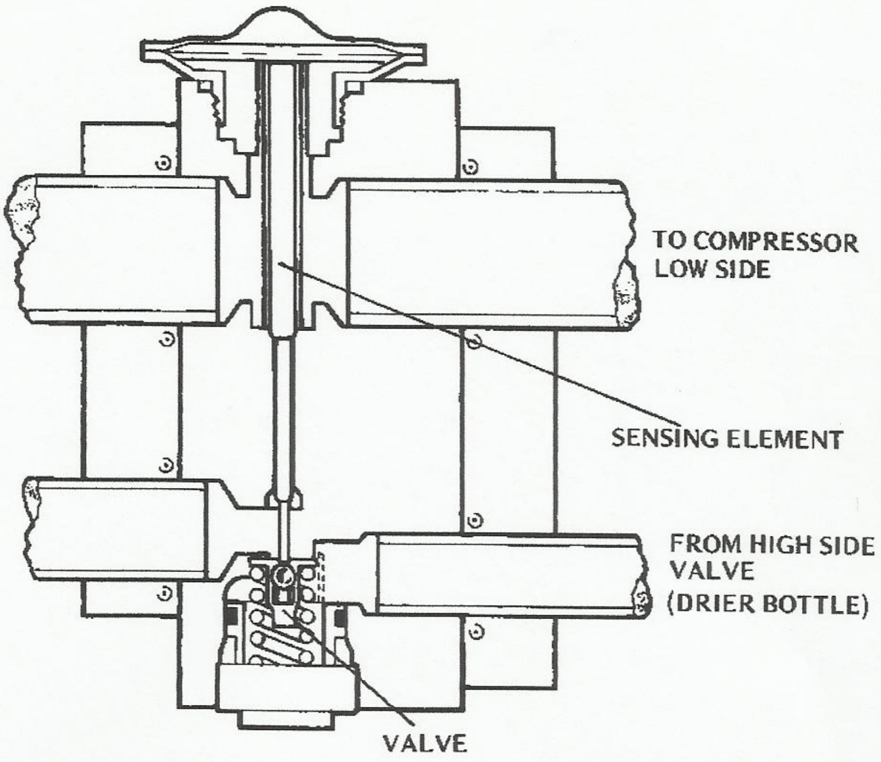




Refrigerant from the receiver/drier enters the expansion valve as a high pressure liquid. As it passes through the metering orifice the pressure drops so does the temperature. This low pressure low temperature atomized refrigerant enters the evaporator colder than the temperature of the air in the vehicle, so a heat exchange takes place. As this heat is taken on by the refrigerant it changes state back into a vapour. This vapour passes into the compressor; this cycle is then repeated.

The expansion valve now used is different to the previous one; it is called a "block valve" (Fig. 18). This valve does not have a capillary bulb sensor or an external equalizer connection as in the previous type.

Control of the valve is accomplished by the return gas from the evaporator passing directly over the sensing element; this is in direct contact with the suction vapour. This method gives a very positive response of the valve to the temperature returning in the suction line.



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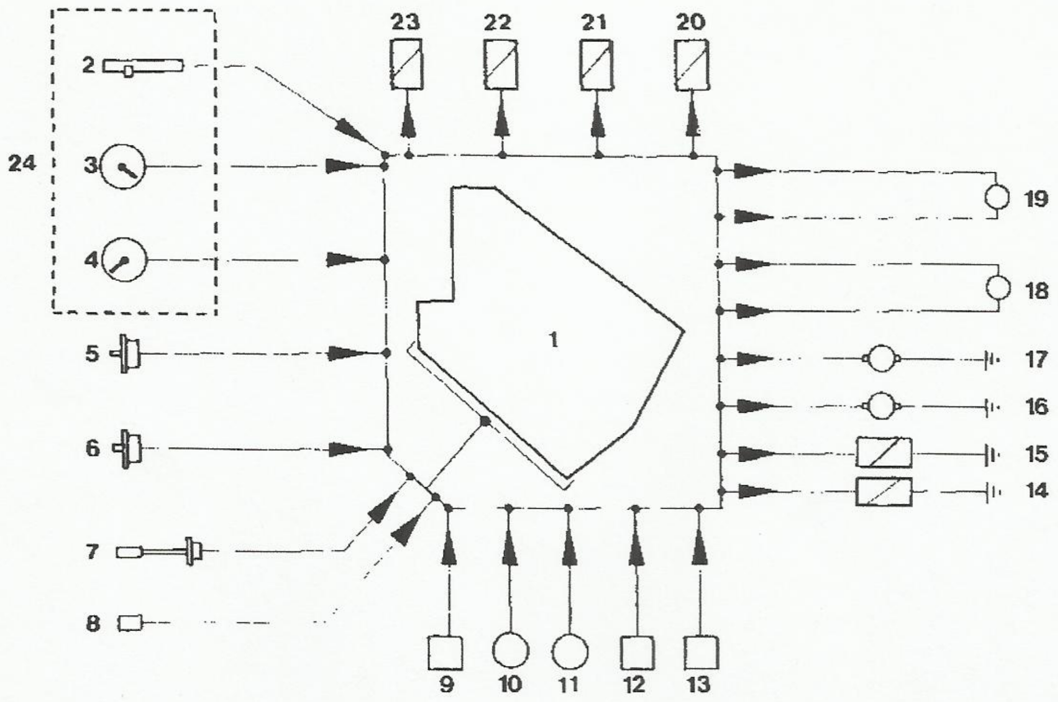
SECTION 7 – THE CONTROL MODULE (MICRO)

The heart of the control unit is a microprocessor. By using the advanced technology available now, Delanair have been able to design and produce a control system which can accurately and consistently control the environment in the vehicle to levels which have not been achieved by any other system. (See Fig. 19).

The system can control the temperature to within 0.5°C using the advanced microprocessor technology.

The control system can be briefly explained without going too deeply into electronics.

The microprocessor uses the digital system to communicate. The term digital means basically an on/off signal, in other words the micro is off when the voltage is below 0.7 volts and on when the signal is above 0.7 volts. However, most of the components within the system require a variable signal to carry out their function, which is termed analogue. An example is the rotary flaps which



1 CONTROL MODULE
2 DIFFERENTIAL TEMPERATURE CONTROL
3 TEMPERATURE CONTROL
4 BLOWER MOTOR SWITCH
5 AMBIENT TEMPERATURE SENSOR
6 IN-CAR TEMPERATURE SENSOR
7 EVAPORATOR TEMPERATURE SENSOR
8 SOLAR SENSOR
9 COOLANT TEMPERATURE SWITCH
10 FLAP FEEDBACK POTENTIOMETER
11 FLAP FEEDBACK POTENTIOMETER
12 BLOWER MOTOR FEEDBACK
13 BLOWER MOTOR FEEDBACK
14 HIGH SPEED RELAY
15 COMPRESSOR CLUTCH RELAY
16 BLOWER MOTOR
17 BLOWER MOTOR
18 FLAP SERVO MOTOR
19 FLAP SERVO MOTOR
20 DEFROST VACUUM SOLENOID
21 RECIRCULATION VACUUM SOLENOID
22 CENTRE VENT VACUUM SOLENOID
23 WATER VALVE VACUUM SOLENOID
24 DRIVER'S CONTROL MODULE

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INPUTS AND OUTPUTS TO THE MICROPROCESSOR

interpreter so that it can understand degrees. This interpreter is called electronically an A.D.C. (analogue to digital converter). So now, by using a potentiometer connected to the rotary flap we can send a varying signal to the A.D.C. which will then communicate with the microprocessor.

In exactly the same way the A.D.C. will receive similar signals from the temperature sensors, the temperature demand control and the temperature differential control, and will then tell the microprocessor what these values are (in digital code).

The control unit then compares these values and the function control switches instructions and determines, separately, for upper and lower levels, whether cooling or heating is required and by what amount.

The flap motors and the fan motors have variable speeds (analogue) so again the microprocessor must talk to an interpreter, a D.A.C. (digital to analogue converter) which has a low output, too low to operate a motor so the outputs pass through an amplifier so that the signal is strong enough to operate the flap motors and the fan motors.

The control unit also has to control four vacuum solenoids. Two relays for high speed fans and a relay for the compressor clutch. These are on/off signals but still too high for the microprocessor to control directly, so again they pass through an amplifier.

The other factors that we have to consider are voltage requirements and protection for the electronics.

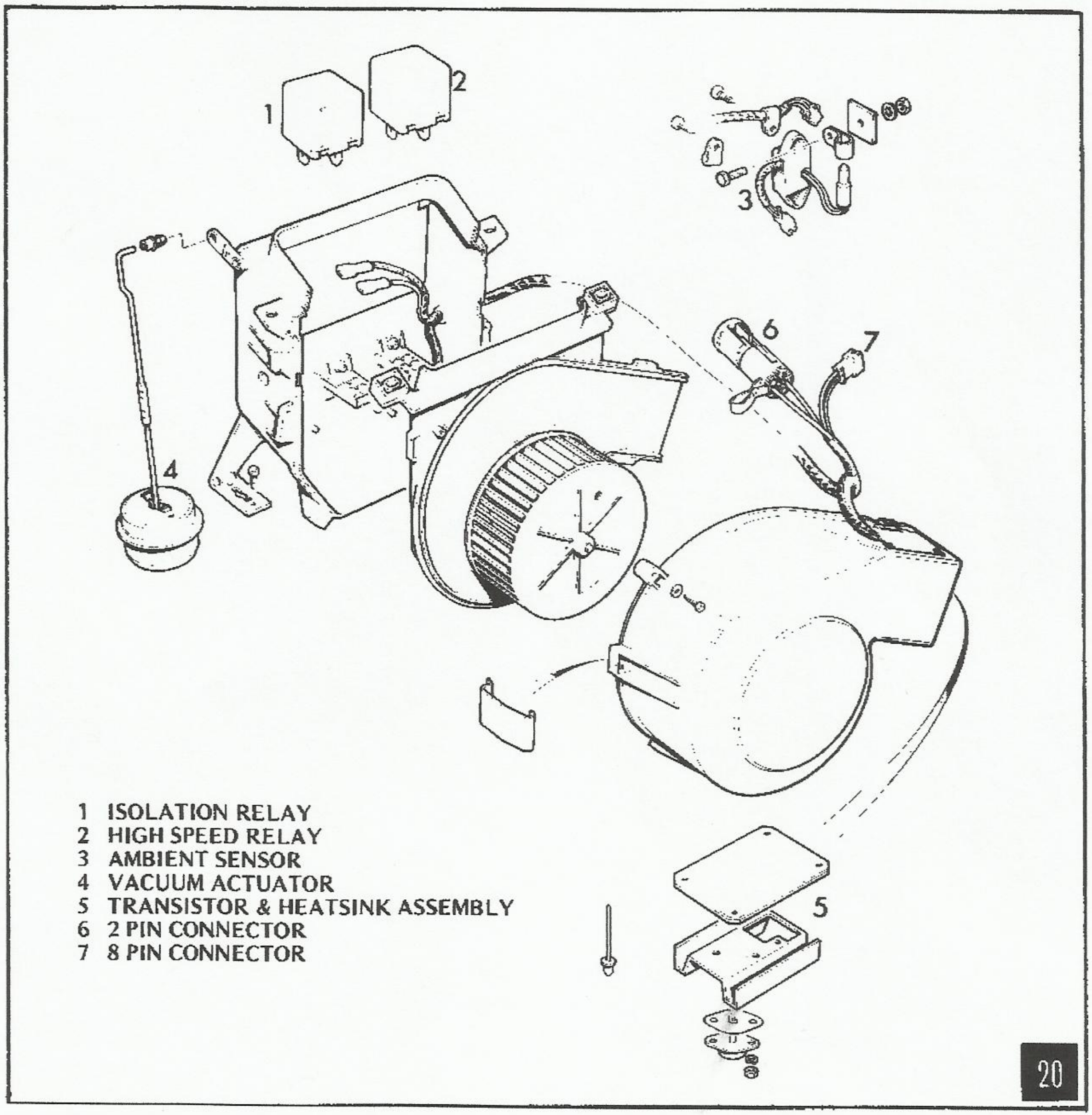
The control units operate on a supply voltage of 5 volts, supplied by a power supply incorporated in the control unit. This has a protection circuit to prevent damage to the electronics due to reversed polarity, excessive voltage and also voltage spikes caused by relays opening and closing in the vehicle's electrical system.

Although the control unit cannot be repaired in service, a series of test pins are accessible for testing the circuits, using the Jaguar Diagnostic System (JDS).

Blower Motors

The blower motors are larger than on the Mk II system, having a maximum output of 90 watts compared to 70 watts on the Mk II.

When the system is switched on and the engine coolant is below 30°C, the fans will be isolated until hot water is available. However, if the programme shifts to a cooling status where air outlet temperatures are below a set value the control unit will override the water temperature switch and allow the fans to run.



However, there will be a delay of 3.0 seconds when system is switched on even in this situation to allow the microprocessor to read all inputs and compute status required, so that fan speeds will not hunt initially.

Right Hand Blower Unit (Fig. 20)

Mounted in the outlet is a heatsink assembly which comprises a back E.M.F. suppressor diode, feedback isolation diode and power transistor.

The unit is supplied with positive power via a two pin connector, whilst the control module communicates via an 8 pin connector.

Left Hand Blower Unit

Similar to right hand except for the absence of the ambient air temperature sensor, and a 5 pin connector block.