



# **1986 Vanagon and Vanagon Syncro**

**Service Training**

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# Vanagon and Camper

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## Special Features

- 2.1 liter waterboxer engine with 95 horsepower
- Optional power windows
- Optional power heated mirrors
- Optional power door locks
- Revised electrical system
- New optimized air conditioning
- New front grille and aerodynamic headlights
- Long life spark plugs
- Elimination of 1000 mile service
- One key system
- 6J x 14 wheels with 185/70R14 tires



# Syncro and Camper Syncro

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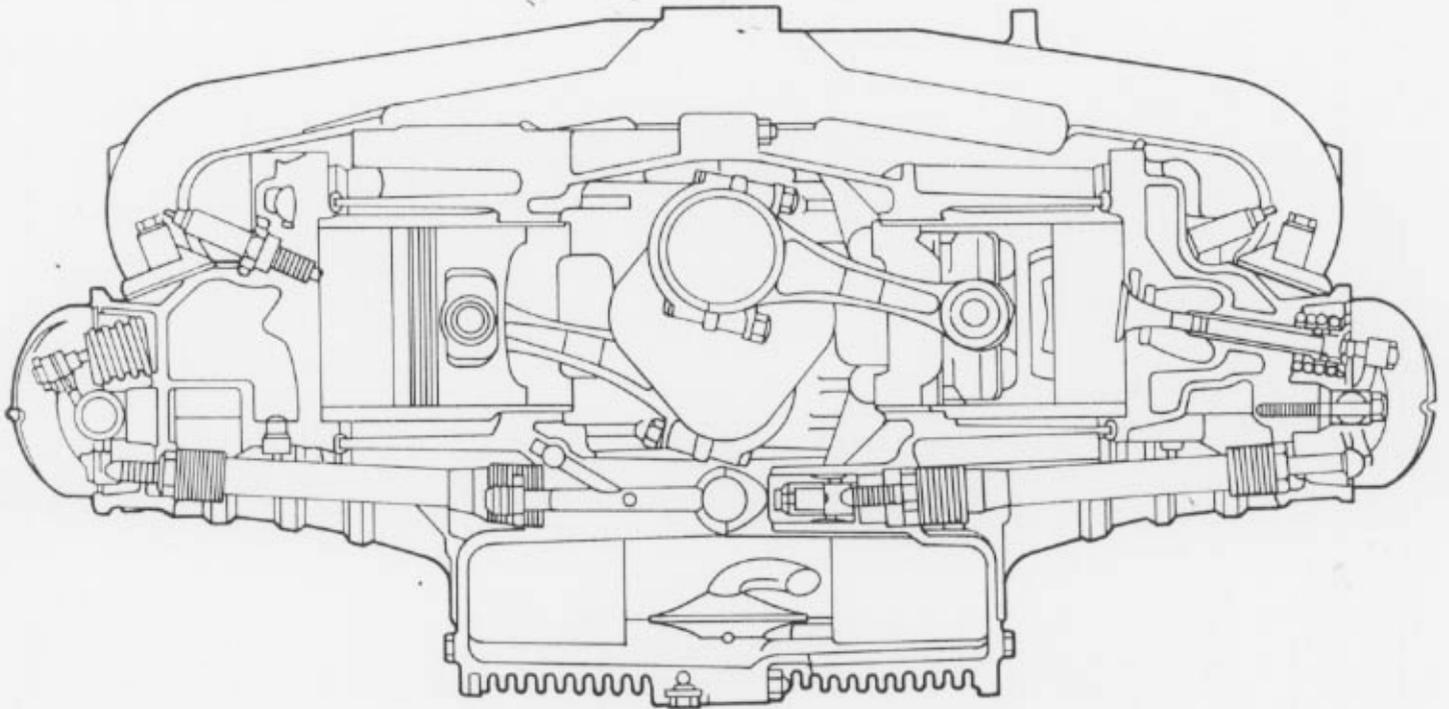
## Special Features

- Full time all-wheel drive
- Special 094-4WD transmission with lower gear ratios
- Engine, transmission, driveshaft and final drive protection rails
- Suspension travel increased 20mm
- Increased ground clearance
- Front final drive with viscous coupling
- Optional rear differential lock
- 6J x 14 wheels with 205/70R14 tires
- 18.5 gallon fuel tank
- Revised electrical system
- Mk II disc brake calipers with 20% larger brake pads



# Engine

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Standard equipment on all new Vanagon models is a 2.1 liter waterboxer engine. The displacement increase is a result of a 7 mm longer stroke. The bore remains at 94 mm. In addition, the same dimensions for the bearings and webs of the crankshaft were retained so production conditions did not need drastic revision.

The upper and lower sealing flanges of the crankcase were reinforced and the sealing flange facing the transmission was strengthened.

Internally there are new pistons with 2 mm deeper valve reliefs, new case halves, connecting rods, and crankshaft.

Additionally, improvements were made to the cooling system and lubrication system. As a result, oil capacity with filter has been increased to 4.2 quarts and cooling system capacity has been increased from 16.8 to 18.5 quarts.

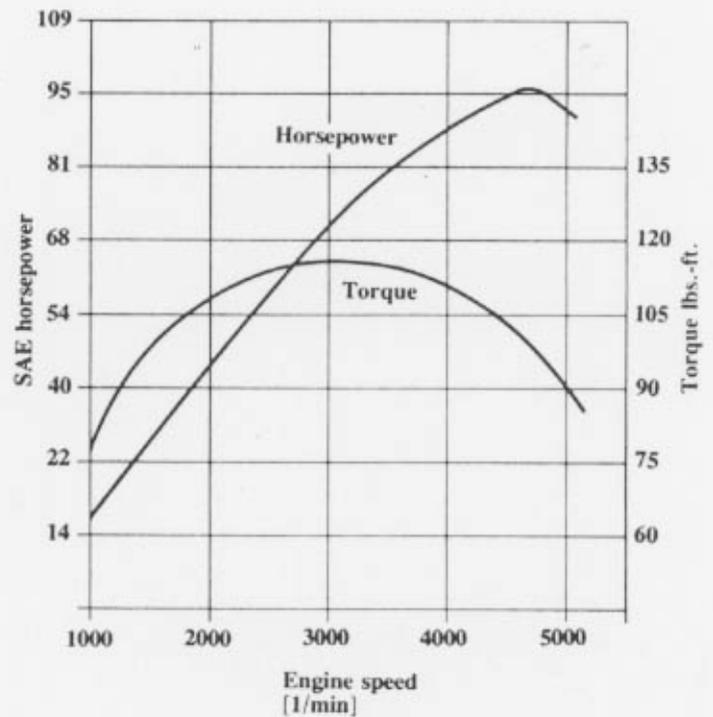
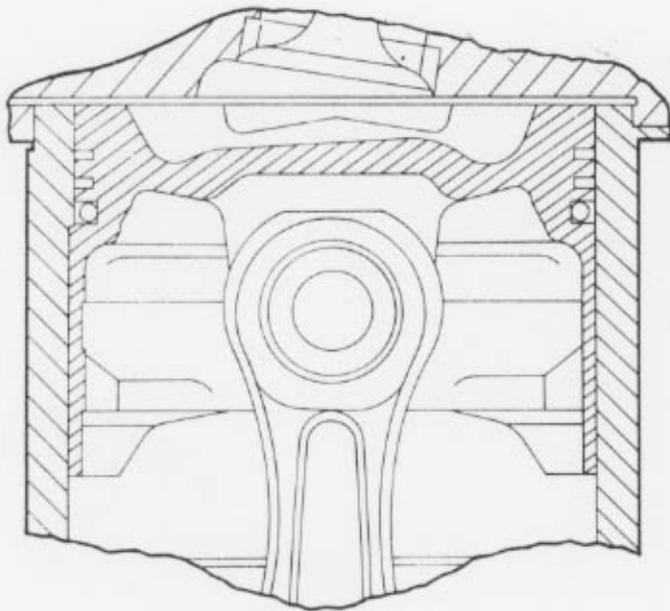
The engine also features the new Digifant fuel and ignition management system to improve vehicle performance in all ranges of engine operation.

Horsepower and torque have been substantially improved over the previous waterboxer engine. Horsepower rose 16% to 95 H.P. at 4800 RPMs and torque increased by 11% to 117 lbs.-ft. at 3200 RPMs.

As before, the valves are recessed in the cylinder head. The depression in the top of the piston, which creates the heron shaped combustion chamber, was altered to produce an increase of compression ratio from 8.6 to 1 to 9.0 to 1.

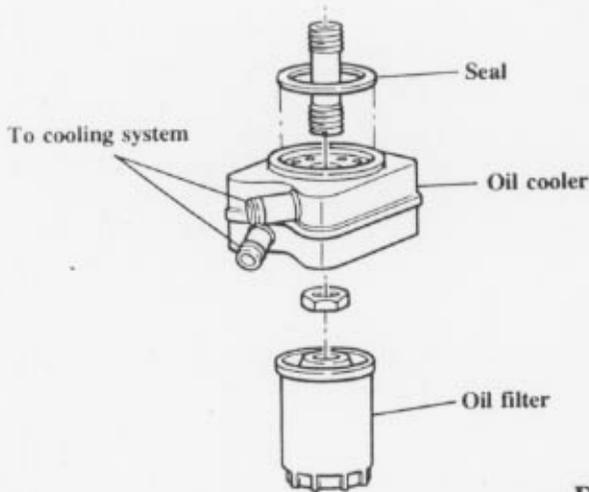
Thus the proven and familiar combustion process was retained. The increase in horsepower is a result of the increase in compression ratio and also to the fact that the valve timing was changed. Inlet and exhaust ports were enlarged and streamlined and intake manifold diameter was increased from 36 mm to 38 mm.

The muffler has been enlarged by 20% to match engine air flow characteristics and reduce noise.



# Lubrication System

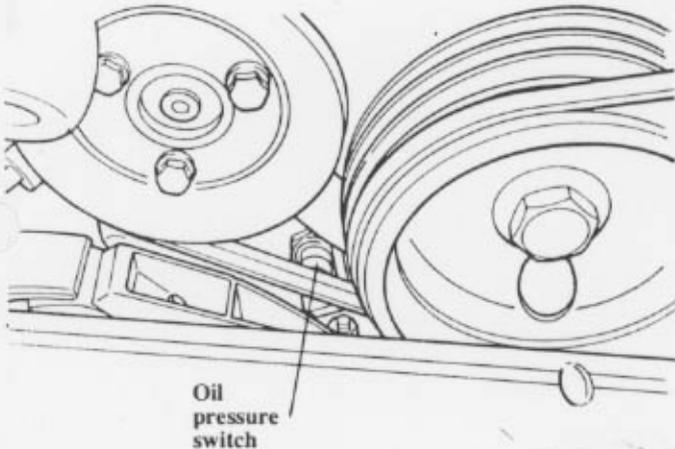
## Engine Oil Cooler



The new 2.1 liter engine features an oil cooler mounted between the oil filter and the engine crankcase. The cooler uses engine coolant to maintain engine oil temperature within a given range.

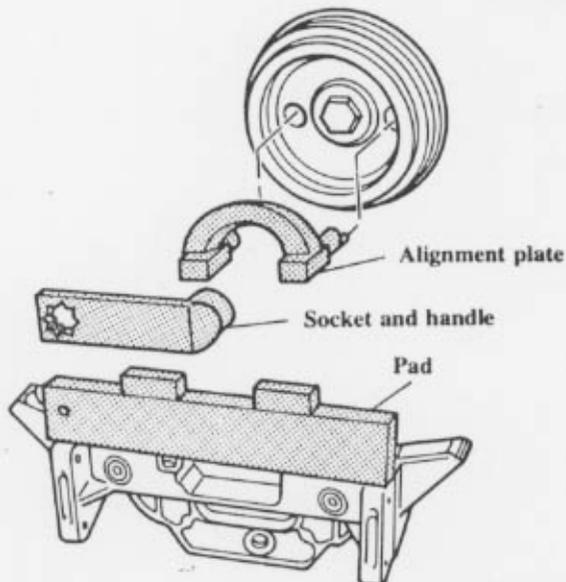
In addition oil capacity has been increased from 3.2 quarts to 4.2 quarts with the filter.

## Dynamic Oil Pressure



Vanagon also receives a dynamic oil pressure system. The additional pressure sensing switch is located in the oil filter bracket near the water pump. If oil pressure falls below 0.9 bar at 2000 RPM, the driver is alerted by an optical and acoustic alarm signal. The dynamic oil pressure control unit is located behind the speedometer in the instrument panel.

## Crankshaft Pulley Tool

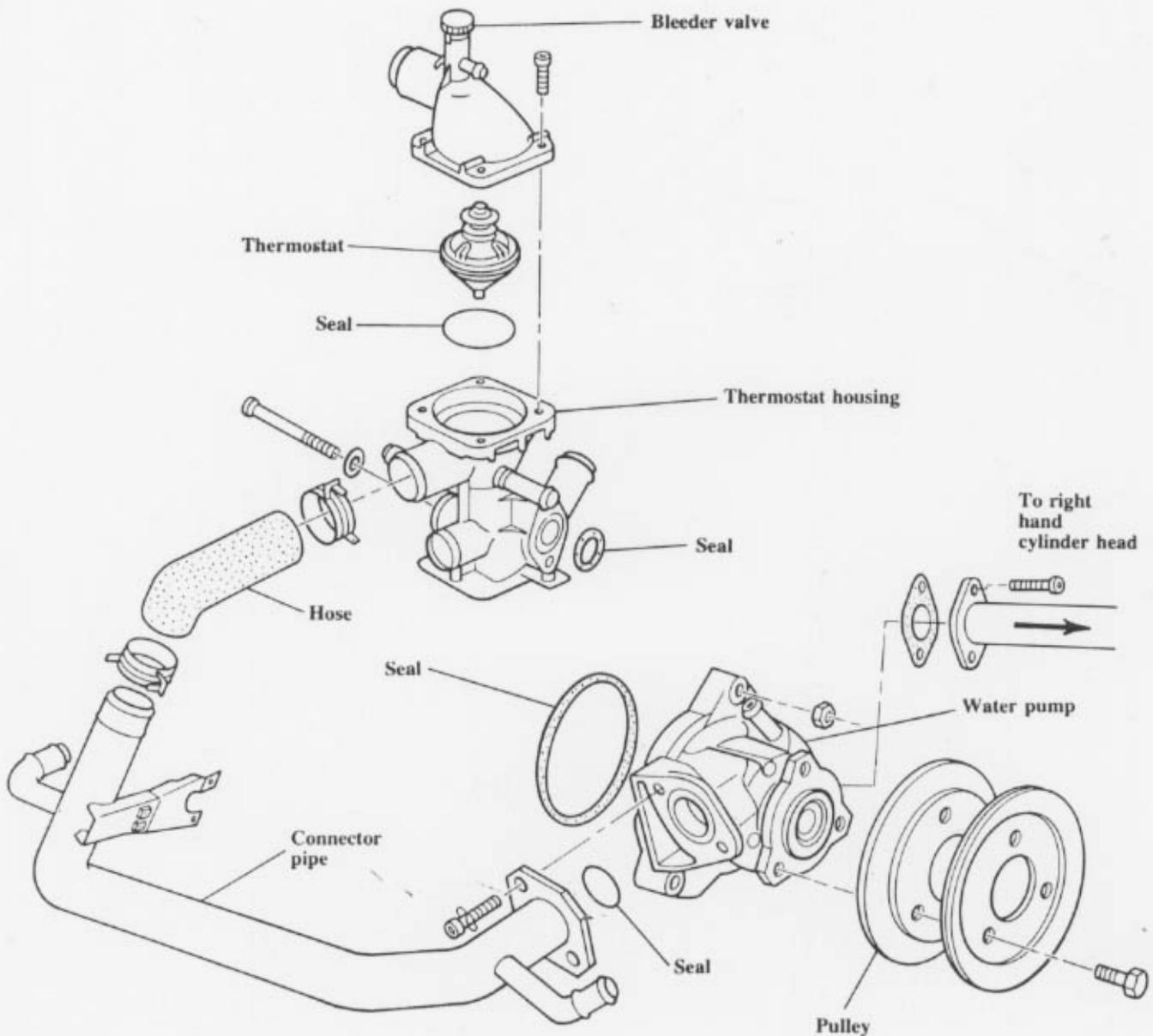


New tool 3149 has been introduced to remove the crankshaft pulley. It consists of three pieces: an alignment plate with two pins that engage the pulley, a pad that the alignment plate rests on, and a socket and handle.

# Cooling System

In order to better handle the increased heat loads experienced under extreme conditions, the cooling system has been redesigned and now includes an oil cooler. Additionally the thermostat housing has been newly designed. It is now made of plastic with glass fiber

reinforcement and is positioned at the exit of cylinder #3. This insures a more even distribution of coolant to both banks of cylinders. The same double acting thermostat that the 1.9 liter engine used has been retained.

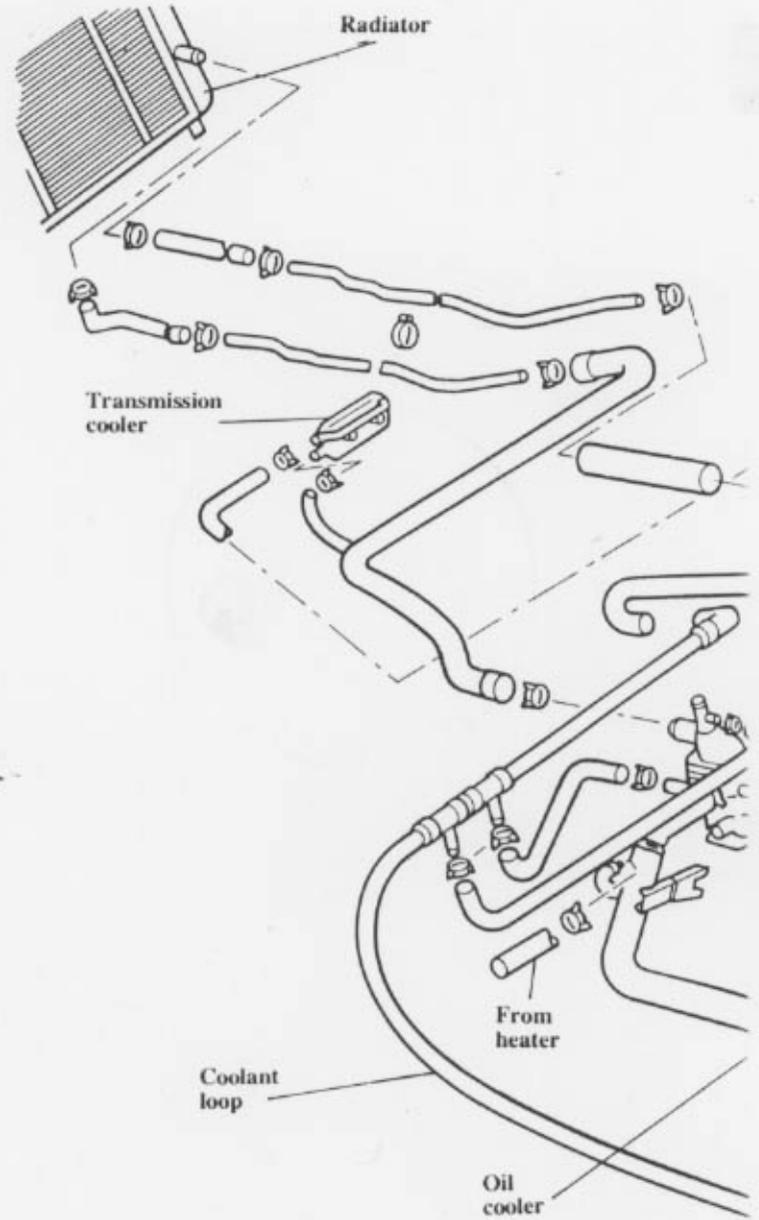


# Cooling System

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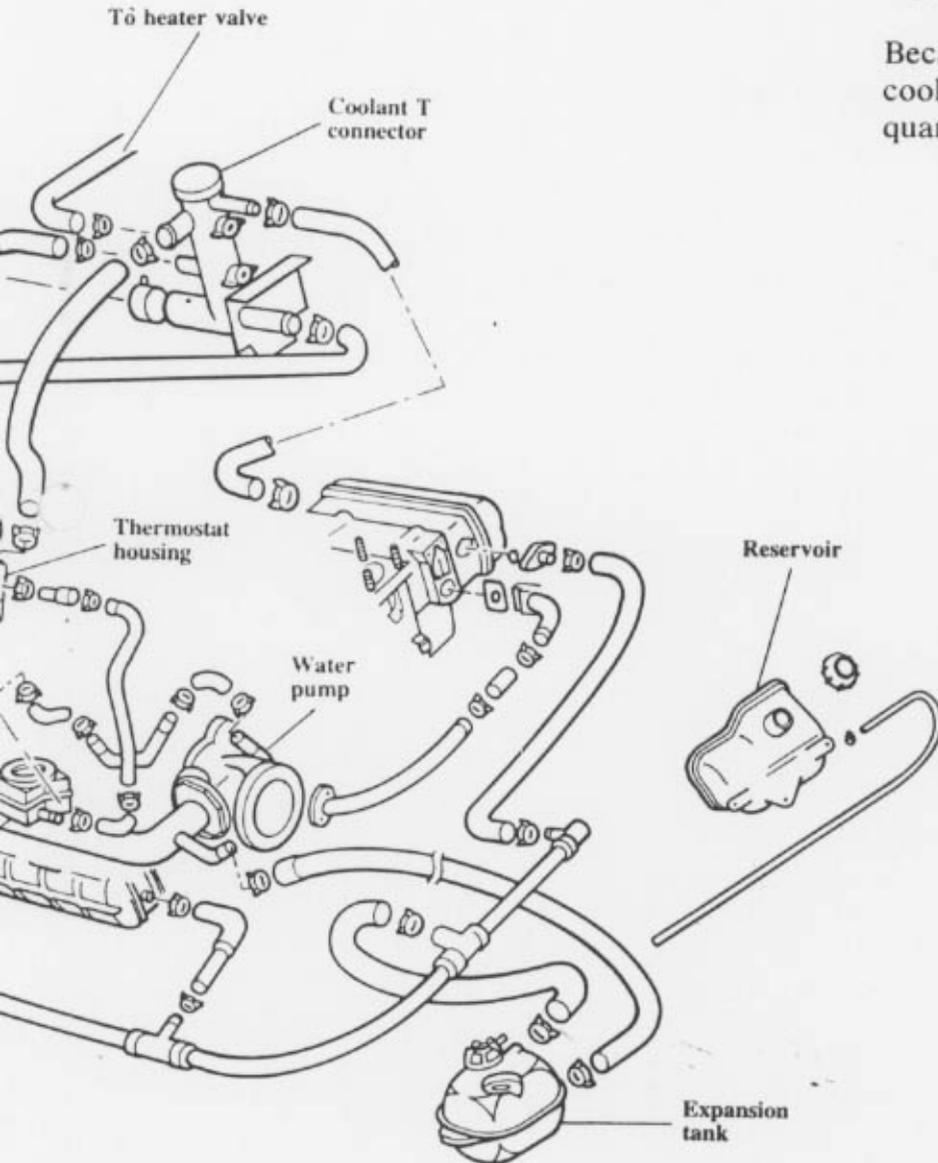
The cooling system has been revised and now includes a number of changes. The thermostat housing has been moved to the outlet of cylinder 3.

A new coolant T connector has been added to the system. It distributes coolant through the system, providing a central connection point for hoses from the right hand cylinder head, heater, transmission cooler, thermostat housing and radiator.



Also new is the coolant loop which is routed around the engine compartment. By being routed at a higher level than the engine, the ability of the engine to bleed air out of the cooling system has been enhanced. Any air present in the cooling system is routed to the coolant expansion tank.

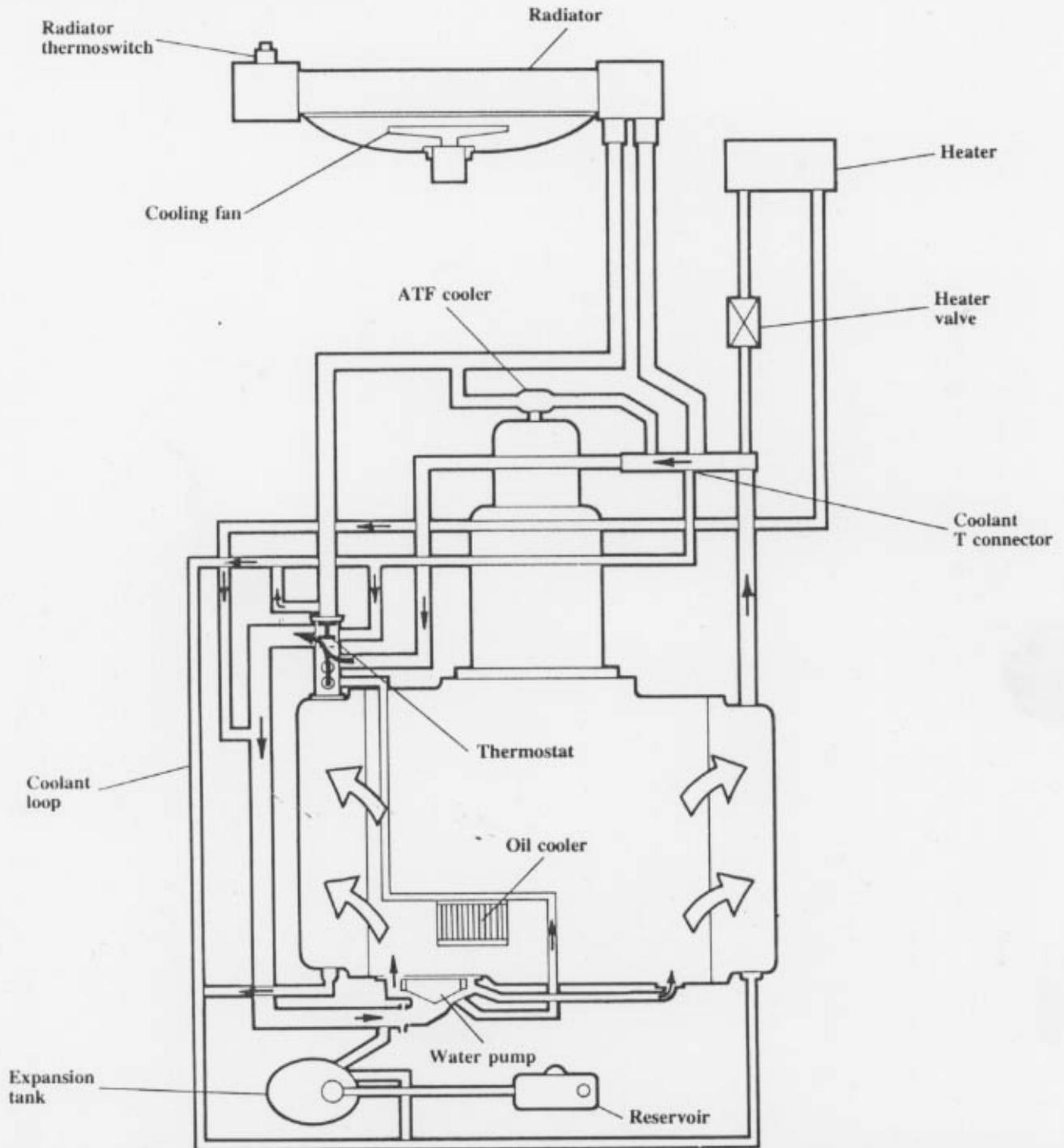
Because of these changes to the coolant system, coolant capacity has been increased from 16.8 quarts to 18.5 quarts.



# Cold Engine Coolant Flow

When the thermostat is closed, coolant does not flow to the radiator. Coolant is delivered by the water pump and is supplied to both sides of the engine, to the oil cooler and through the heater core. A certain flow is always maintained

through the coolant loop which allows any air in the system to be bled to the expansion tank. Coolant flows from the coolant T connector to the thermostat housing through the connecting hose.

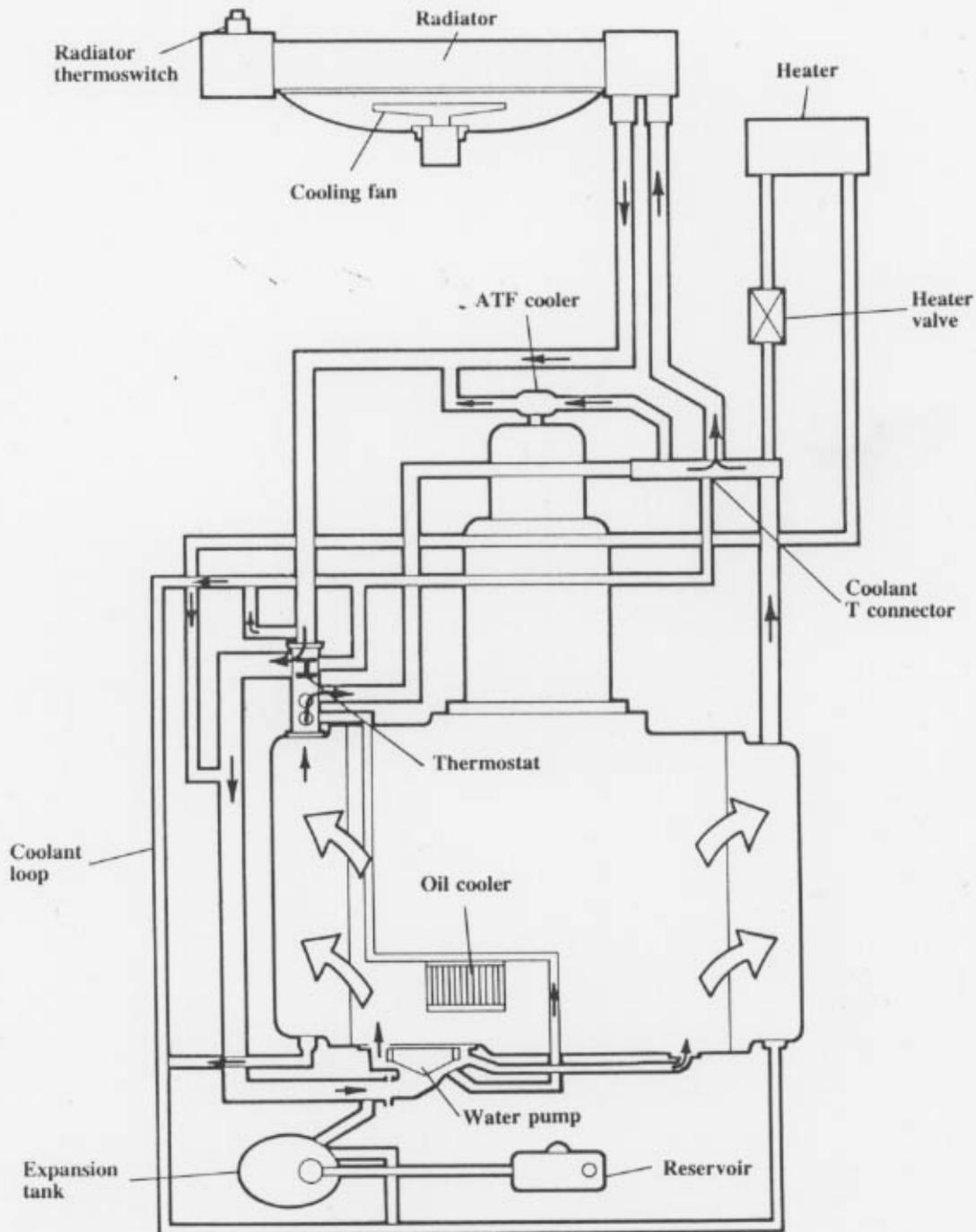


# Warm Engine Coolant Flow

When the engine coolant temperature rises, the thermostat closes the passage between the recirculation return and opens the passage from the thermostat housing to the radiator. Coolant

now flows the other direction from the thermostat housing to the coolant T connector.

Coolant is also directed to the ATF cooler.



# Fuel System

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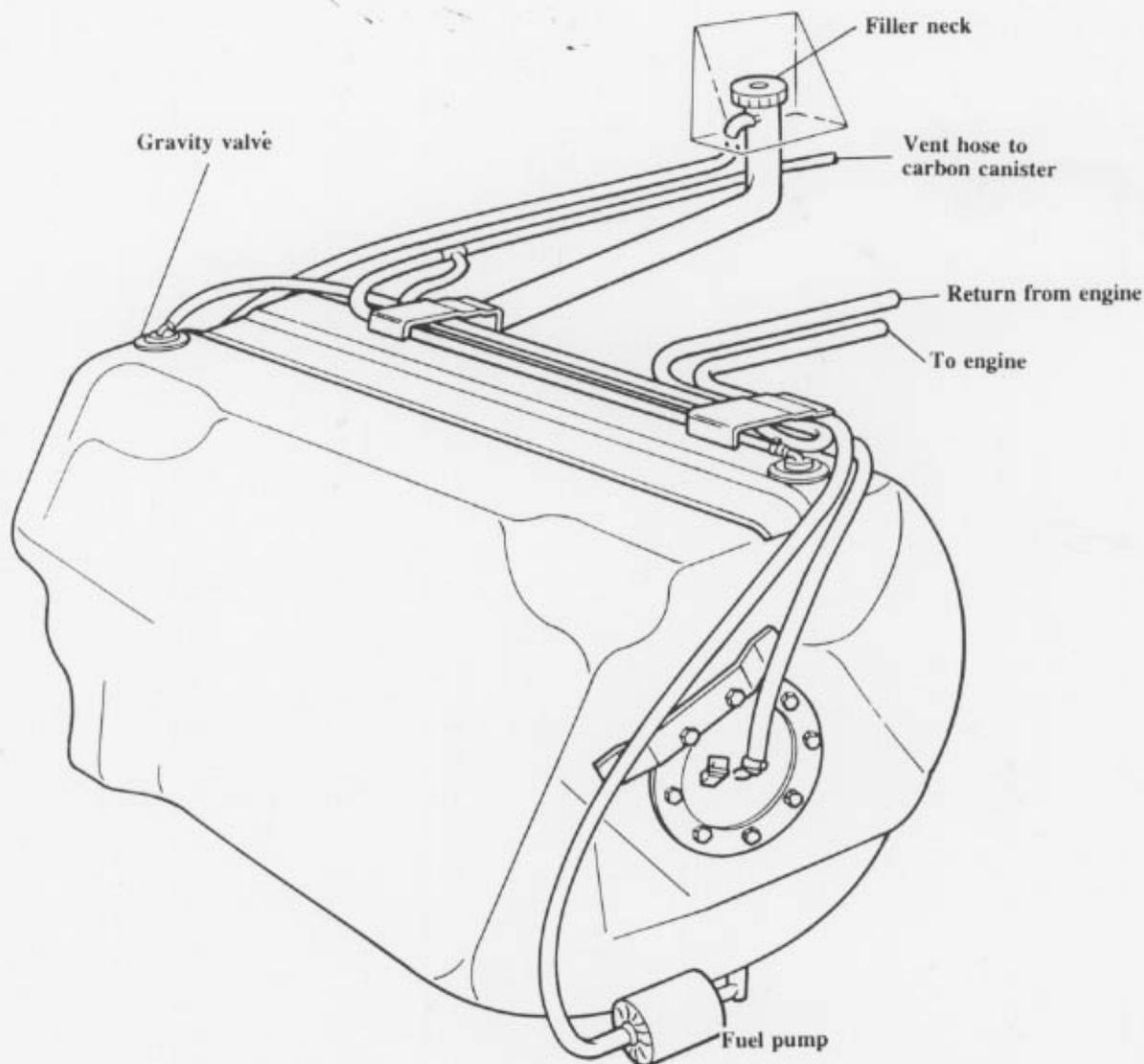
The Syncro's new plastic fuel tank and filler neck have been relocated. They are now located at the rear of the vehicle over the transmission, in front of the rear axle.

By matching the tank contour closely to the shape of the body, fuel capacity has been increased from 15.9 gallons to 18.5 gallons. This new location was necessitated because of the Syncro's strengthened front subframe and front axle final drive unit.

The electric fuel pump is located near the fuel tank on the left hand side of the vehicle.

The fuel gauge sending unit is located at the left side of the tank for easy access and incorporates the hose connection for fuel return from the engine compartment.

In addition, tank ventilation is accomplished by two gravity valves which direct vapors to the carbon canister.



# Digifant System

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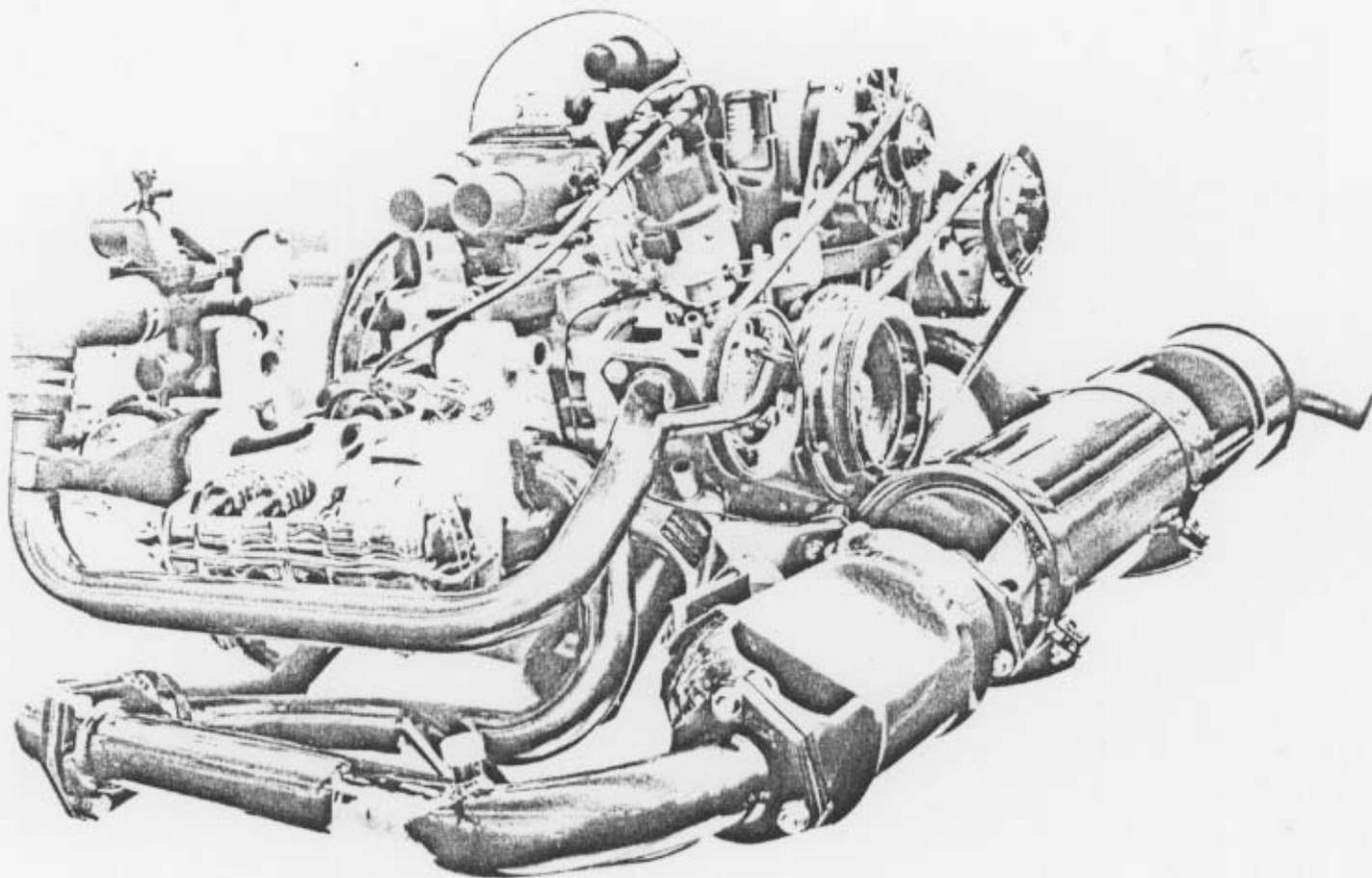
New on the 2.1 liter Vanagon engine is the Digifant fuel and ignition control system. Digifant is a development of the Digi-Jet fuel injection system combined with the map controlled digital ignition system.

Through the use of a single control unit, all of the functions of the fuel system, ignition system and oxygen sensor system are carefully controlled to provide optimum mixture and ignition control for improvements in idling characteristics,

acceleration, deceleration and overall driveability.

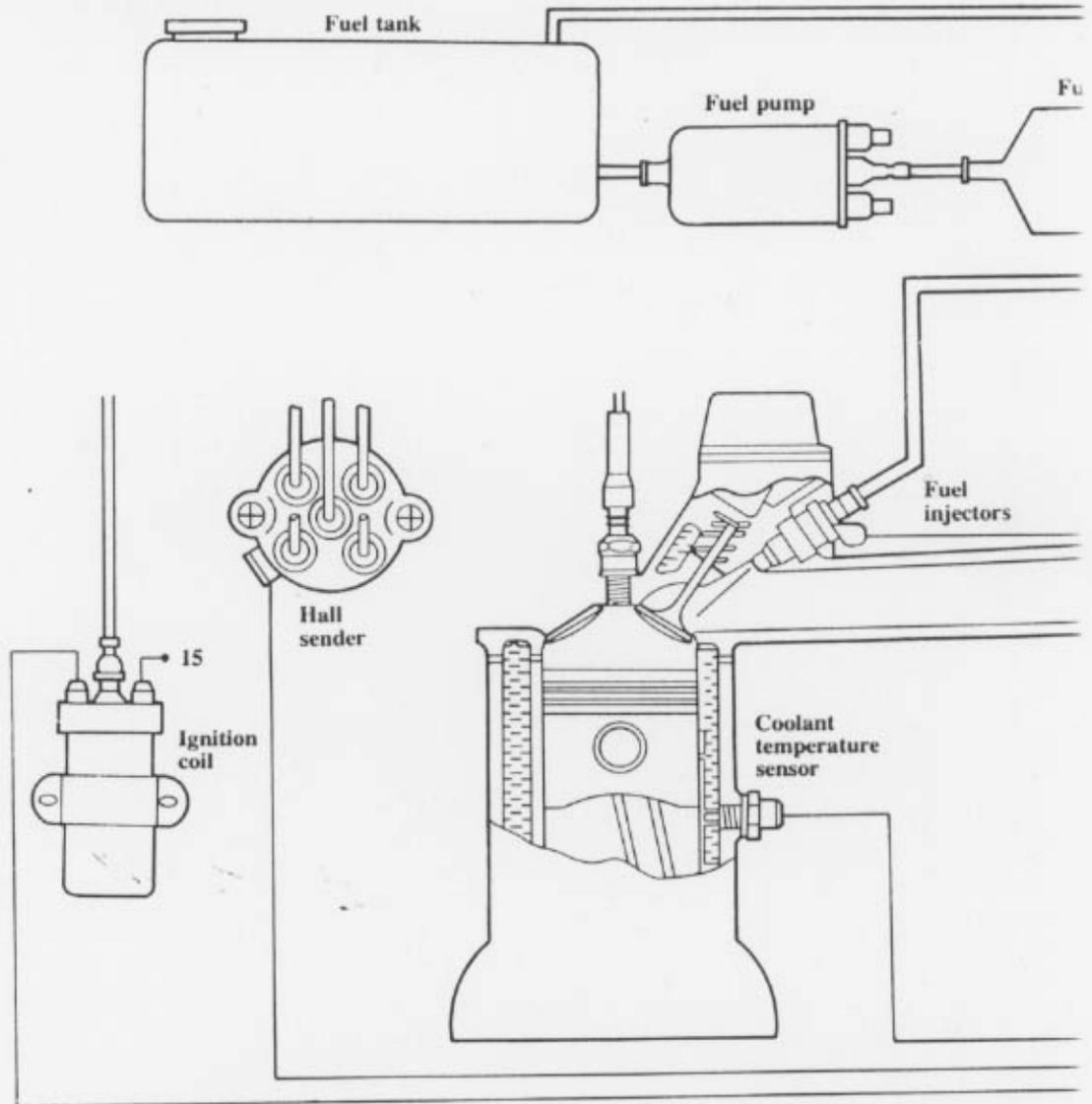
The new system features a larger throttle bore diameter, increased from 45 mm to 50 mm.

A new idle stabilization system has been incorporated to further streamline the system and eliminates the need for a digital idle stabilizer and auxiliary air regulator.



# Digifant System

The individual components of the Digifant system work together to manage all aspects of engine operation.

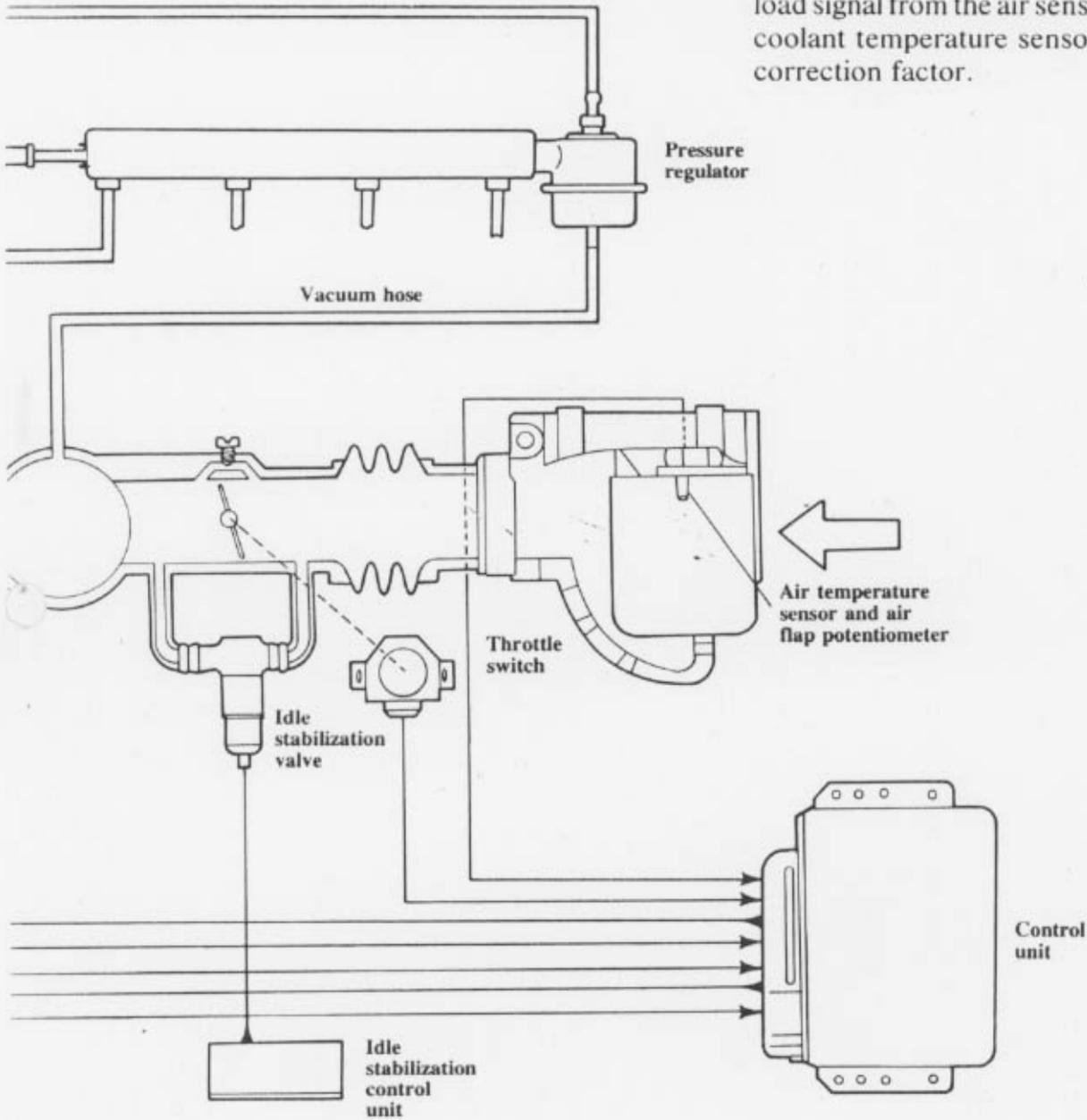


Fuel injection control is electronic and is based on the measurement of air entering the intake and on engine speed measured by the Hall sender. The coolant temperature sensor provides correction during engine starting and warm up.

The oxygen sensor, intake air temperature sensor and throttle switch provide the control unit with additional information to assure

smooth performance under all driving conditions. A separate control unit is used for the idle stabilization valve.

Ignition timing control is determined by an engine speed signal from the Hall sender, and a load signal from the air sensor. A signal from the coolant temperature sensor provides a correction factor.



# System Components

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The heart of the Digifant system is the new electronic control unit. The new control unit incorporates all the functions of the fuel system and ignition system and provides both the actuation signal for the fuel injectors and optimum ignition timing point for all engine operating conditions.

Injection duration opening signals are provided based on the following inputs:

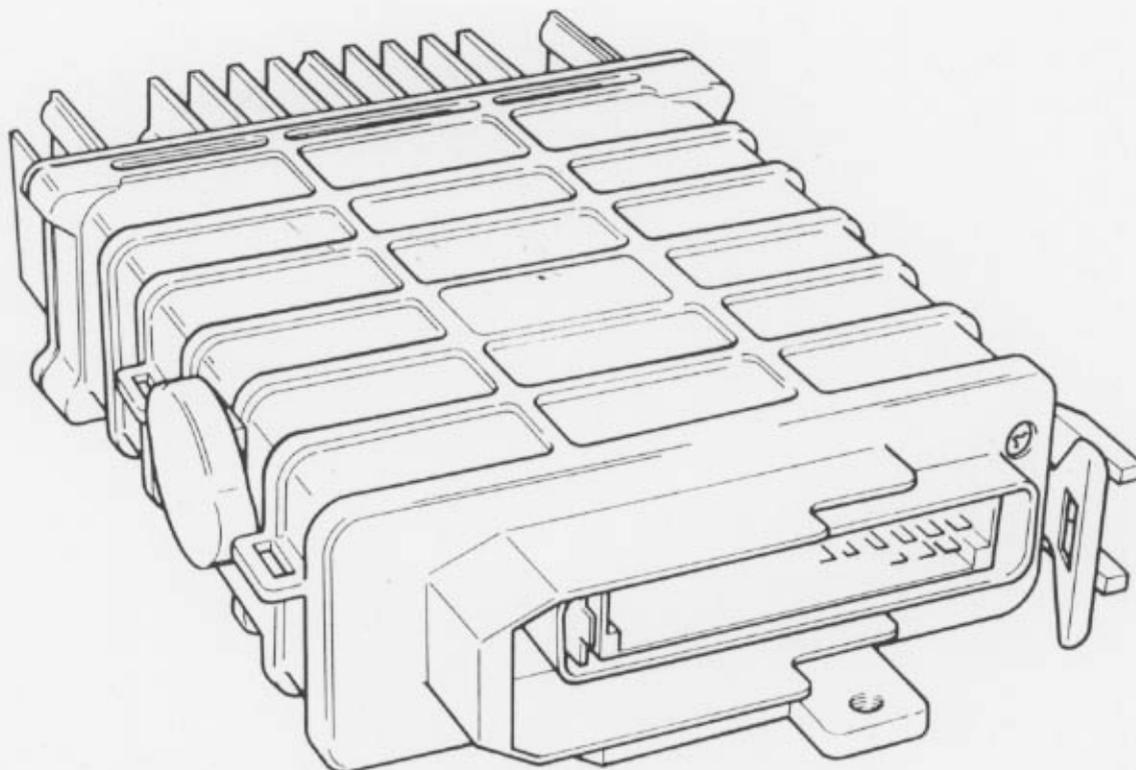
- Engine speed
- Intake air volume
- Coolant temperature
- Oxygen content in the exhaust gas
- Battery voltage
- Throttle position
- Intake air temperature

Digifant therefore provides complete fuel injection control throughout the entire range of engine speed, load and temperature conditions.

The injector opening time is taken from a program in the control unit at 16 points for RPM and 16 points for load for a total of 256 operational points. Injection times can be determined between these fixed points for a total of 65,000 theoretical different opening duration points.

Emergency functions are programmed into the control unit's memory so the system will continue to operate in the event of a faulty intake air temperature sensor or a faulty coolant temperature sensor.

The control unit provides the ground for the fuel pump relay and protects the engine by shutting off the fuel pump if engine speed reaches 5600 RPM.

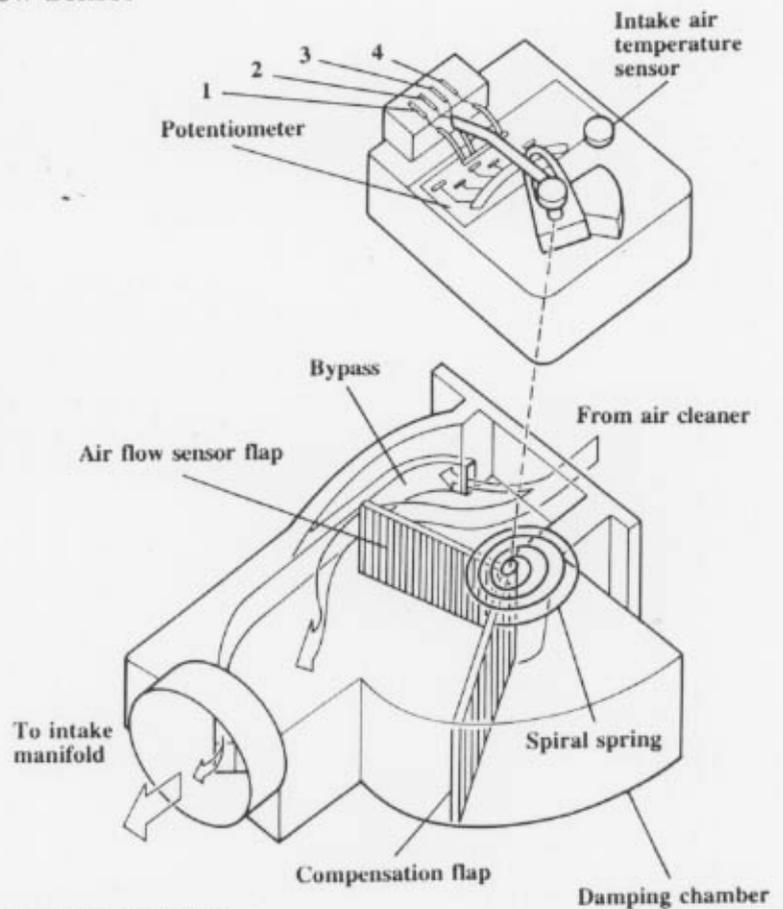


## Air Flow Sensor

The Vanagon with Digi-Jet uses a new air flow sensor with revised resistance values. The air flow sensor measures the amount of air entering the intake manifold and sends a voltage signal to the control unit.

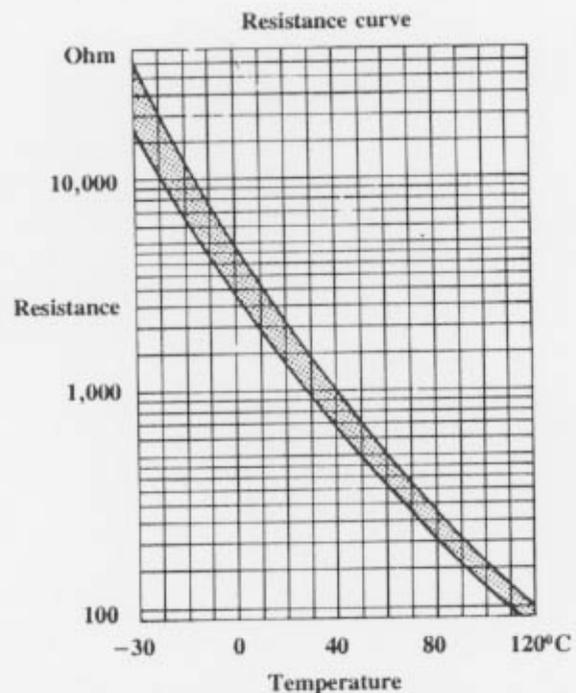
Intake air opens the air flow sensor flap which actuates the potentiometer to determine the voltage signal. This signal and the engine speed information supplied by the Hall sender are used as the principal inputs for the determination of fuel injector opening duration and ignition timing points.

A compensation flap connected to the air sensor dampens sudden movements of the air sensor flap due to oscillations of the intake air.



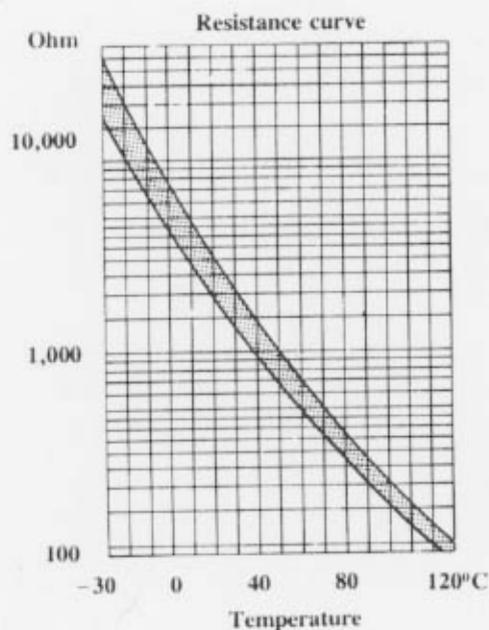
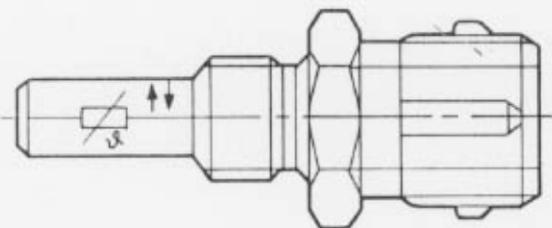
## Intake Air Temperature Sensor

An intake air temperature sensor is mounted in the air flow sensor housing. It is a negative temperature coefficient (NTC) resistor, which means its resistance value drops as its temperature increases. The signal it supplies to the control unit is used to modify fuel injection rate depending on intake air temperature for hot starting. The sensor can be tested by measuring the resistance value of the sensor and comparing the reading to the graph.



# System Components

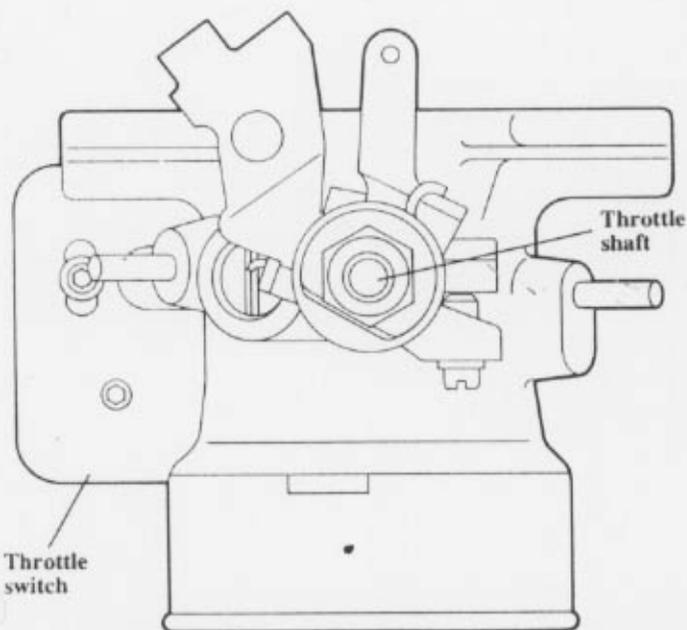
## Coolant Temperature Sensor



The coolant temperature sensor is also a negative temperature coefficient resistor (NTC). The resistance signal it produces is used by the control unit to determine cold start enrichment. It also provides a signal to continue to enrich the mixture during engine warm up.

The sensor can be checked by measuring its resistance value at a given temperature and comparing it to the graph.

## Throttle Switch



Digifant uses a single throttle switch attached to the throttle plate shaft. This switch consists of two sets of contacts wired in parallel.

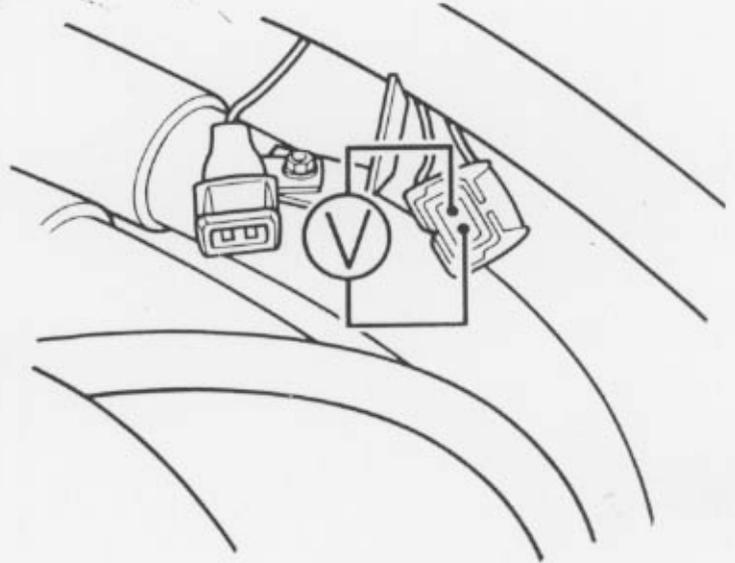
The idle contacts are closed when the throttle is closed, providing a ground signal to the control unit that actuates fuel shut-off during deceleration.

The second set of contacts close at full throttle to provide the required mixture enrichment for full load operation.

When measuring the voltage to the throttle valve switch, a reading of approximately 5 volts across the terminals of the wiring connector should be measured with the ignition on.

A test light should **never** be used to test the throttle switch because damage to the internal circuitry of the control unit could result.

Since both sets of contacts are electrically connected in parallel, the control unit determines which set is closed based on intake air quantity. This signal from the throttle switch provides either deceleration fuel shut-off or full throttle enrichment.

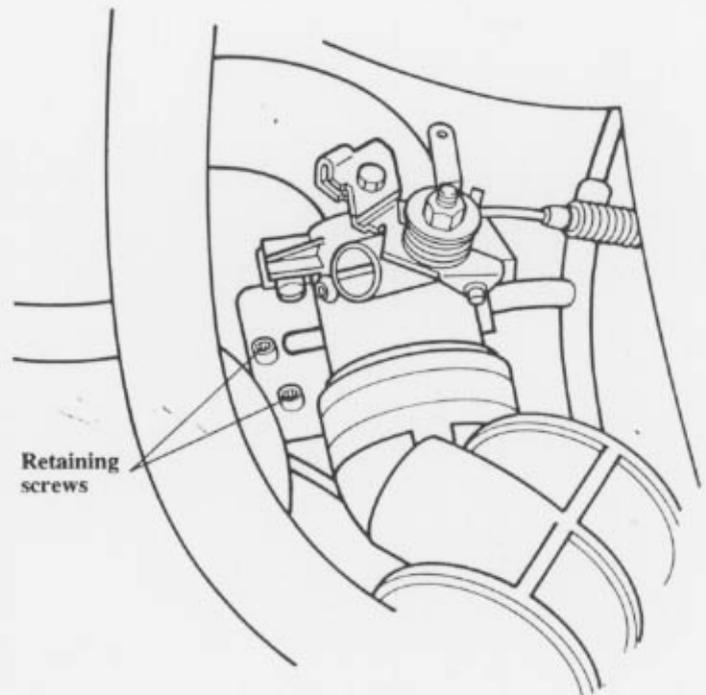


The adjustment of the throttle valve switch is very critical because if the idle contacts are open at idle, the engine will stall when cold and the deceleration fuel shut-off feature will not function.

If the idle contacts remain closed with the throttle open, fuel shut-off will occur at speeds between approximately 1500 and 1700 RPMs.

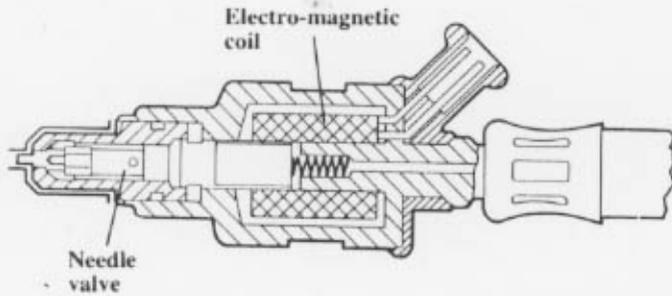
If the throttle switch does not close at full throttle, no full throttle enrichment will occur and full load performance will be low.

The throttle switch is adjusted via the two retaining screws.



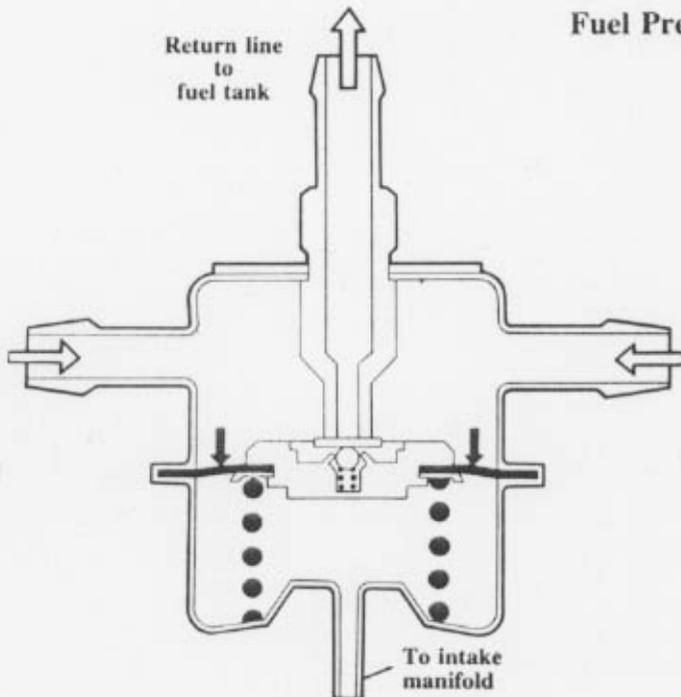
# System Components

## Fuel Injectors



The injection valves inject fuel directly into the intake manifold near the intake valve. Injector opening time is regulated by the control unit based on inputs from the various engine sensors. As with Digi-Jet, the resistance value of each injector remains at 16 ohms.

## Fuel Pressure Regulator

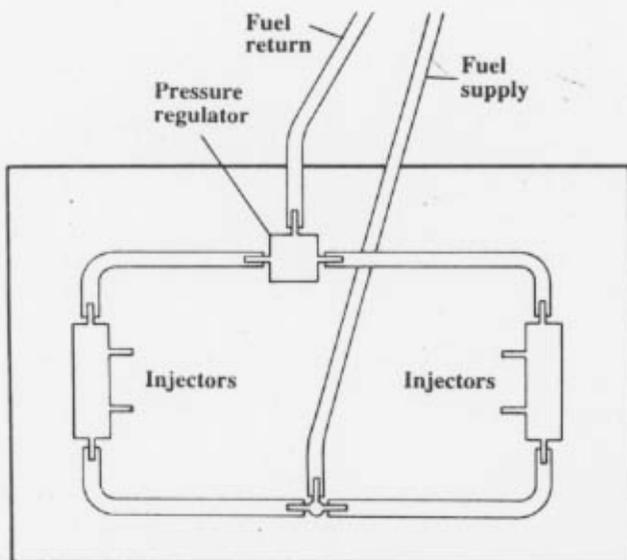


The system pressure regulator is used to maintain a constant fuel pressure to all injectors by regulating the quantity of fuel returned to the fuel tank.

The regulator has a hose connection to the intake manifold so it can sense changes in manifold vacuum.

Fuel pressure at idle with the vacuum hose connected is about 2.2 bar (33 PSI), and about 2.6 bar (36 PSI) with the vacuum hose disconnected.

When the engine is shut off, the regulator closes and seals to maintain fuel pressure in the injector lines.



## Cold Engine Operation

The Digifant system determines all aspects of cold engine operation through the signals the coolant temperature sensor sends to the Digifant control unit and to the idle stabilization control unit.

When a cold engine is started, terminal #1 of the control unit is energized from starter motor terminal #50. The control unit lengthens the opening signal to the injectors and more fuel is supplied. This eliminates the need for a cold start valve and thermotime switch.

The coolant temperature sensor provides a signal which determines the amount of enrichment and the control unit limits injection time to prevent flooding in the event that the engine fails to start.

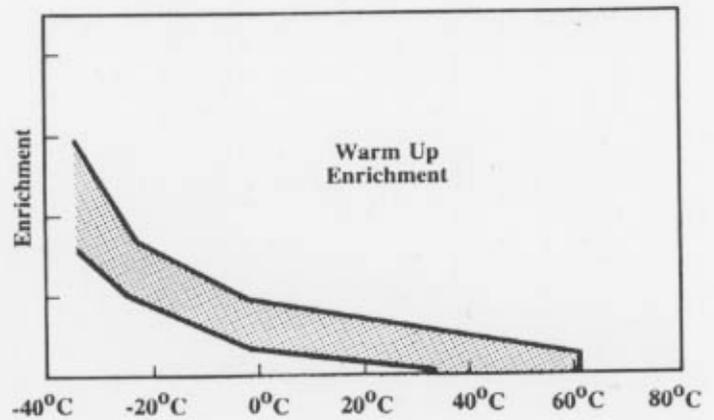
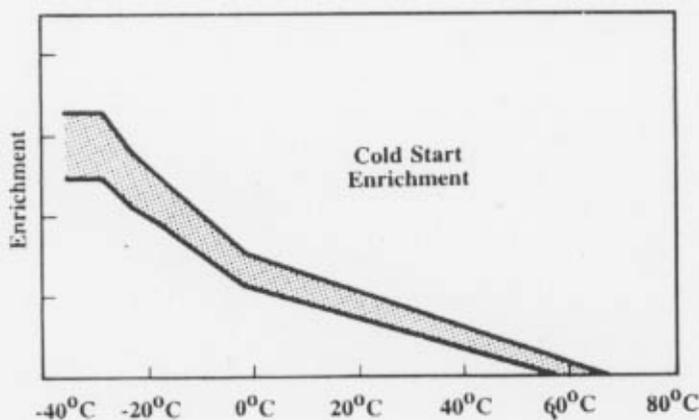
After the engine has started, the control unit continues to enrich the mixture based on a signal from the coolant temperature sensor until the engine reaches operating temperature.

## Deceleration Fuel Shut-Off

To improve fuel economy and to reduce emissions, a deceleration fuel shut-off feature closes the fuel injectors through a signal from the idle switch. Fuel shut-off will occur only when:

- The throttle is closed
- Coolant temperature is above 50°C (122°F)
- Engine speed is above 1250 RPMs
- Engine speed was above 2600 RPMs.

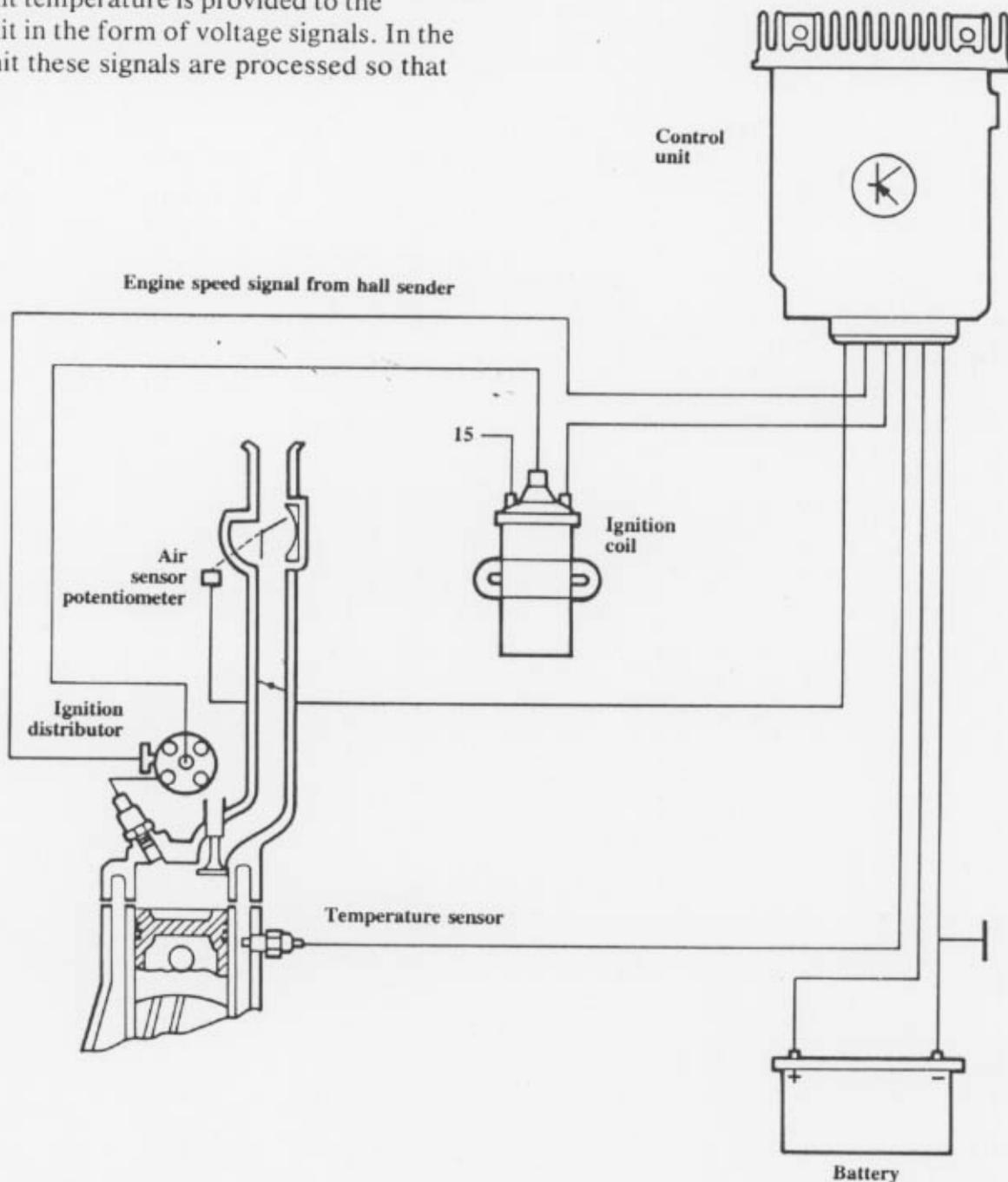
The control unit reactivates the fuel injectors once engine speed drops to 1250 RPMs. After the injector shut-off period the oxygen sensor system is deactivated for 36 crankshaft revolutions to allow the exhaust gas content to stabilize.



# Ignition Control

The map controlled ignition system was developed by Volkswagen for the Vanagon. It operates on the principle of a timing map which is programmed into the control unit. Information supplied to the control unit on engine load, speed and coolant temperature is provided to the control unit in the form of voltage signals. In the control unit these signals are processed so that

the ignition coil is controlled via terminal #1 in accordance with the programmed ignition map. The separate ignition control unit and digital idle stabilizer used in the past have been eliminated.

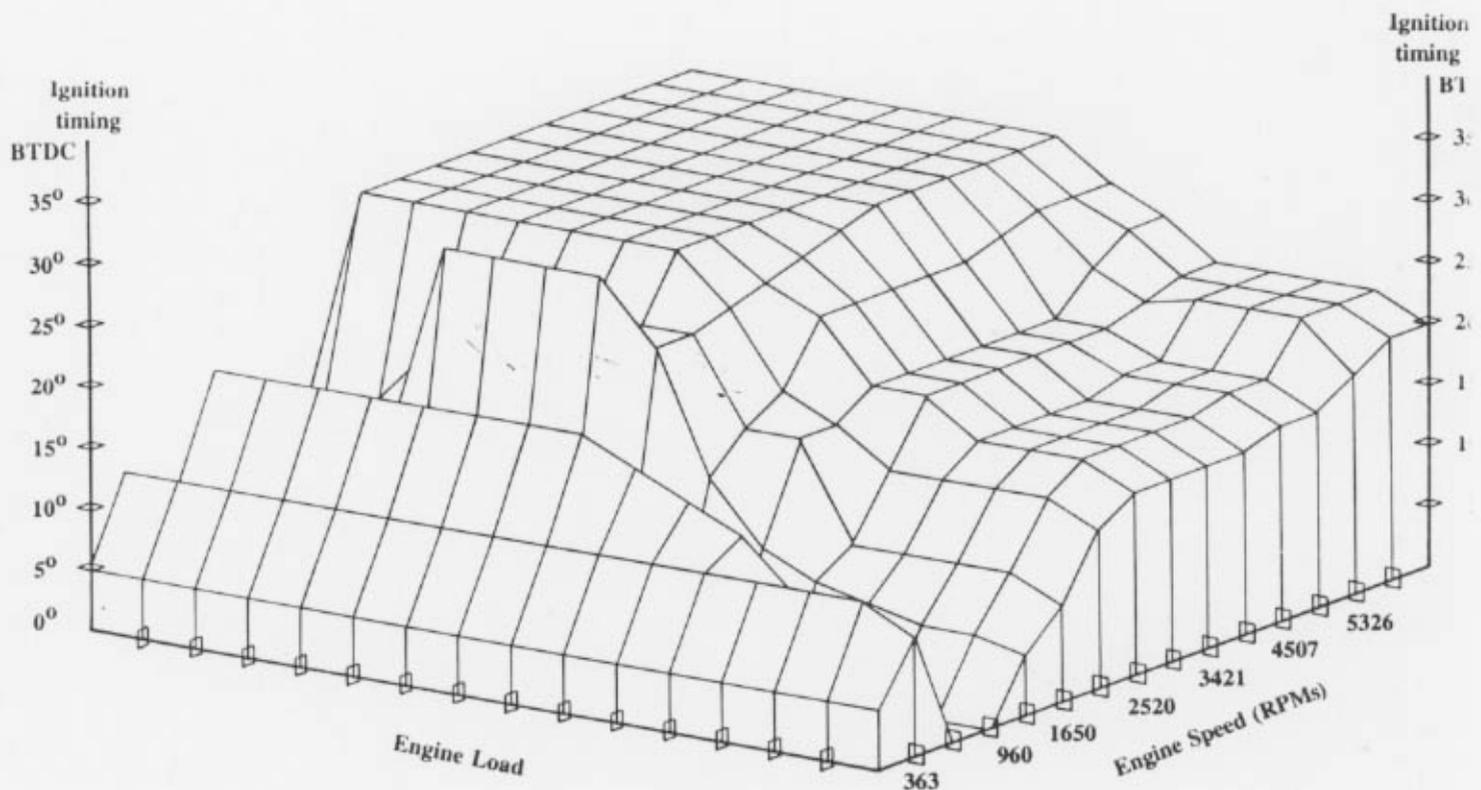


Once the engine reaches operating temperature, the timing is determined by the map shown.

An engine speed signal comes from the Hall sender in the distributor and measurement of engine load is accomplished through a signal from the air sensor potentiometer. These two signals establish the ignition timing point which is stored in the ignition map in the control unit's memory at 256 single operational points, 16 fixed points for each engine load point and 16 for each RPM point. The coolant temperature sensor provides a correction factor.

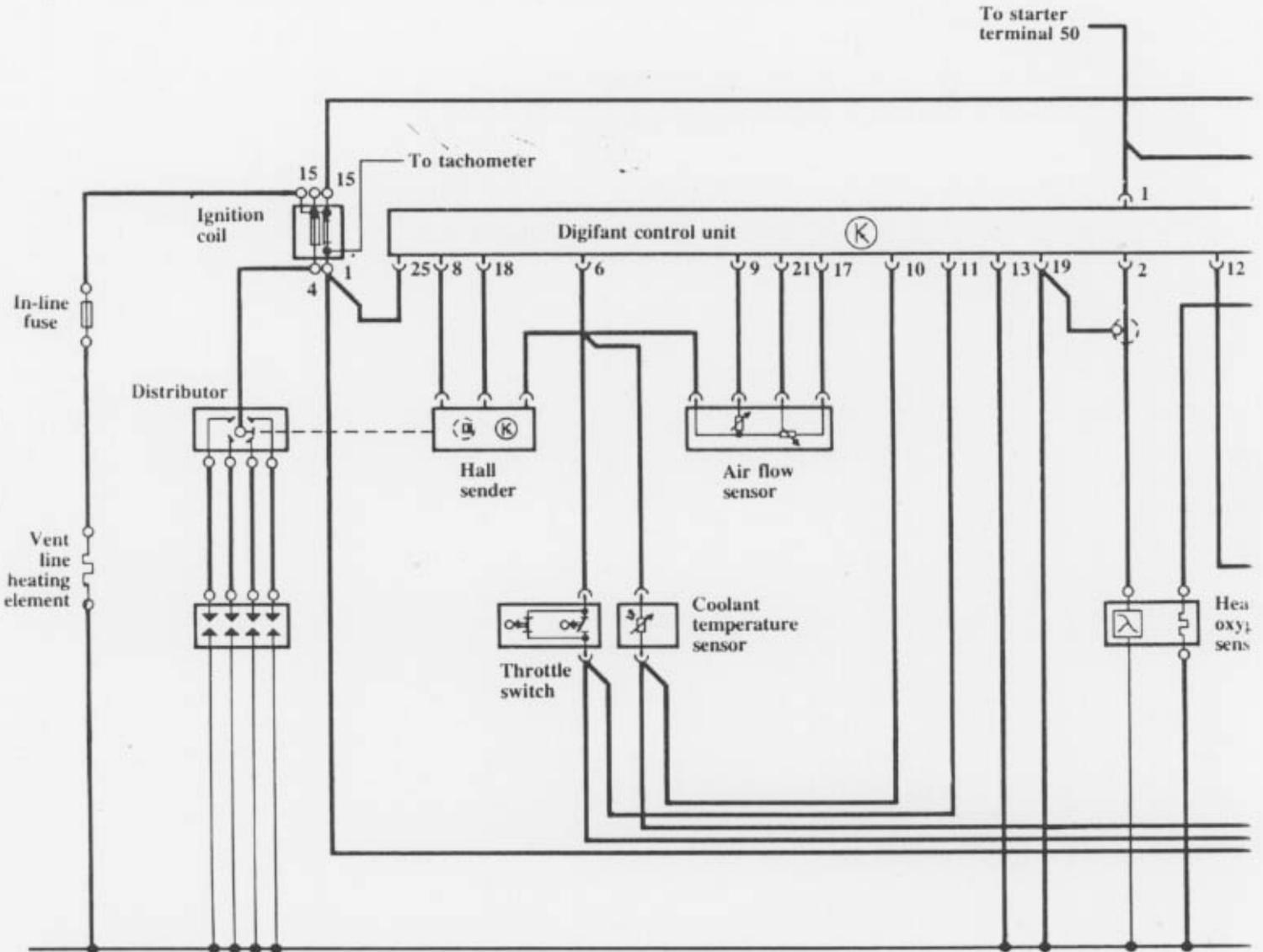
The engine coolant temperature sensor signals the control unit to determine ignition timing based on engine temperature. Throughout the engine warm-up phase, ignition timing is constantly being corrected.

This sophisticated system is capable of providing optimum ignition control throughout the entire range of engine speed and load conditions.

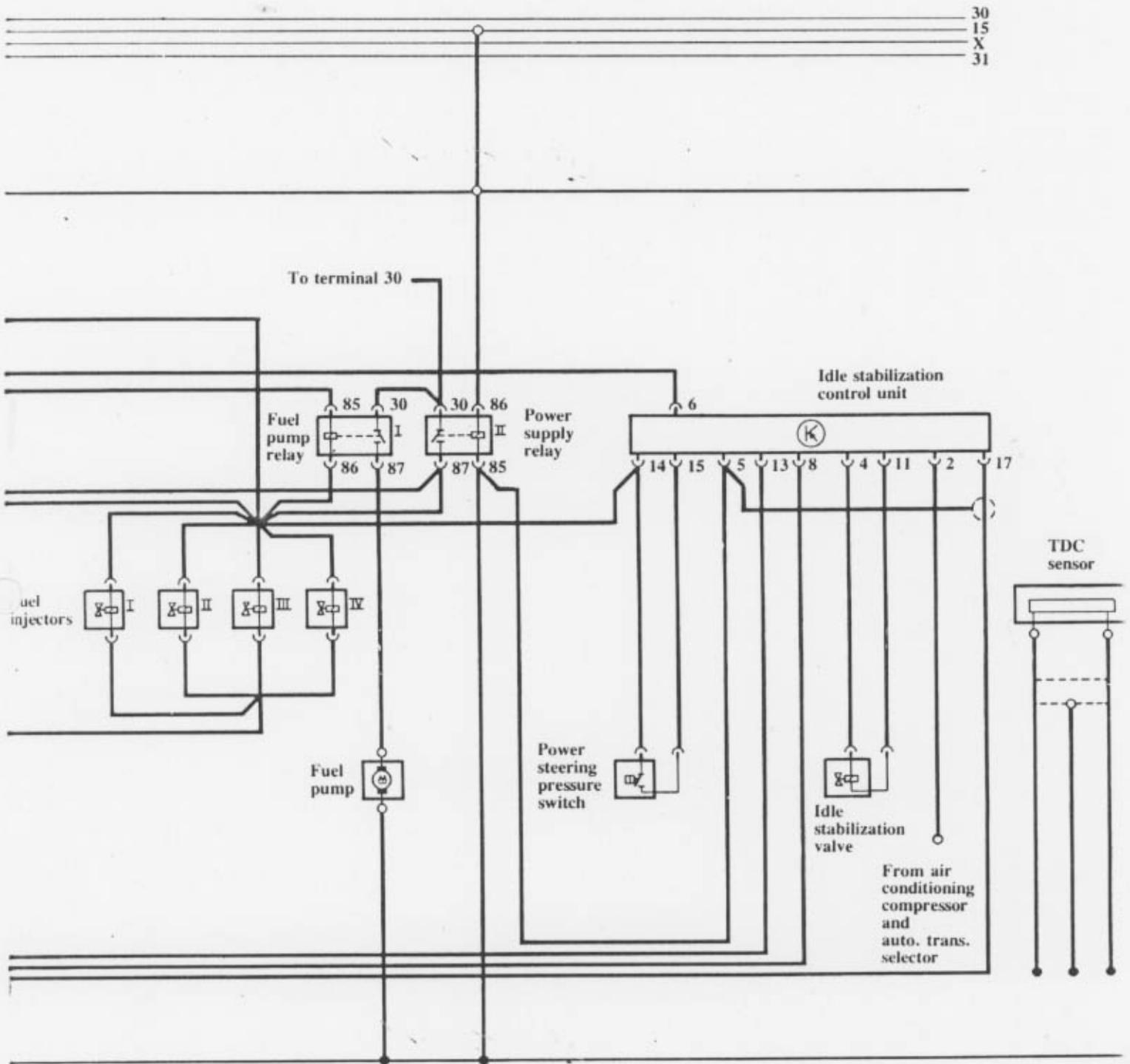


# Functional Diagram

30  
15  
X  
31



# Functional Diagram



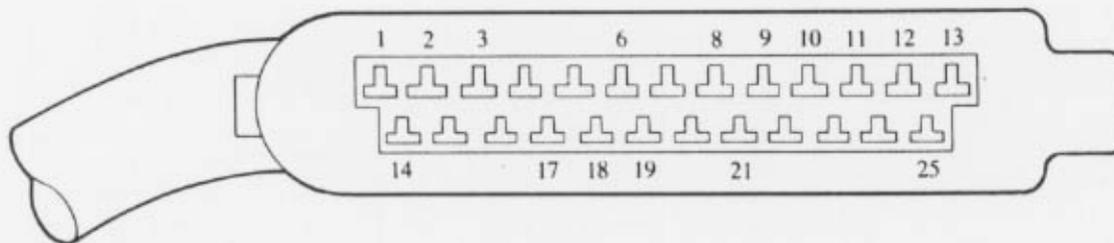
# System Checks

## System Check With Volt/Ohmmeter

### Note

Entire system can be checked electrically at disconnected multi-pin connector of control unit

| Ohmmeter to terminal:  | Components   | Checks   | Specification                           |
|------------------------|--|--|---|
| 2 and 13               | Oxygen Sensor  | <ul style="list-style-type: none"> <li>• Connector disconnected and grounded</li> <li>• Connector connected</li> </ul> | 0 ohms<br>$\infty$ ohms                 |
| 6 and 9                | Temperature Sensor I (Intake Air Temperature)  | <ul style="list-style-type: none"> <li>• Resistance at 20°C (68°F)</li> </ul>  | 2300-2700 ohms                          |
| 6 and 10               | Temperature Sensor II (Coolant Temperature)  | <ul style="list-style-type: none"> <li>• Resistance at 20°C (68°F)</li> </ul>  | 2300-2700 ohms                          |
| 6 and 11               | Throttle Switch  | <ul style="list-style-type: none"> <li>• Idle Position</li> <li>• Full Throttle Position</li> </ul>                    | 0 ohms<br>0 ohms                        |
| 6 and 17               | Intake Air Sensor  | <ul style="list-style-type: none"> <li>• Resistance/Potentiometer</li> </ul>   | 500-1000 ohms                           |
| 12 and 14              | Fuel Injectors   | <ul style="list-style-type: none"> <li>• Resistance</li> </ul>   | approx. 3-5 ohms                        |
| 17 and 21              | Intake Air Sensor  | <ul style="list-style-type: none"> <li>• Resistance/Potentiometer</li> </ul>   | Changing ohms as sensor plate is opened |
|                        | Individual fuel injectors  | Resistance   | 16.0 to 16.4 ohms                       |
| 13 and Ground          | Control unit ground connection   | Wiring   | 0 ohms                                  |
|                        |  |  |   |
| Voltmeter To Terminal: | Components   | Checks   | Specifications                          |
| 1 and 13               | <ul style="list-style-type: none"> <li>• Wiring from starter</li> <li>• Starting injection and enrichment</li> </ul> | <ul style="list-style-type: none"> <li>• Voltage at terminal 50 during cranking</li> </ul>                             | Cranking voltage                        |
| 3 and 13 Bridged       | Fuel pump relay  | <ul style="list-style-type: none"> <li>• Ignition ON</li> </ul>  | Fuel pump runs                          |
| 13 and 14              | Power Supply Relay   | <ul style="list-style-type: none"> <li>• Ignition ON</li> </ul>  | Battery Voltage                         |



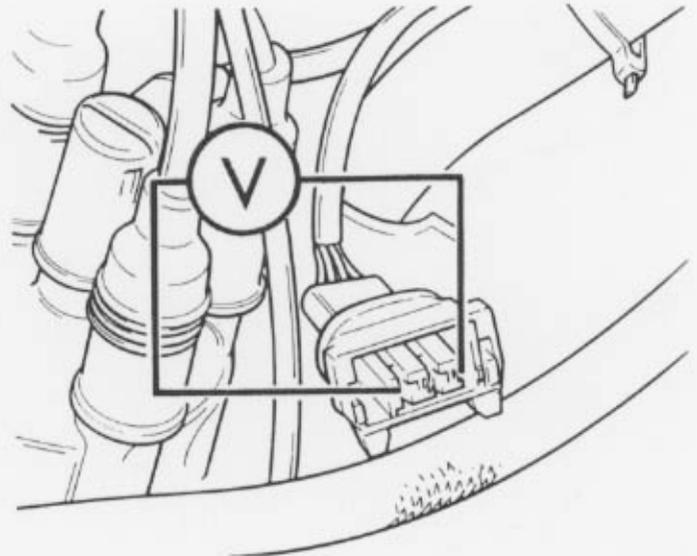
If no spark is present at terminal #4 of the ignition coil when cranking, follow the following sequence:

## Part A

- Remove the wiring connector from the distributor
- Switch the ignition on
- Measure voltage at outer terminals of wiring connector.
- Reading should be minimum 5 volts. If voltage is present, go to **Part B**
- If voltage is not present at the outer terminals, remove the wiring connector from the Digifant control unit and check for voltage across terminals 13 and 14.
- If battery voltage is present, check for continuity between terminal 6 of the control unit and the brown/white wire at the distributor wiring connector and terminal 8 of the control unit and the red/black wire at the distributor wiring connector.
- If wiring is OK, replace the control unit and retest.

## Part B

- Reconnect wiring connector to distributor and peel back rubber boot
- Connect a voltmeter between the center terminal of the wiring connector and battery (+)
- Crank engine
- Voltmeter reading should fluctuate
- If not, replace Hall sender and retest
- If voltage reading fluctuates, check the wiring between the center terminal (green wire) of the distributor wiring connector and terminal 18 of Digifant control unit.
- If wiring is OK, replace Digifant control unit.



# Idle Stabilization

The idle stabilization system used on the Vanagon insures that the idle speed remains constant at predetermined levels during all engine operating conditions by controlling the amount of air bypassing the throttle plate.

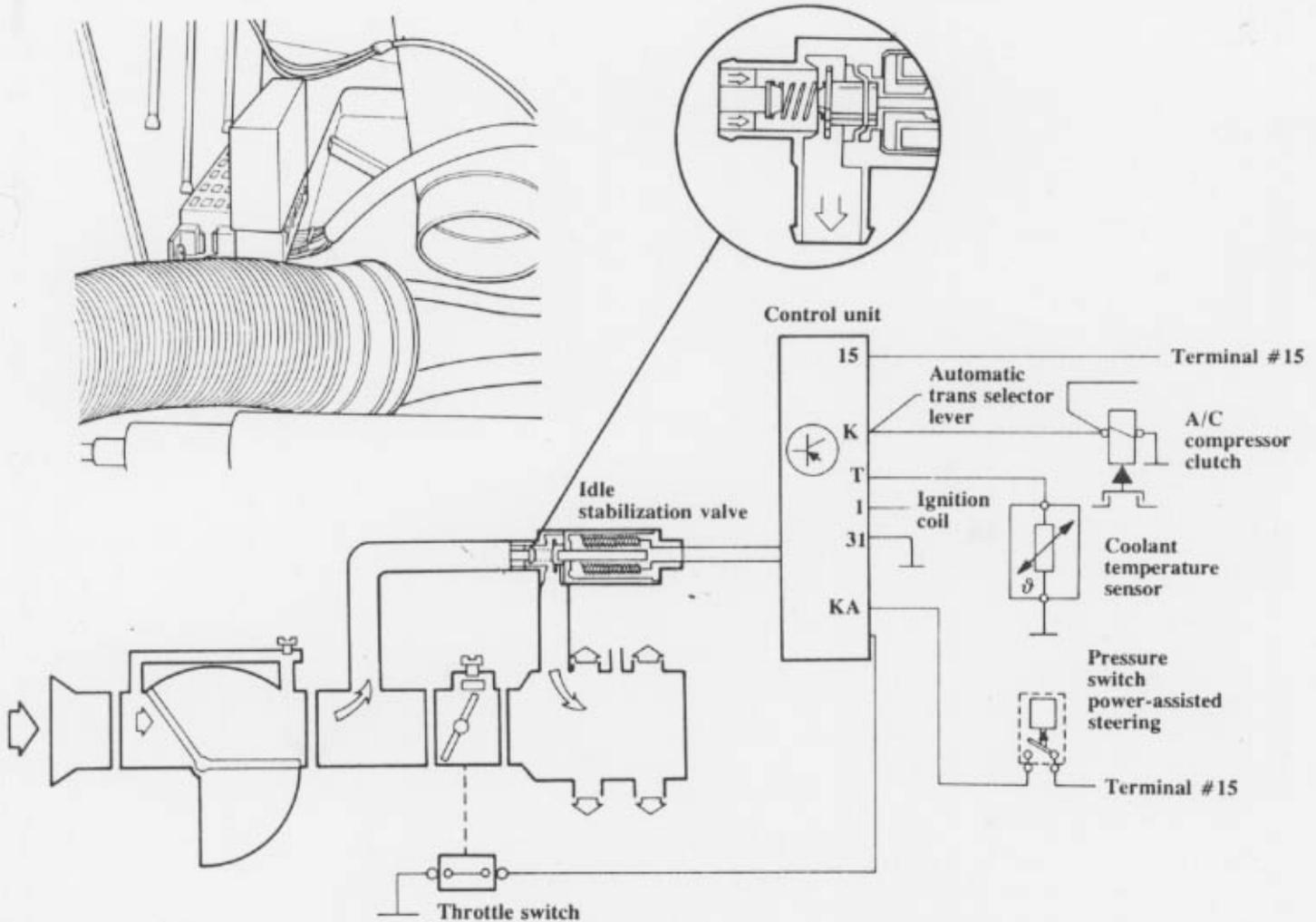
If engine idle speed varies from the value stored in the control unit, the idle stabilizer valve will adjust the volume of air entering the engine at idle. This maintains idle speed within certain limits.

The idle stabilizer valve is operated by a control unit located in the engine compartment near the

air cleaner intake hose. The control unit receives inputs from the following components:

- Throttle switch
- Coolant temperature sensor
- A/C compressor clutch
- Ignition coil terminal #1
- Automatic transmission selector switch
- Power steering pressure switch

With this system, the auxiliary air regulator and digital idle stabilizer are eliminated and any periodic idle adjustment is no longer required.



All checks and adjustments are made under the following conditions:

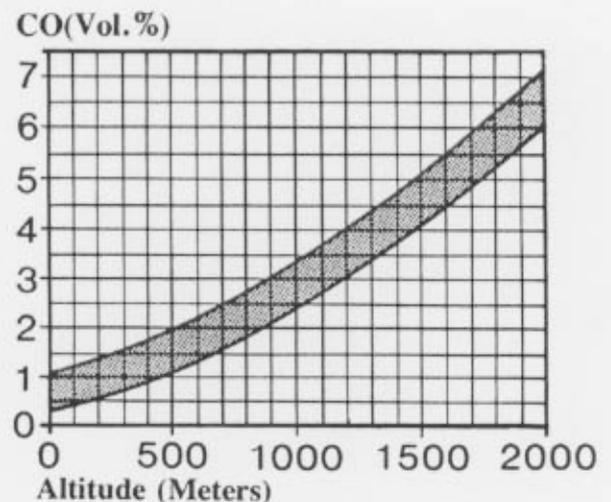
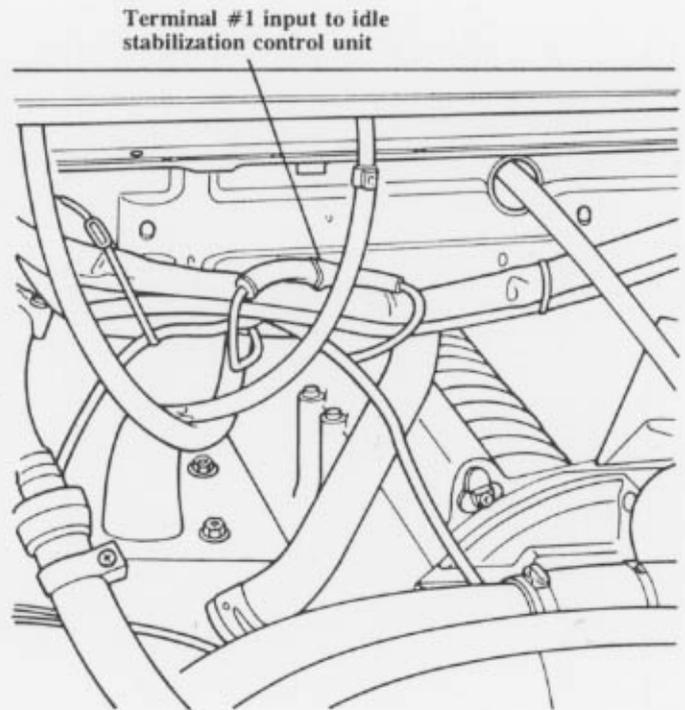
- Engine warm with oil temperature above 80° C (176° F)
- All electrical consumers off.
- Crank case breather hose removed from breather valve and plugged.
- Carbon canister hose pinched closed.
- VW 1367 connected with adapter VW 1473.

## Ignition Timing

- Disconnect coolant temperature sensor.
- Check ignition timing at 2000-2500 RPM.
- Base value 5° ± 2° BTDC - if out of specification adjust to new base value of 5° ± 1° BTDC.
- Reconnect coolant temperature sensor.
- Check ignition timing at 3000 RPM.
- Specification 35° ± 5° more than base value specification.

## Idle Speed And CO% Content

- Disconnect oxygen sensor.
- Disconnect terminal #1 input to idle stabilization control unit.
- Measure idle speed.
- Specification 880 ± 50 RPM
- Measure CO% content.
- Refer to altitude correction chart for specification.
- Specification with oxygen sensor connected 0.7% ± 0.4%.



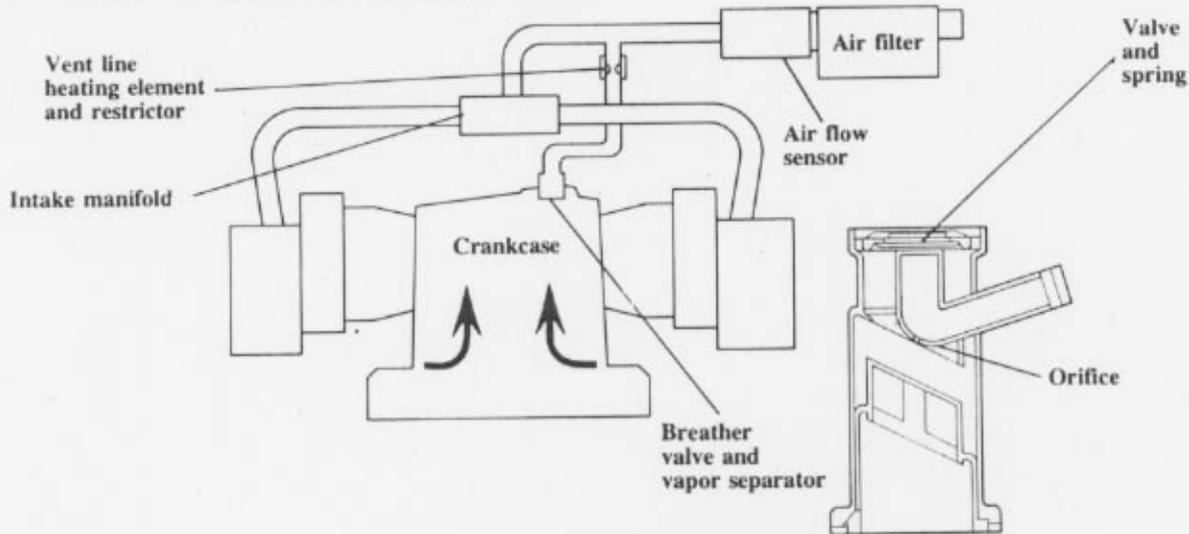
# Emission Control

## Crankcase Emission Control

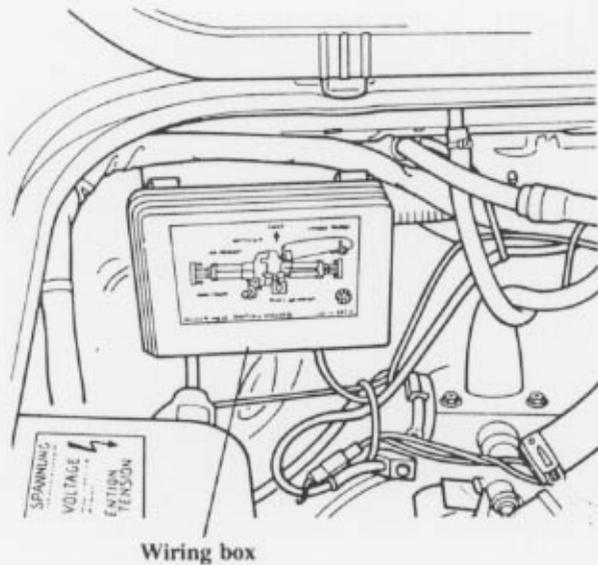
Crankcase vapors are drawn through a breather valve and vapor separator into the intake manifold where they are distributed to all cylinders for reburning.

The breather valve operates via intake manifold vacuum. When manifold vacuum is high, such as

at idle and during deceleration, the valve is closed as spring pressure on the valve seat is overcome. As manifold vacuum drops, such as at highway speeds, the valve opens to allow more vapors to be admitted into the intake manifold.

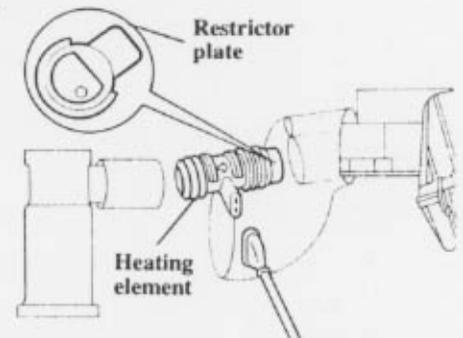


## Vent Line Heating Element



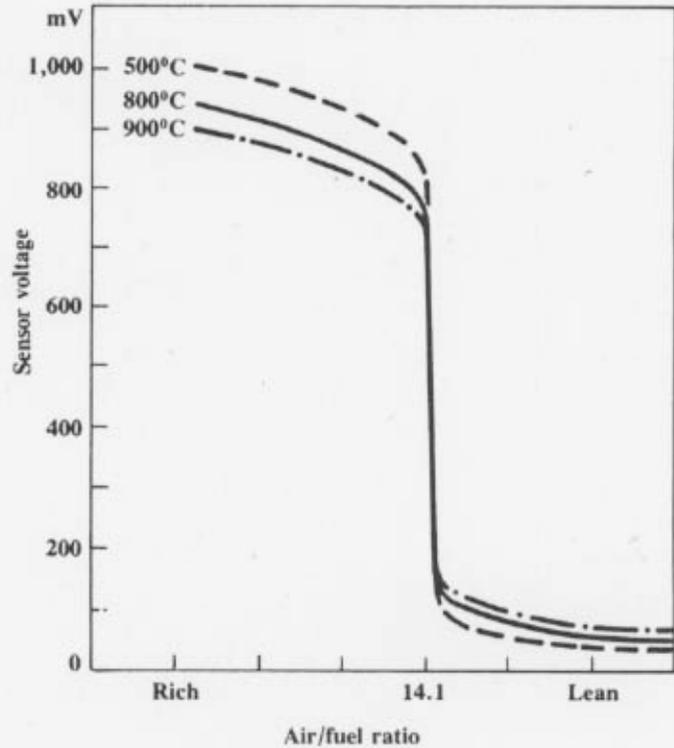
A heating element is used in the crankcase vent line to prevent icing during cold engine operation. This element has a 5.5 mm hole in the restrictor plate. The element can be checked with an ohmmeter. Resistance should be between 4 ohms and 17 ohms at 25°C (77°F).

The circuitry to operate the heating element is protected by an in-line, 5 amp fuse located in the wiring connector box in the engine compartment.

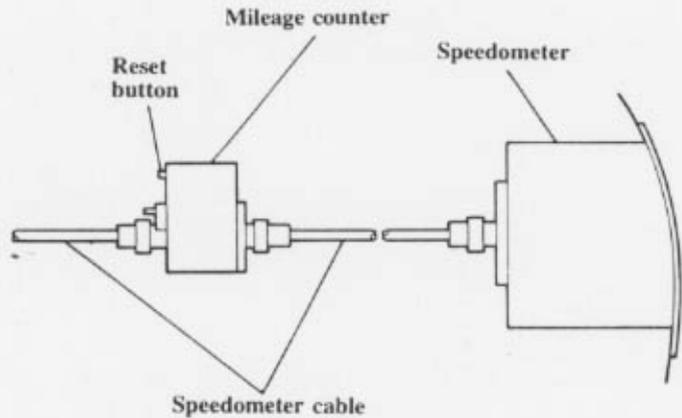


## Oxygen Sensor

With Digifant, a separate control unit and frequency valve are not needed to control the oxygen sensor system. The sensor is connected directly to the Digifant control unit. The control unit processes the voltage signal from the oxygen sensor and adjusts the opening duration of the injectors accordingly, maintaining the air/fuel ratio required for the catalytic converter. The Vanagon uses a 400 cell catalyst with the oxygen sensor threaded into it. The oxygen sensor has its own heating element and has a 60,000 mile replacement interval.



The mileage counter activates a warning light on the dash. At 60,000 miles, the light should be reset and the oxygen sensor replaced. The counter is located in the front of the vehicle, next to the left hand side radius rod.



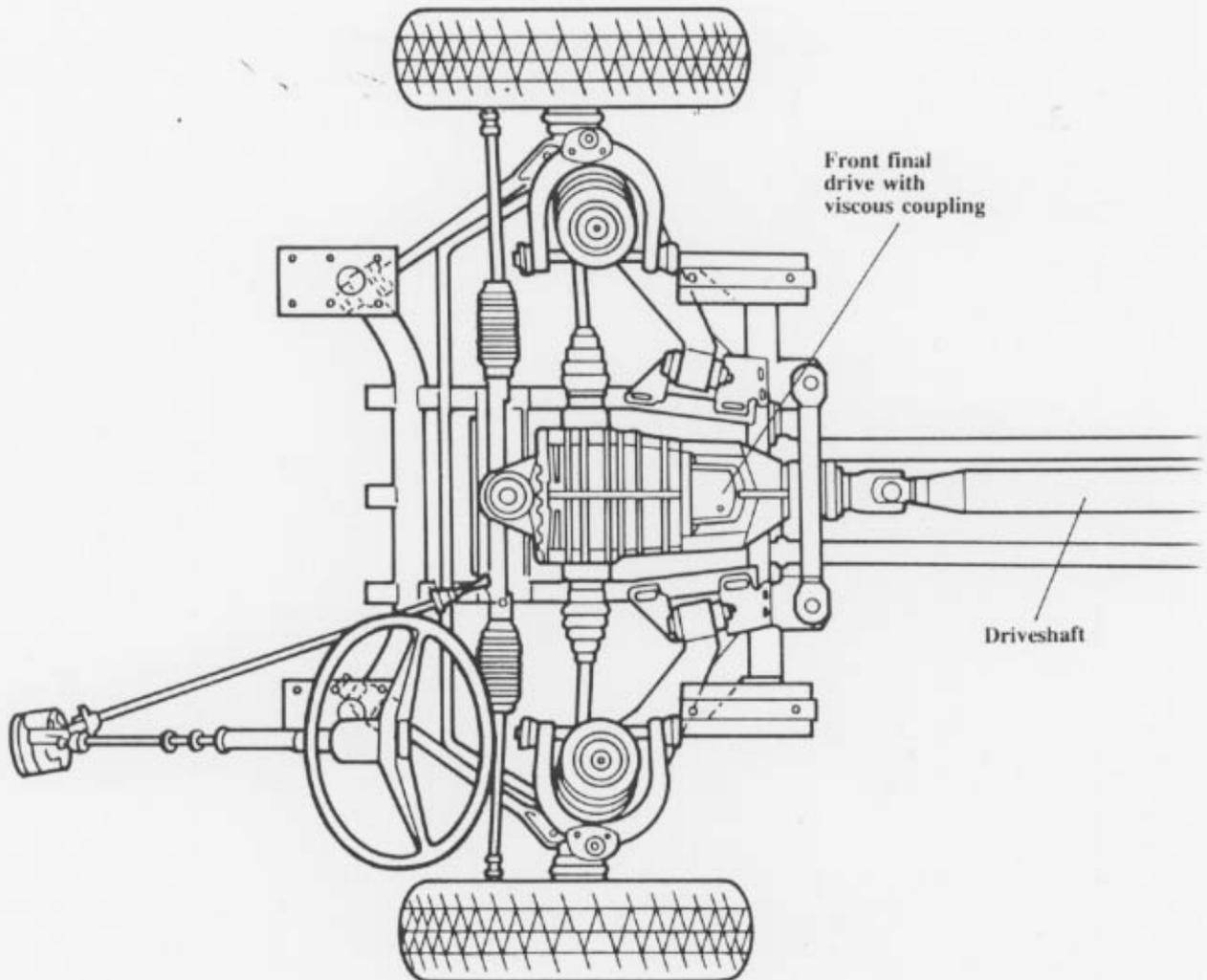
# Permanent All-Wheel Drive

With the introduction of the Vanagon Syncro, Volkswagen offers permanent all-wheel drive based on the use of a new viscous coupling.

Although the rear engine and rear wheel drive provide positive traction under most driving conditions, all-wheel drive means a further improvement under difficult driving surface conditions.

The result of this new drive concept is a vehicle that meets the following design objectives:

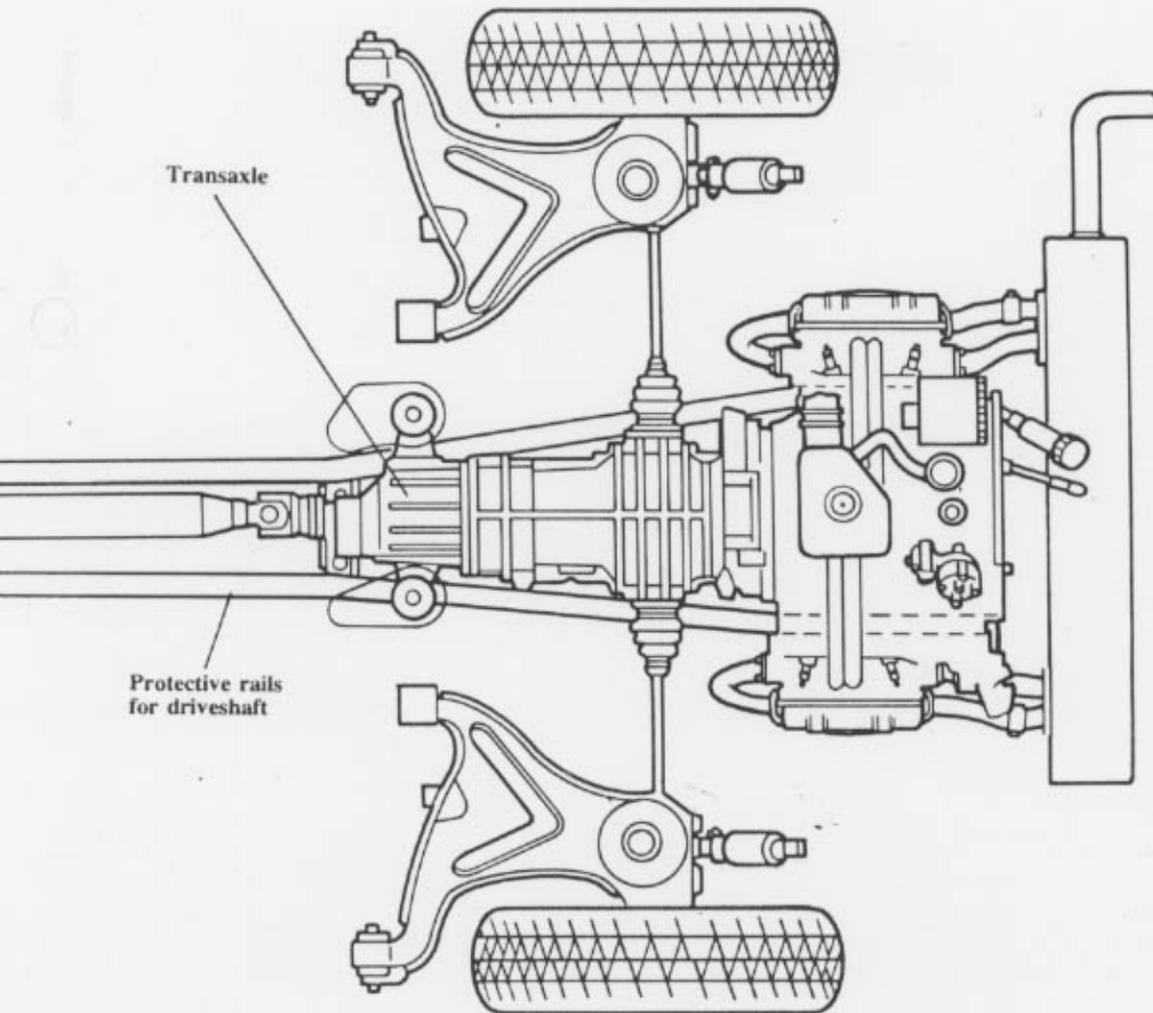
- Permanent all-wheel drive
- No modifications to the body
- As few additional parts as possible
- Low maintenance requirements
- Excellent handling characteristics
- No loss of passenger riding comfort



# Permanent All-Wheel Drive

Unlike other all-wheel drive systems, Vanagon's unique viscous coupling allows a certain amount of speed difference between the driveshaft and front axle, and can automatically make a very rigid connection as the speed difference between the driveshaft and front axle begins to increase.

This revolutionary new concept was introduced because of its inherent advantages: Its small size enables it to be housed in the front final drive housing, and it operates constantly and automatically to transmit the required power to the front differential as soon as it becomes necessary for improved traction.



# Front Axle Final Drive

The Vanagon Syncro front axle final drive is a completely new design. It is specially designed for all-wheel drive and houses the viscous coupling.

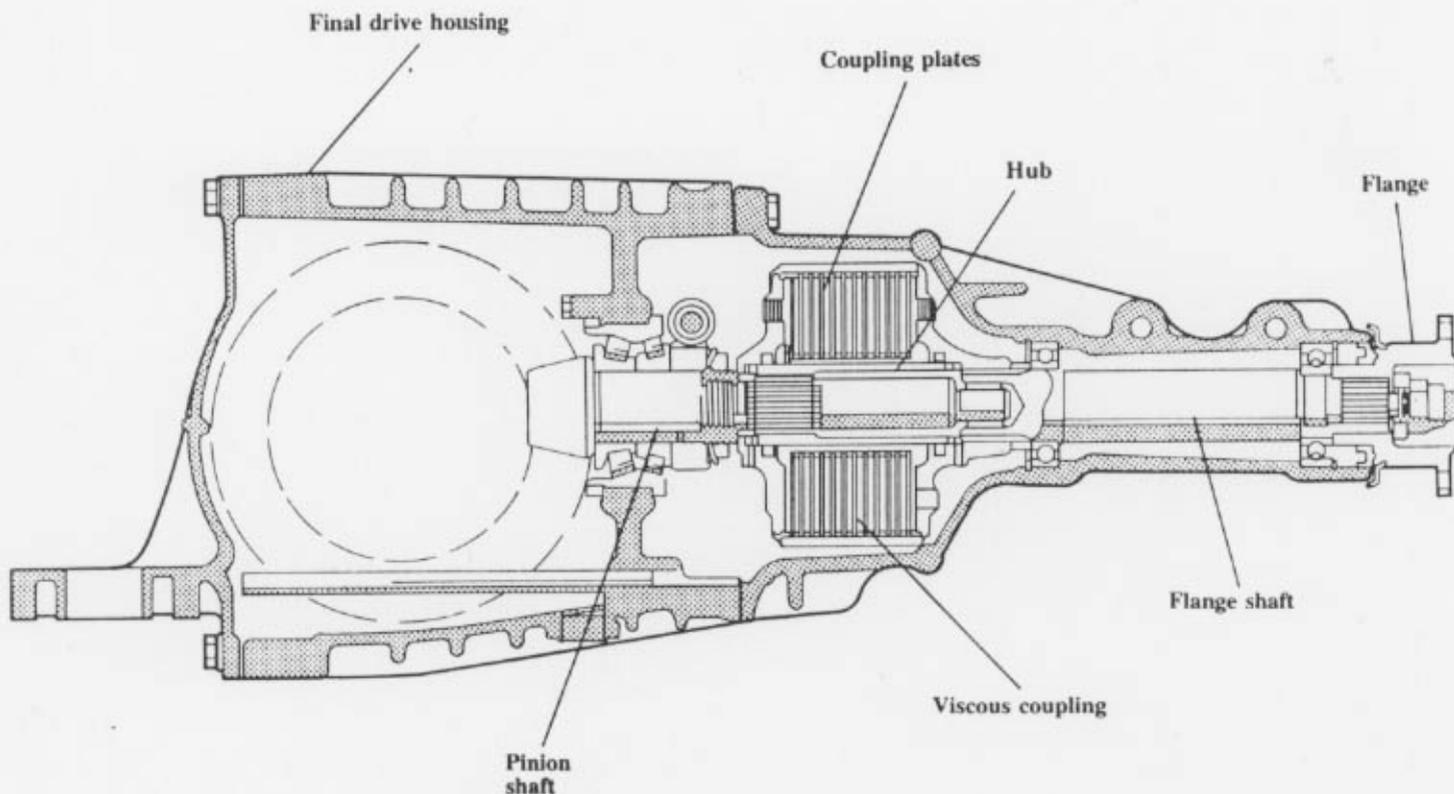
Power is transmitted from the flange shaft to the viscous coupling housing and from there, via the individual coupling plates to the viscous coupling hub, and finally to the pinion shaft.

The pinion shaft is located in the final drive housing by a double taper roller bearing and a

needle roller bearing inside the end of the flange shaft. The flange shaft itself is supported by two ball bearings, one at each end.

An oil tube in the bottom of the housing prevents all the oil from draining away from the final drive when the vehicle is driven up a steep grade. This insures that the final drive is sufficiently lubricated under such conditions.

The lubrication oil for the final drive is also used to cool the outside of the viscous coupling.



# Viscous Coupling

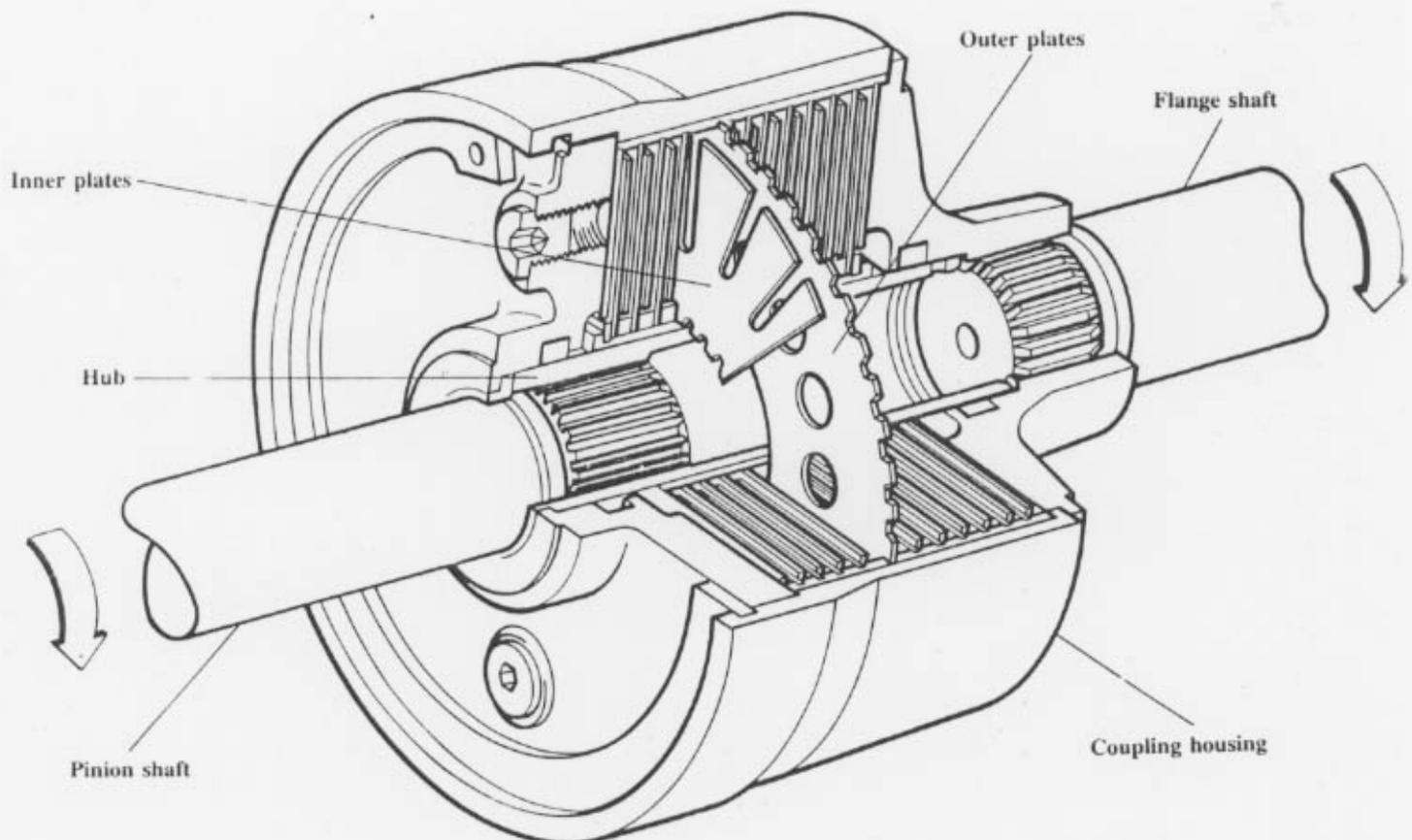
The viscous coupling is fitted inside a drum-shaped housing and completely sealed. Two packs of steel discs are alternated inside the housing. One set of plates is splined to the coupling housing and is driven by the flange shaft. The second set is internally splined to the pinion shaft of the front differential.

There are a total of 48 plates, 24 internally splined and 24 externally splined.

The viscous coupling has no engagement device, it constantly operates. The discs remain equally

spaced with 0.2 mm gap between them, which is maintained by shims between the plates.

The viscous coupling is filled with a special silicon fluid. This fluid is used to transmit the flow of force from the flange shaft via the plates to the pinion shaft of the front differential. Because of the use of this silicon fluid, power transmission occurs automatically and more smoothly than an engageable lock and also means that the viscous coupling is capable of dampening oscillations and shocks in the drivetrain.



# Viscous Coupling

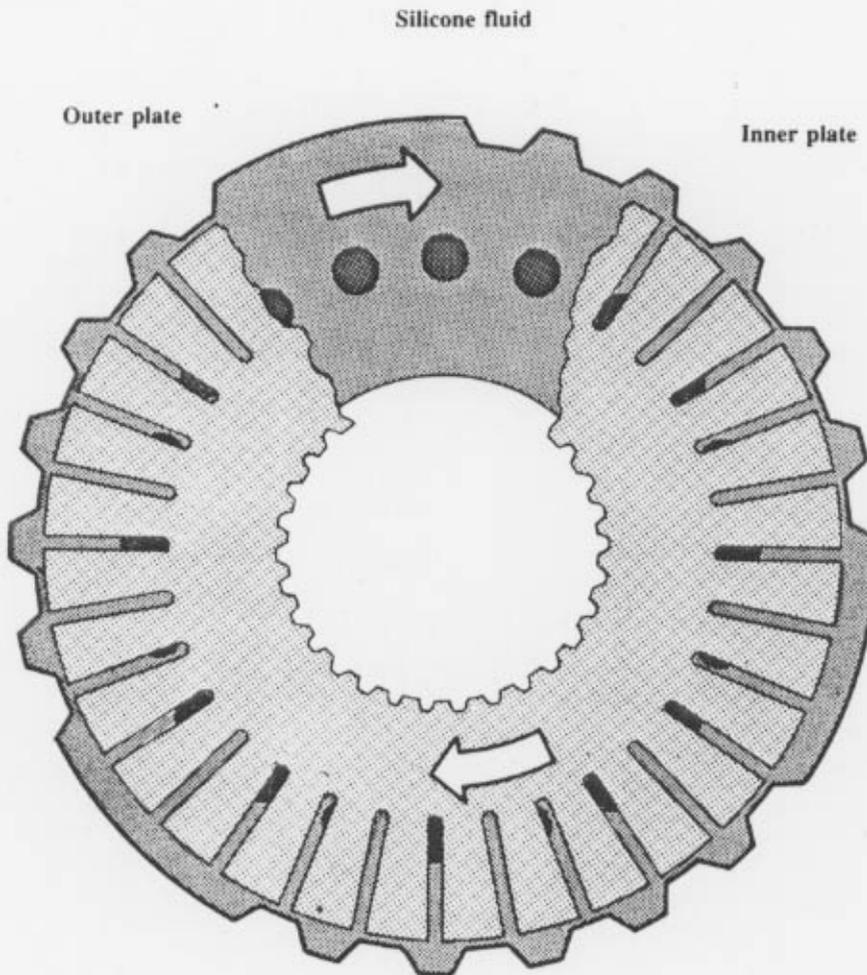
The locking characteristics of the viscous coupling are determined by:

- Number of plates
- Distance between the plates
- Plate surface area
- Shape of the plates
- Properties of the silicon fluid

When the difference in speeds between the flange shaft and the pinion shaft is less than 6%, the viscosity of the silicon fluid is low. This allows the plates to slip, resulting in no transfer of power between them.

However, when the speed difference between the two shafts becomes greater than 6%, which could happen if the rear wheels lost traction on a slippery road surface, the outer splined plates connected to the flange shaft begin to cut or shear the silicon fluid.

The shearing action of the silicon fluid causes internal heat and results in a sharp increase of the fluid's viscosity. It becomes more difficult for the fluid to become sheared and the coupling locks up.



# Viscous Coupling

This shearing action between the two sets of plates also leads to an expansion of the silicon fluid and a rise in pressure inside the sealed viscous coupling. The rise in pressure is controlled by a small measured quantity of air that is included in the drum during manufacture before it is sealed.

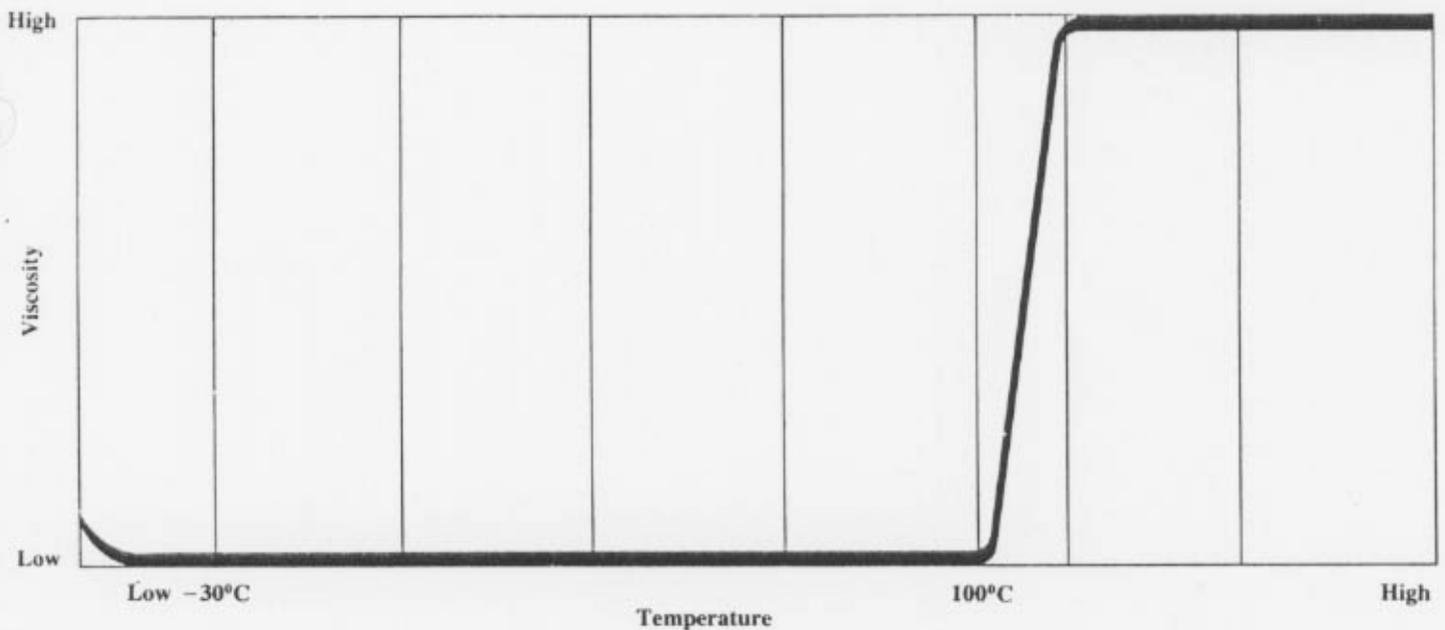
Because of the rapid rise in temperature and pressure, lock-up occurs very quickly, in about 1/10 second or approximately 1/4 turn of the tire.

Power is now transmitted between the plates with the fluid as a medium.

At the point of lock-up, a self regulating effect takes over. As practically no relative movement takes place between the two sets of discs, the temperature of the silicon fluid drops and the pressure inside the coupling drops. Now a level of slip is maintained in accordance with the speed changes between the front and rear axles.

This unique silicon fluid is patented and has the ability to increase its viscosity quickly when it is heated. The fluid's viscosity does not, however, increase when temperature decreases.

Viscous Coupling Silicon Fluid



# Transmission

The manual transmission used on the Syncro has the designation 094-4WD and incorporates a newly developed reduction design for the low and reverse gears.

The low gear has a 60% lower ratio than 1st gear on the previous 094 transmission and is in the same shift plane as reverse. This feature provides easy shifting between the two gears to help "rock" the vehicle in the event it gets stuck.

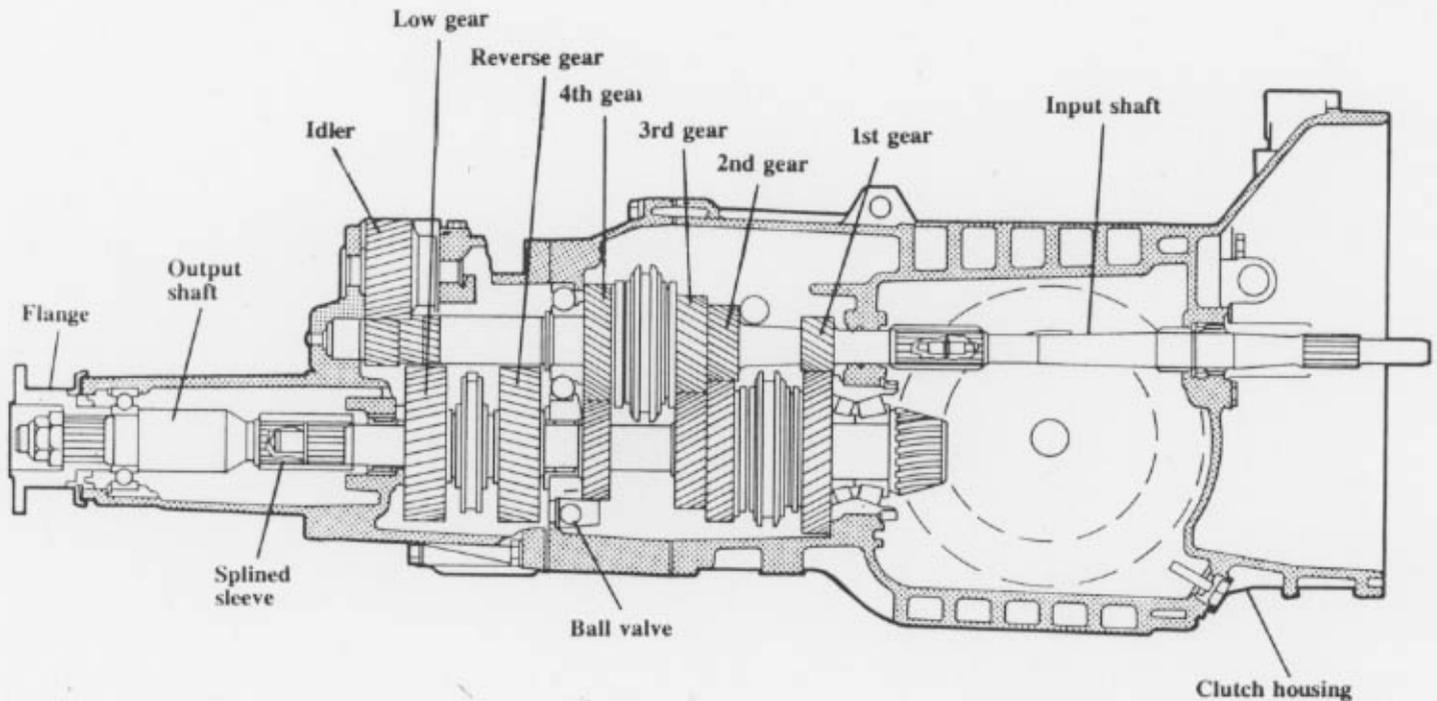
The transmission has an additional housing for these two gears and an output shaft housing for the driveshaft. In order to provide space for the output shaft, the shift linkage had to be modified slightly.

The input shaft and pinion shaft have been increased in length. In order to attain a lower gear ratio for the low and reverse gears, an idler gear and intermediate gear have been installed.

The output shaft is located in the housing by a ball bearing and a roller bearing, which also supports the pinion shaft. The pinion shaft and output shaft are connected by a splined sleeve.

Additionally, a ball valve is located in the transmission housing. It retains a certain amount of oil in the bearing housing when the vehicle is being driven up a steep grade.

| Gear Ratios |          |          |          |          |              |             |
|-------------|----------|----------|----------|----------|--------------|-------------|
| Low gear    | 1st gear | 2nd gear | 3rd gear | 4th gear | Reverse gear | Final drive |
| 6.03        | 3.78     | 2.06     | 1.23     | 0.85     | 6.03         | 4.86        |

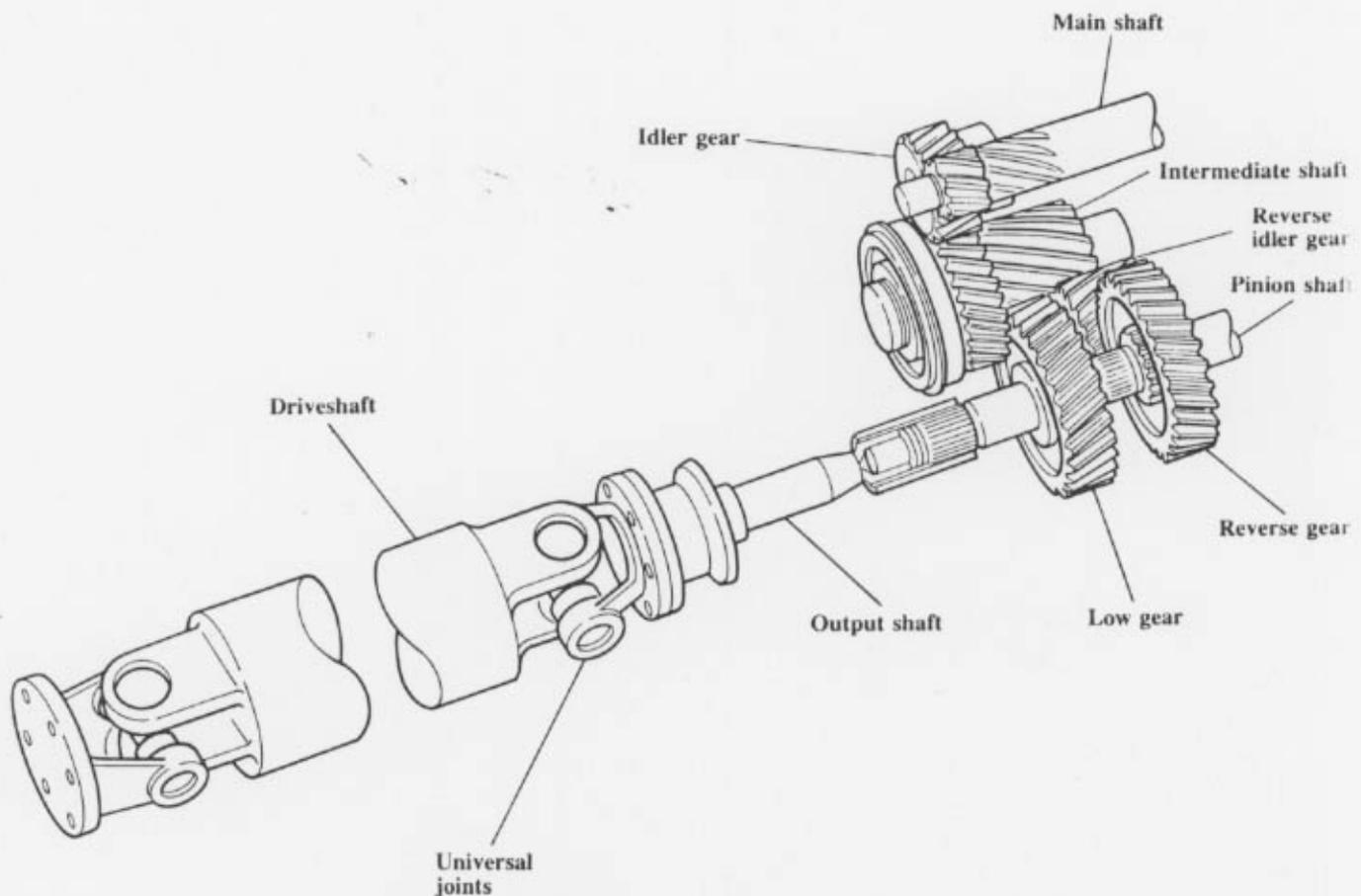


The new design for the low gear and reverse is accomplished through the gear set in the special housing attached to the transmission housing.

When low gear is selected, power is transmitted from the transmission main shaft via the idler gear to the intermediate shaft. The smaller gear on the intermediate shaft meshes with the low gear, which is locked to the pinion shaft by the action of the shift fork on the lock sleeve. Output is directed to the pinion shaft and driveshaft through the sleeve.

When reverse is selected, the lock sleeve connects reverse gear to the pinion shaft.

Power flows from the intermediate shaft via the reverse gear idler to the reverse gear. From there, power is directed to both the pinion gear and to the driveshaft. A driveshaft connects the transmission and front final drive. It has two maintenance free universal joints and has been balanced as a unit. Changes in angle between the main gear box and the front differential can thus be compensated for. The front differential is mounted in bonded rubber bushings so the need for changes in driveshaft length is eliminated.



# Rear Differential Lock

In addition to the standard viscous coupling, the Vanagon Syncro will also offer a rear differential lock as an option. The shift valve for the lock is located in the center of the dash panel beneath the indicator lamp panel.

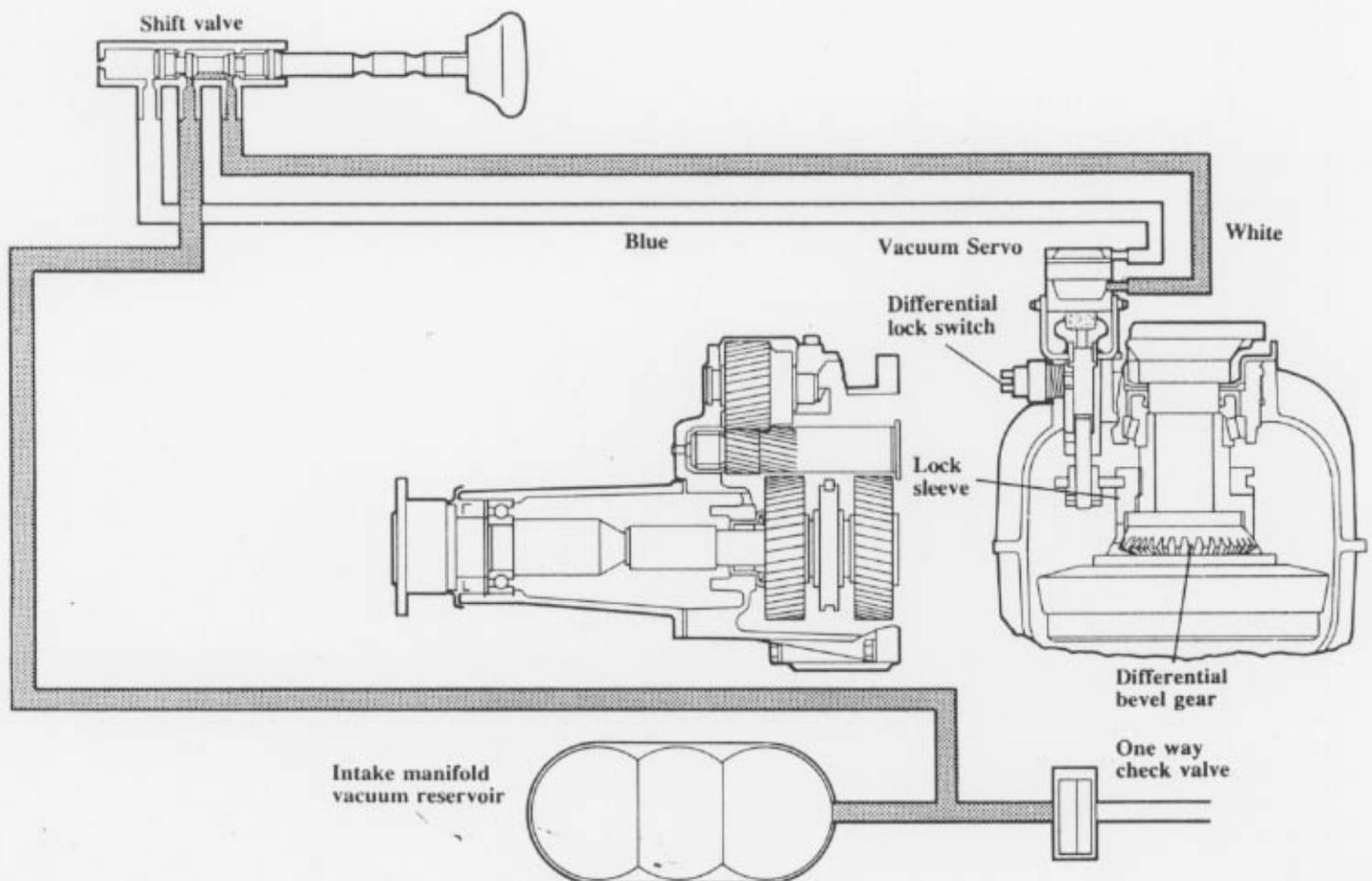
When the shift valve is pulled out, the differential lock is engaged via the lock sleeve located in the differential.

The engagement of the lock occurs as intake manifold vacuum is directed by the shift valve to the engagement side of the vacuum servo through the white colored plastic tubing. The lock sleeve is then pushed into engagement with the differential bevel gear.

A vacuum reservoir located next to the right hand frame rail stores vacuum for lock operation and works in conjunction with the one way check valve to insure that sufficient vacuum is maintained at all times.

Disengagement of the lock occurs when the shift valve is pushed in and vacuum is directed through the blue plastic tubing to the disengagement chamber of the vacuum servo.

The lock should only be engaged on icy, snowy or muddy surfaces at low speeds if the vehicle is in danger of becoming stuck.



# Drivetrain Protection

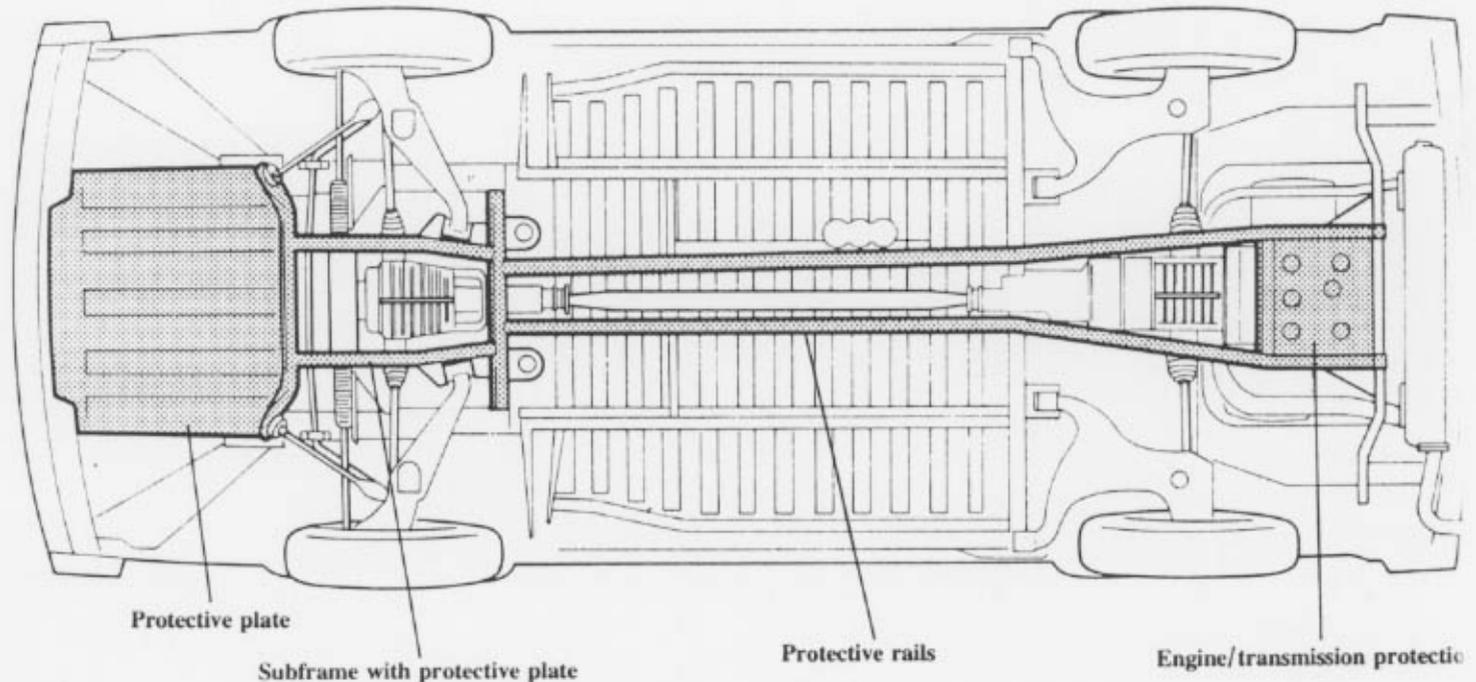
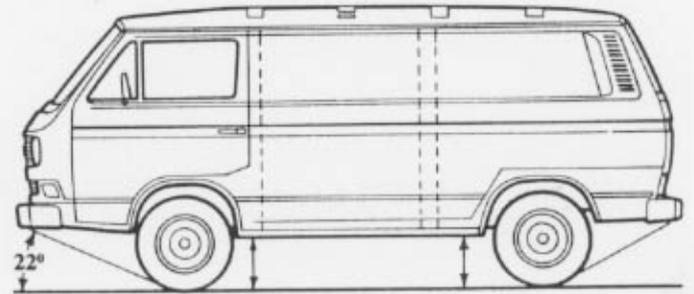
Underneath the Syncro, protective rails have been added which extend from the front subframe to the rear engine mount. These rails provide protection for the driveshaft. In the rear, there is a skid plate under the engine and transmission, and in the front, a protective skid plate is bolted to the body to protect the front axle and final drive.

All parts related to the all-wheel drive system increase the vehicle weight by approximately 140 kilograms (308 pounds).

Most of this additional weight is in the form of this protection, which insures that the engine, transmission, driveshaft and front final drive are not damaged by rocky terrain. It also results in weight distribution of close to 50/50.

In order to improve travel over hilly areas, the angle between the front tire and bottom of the front bumper has been increased from  $19^{\circ}$  to  $22^{\circ}$  on the Syncro.

Additionally, the vehicle was raised 60 mm, providing an increase in ground clearance, despite the additional protection rails and shielding for the engine and transmission.



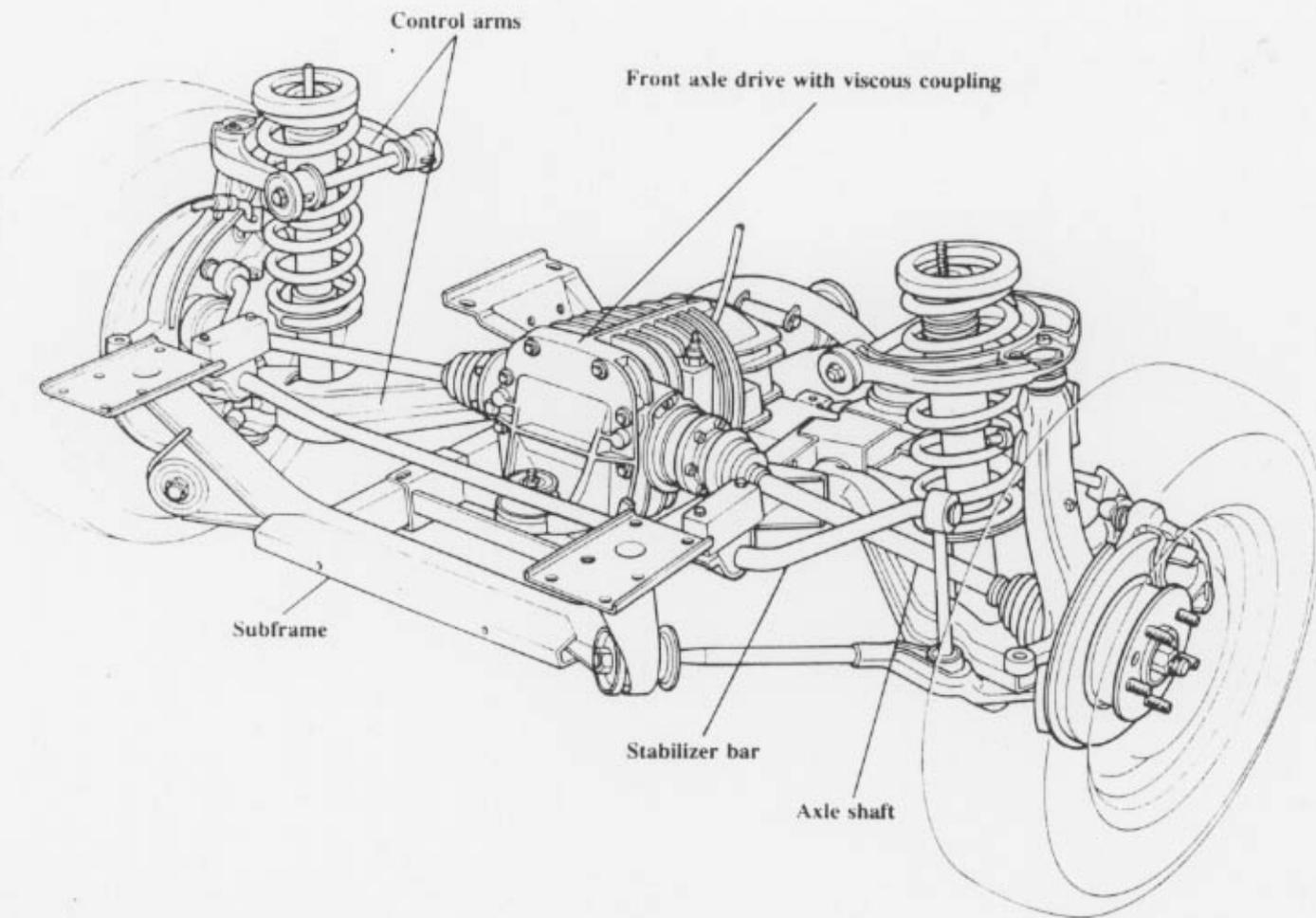
# Front Suspension

To accommodate the front final drive, the front axle subframe has been redesigned. It contains the final drive mounts and supports the radius rods, lower control arms, and stabilizer bar. Because of the higher loads to be expected, the stronger subframe has more mounting bolts, although it is shaped in such a way that modifications to the body were not necessary.

The front wheels are attached to a double control arm suspension and are supported by new coil springs and redesigned shocks. This design results in increased ground clearance, and a 20 mm increase in suspension travel.

The front of the final drive is secured to the subframe through one bonded rubber bushing and at the rear by a mounting bracket. The front mounting bracket attaches to the frame through elongated holes so that the driveshaft and front final drive can move longitudinally and therefore be assembled stress free.

Because both the transmission and front final drive are mounted by bonded rubber bushings, it is not necessary to provide length adjustment for the driveshaft.



# Front Suspension

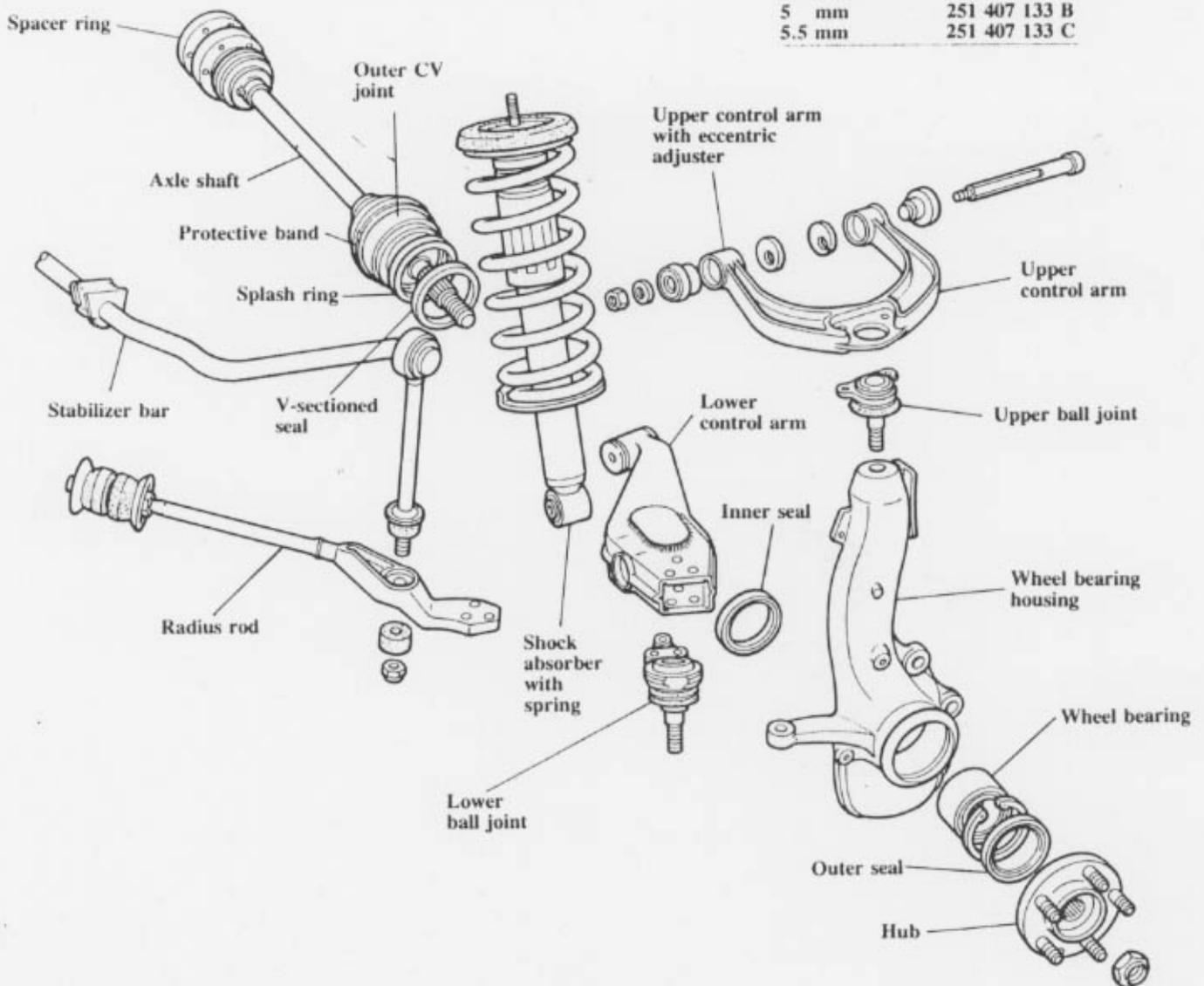
The addition of all-wheel drive on the Syncro models has necessitated changes to the front suspension. The front wheel bearing housings are new and house the front axle bearings and seals. The front wheel drive is via equal length axles.

The new outer wheel bearing housing attaches to the upper and lower control arms with ball joints. As before, caster is adjusted by lengthening or shortening the radius rods, and camber is

adjusted by the upper control arm inner bolt and eccentric washers.

When checking the upper control arm during alignment, it is important that no more than 0.5 mm clearance exists between the eccentric washer and the bonded rubber bushings when the bolt is loosened. To insure this, the following eccentric washer thicknesses are available.

| Thickness | Part-No.      |
|-----------|---------------|
| 4 mm      | 251 407 133 A |
| 5 mm      | 251 407 133 B |
| 5.5 mm    | 251 407 133 C |



# Front Suspension Components

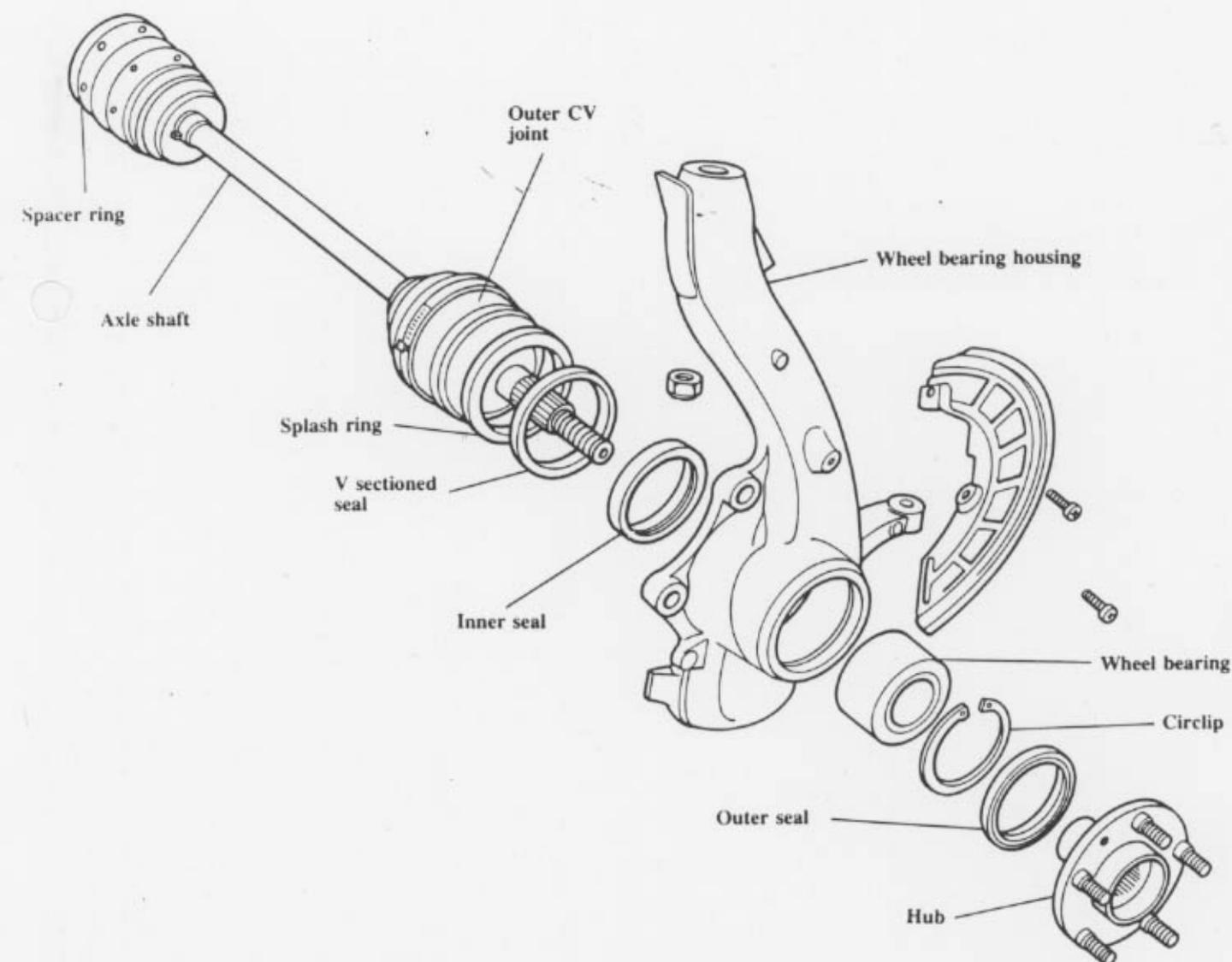
The wheel bearing housing, wheel bearing, and hub are all new. The wheel bearing is protected by two seals. Both the inner and outer seals are filled with grease to prevent water from entering.

In addition, to protect the inner seal, there is a splash ring on the outer CV joint. A "V" shaped seal is inserted in this splash ring and its sealing lip rides against the inner seal. This splash ring and extra seal provide additional protection for the

inner seal because this is an especially critical part of the suspension.

The spacer ring between the final drive flange and the inner CV joint insures that the hub has sufficient clearance under all extremes of suspension travel.

The Syncro also has modified Mark II disc brake calipers fitted to the front suspension.



# Tire and Wheel Specification

## Wheel Alignment Data For Front And Rear Axles

When checking wheel alignment, the following conditions are important:

- except in emergency alignment should not be checked until vehicle has run 1,000-2,000 miles and coil springs have settled
- vehicle empty
- tire pressures correct
- test surface level and horizontal
- vehicle bounced several times
- steering gear correctly adjusted
- steering linkage free of play

| Front Axle   | Vanagon       |              | Vanagon Syncro |              |
|--|---------------|--------------|----------------|--------------|
|  | Empty         | Maximum Load | Empty          | Maximum Load |
| Toe per wheel (not pressed)  | +10' ± 15'    | 0° ± 15'     | 0' - 10'       | +0° 12'      |
| Camber (wheels in straight-ahead position)                           | 0 ± 30'       | 0 ± 30'      | +20' ± 20'     | -30'         |
| Toe angle difference, at 20° lock to left and right (not adjustable) | 1° 10' ± 20'  | 1° 50' ± 20' |                |              |
| Caster (vehicle level)   | +7° 15' ± 15' | +6° ± 15'    | +4° 40' ± 15'  | +3° 35'      |

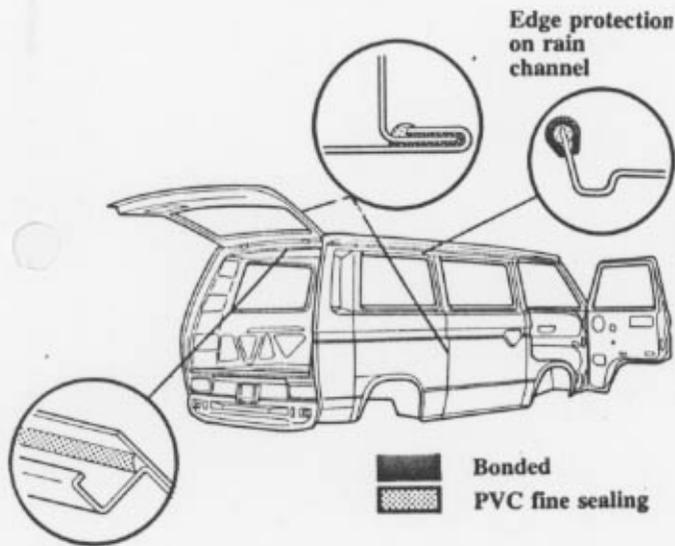
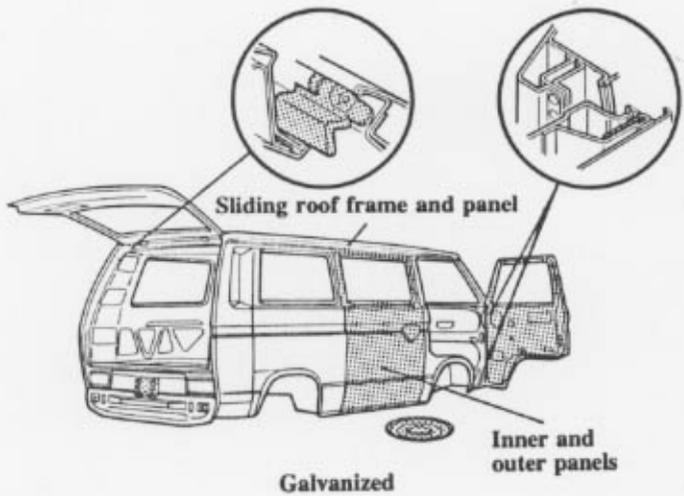
### Rear Axle

|  |            |               |                     |         |
|--|------------|---------------|---------------------|---------|
| Toe per wheel                                      | 0° ± 10'   | +10' ± 10'    | +5' ± 10'           | +0° 5'  |
| Camber   | -50' ± 30' | -2° 10' ± 10' | -15' + 30'<br>- 10' | -1° 10' |
| max. permissible difference between left and right | 30'        | 30'           | 20'                 | 20'     |

## Tires and Wheels

|                | Tire Size  | Wheel Size | Inflation Pressures |                |
|----------------|------------|------------|---------------------|----------------|
| Vanagon Syncro | 205/70R14C | 6J x 14    | Front               | 2.5 bar 36 PSI |
|                |            |            | Rear                | 3.0 bar 44 PSI |
|                |            |            | Spare               | 3.0 bar 44 PSI |
| Vanagon        | 185 R 14C  | 5½J x 14   | Front               | 2.7 bar 39 PSI |
|                |            |            | Rear                | 3.3 bar 48 PSI |

# Corrosion Protection



To improve corrosion protection, many measures have been introduced.

Components which are particularly susceptible to corrosion are made from sheet metal which is galvanized on one side. The zinc coated side faces inward to offer good protection in body cavities. The approximately 12 micron (0.012 mm) thick coating offers excellent protection against rust formation.

To prevent sheet metal connections from trapping moisture, doors and flaps are bonded and fine sealed.

After assembly, the bare body is submerged in a degreaser. This is followed by a coating of zinc phosphate and then cathophoretic dip priming. This dip priming process is capable of applying a coating that is about four times thicker at folds and edges than could be attained using other processes.

# Corrosion Protection

The underside of the body, particularly areas which are highly exposed to stone damage, receive special coatings that provide extra protection against paint chipping and corrosion.

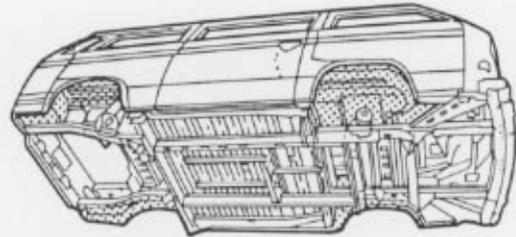
In order to guarantee even protection for the critical floor section, robots spray the PVC underbody sealant, providing a highly flexible coating, especially in the wheel housings.

Areas which are particularly endangered by stone damage, such as the front cross panel, wheel arc panels, sill panels and wheel housings are protected with another intermediate coating of damage resistant material.

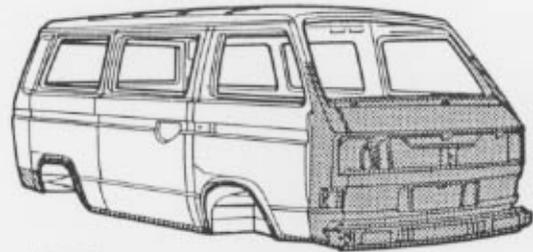
After painting, the complete floor section is treated with wax.

Body cavities which are endangered by corrosion are additionally protected with a wax process that applies coating to a number of large, though critical, areas of the body.

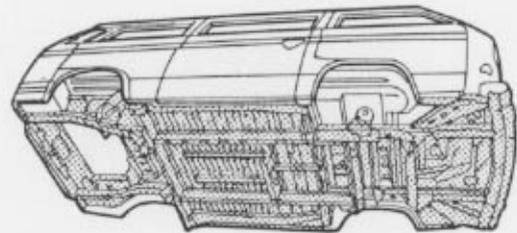
The combination of all these processes provides effective protection against corrosion.



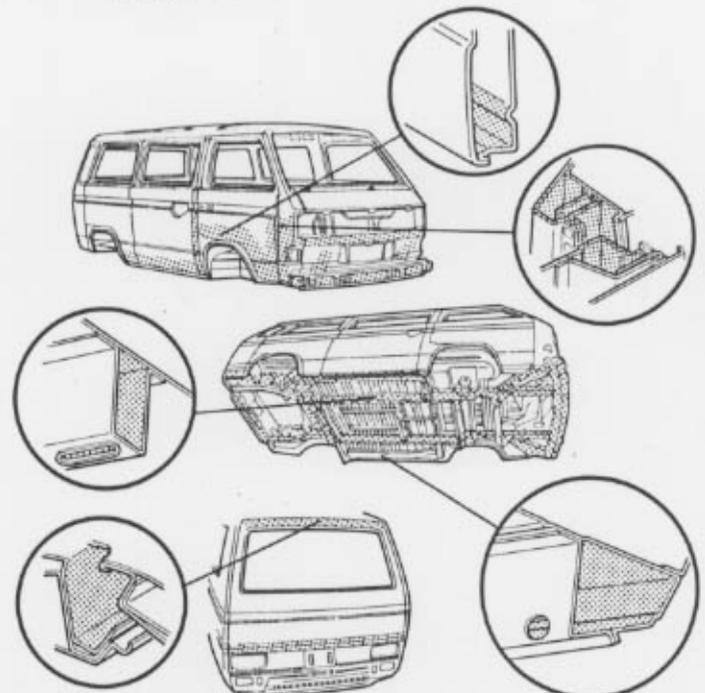
Intermediate stone damage protection coat



PVC Stone damage protection



Wax



# Air Conditioning

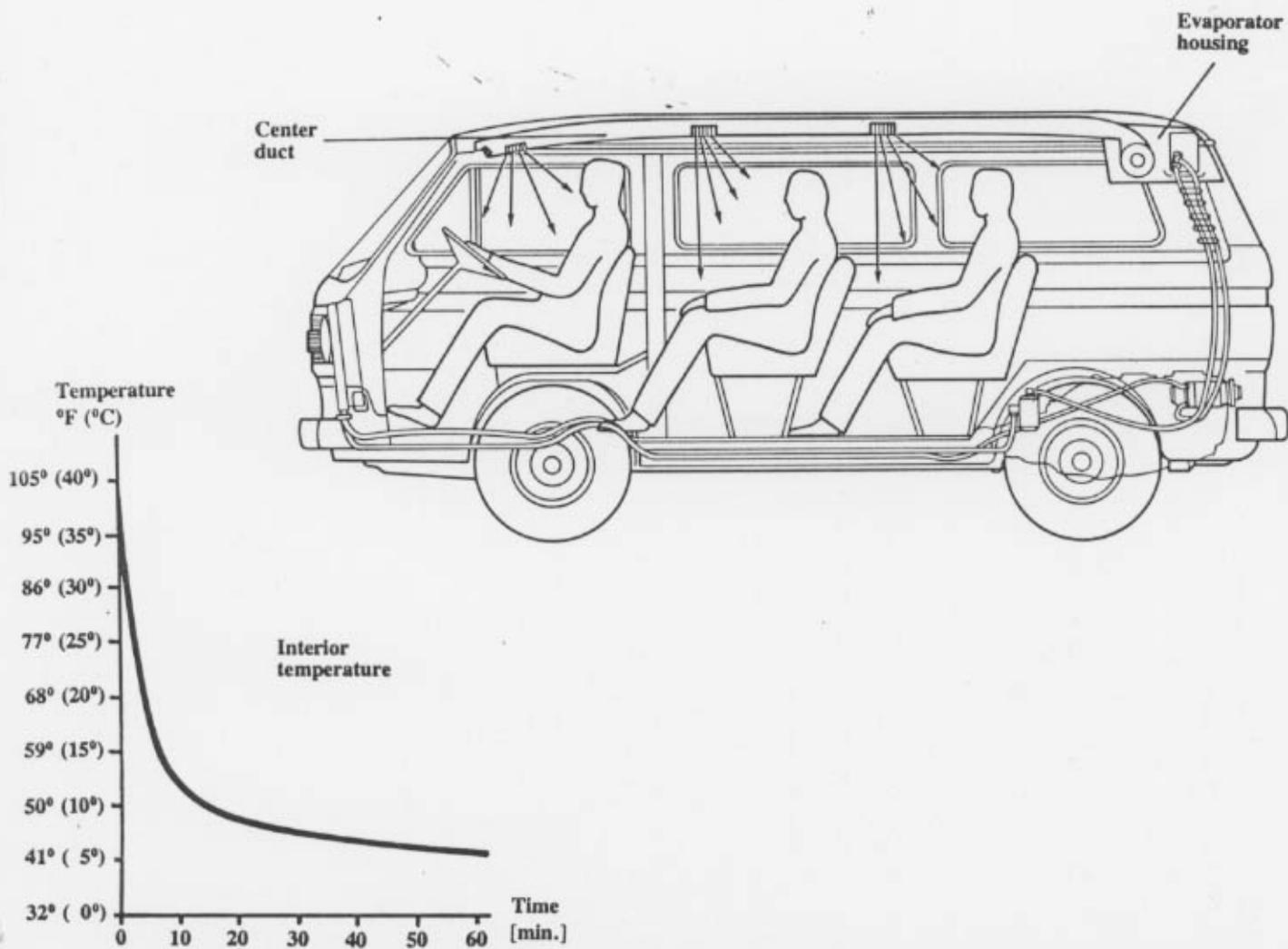
The new Vanagon air conditioning system offers vast improvements in the areas of air flow and interior temperature. New features include rear mounted evaporator with two 4 speed fans, H-block expansion valve and a new, higher capacity 3 speed radiator cooling fan.

Air flow from the system has been increased, resulting in lower vent temperatures, lower average interior temperature and quicker temperature lowering.

As a result, overall cooling performance and customer comfort have been greatly enhanced.

The system consists of all new interior duct work, running through the center of the passenger compartment and exiting through outlets in the center duct and the front housing.

New simplified controls provide optimum temperature control. The 4 speed fan is controlled by a switch located in the front housing above the driver's head. A temperature control switch determines evaporator temperature via an electronically controlled thermostat. It is also located in the front housing.

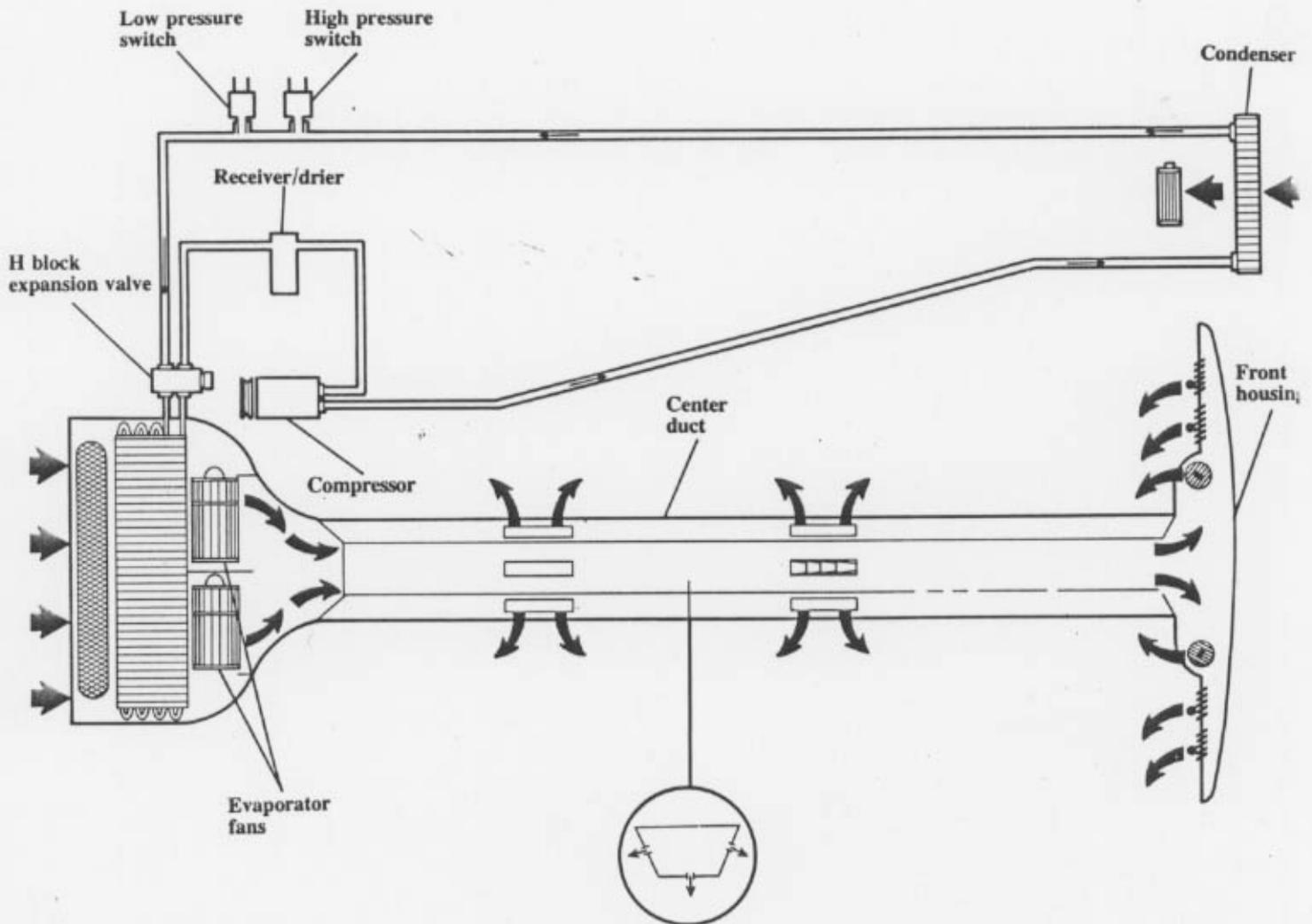


# Air Conditioning

The new optimized air conditioning system uses strictly recirculated air that is drawn through the evaporator at the rear of the vehicle by two new fan motors. The cooled, dehumidified air is directed throughout the passenger compartment.

Refrigerant flows from the compressor to the condenser and to the evaporator via an H block expansion valve. Both the expansion valve and

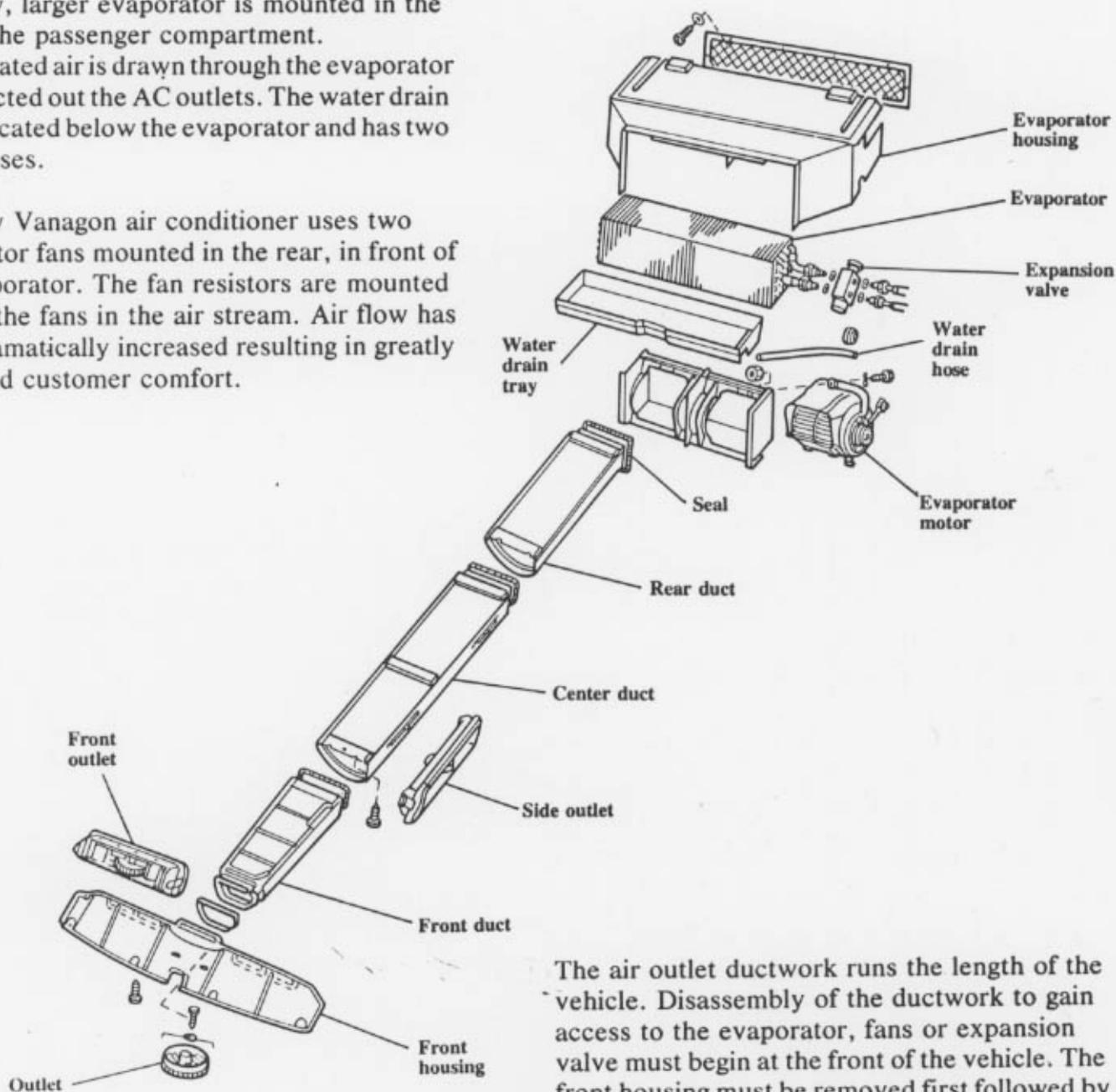
the evaporator are housed in the panel at the rear of the vehicle. A water drain tray collects condensation and routes it out of the passenger compartment through two hoses, one on each side of the vehicle. The new plastic evaporator housing can be removed by separating it from the center duct. Refrigerant capacity has been increased to 1450 grams (52 ounces).



# Air Conditioning Components

The new, larger evaporator is mounted in the rear of the passenger compartment. Recirculated air is drawn through the evaporator and directed out the AC outlets. The water drain tray is located below the evaporator and has two drain hoses.

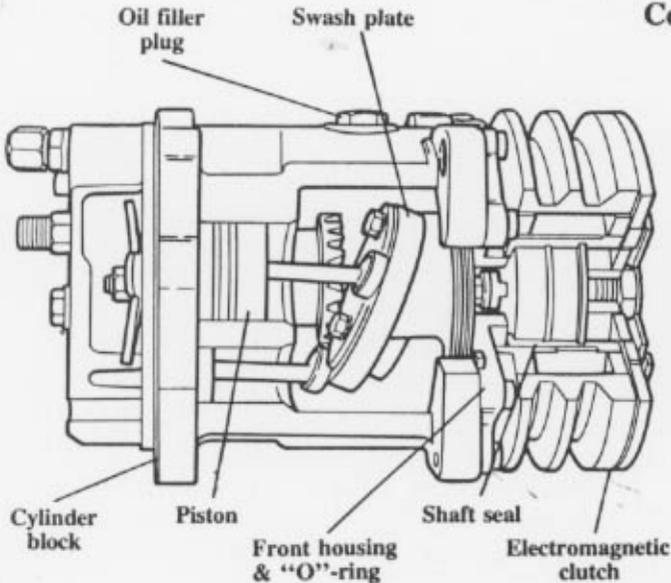
The new Vanagon air conditioner uses two evaporator fans mounted in the rear, in front of the evaporator. The fan resistors are mounted next to the fans in the air stream. Air flow has been dramatically increased resulting in greatly improved customer comfort.



The air outlet ductwork runs the length of the vehicle. Disassembly of the ductwork to gain access to the evaporator, fans or expansion valve must begin at the front of the vehicle. The front housing must be removed first followed by the front duct, center duct, rear duct and finally the evaporator housing. The procedure is reversed for reassembly.

# Air Conditioning Components

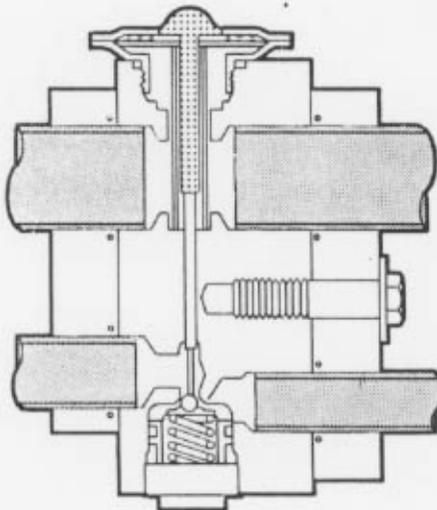
## Compressor



The Vanagon uses a Sanden 5 cylinder compressor. This compressor is used because of its high output capacity combined with its small overall size and light weight.

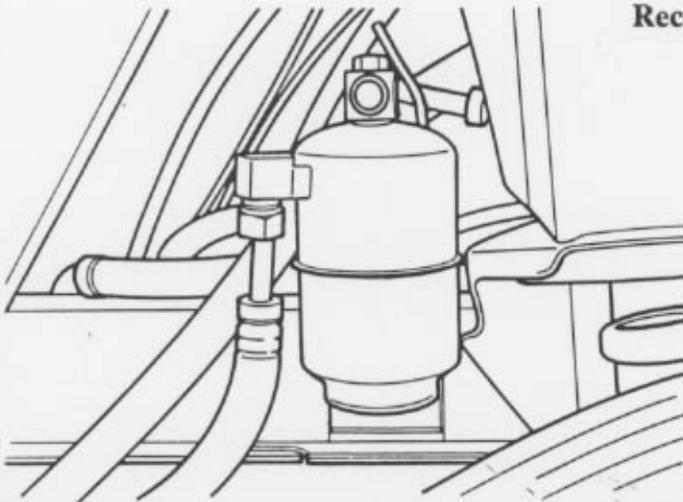
The compressor consists of a swash plate which operates five separate pistons to circulate and compress the refrigerant. Lubrication pressure is supplied by utilizing the difference in pressure between the intake and supply ports.

## Expansion Valve



The expansion valve is mounted next to the evaporator under the plastic cover. A sensing element measures the temperature of the refrigerant as it leaves the evaporator. The sensing element is connected to a ball valve on the evaporator inlet. It controls the flow of refrigerant into the evaporator based on the evaporator outlet temperature. By using an "H" type expansion valve the flow of refrigerant can react more quickly to the changes in heat load on the system resulting in more constant evaporator temperature.

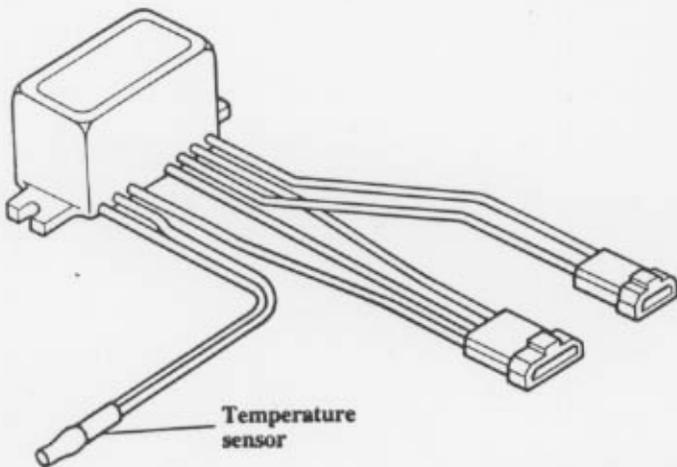
## Receiver/Drier



The receiver/drier is mounted in the left rear fender well next to the tire and houses the high pressure blow out plug. Access to the sight glass is easily attainable through the tire well opening.

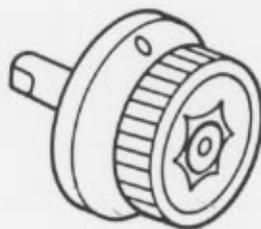
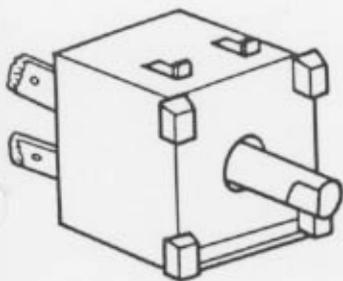
# Air Conditioning Components

## Evaporator Thermostatic Switch



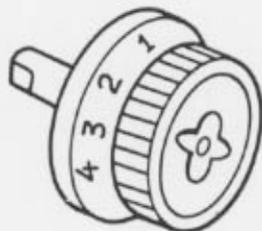
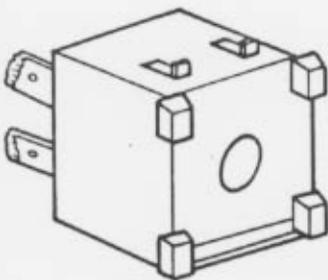
The thermostatic switch uses a PTC (positive temperature coefficient) resistor and a temperature probe to maintain evaporator temperature at the desired level. It uses input from the temperature control mounted in the front air outlet panel to cycle the compressor through the relay circuitry.

## Evaporator Temperature Control Switch



The temperature control switch sets the interior temperature at the desired level. It is a rheostat with switch contacts that direct current to the fan speed switch. It is located in the air outlet duct in the front of the vehicle.

## Evaporator Fan Speed Switch

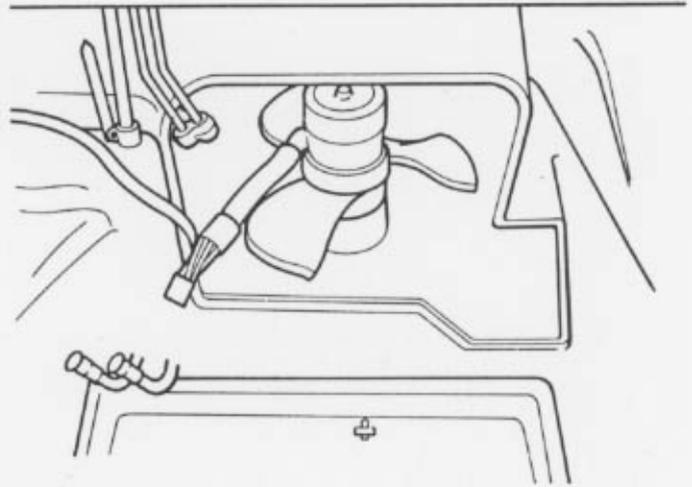


This switch has four speed positions for the evaporator fans. Low and second speed are controlled directly by the switch. Third speed is via contacts in the AC control relay and high speed is activated by a separate relay.

# Air Conditioning Components

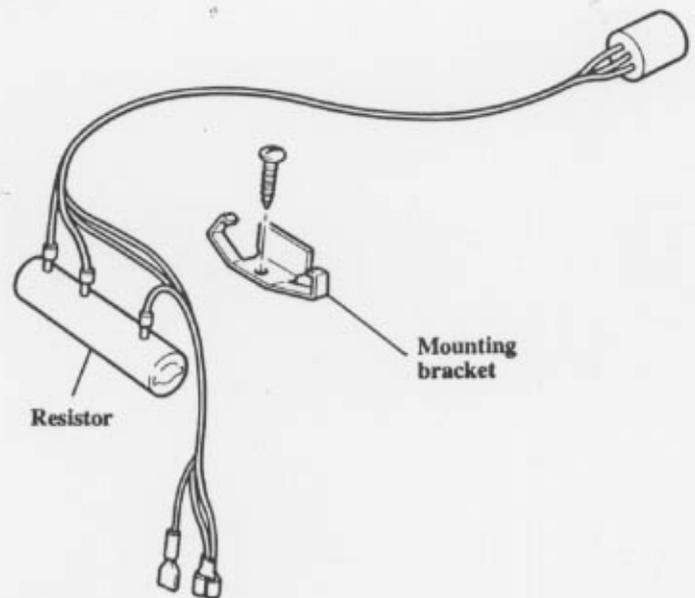
## Radiator Fan

Vanagon models with air conditioning use a 450 watt fan motor. The fan runs on three speeds, regulated by a resistor located behind the left front headlight. Second speed and high speed operate via separate relays.



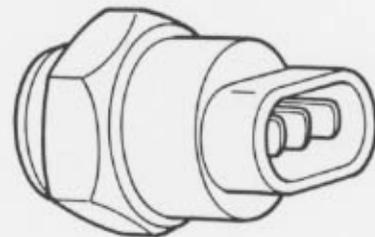
## Fan Resistor

This resistor has two separate resistances and controls low and second speeds of the radiator cooling fan. The radiator cooling fan operates on second speed when discharge pressure reaches 15 bar (218 PSI). Both resistances are used (low speed) when coolant temperature reaches 95°C (203°F) and whenever the air conditioning fan is switched on.



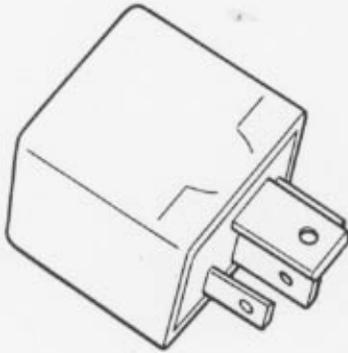
## Radiator Thermoswitch

This switch has two sets of contacts. The first set of contacts closes at 95°C (203°F) and operates the radiator fan on low speed. The second set of contacts closes at 105°C (216°F) and operates the fan on high speed through the high speed fan relay.



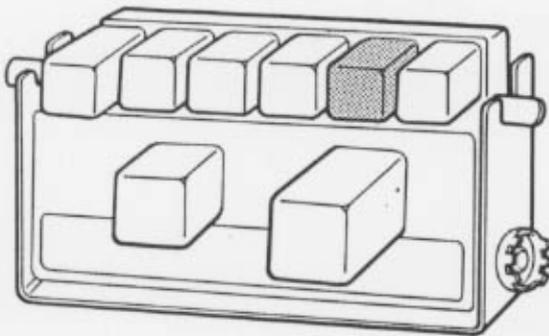
# Air Conditioning Components

## High Speed Radiator Fan Relay



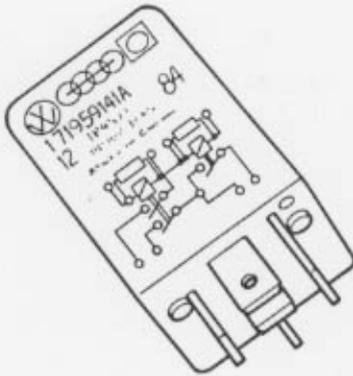
This relay operates the radiator fan via a signal from the radiator thermost switch. When coolant temperature reaches 102°C (216°F), the relay closes and the radiator fan resistance is bypassed so the cooling fan operates on highest speed. This relay is located behind the fuse and relay panel.

## Second Speed Radiator Fan Relay



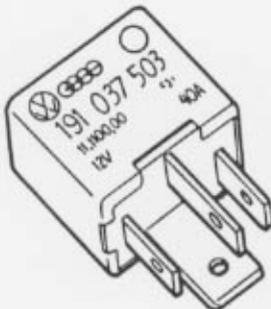
This relay operates the fan on second speed when high side pressure reaches 15 bar (218 PSI), coolant temperature reaches 95°C (203°F), or the AC is switched on. It is located in the fuse and relay panel.

## AC Control Relay



The AC control relay provides current for all aspects of air conditioning operation, including evaporator fans, and compressor clutch operation. This relay is located in the rear of the vehicle behind the left hand trim panel.

## High Speed Evaporator Fan Relay



This relay receives a voltage signal via the AC temperature switch and fan speed switch. When high (4th) speed is selected, the relay closes and the evaporator fan operates on high speed by bypassing the resistance. It is located at the rear of the vehicle behind the left hand trim panel.

# Air Conditioning Components

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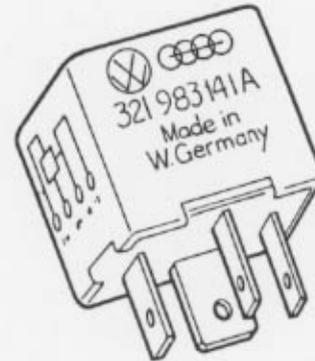
## Ambient Temperature Switch

This switch controls the operation of the compressor and prevents compressor clutch engagement when outside temperature is below 5°C (41°F).



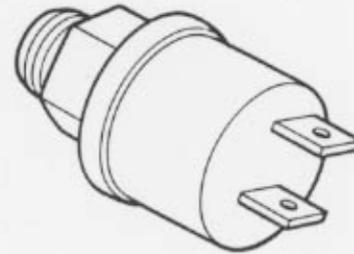
## Engine Overheat Relay

This relay is normally closed. When coolant temperature rises above 102°C (215°F) power to the compressor clutch is interrupted and the radiator fan operates on its highest speed. It is located in the rear of the vehicle behind the left hand trim panel.



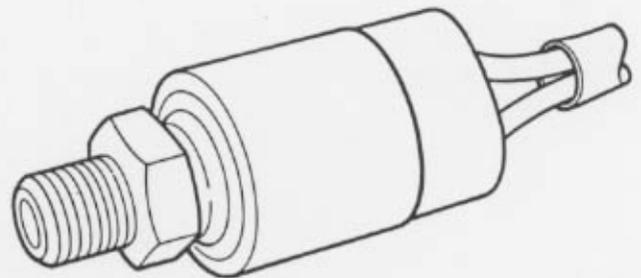
## Low Pressure Switch

This switch opens the circuit to the compressor in the event that discharge side pressure drops below 2 bar (29 PSI).

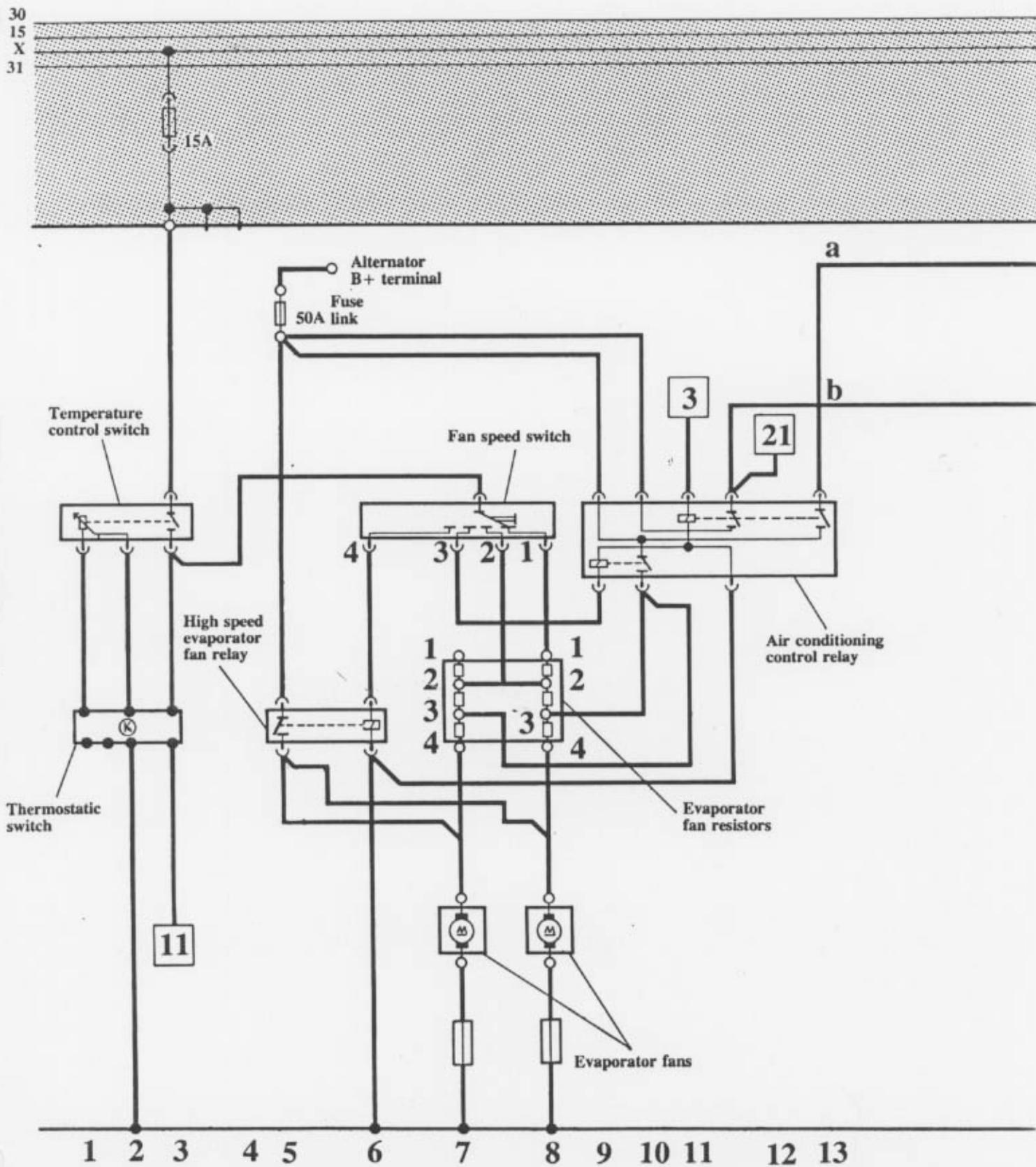


## High Pressure Switch

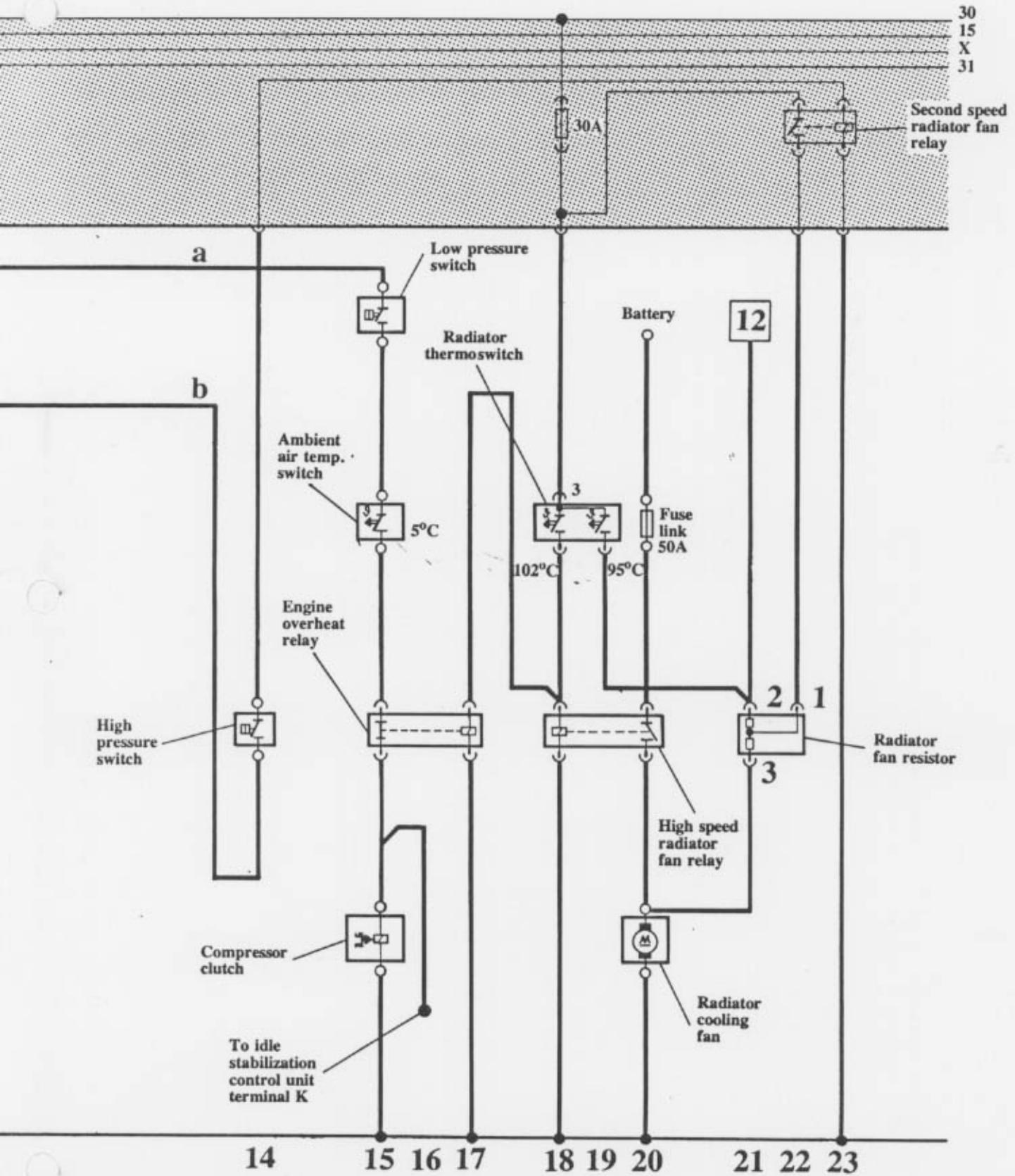
This switch allows the radiator cooling fan to operate on 2nd speed when air conditioning discharge side pressure exceeds 15 bar (218 PSI).



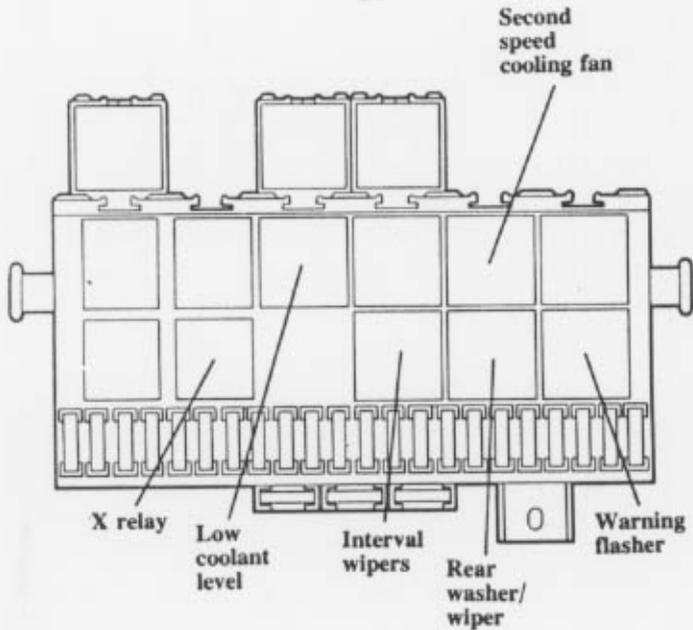
# Functional Wiring Diagram



# Functional Wiring Diagram

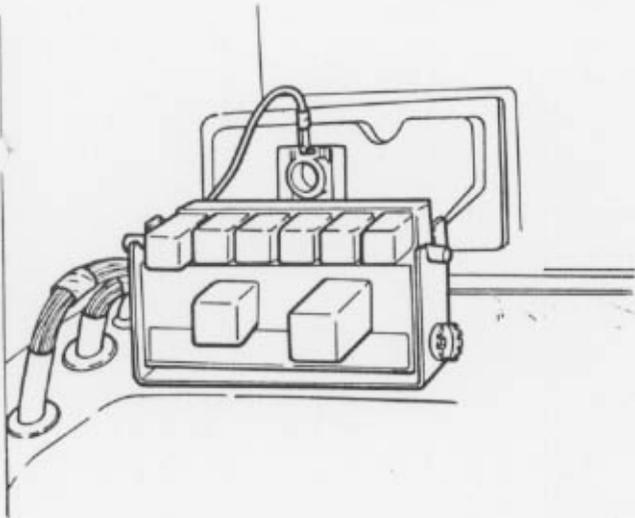


# Central Electric



The Vanagon receives a new fuse and relay panel. This system relies on internal wiring for the vehicle's circuitry, similar to that used on the Quantum and Jetta models.

Its location is unchanged from the previous year's model and it now provides a central location for fuses and relays. This was done to centralize the layout of the electrical system.

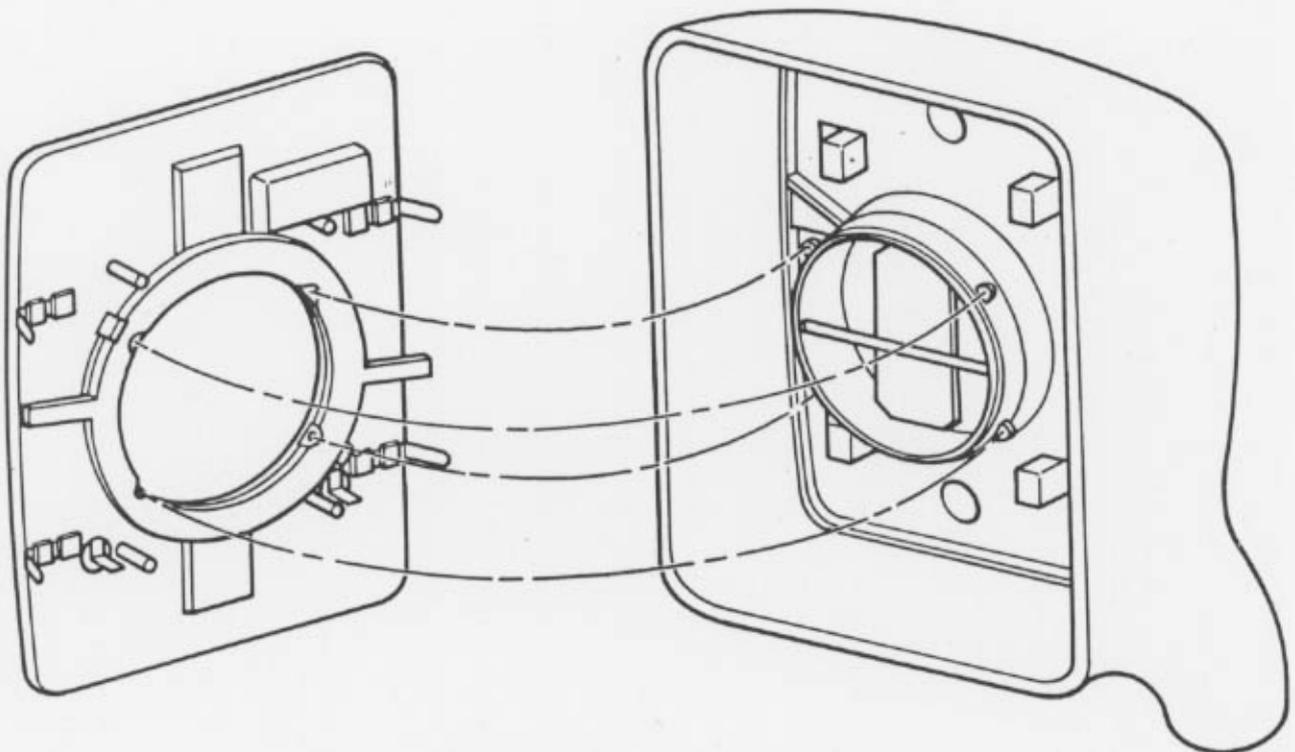
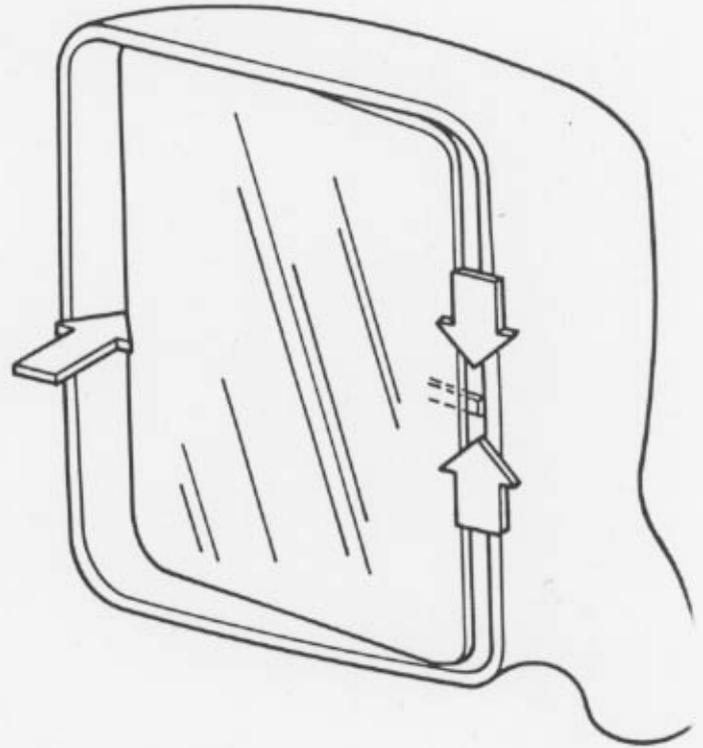


## Power Mirrors

For 1986, the Vanagon can be equipped with optional electrically operated and heated outside mirrors.

In the event that the mirror glass needs replacement,

- Push the mirror outer edge fully forward to gain access to the lever behind the glass.
- Move lever counterclockwise to unlatch the mirror assembly and tilt the mirror out. The wires for mirror heater can now be disconnected.
- To reassemble, reverse the procedure and recheck mirror operation.

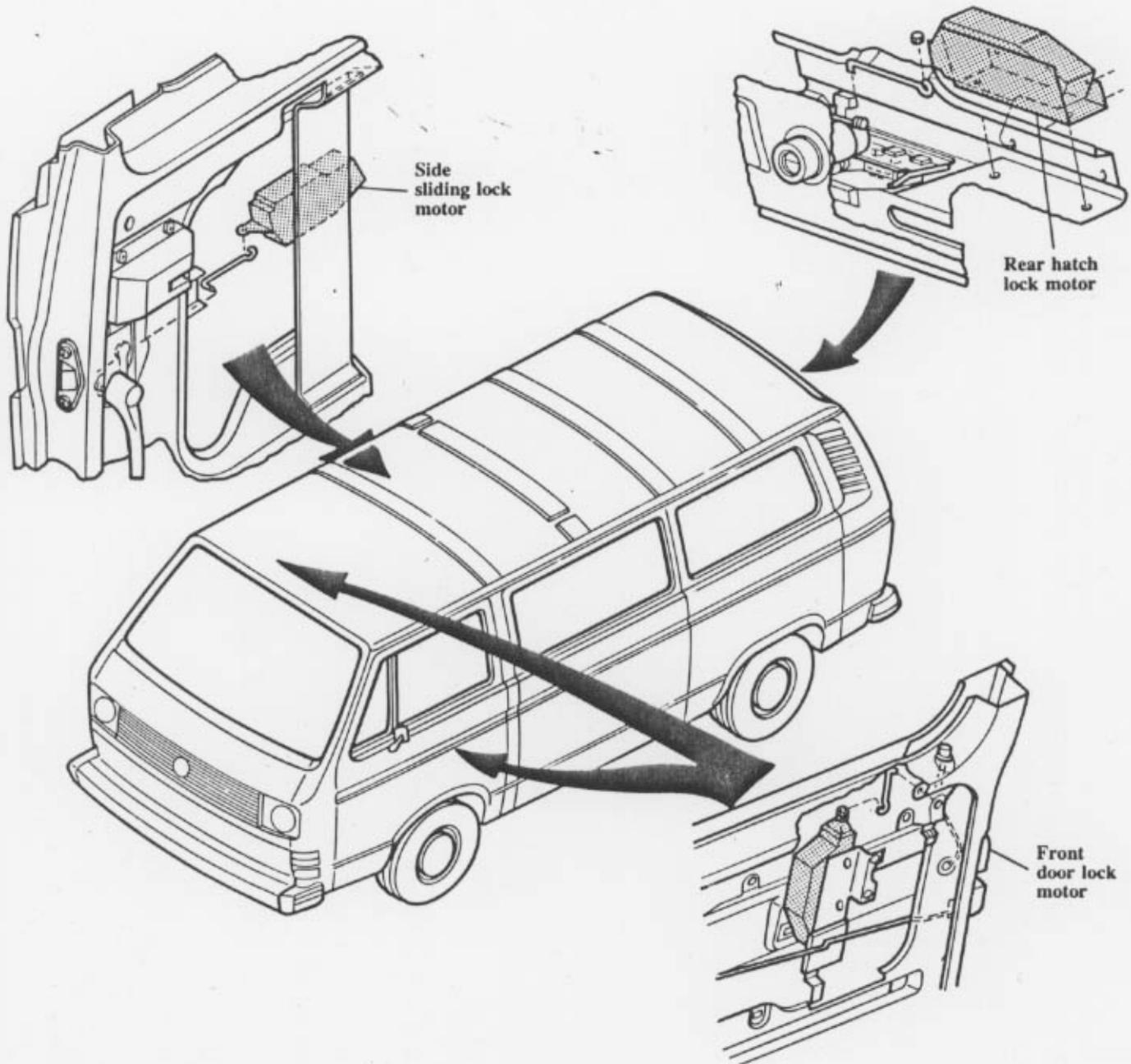


# Power Accessories

## Power Locks

A central locking system will also be made available on the Vanagon. This system uses electric motors to lock and unlock both front doors, the side sliding door and the rear hatch.

When the lock of either front door is activated, all doors are either locked or unlocked. When either the side sliding door or rear hatch lock is activated, only that individual lock operates.

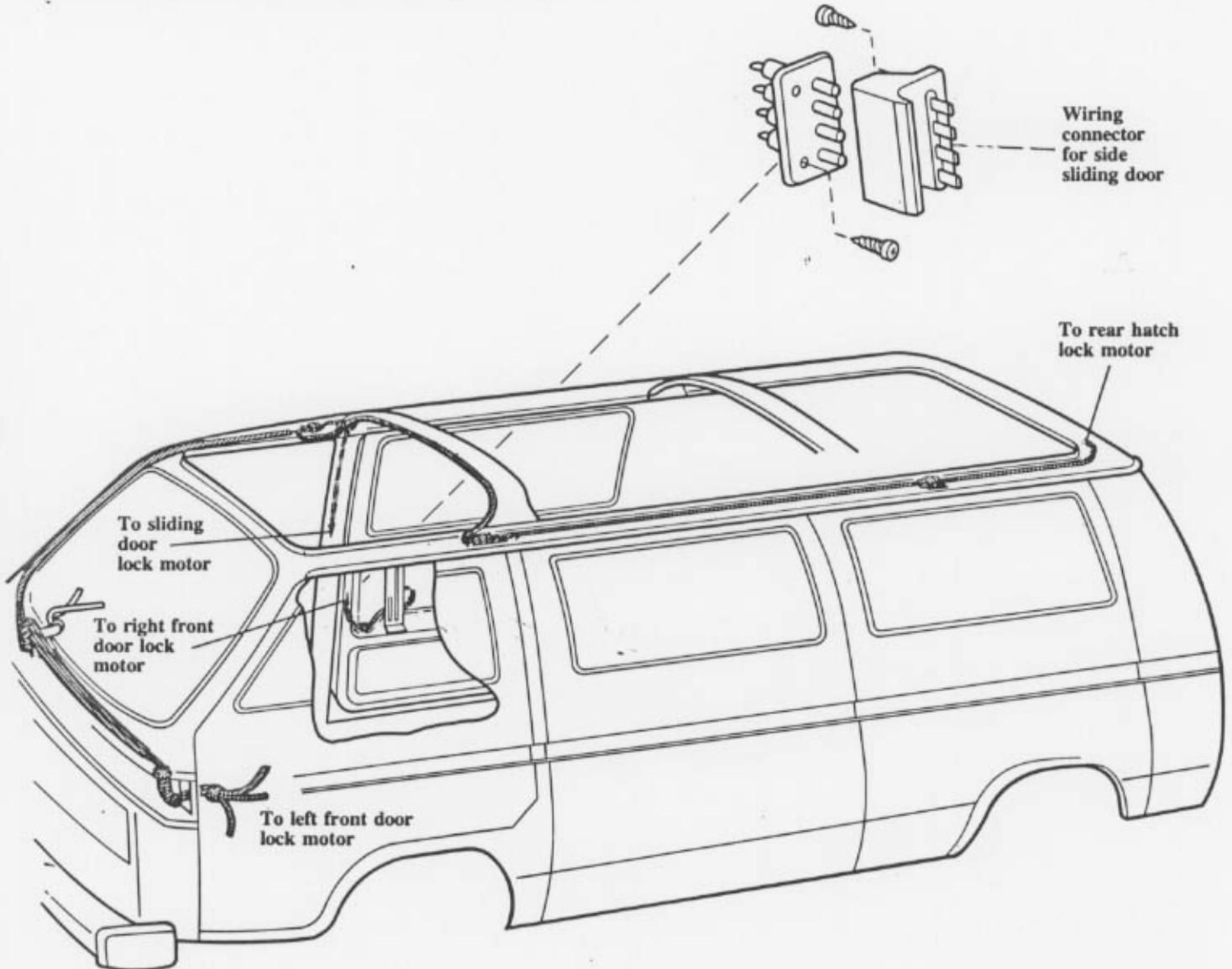


## Power Locks

The wiring for the central locking system is routed through the vehicle and connects all lock motors together. The side sliding door uses a unique contact plate to provide current for lock motor operation.

modes. When the lock cylinder is in the horizontal position, the rear hatch can be locked by activating either front door lock. When it is in the vertical position it is excluded from the central locking function.

The lock for the rear hatch has two operating



# Power Accessories

## Power Locks

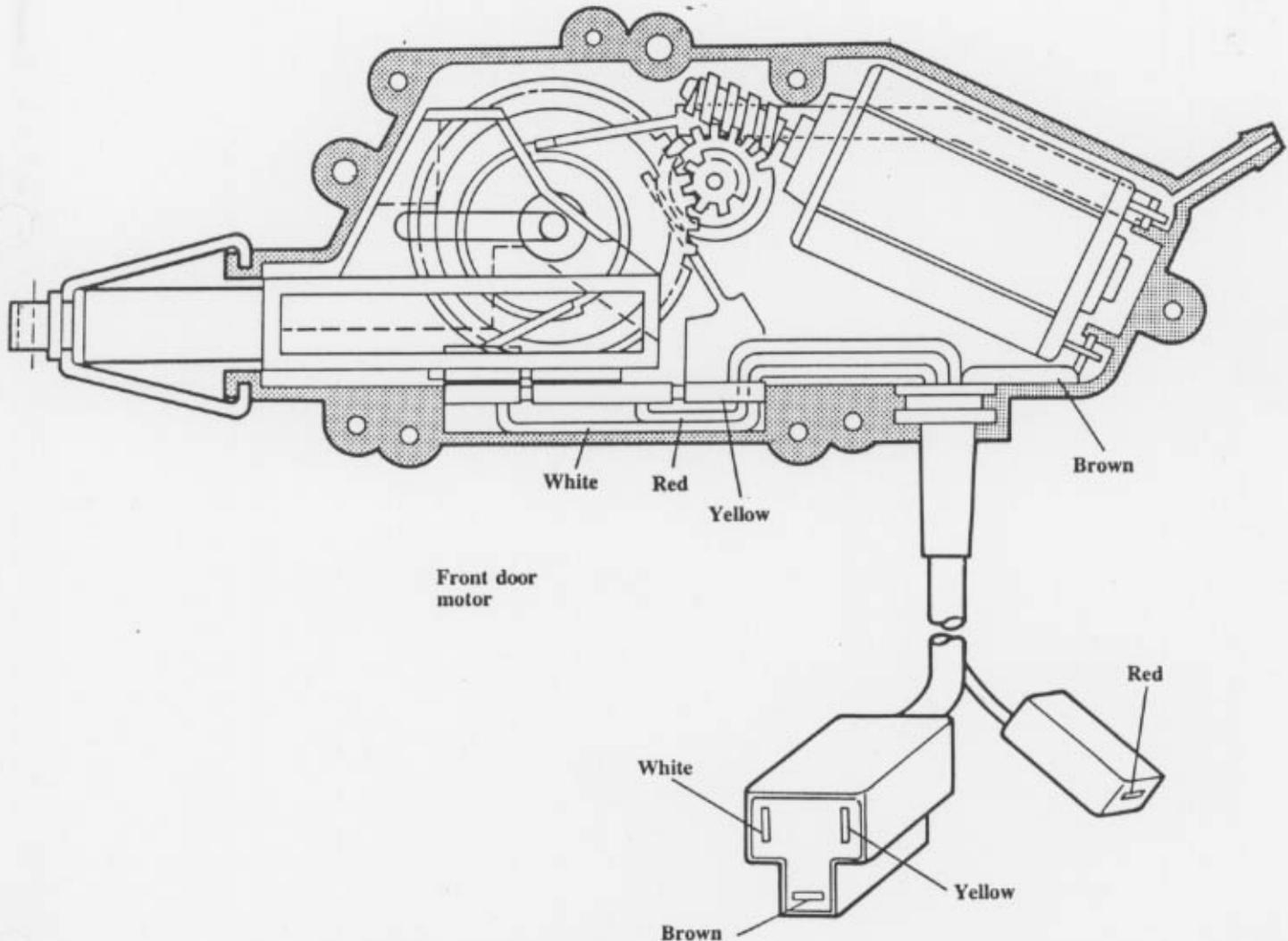
The door lock solenoid consists of a motor with a continuous screw gear attached to its driveshaft, a reduction gear which has two separate gears, and a large driven gear with two separate electrical contact surfaces.

The drive plunger, which is attached to the lock mechanism in each door, engages the large driven gear and has two ramps.

When door locking is desired, current is applied through the wire, to the contact arm on the inner electrical contact segment on the large driven

gear, through the other contact on the inner segment, through the motor and out of the servo via the brown wire to ground. The motor is energized and turns one half turn. At that point, the segment on the large driven gear has turned so that the contact is broken and the motor stops turning.

During the turning of the motor, the pin on the large driven gear has pushed the ramp on the drive plunger and the drive plunger extends, moving the linkage to lock the door.



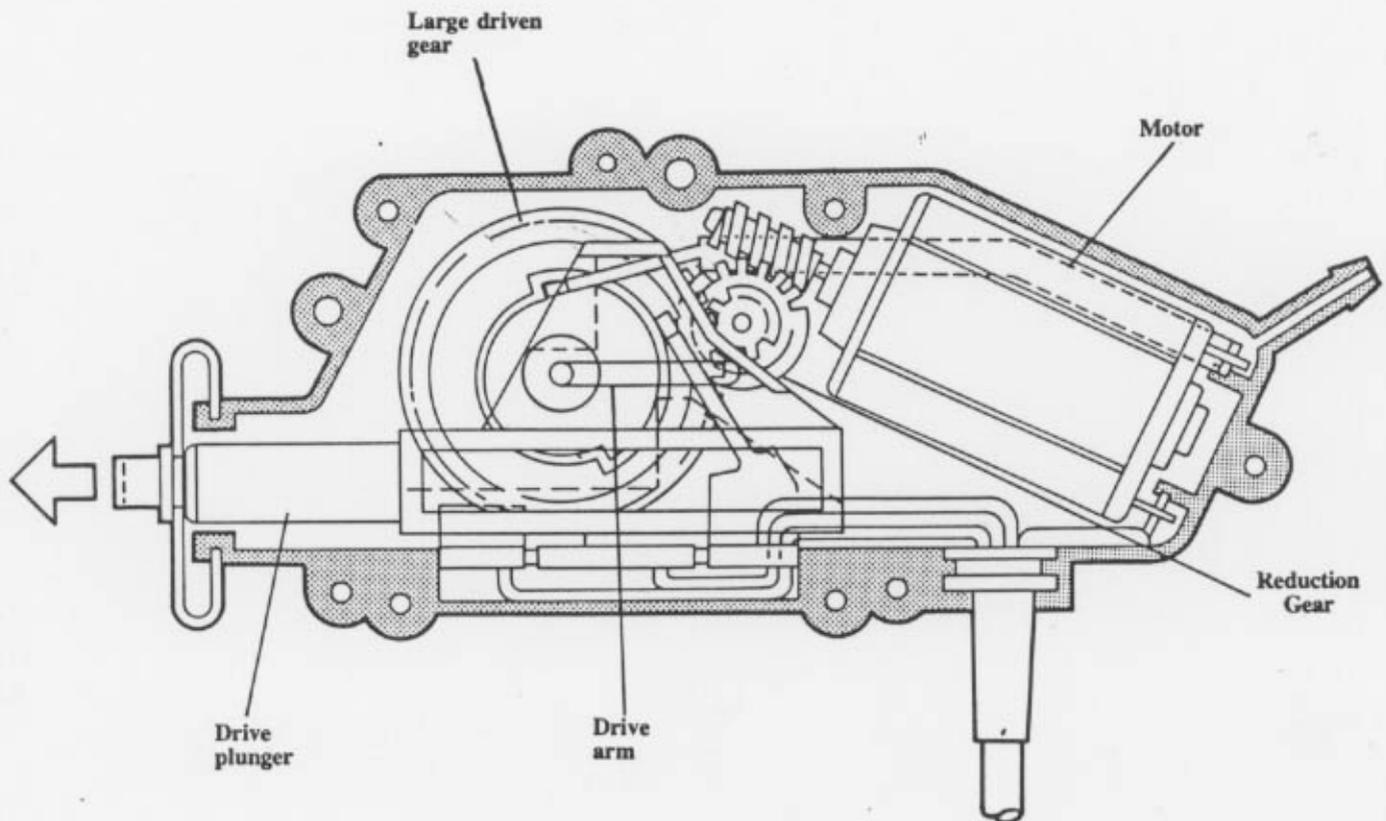
## Power Locks

When the key is turned to unlock the doors, current is directed to the servo.

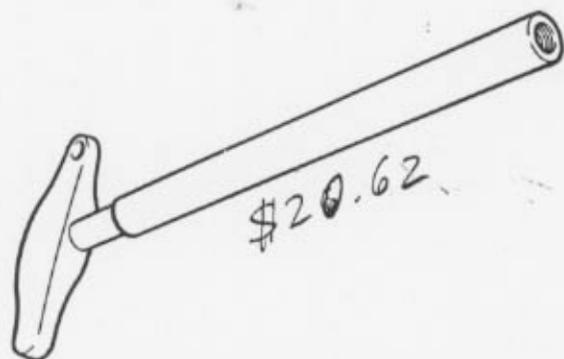
The contact arm rests on the outer contact segment of the large driven gear. This contact supplies current to the motor and it turns until contact is broken, after one half turn. The pin on the large driven gear now pushes on the ramp to retract the drive plunger, and the door lock releases.

Whether the lock is engaging or disengaging, the motor always turns the same direction.

The front door lock servos have an additional wire in a separate wire connector. This separate wire provides current to the front motors. These two servos relay the actuation signals to the other door locks so that all doors can be centrally locked by activating either of the front door locks.

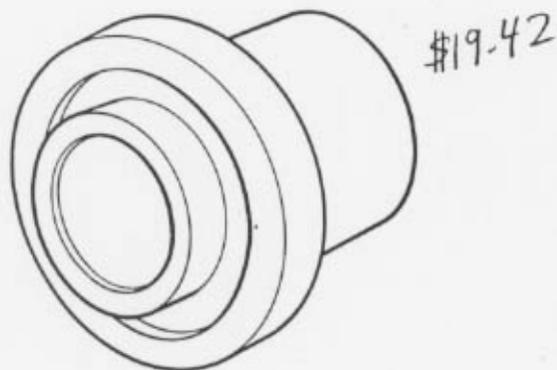


# Special Tools



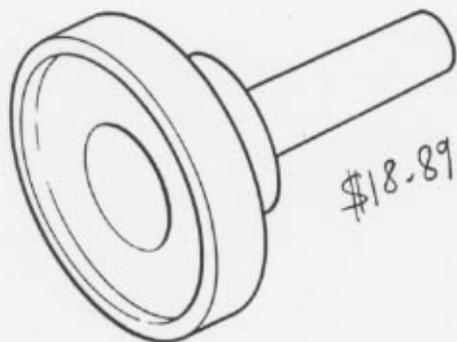
3141

T handle used to install front shock absorbers.



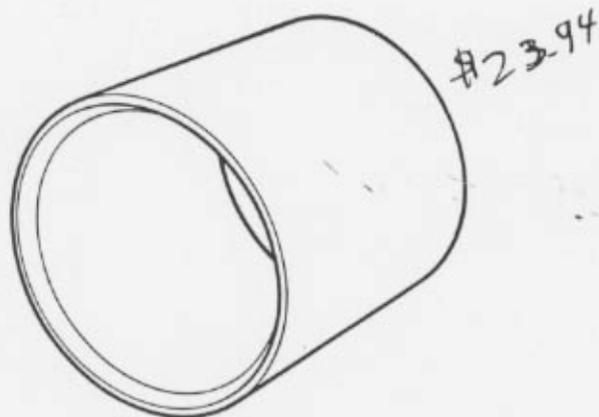
3142

Driver used to install the driveshaft flange seals in the front final drive and transmission.



3143

Seal driver used to install the oil seals in the front wheel bearing housing.



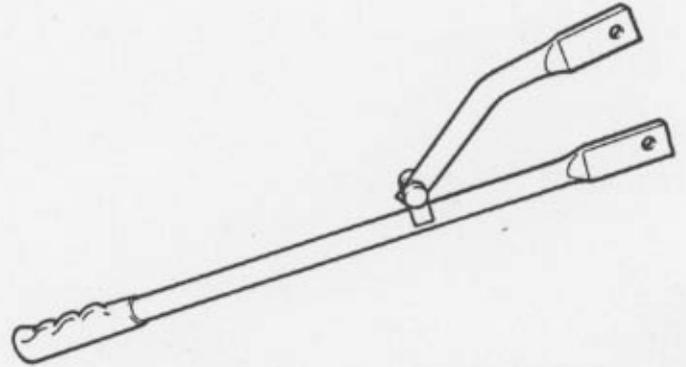
3144

Press sleeve used to remove and install front wheel bearings.

3145

Retaining handle used to hold the driveshaft flanges during removal and installation.

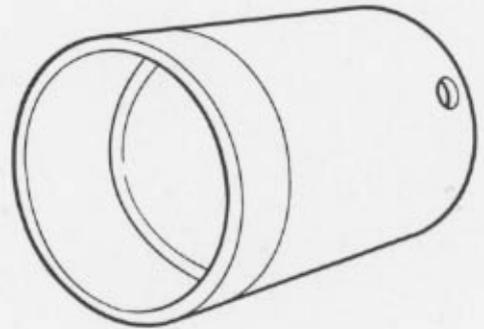
*\$76.62*



3146

Press sleeve used to remove and install lower ball joints.

*\$24.34*



3149

Retainer and socket used to remove and install the three groove crankshaft pulley.

*\$168.25*

