Audi Turbo Quattro Coupe Introductory Service Training Information

This is one of two documents ca. 1982, which were used to train Audi mechanics on the internal workings of the then-new ur-quattro.

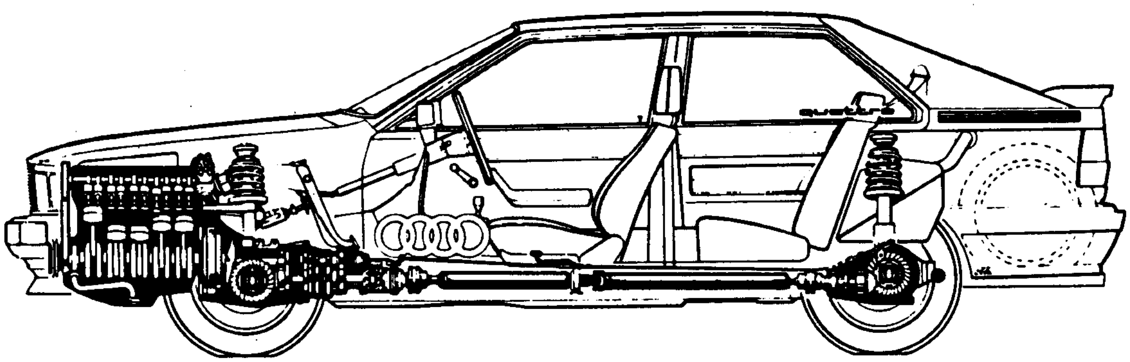
This document is the “How Things Work” introduction, with pictures of the important mechanical components of the turbo engine and quattro drivetrain.

“IST Maintenance and Adjustments” provides the details of tuning the Bosch CIS-Lambda system, as well as the quattro components. The Maintenance and Adjustments document provides the turbo engine information which is completely missing from the Bentley’s shop manual.

This PDF file is scanned and stored at 300 dpi, so that it can be printed at high quality. This page and the blank page to its left are there so that facing pages of the original manual are correctly displayed on-screen.

Audi

Introductory Service Training Information



quattro

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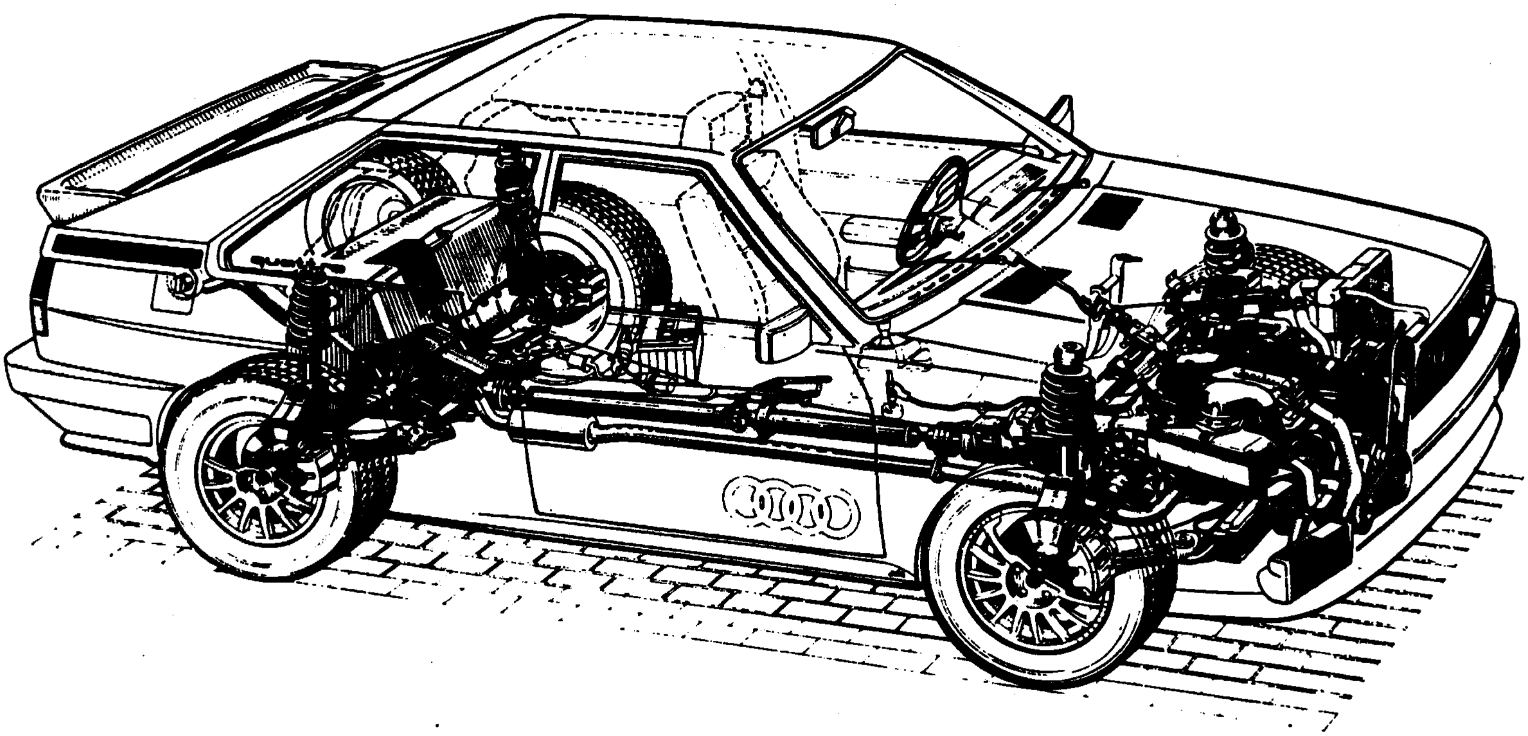


The Audi Quattro is the first high performance sports coupe sold in the U.S. with full time four wheel drive. This performance car of the future is powered by Audi's turbocharged five cylinder engine which, with the help of an intercooler, produces 160 horsepower for 0-50 mph times of 5.3 seconds and a top speed of almost 130 miles per hour.

Although the advantages of four wheel drive in off-road conditions are well-known, the Audi Quattro demonstrates improved safety and performance benefits on the highway. Wheel lockup while braking is much less likely, steering response remains neutral through on-off throttle changes and traction during acceleration is considerably improved.

The Audi Quattro has a long list of standard equipment including; power windows, electrically adjustable and heated mirrors, automatic door locks, air conditioning and a stereo cassette radio. Options are limited to sunroof, heated seats, leather interior and a rear wiper.

1982 SPECIFICATIONS

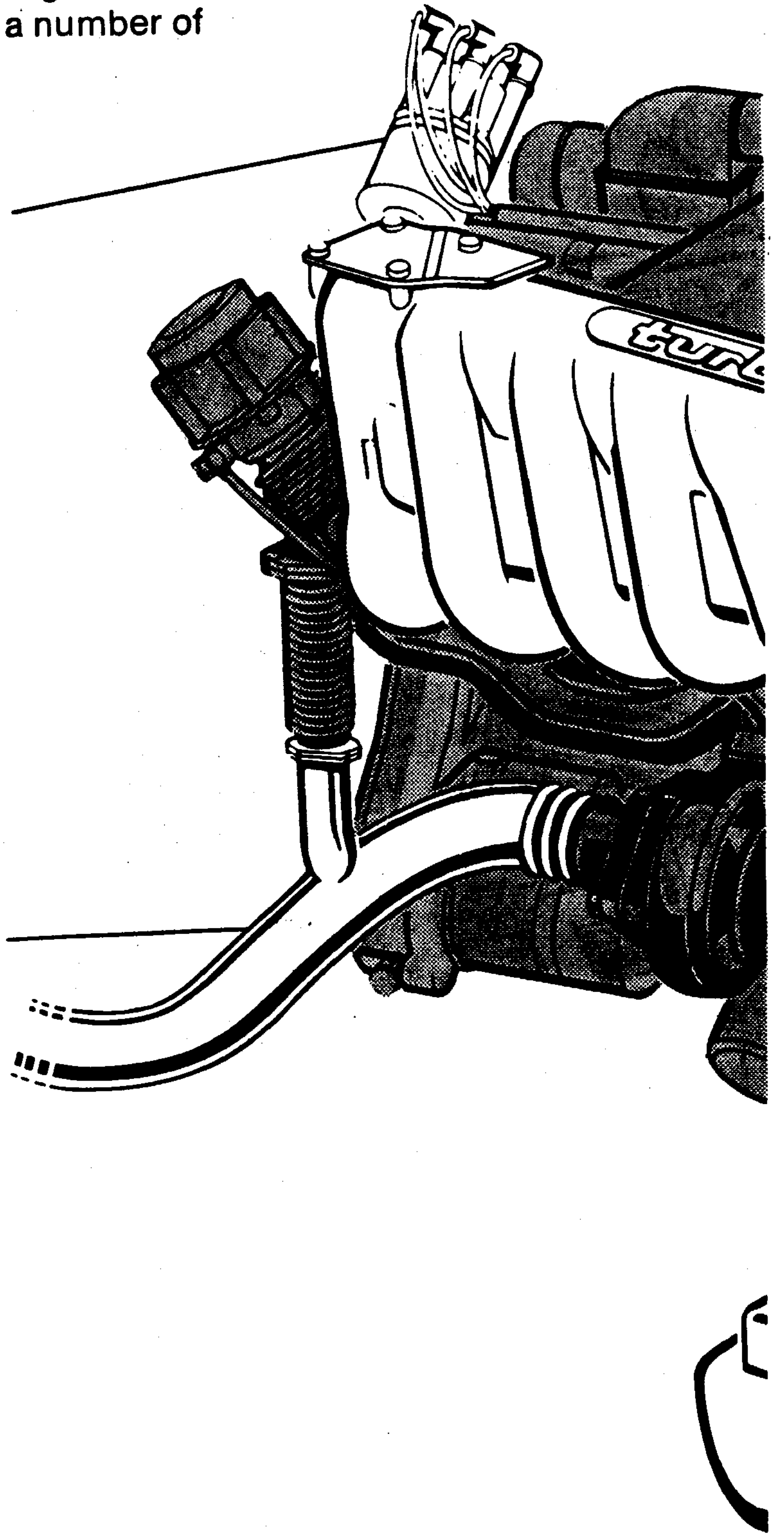
AUDI QUATTRO

ENGINE:	
Type	5-cylinder, in-line
Bore	79.5 mm (3.13 in.)
Stroke	86.4 cc (3.40 in.)
Displacement	2144 cc (130 cu. in.)
Compression ratio	7.0:1
Horsepower (SAE)	160 at 5500 RPM
Maximum torque (SAE)	170 at 3000 RPM
ENGINE DESIGN:	
Engine block	Cast iron, tilted 27°
Cylinder head	Aluminum alloy
Valve train	Single overhead cam, spur belt driven
Cooling system	Watercooled, thermostatically controlled 2-speed electric fan
Fuel system	CIS Fuel Injection w/oxygen sensor; exhaust turbocharging w/intake air "intercooler"
Fuel requirement	Unleaded premium
ELECTRICAL SYSTEM:	
Battery	12V/65 Amp. hr.
Alternator	90 Amp.
Ignition system	Fully electronic, w/idle stabilization
Firing order	1-2-4-5-3
DRIVE TRAIN:	Engine and transmission in front, final drives front and rear; front, rear and center differentials (lockup contol for center and rear differentials)
Clutch	Single disc, dry
Gear ratios — 1st	3.60
2nd	2,13
3rd	1.36
4th	0.97
5th	0.78
Reverse	3.17
Final Drive	3.89
FRAME & BODY:	Unitized all-steel construction
SUSPENSION:	
Front	Independent MacPherson struts with negative roll radius; stabilizer bar, coil springs
Rear	Indepedent coil spring struts
BRAKES:	Hydraulic dual circuit w/pressure regulator, hydraulic power assist
Front	Vented discs - 280 mm diameter
Rear	Solid discs - 240 mm diameter
WHEELS:	6 x 15 Alloy
TIRES:	205/60 x 15 steel belted radial
STEERING:	
Type	Rack and pinion, power-assisted
Turns: lock-to-lock	3.4
Turning circle: curb-to-curb	34 feet
CAPACITIES:	
Engine	4.75 quarts (oil change capacity, w/filter)
Fuel tank	23.8 gallons
Cooling system	9.8 quarts
Trunk (SAE)	12 cu. ft.
DIMENSIONS:	
Wheelbase	99.5 in.
Front track	56.0 in.
Rear track	57.4 in.
Overall length	178.2 in.
Overall width	67.9 in.
Height (unloaded)	52.0 in.
Ground clearance (unladen)	5.3 in.
Curb weight	3072 lbs.
PERFORMANCE:	
0 - 50 mph	5.3 seconds
0 - 60 mph	7.5 seconds
Top speed (in 4th gear)	128 mph

Fuel consumption - EPA
17 mpg - City
28 mpg - Highway

Quattro Engine

The Quattro engine with an output of 160 hp, is a refinement of the Audi 5000 Turbo 5 cylinder engine. The increase in power was made possible by a number of engine changes.

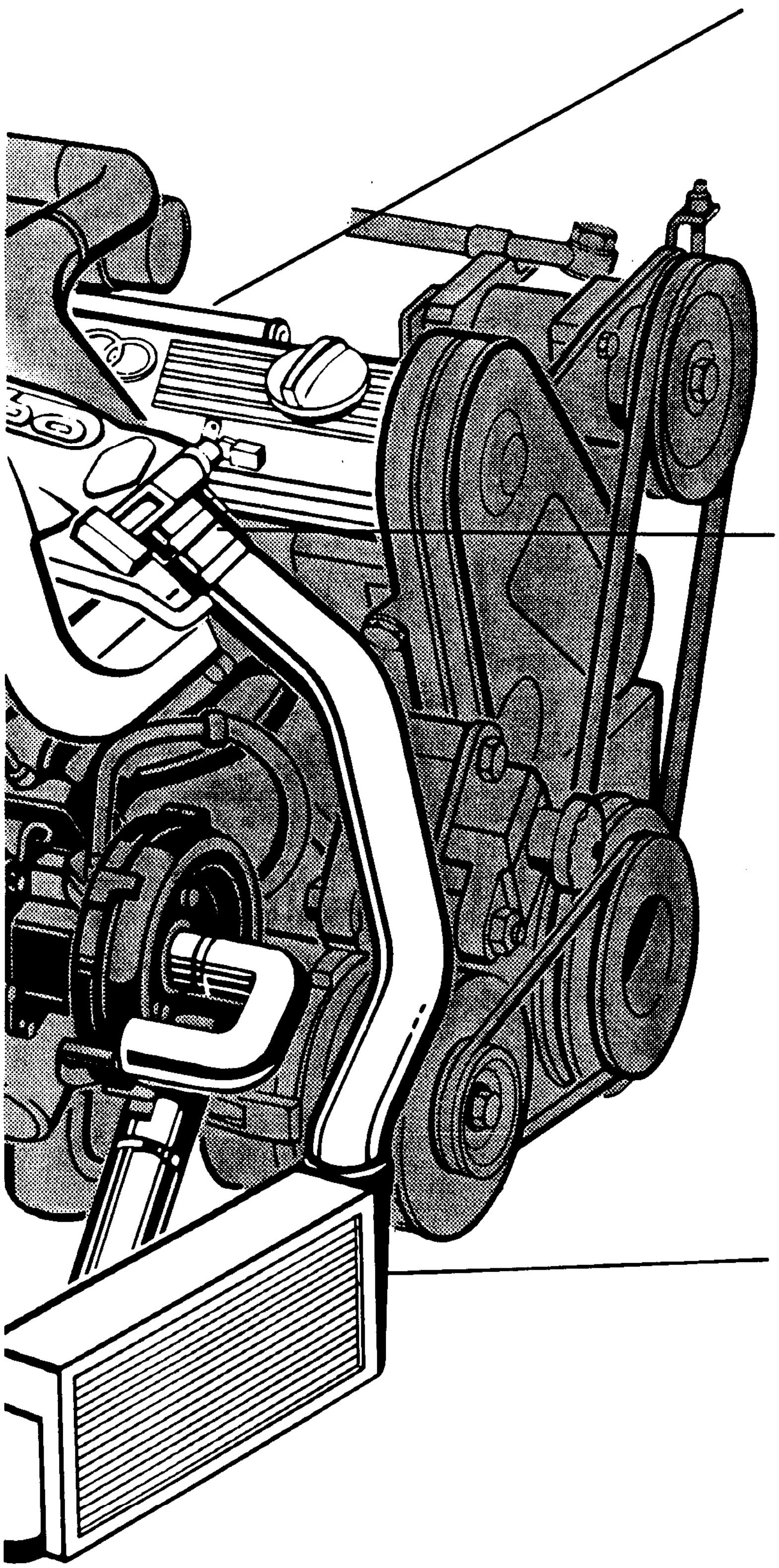


Electronic, engine control system

Through information sensors, an electronic control unit asseses the engine's operating conditions and determines the best possible ignition timing.
The same control unit also controls the operation of the oxygen sensor system.

Exhaust system

The design of the exhaust system is similar to the Audi 5000 Turbo. The exhaust pipe diameter, however, has been increased from 60 to 65 mm in order to cope with the greater volume of exhaust gas, resulting from the increased engine power. In addition,the exhaust pipes are now made of stainless steel.



Crankcase vent system

The Audi Quattro has a new crankcase vent system. At idle the PCV valve is nearly closed so that most of the crankcase fumes flow through a restrictor to the air duct above the air sensor plate. As pressure in the intake rises the PCV valve opens and allows the crankcase fumes to flow directly into the intake manifold.
Under boost conditions the PCV valve shuts and crankcase fumes are once again routed to the air duct above the air sensor.

Intake system

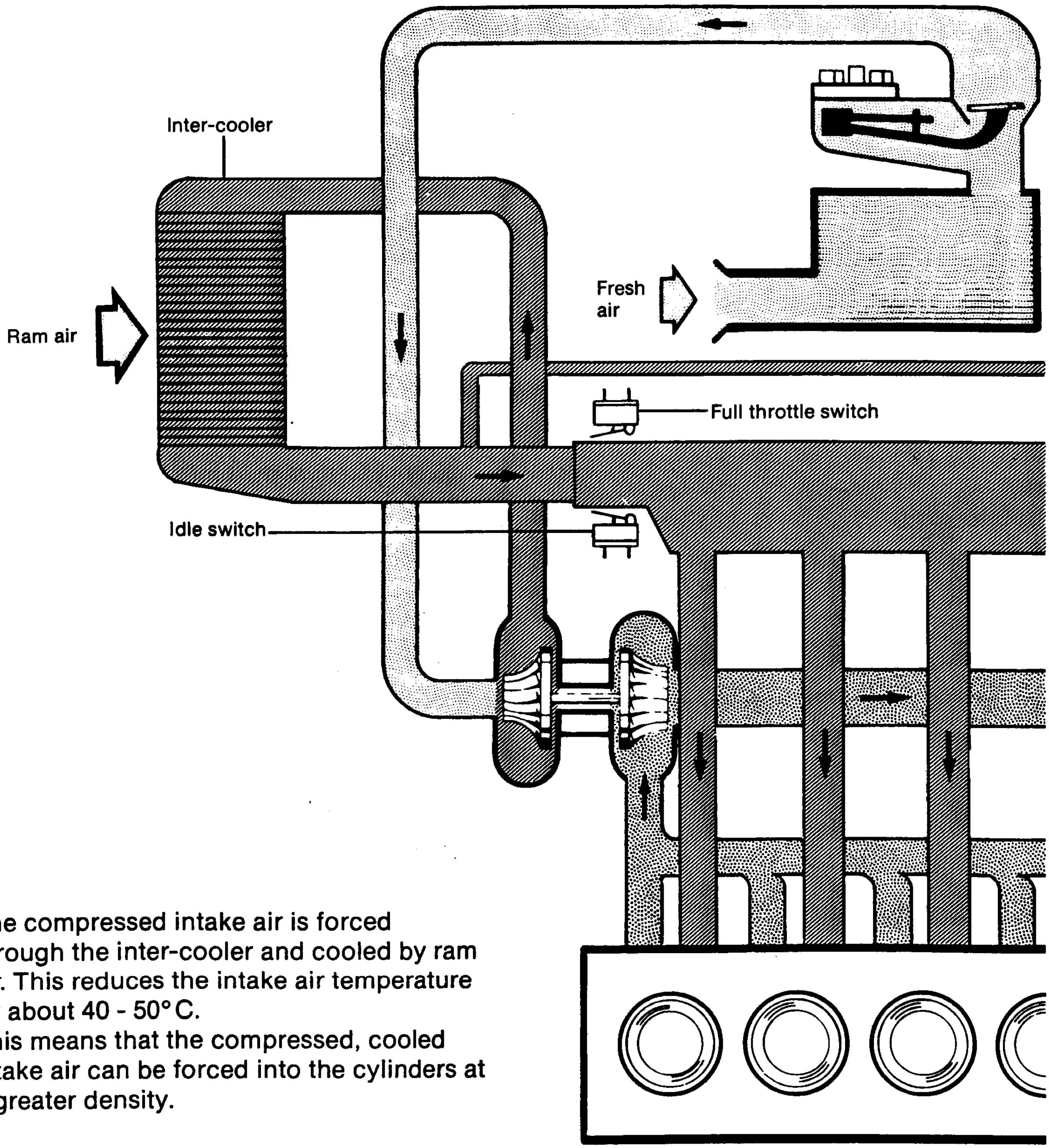
A single stage throttle valve housing is mounted to the front side of the newly designed intake manifold.

Intake air cooling

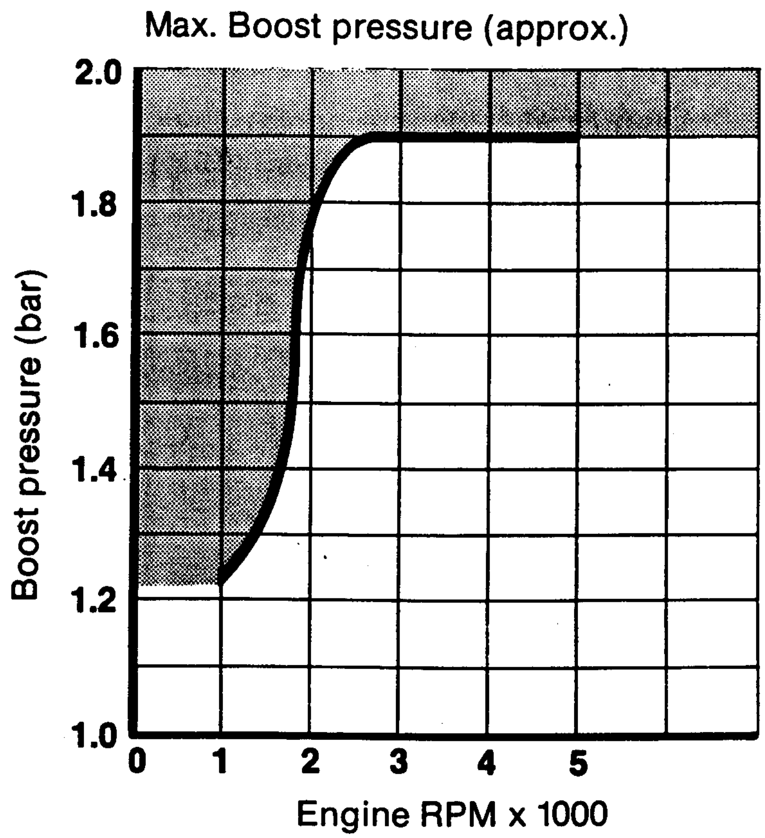
The inter-cooler is mounted so that a maximum "ram air" effect is attained. This ensures a reduction in the intake air temperature.

Turbo System

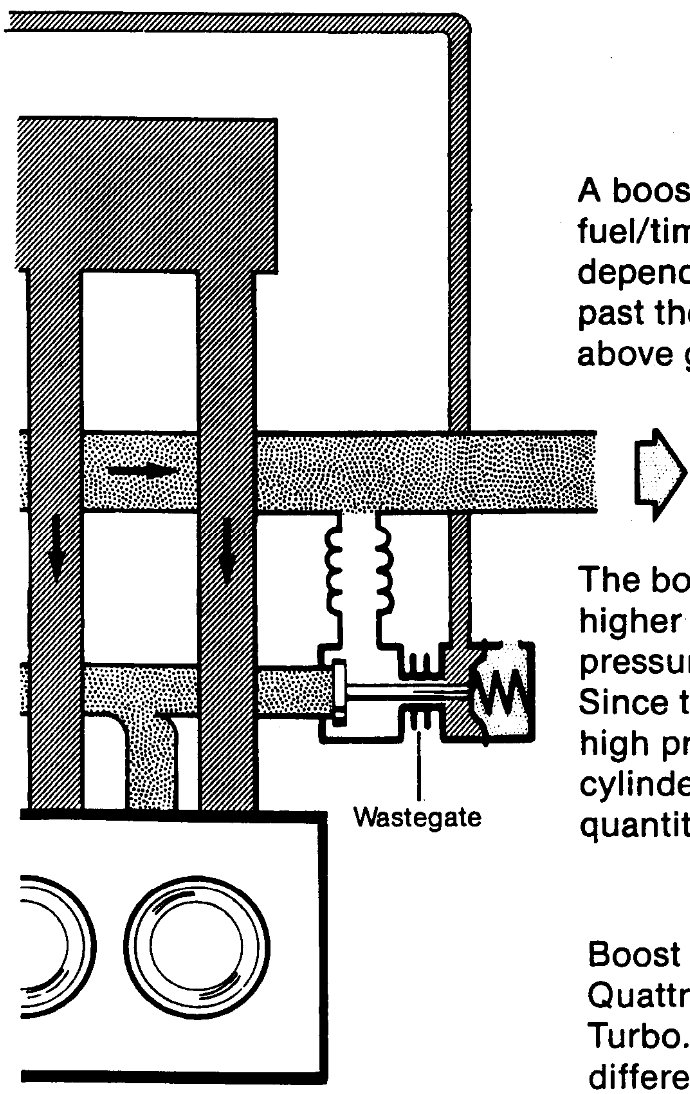
The Audi Quattro has 30 more horsepower than the Audi 5000 Turbo (160hp vs. 130hp). This increase in power is mainly the result of the air to air inter-cooler.



The compressed intake air is forced through the inter-cooler and cooled by ram air. This reduces the intake air temperature by about 40 - 50°C.
This means that the compressed, cooled intake air can be forced into the cylinders at a greater density.



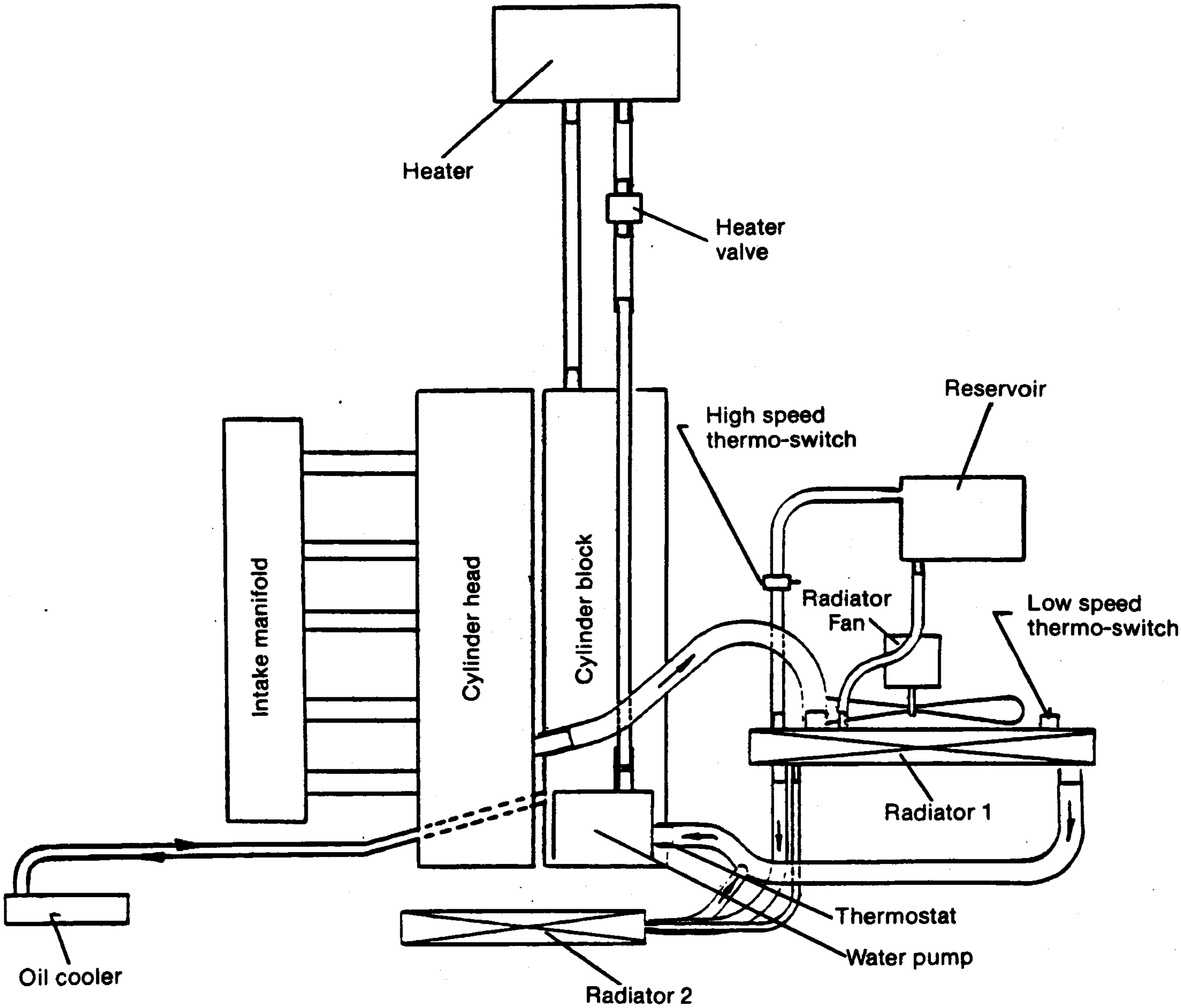
A boost pressure safety system is built into the fuel/timing control unit. The maximum boost pressure depends on engine speed. Anytime boost presure rises past the safe limit, (that is into the shaded area of the above graph), the fuel pump will be switched off.

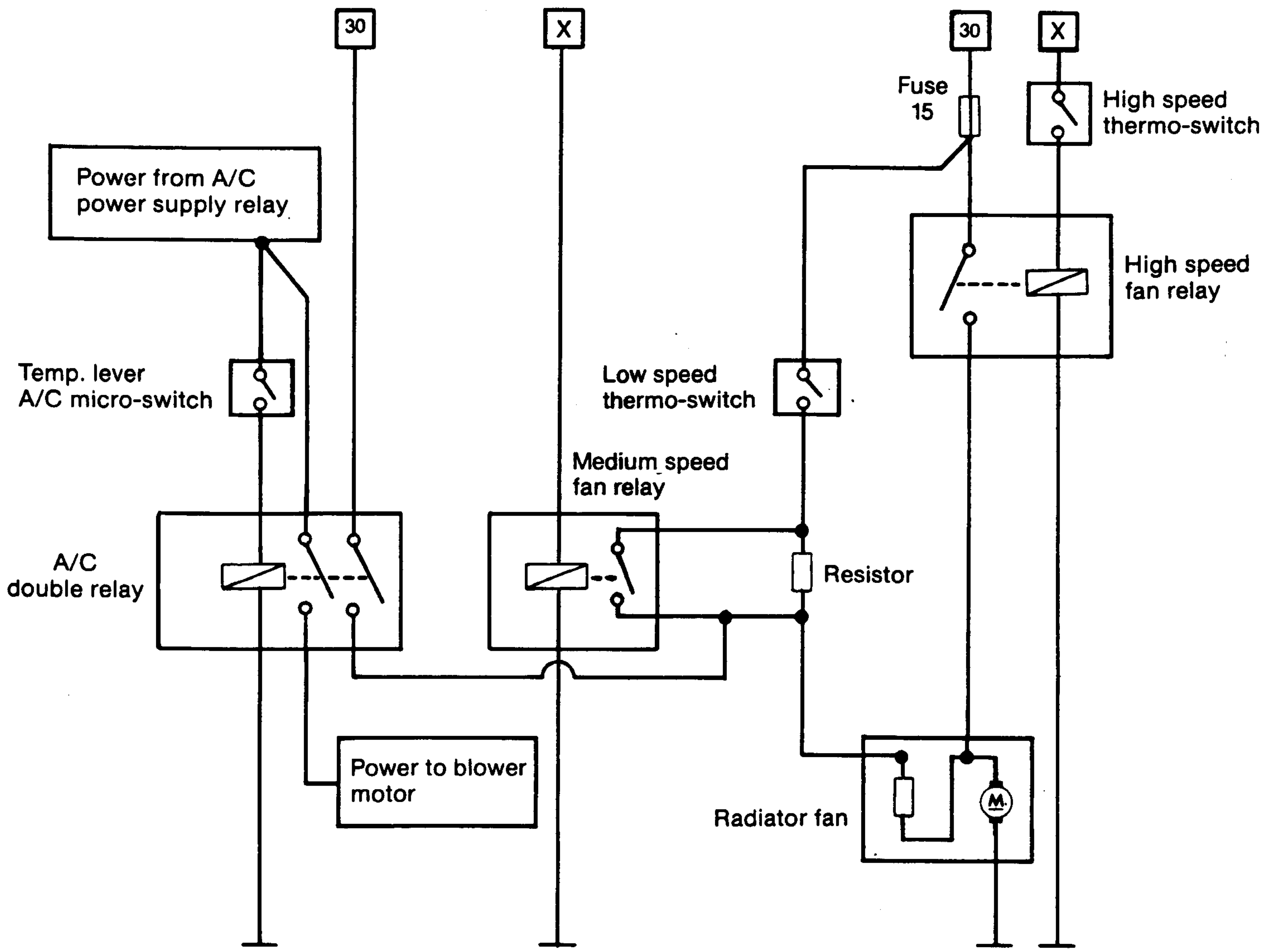


The boost pressure on the Audi Quattro is about 25% higher than the Audi 5000 Turbo. The increase in boost pressure is made possible by the use of the inter-cooler. Since the intake air is cooled by the inter-cooler more high pressure air can be safely forced into the cylinders. By simultaneously increasing the fuel quantity engine power and torque can be increased.

Boost pressure is controlled by the wastegate. The Quattro wastegate is similar in design to the Audi 5000 Turbo. The wastegate control system, however, is different. The wastegate control diaphram is operated by intake pressure rather than exhaust pressure.

Cooling System





Radiator Fan Operation

The radiator fan motor operates at three different speeds. It acts as the fan for both the radiator and the A/C condenser. The fan is activated by either coolant temperature or by the A/C double relay.

Low speed - The low speed radiator thermo-switch operates the fan at low speed, if the ignition is off, by providing voltage to the fan motor through a resistor on the body and one resistor built into the motor.

Medium speed - When the ignition is switched on, the medium speed fan relay will be energized. As soon as the low speed thermo-switch closes, voltage will be supplied to the radiator fan through the closed contacts of the medium speed relay. The resistor on the body will be bypassed and voltage will be supplied to the fan through the resistor which is built into the radiator fan.

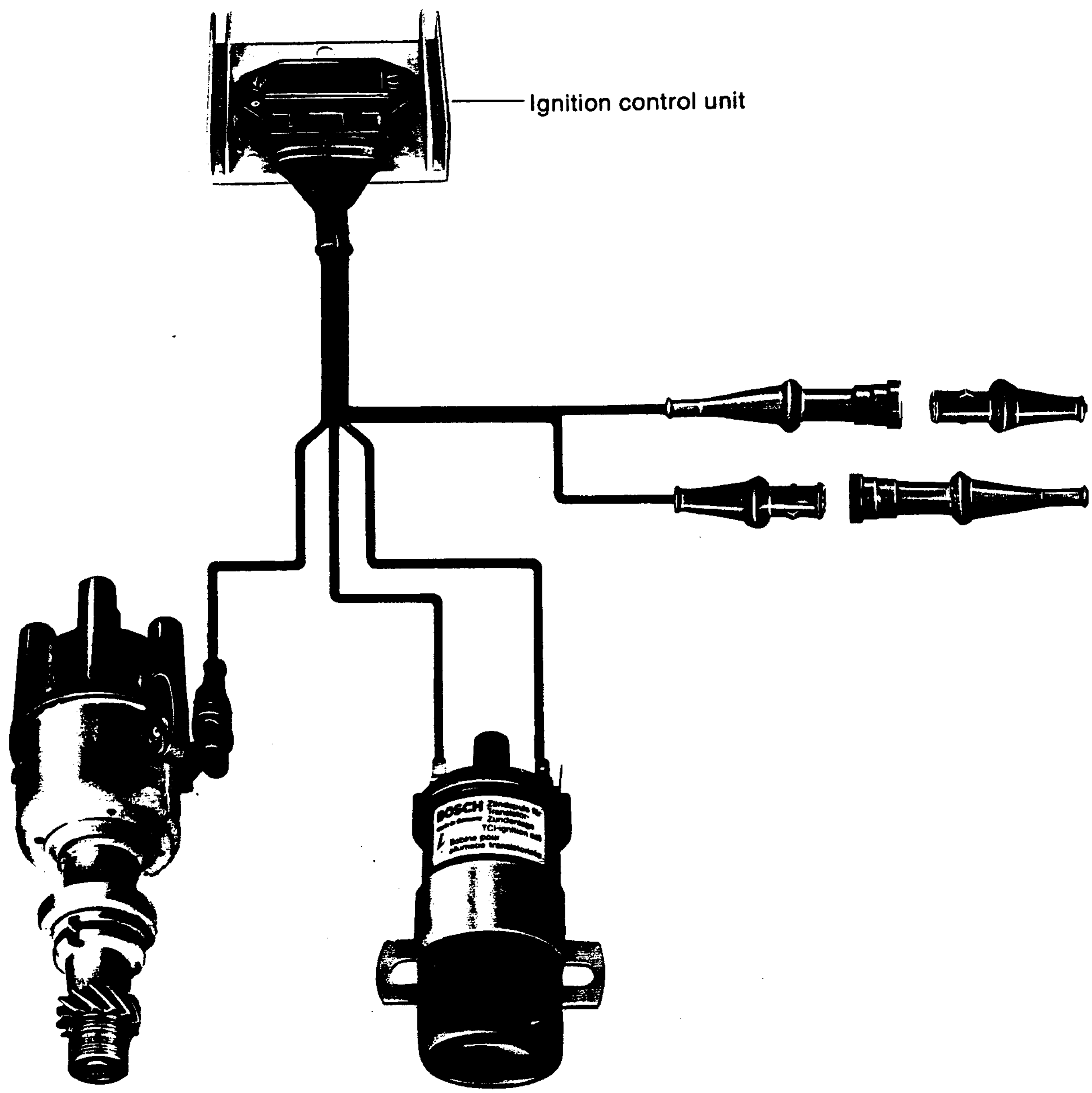
The medium speed of the radiator fan will also be activated whenever the air conditioning is on.

High speed - When the high speed thermo-switch closes, the high speed fan relay will be energized and voltage will be supplied directly to the radiator fan.

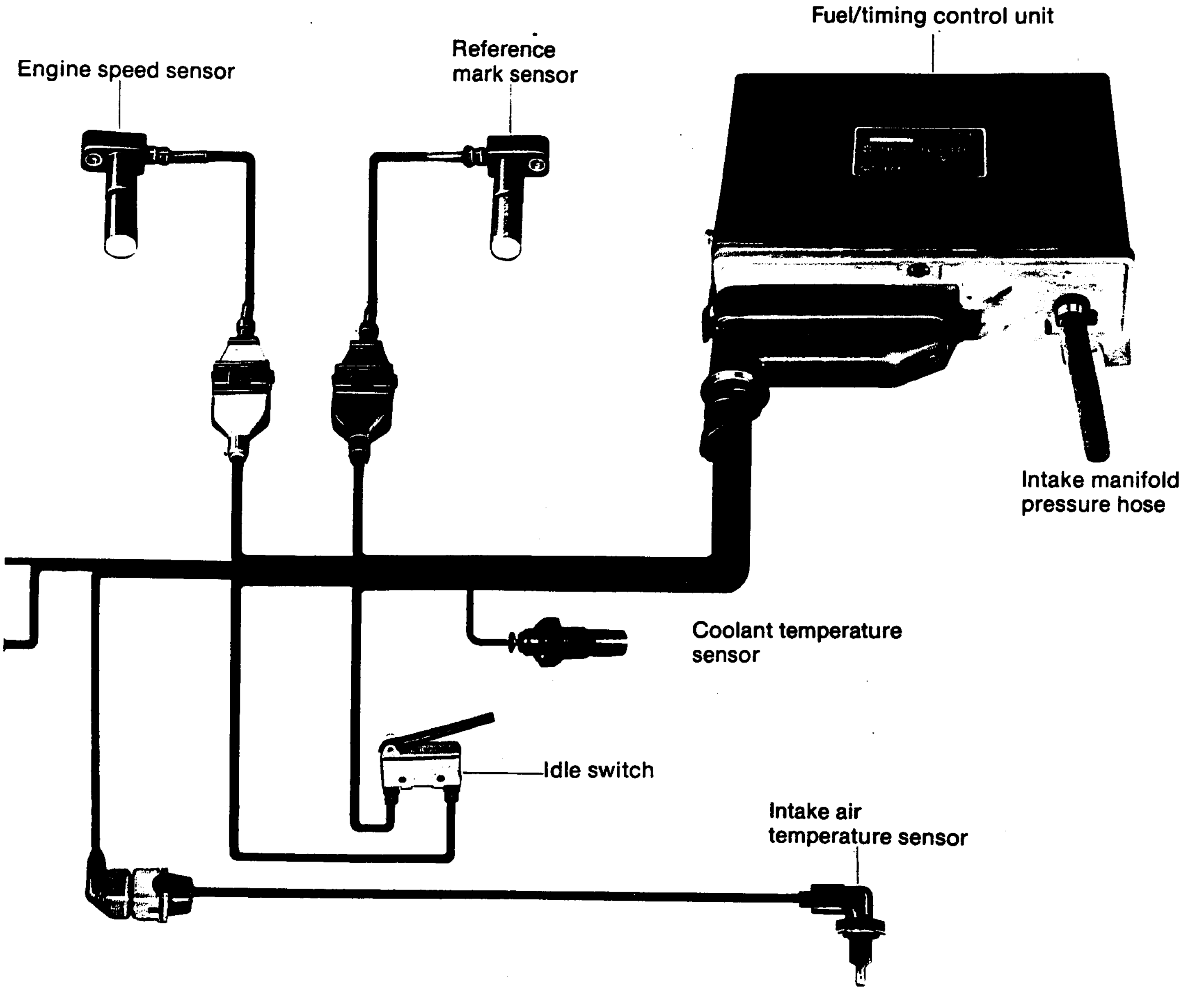
Hartig Electronic Ignition System

A digital timing control system, called the Hartig Electronic Ignition System, is used on the Audi Quattro. Unlike other Audi ignition systems there is neither a centrifugal advance, nor is there a vacuum advance or vacuum retard mechanism. With the Hartig ignition system, ignition timing is electronically controlled.

A single control unit is used to control the operation of both the ignition system and the oxygen sensor system. In this section the operation of the timing control system will be described.



Engine speed, intake pressure, intake air temperature, coolant temperature and an idle switch, provide input to the fuel/timing control unit. The fuel/timing control unit then determines the optimum ignition timing for all engine operating conditions.



The parts of the Hartig electronic ignition system

- Engine speed sensor. It is actuated by the teeth on the flywheel.
- Reference mark sensor. It is actuated by a pin on the flywheel.
- Idle switch. It is operated by a lever on the throttle valve shaft.
- Intake air temperature sensor. The intake air flows through the sensor in the intake manifold.
- Intake manifold pressure sensor. It is located in the fuel/timing control unit and is subjected to intake manifold pressure.
- Coolant temperature sensor. The coolant temperature sensor is a variable resistor which provides the control unit with information on engine temperature.

Operation

Information sensors

When the engine is running the sensors send the following signals to the fuel/timing control unit.

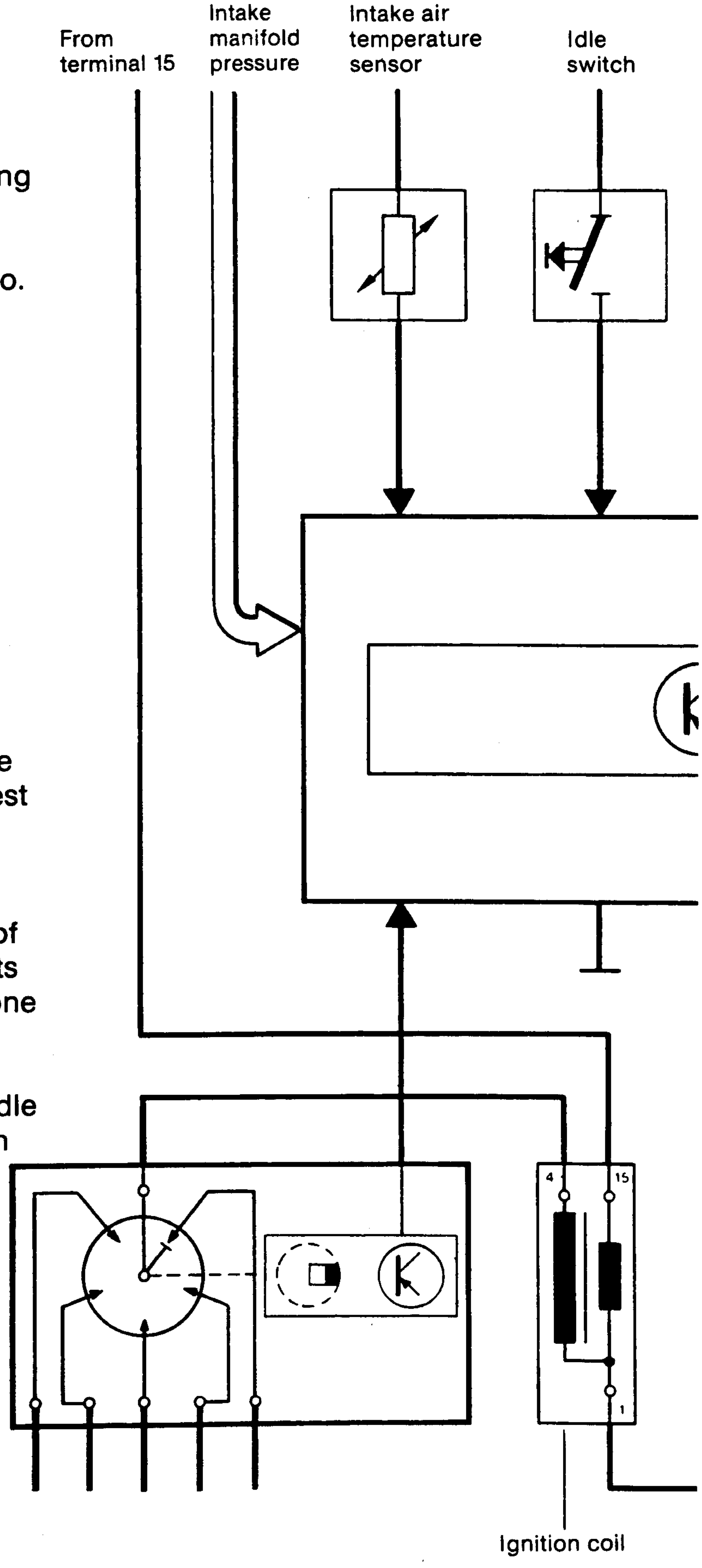
- Engine speed
- Reference mark (60° before TDC on No. 1 cylinder)
- Hall sender (identifies ignition TDC on No. 1 cylinder)
- Intake manifold pressure
- Intake air temperature (This signal is processed by the timing control unit only when boost pressure is above 1.1 bar)
- Closed throttle valve condition
- Coolant temperature sensor

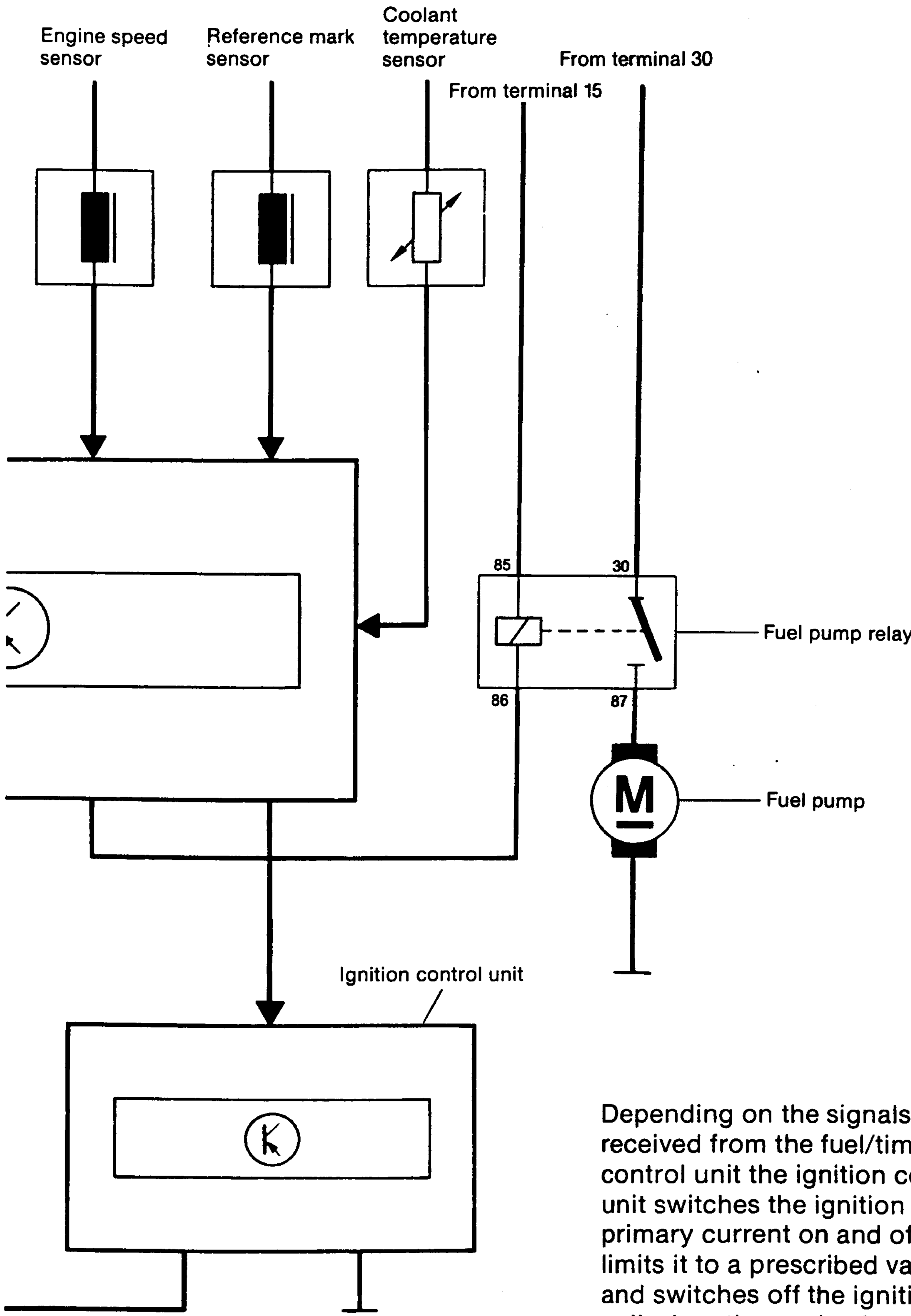
Fuel/timing control unit

From the information sensor impulses, the fuel/timing control unit determines the best possible ignition timing, for all engine operating conditions and actuates the ignition control unit.
Safety circuits limit the maximum speed of the engine to 6750 rpm. The safety circuits will also switch off the fuel pump within one second if the engine should stall.
A self check system will limit the engine speed to 4000 rpm if there is a defective idle switch or intake air temperature sensor. In addition, if the intake air temperature sensor is defective the ignition timing will be retarded .

Ignition distributor with Hall sender

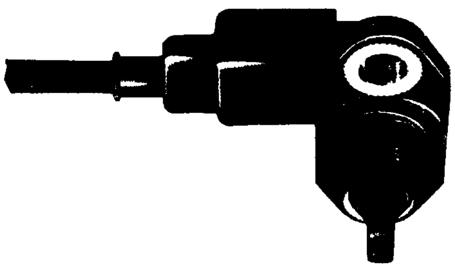
The Hall sender produces one broad signal, just before ignition TDC on No. 1 cylinder, per distributor shaft rotation. This signal allows the reference mark signal of 60° before TDC on No. 1 cylinder to be accepted as the reference mark signal in the control unit.





Depending on the signals received from the fuel/timing control unit the ignition control unit switches the ignition coil primary current on and off, limits it to a prescribed value and switches off the ignition coil when the engine is not running.

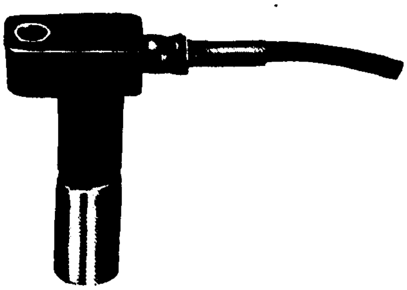
Information Sensors



Intake air temperature sensor

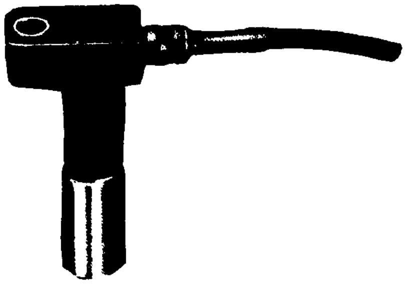
The electrical signal from the intake air temperature sensor changes as the air temperature varies. This signal is processed in the timing control unit whenever boost pressure is above 1.1 bar.

In general, the intake air temperature sensor will cause ignition timing to retard as air temperature increases. This helps to prevent engine "knock" or "pinging". Location: front of intake manifold.



Reference mark sensor

By means of a pin on the flywheel the reference mark sensor produces one impulse per crankshaft revolution. This impulse is processed in the fuel/timing control unit as the reference mark signal of 60° before TDC.
The reference mark sensor works together with the Hall sender to identify ignition TDC for No. 1 cylinder.
Location: on the side of the cylinder block.

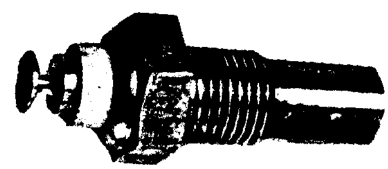


Engine speed sensor

The speed sensor produces 135 impulses per crankshaft revolution, (ie: one impulse per tooth on the flywheel.) These impulses are processed in the control unit as the signals for determining engine speed and ignition timing.
The fuel/timing control unit calculates engine rpm by counting the number of flywheel teeth which pass the speed sensor per unit of time. By counting the flywheel teeth passing the speed sensor after the reference mark pin, the control unit determines crankshaft position.

Coolant temperature sensor

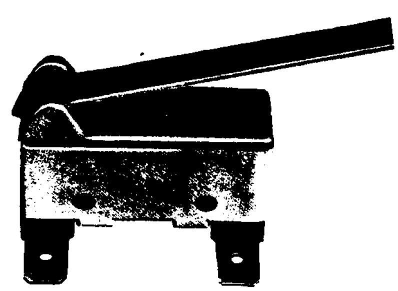
The coolant temperature sensor provides the fuel/timing control unit with information on engine temperature. When the engine is cold (below about -3° C) the coolant temperature sensor will cause the ignition timing to be advanced.
Location: On the engine block just below cylinder No. 1 spark plug.



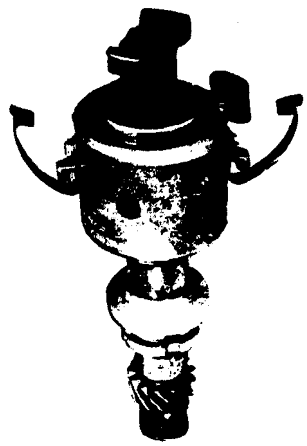
Idle Switch

The idle switch performs three functions:

- With the throttle closed, if idle speed drops below 820 rpm the idle stabilizer function in the control unit will be switched in.
- When engine speed is above 1000 rpm, on deceleration, the idle switch activates the deceleration control function in the control unit.
- When the throttle valve is opened, the control system for determining ignition timing is switched in.
  Location: On the throttle valve housing.



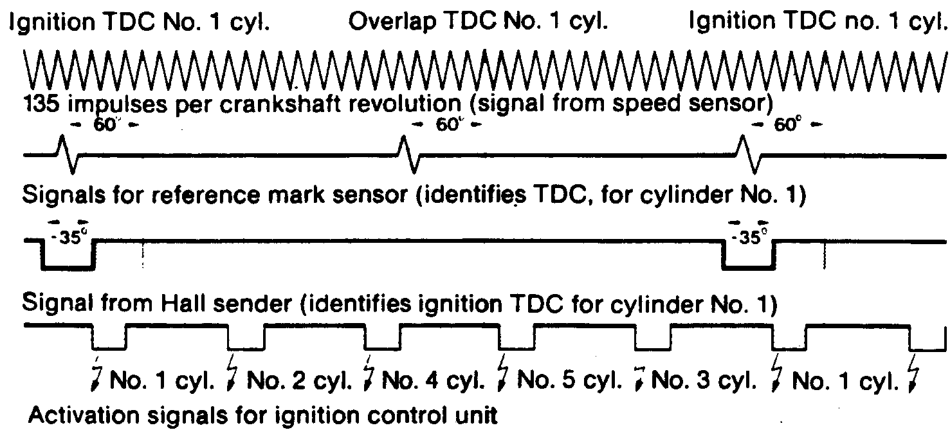
Distributor and timing control unit

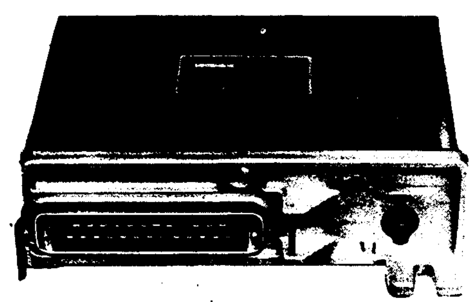


Distributor with Hall sender

The Hall sender produces one broad signal per distributor shaft rotation just before ignition TDC on No. 1 cylinder.
The signal from the Hall sender only permits the signal of 60° before ignition TDC on No. 1 cylinder to be accepted as a reference mark signal in the control unit.

Control signals diagram

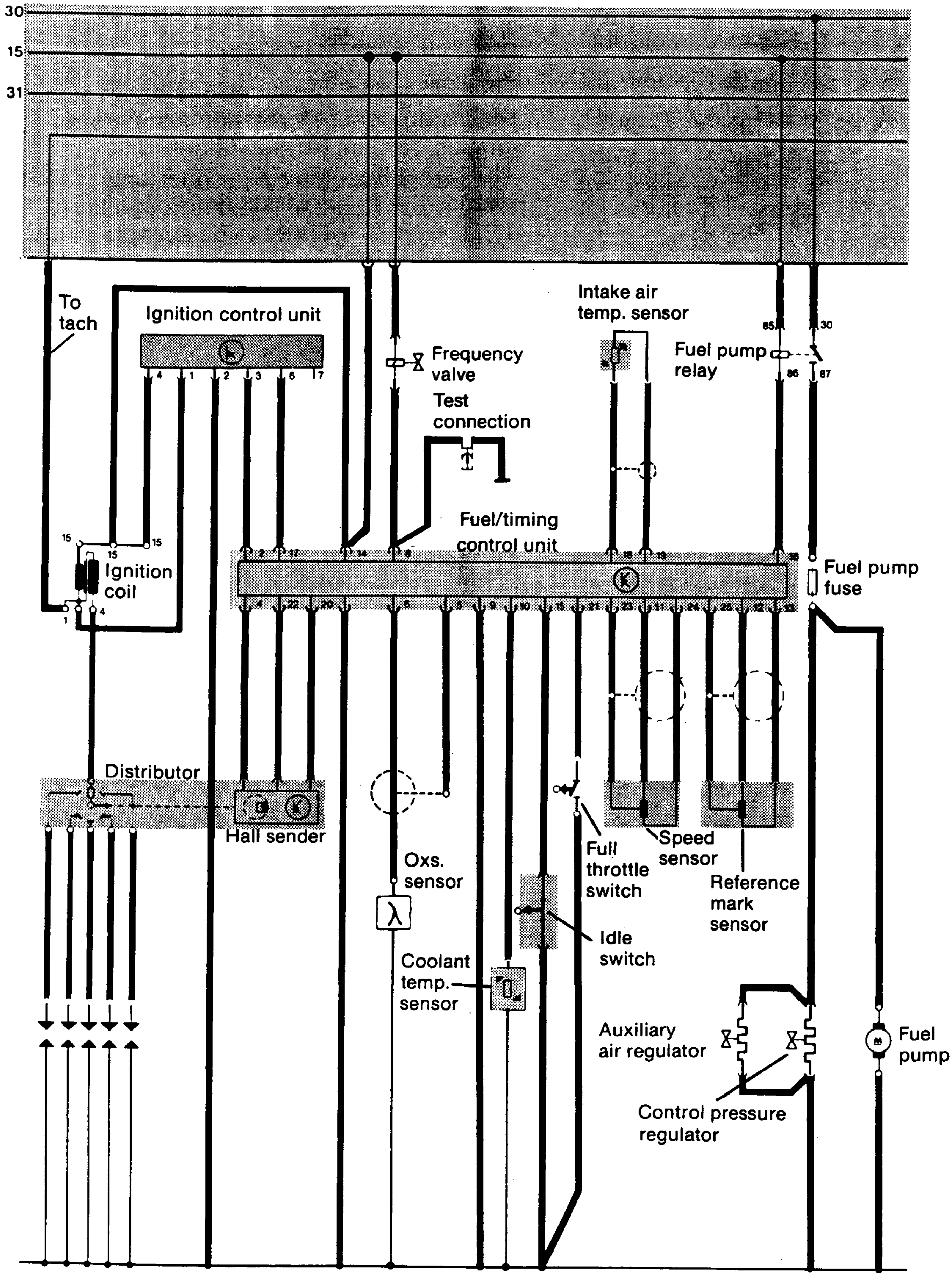




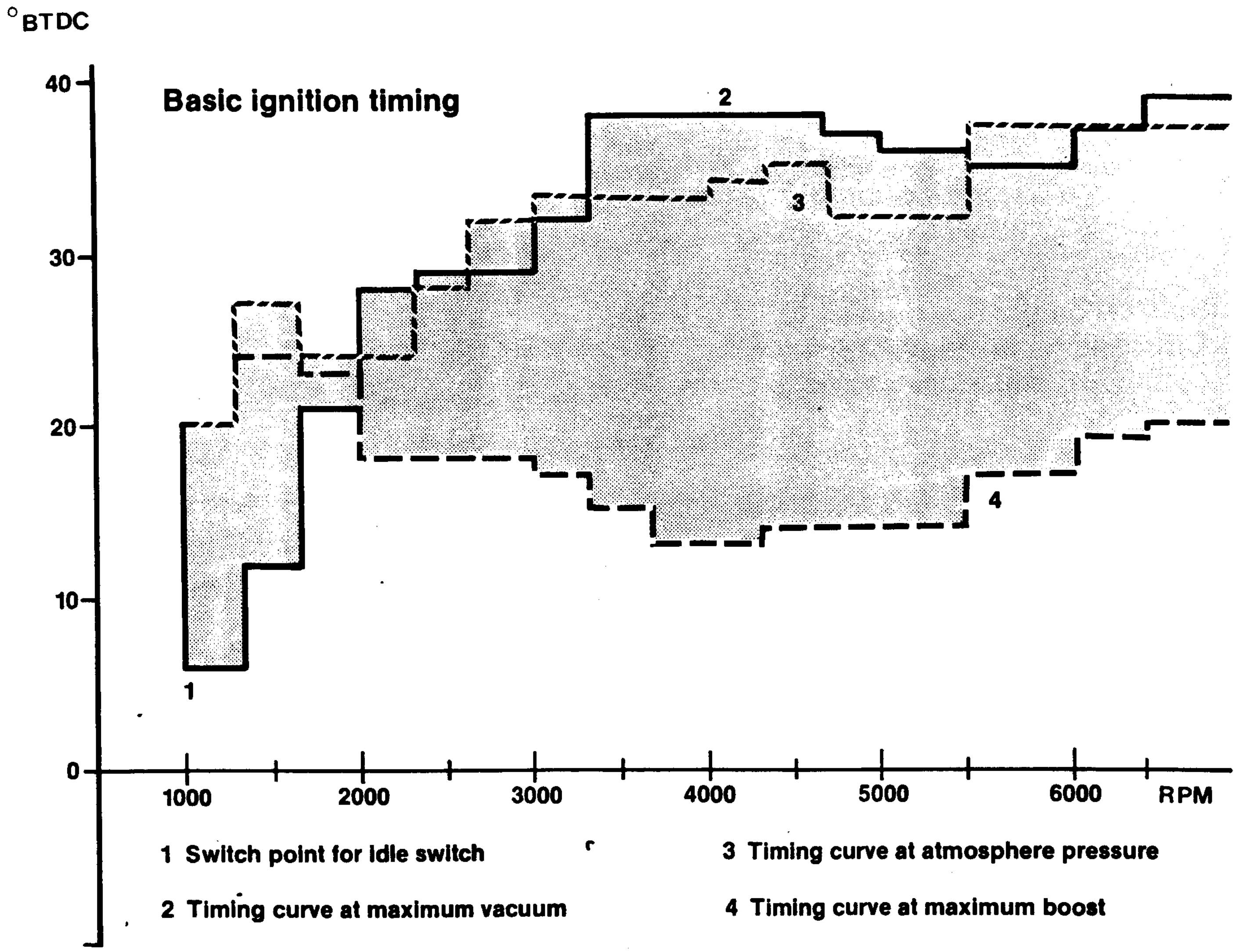
Fuel/Timing control unit

Based on the signals received from the information sensors, the control unit determines the best ignition timing for all engine operating conditions.
When the throttle valve is closed, the ignition timing will be determined by the idle stabilizer function in the control unit. The idle stabilizer function will be switched in if engine speed is below 820 rpm.
When the throttle valve is opened, ignition timing is determined by engine speed, intake manifold pressure, coolant temperature and above 1.1 bar boost pressure, ignition timing is influenced by the intake air temperature sensor.
On deceleration the ignition timing is determined by an engine speed characteristic line, programmed into the control unit memory.

Current Flow Diagram



Timing Control



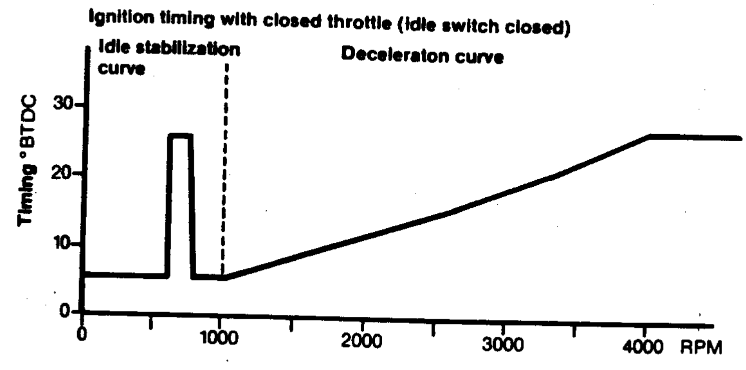
This diagram shows the basic ignition timing curves when the throttle is opened (that is when the idle switch is open). Ignition timing, at any given moment, will be somewhere in the shaded area of the graph depending on engine speed and intake manifold pressure. Other inputs to the control unit such as coolant temperature, deceleration, idle and intake air temperature will cause the ignition timing to vary from what is shown on the graph.

The three graphs on the next page show an approximation of how additional inputs modify the basic ignition timing.

Ignition Timing with closed throttle

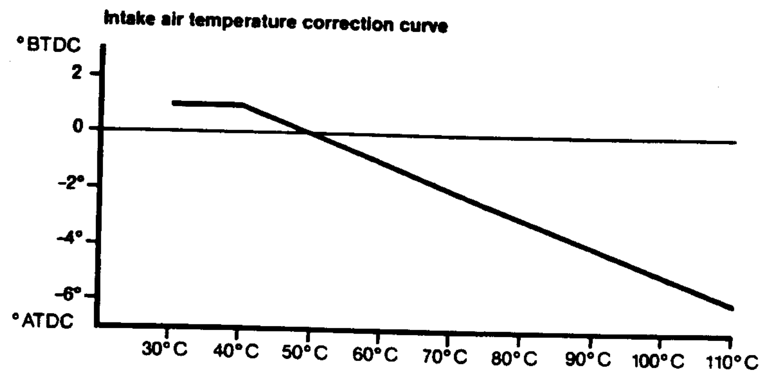
The idle stabilizer function, in the fuel/timing control unit, does not start to work until idle speed is below 820 rpm. Between 720 and 820 rpm ignition timing will be advanced from 6° to 26° BTDC. The idle stabilizer advances the timing to 26° BTDC when engine speed is between 600 to 720 rpm.
The idle stabilizer does not work when engine speed is below 600 rpm. Below 600 rpm, that is at engine cranking speed, the timing is relatively retarded to ensure easy starting.

During deceleration the basic timing is advanced, depending on engine rpm, to ensure low exhaust emissions and to prevent backfiring.



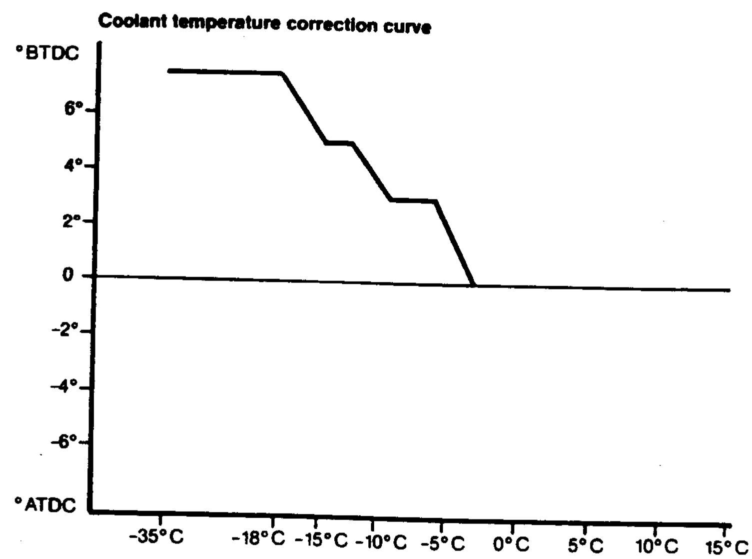
Intake Air Temperature Curve

In general, the basic ignition timing will be retarded as intake air temperature rises. The timing is retarded in order to prevent detonation when the temperature rises. The intake air temperature information is processed by the control unit only when boost pressure is above 1.1 bar.



Coolant Temperature Curve

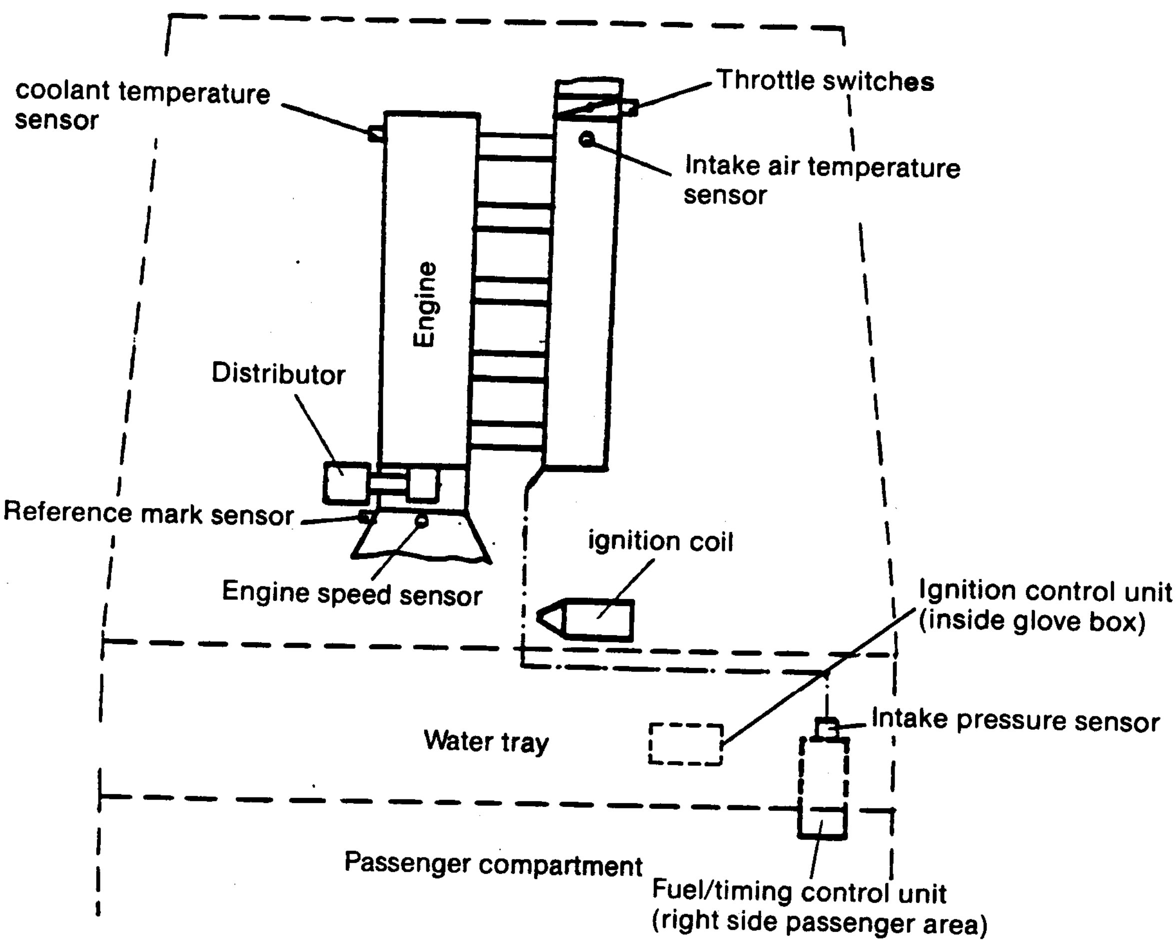
Whenever engine coolant temperature is below -3° C the basic ignition timing will be advanced. Advancing the timing at low temperatures helps to ensure complete combustion of the air fuel mixture thereby ensuring good cold engine performance.



Remember, the basic ignition timing is determined by engine speed and intake manifold pressure. The basic timing is then altered by inputs on throttle position, intake air temperature and engine coolant temperature. As an example, if engine speed is at 5000 rpm and boost pressure is at the maximum, the basic timing will be at 14° BTDC. Now if intake air temperature is at 70° C, the timing will be retarded 2°. Total timing will then be 12° BTDC.

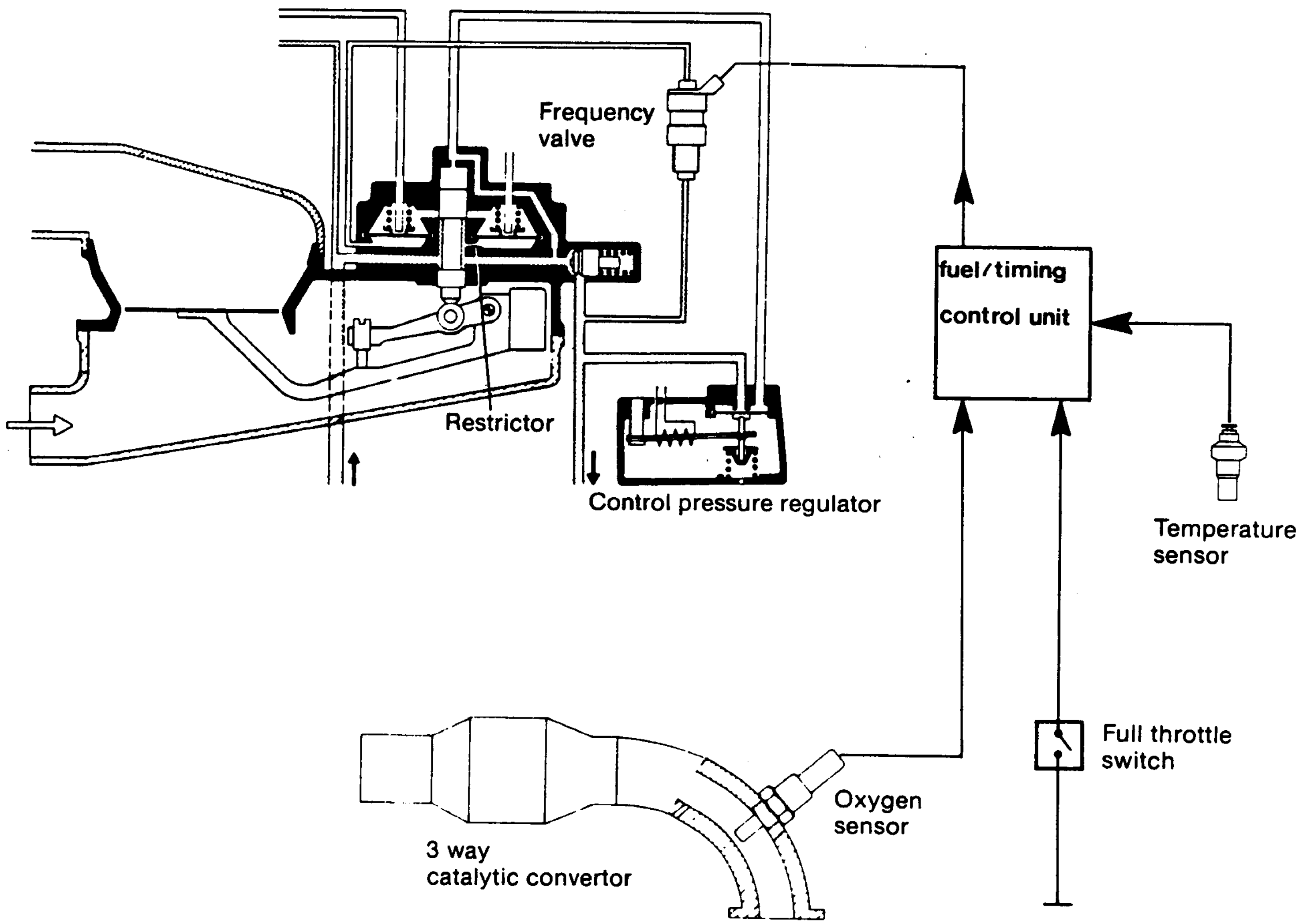
Operation/Location

Information about engine speed, throttle position, intake air pressure, coolant temperature and intake air temperature are processed by the fuel/timing control unit and the correct ignition timing for these conditions is selected from the control unit memory. When the crankshaft is at the correct position the fuel timing control unit sends a signal to the ignition control unit. The ignition control unit will then switch off the ignition coil primary voltage and cause the coil to fire.



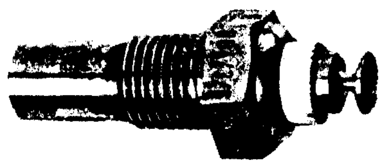
Oxygen Sensor System

A sensor located in the exhaust system senses the oxygen content of the exhaust gases. The amount of oxygen in the exhaust varies according to the air/fuel ratio. The oxygen sensor produces a small amount of voltage that varies depending on the amount of oxygen in the exhaust. This voltage signal is sent to the fuel/timing control unit. The fuel/timing control unit works together with a frequency valve which will vary the amount of fuel delivered to the engine.

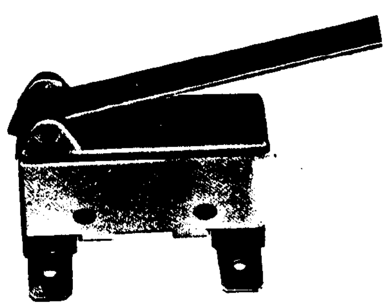


Oxygen Sensor System

The CIS components used on the Audi Quattro perform the same basic functions as they do on other Audi models. However, there have been some changes made to the oxygen sensor system.



Coolant temperature sensor
A new coolant temperature sensor replaces the old style oxygen sensor thermo-switch. This coolant temperature sensor is the same sensor which was described in the ignition section of this booklet. The control unit processes information from this sensor and uses this information to make decisions about both ignition and fuel control.

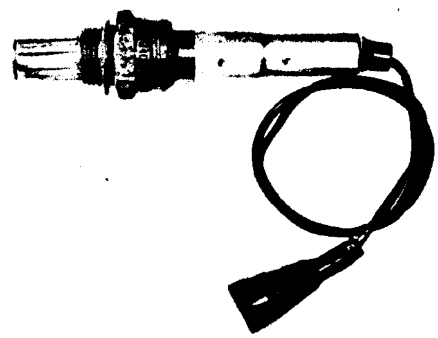


Full throttle switch

When the throttle valve is just a little more than three-forths of the way open, the full throttle switch will close and complete an electrical circuit. As soon as the throttle switch closes the control unit will cause the quantity of fuel delivered to the engine to increase. The "duty cycle" during enrichment will be increased to 70-77% depending on engine rpm.

Oxygen sensor

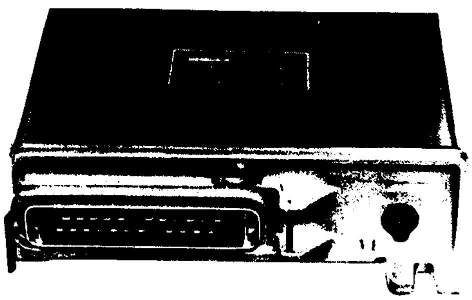
As soon as the oxygen sensor reaches operating temperature (about 300° C) it begins to send a voltage signal to the fuel/timing control unit. The strength of this signal varies depending on the amount of oxygen in the exhaust. The control unit processes information from the oxygen sensor and then makes a decision on whether to enrichen or lean the quantity of fuel.



Frequency valve

The frequency valve is an electromagnetic valve which is attached to the lower chamber of the fuel distributor. By opening and closing many times per second the frequency valve varies the pressure inside the fuel distributor, thereby controlling the amount of fuel delivered to the engine. The frequency valve is controlled by the fuel/timing control unit.

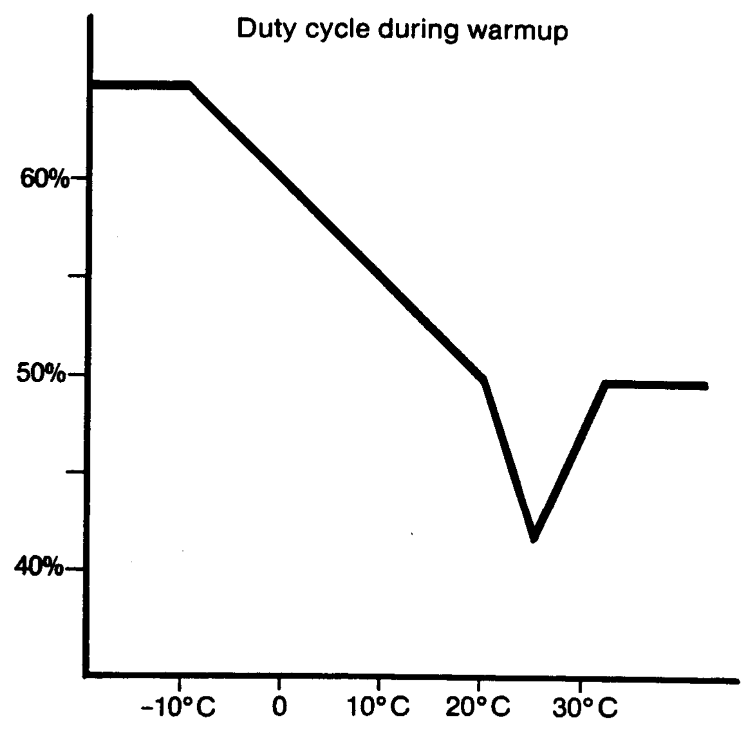
Fuel/Timing Control Unit



The oxygen sensor system control unit has been incorporated into the same unit used for timing control. This fuel/timing control unit controls all major engine functions. The fuel/timing control unit receives information from the oxygen sensor, coolant temperature sensor and the full throttle switch. Based on these inputs, the control unit determines the correct "duty cycle" and then controls the operation of the frequency valve.

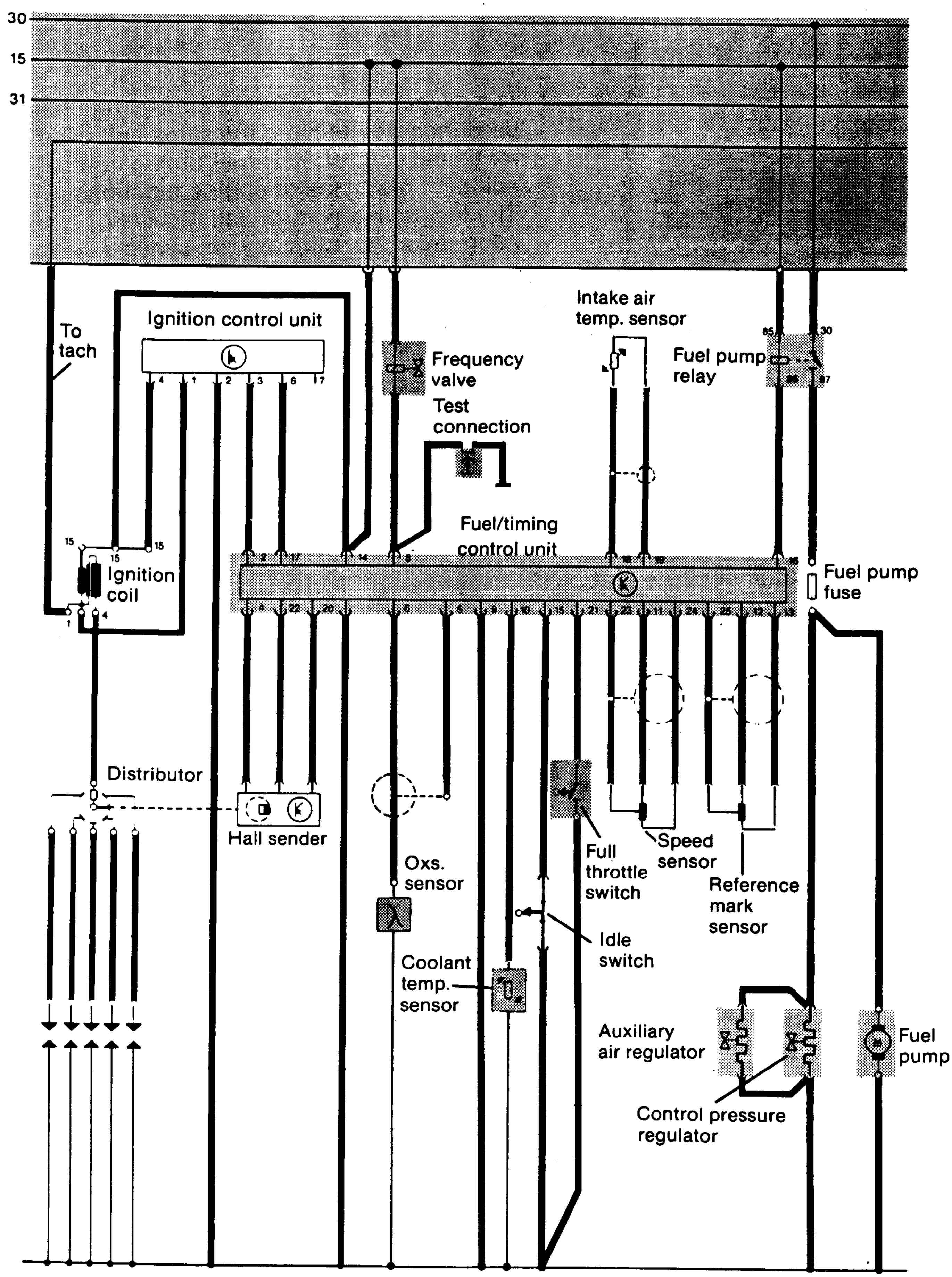
It is not possible to have "closed loop" control unless coolant temperature is above 32°C and unless the oxygen sensor has warmed up. Until coolant temperature rises above 32°C and until the oxygen sensor warms up, the duty cycle is regulated at a fixed amount.

Depending on coolant temperature, the duty cycle reading during oxygen sensor warm up will be between 42% to 65%.



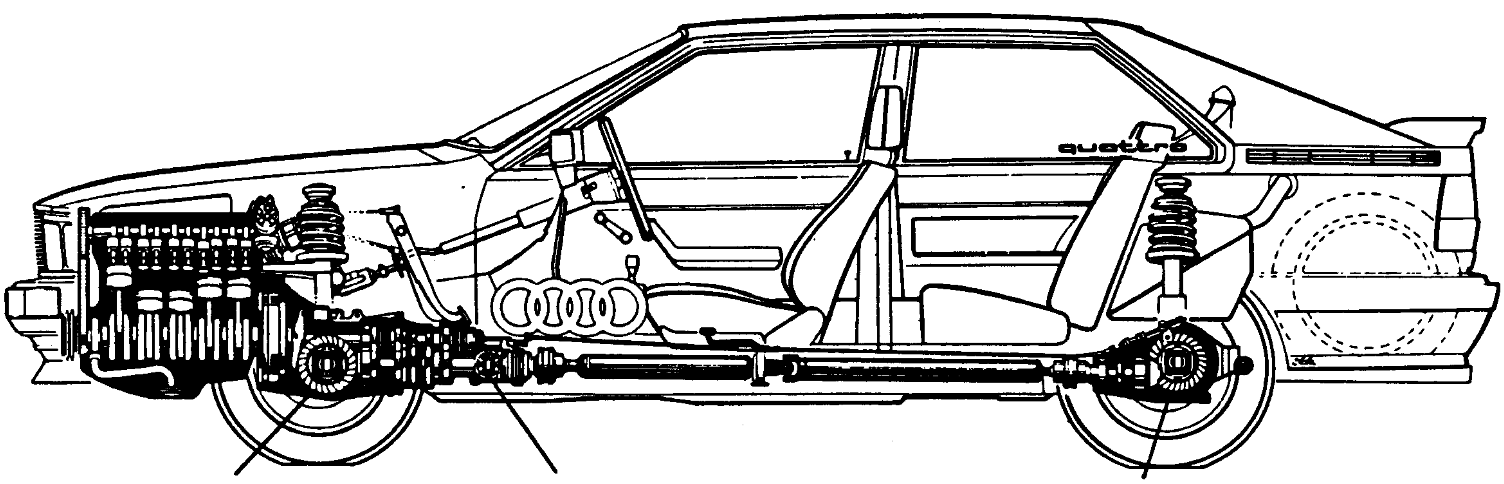
The coolant temperature sensor also influences the duty cycle during engine cranking. When the temperature is less than 60°C the duty cycle during cranking will be about 80%. Above 60°C the duty cycle will be about 50%.

Current Flow Diagram



Four Wheel Drive

The Audi Quattro has full time four wheel drive. The permanent four wheel drive offers a number of advantages.
Particularly when:
- Driving on slippery roads
- Driving at high speeds
- Driving up steep hills
- and under load change conditions

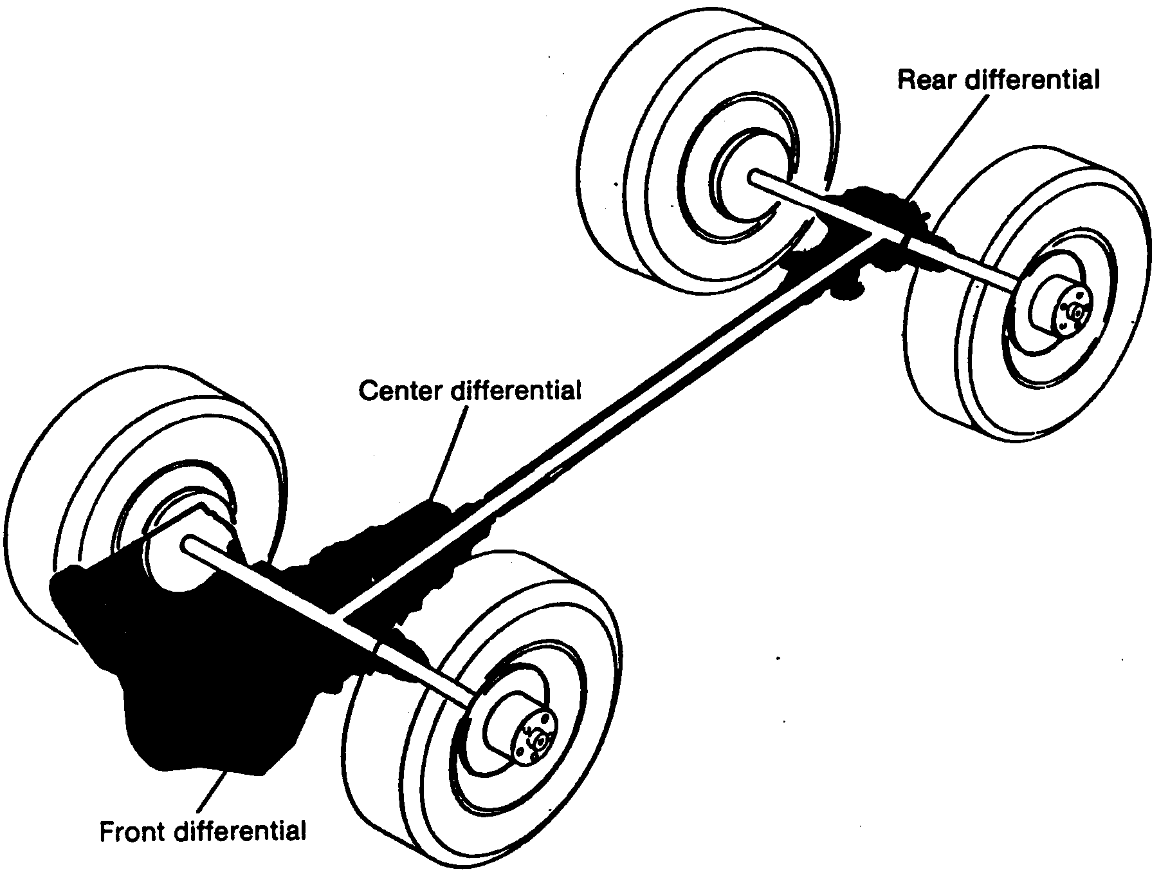


The Audi Quattro, unlike most four wheel drive vehicles, does not use a transfer gearbox. Instead, the existing 016 five speed transmission was modified and a central differential was incorporated into the transmission. This design has reduced the weight penalty and the power losses, caused by a transfer gearbox.

Because the Quattro uses three differentials (center, front and rear) each wheel is free to turn at a different speed when cornering. This further reduces power loss and increases tire life by minimizing "tire scrub."

Differential Locks

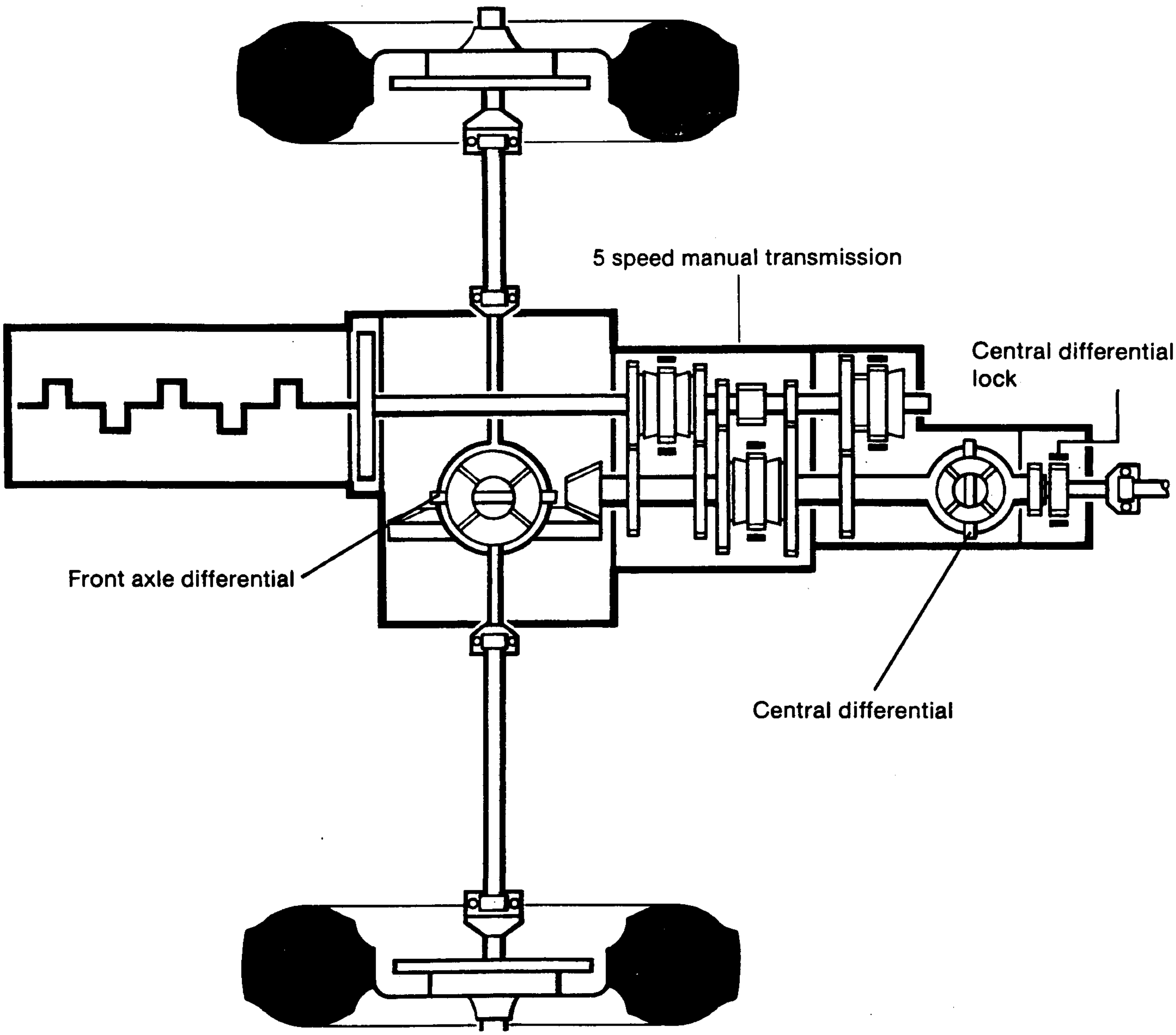
For driving on slippery roads the center and rear differentials can be locked.



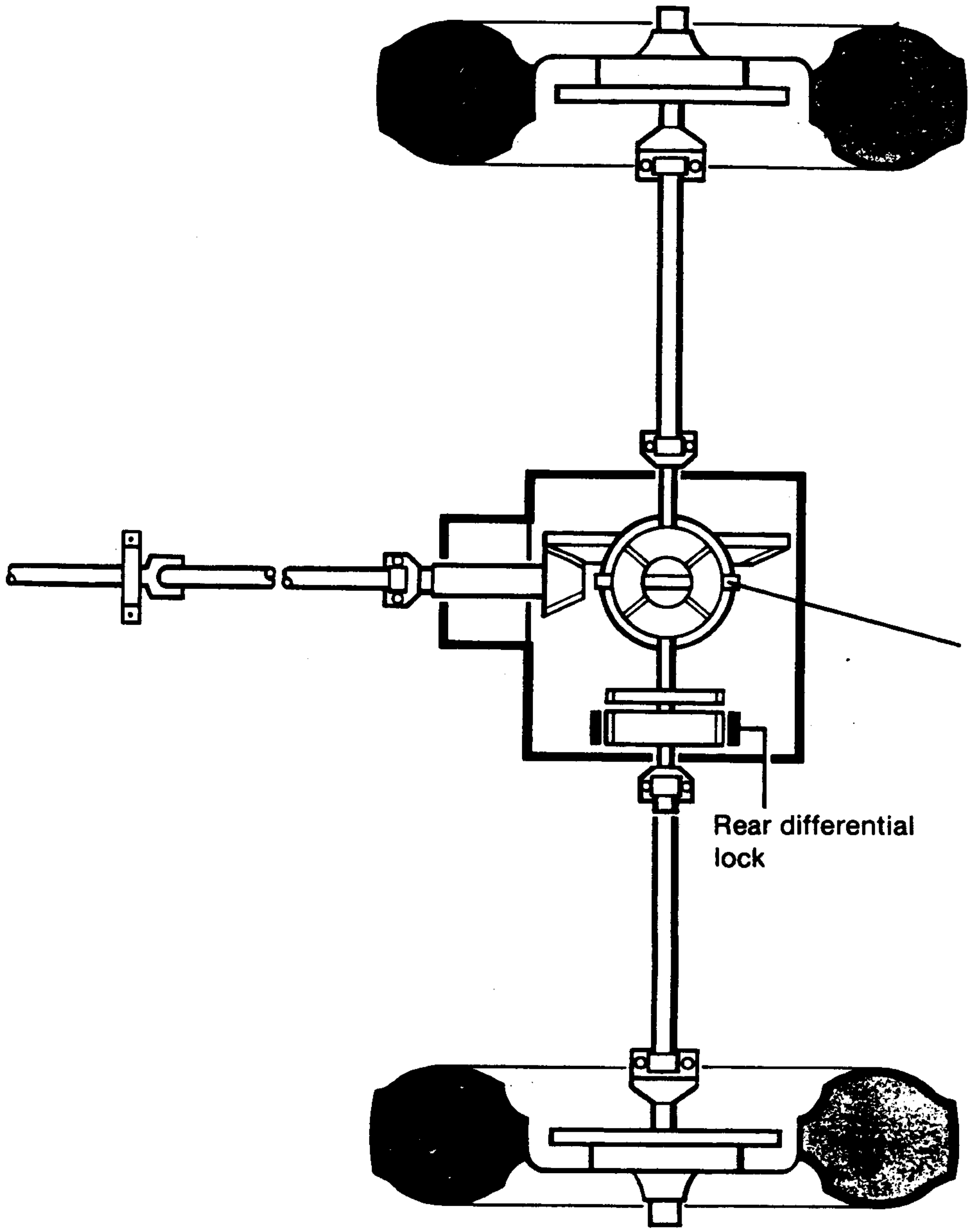
When the central differential is locked, power is transmitted equally to the front and rear differentials. That is, the front and rear differentials turn at the same speed. When the rear differential is locked, power is transmitted equally to both rear wheels and both rear wheels turn at the same speed. With the differentials locked, the Audi Quattro exhibits its best driving characteristics for slippery road conditions. At least three wheels, both rear and one front, must spin before the drive traction is lost.

The front differential can never be locked because the front wheels must be able to turn at different speeds. Steering would become very difficult if the front differential were locked.

Power Flow



The power is transmitted via the 5 speed manual transmission to the central differential and from the central differential, through a drive-shaft, to the rear axle final drive. Power is also transmitted via the pinion shaft to the front axle differential.



When the coefficient of friction between the road surface and the tires is low, the differential locks, for both the central and rear axle differentials, can be engaged to improve traction. The differential locks can be engaged either when the car is stationary or while driving. Two warning lamps on the console indicate when the differentials are locked.

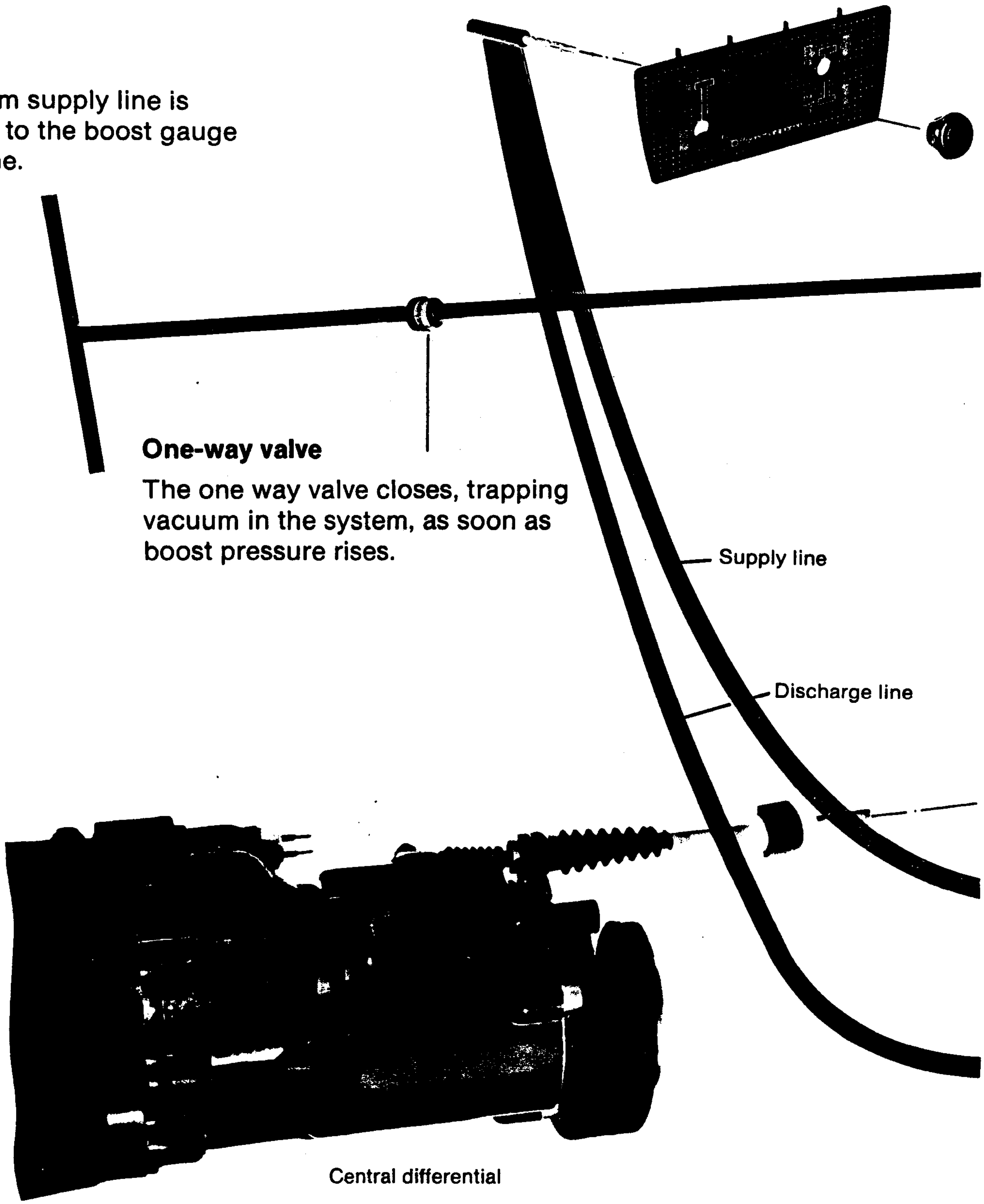
Operation of Differential Locks

On all Quattros the central and rear differential locks are operated by a vacuum system. Both locks are engaged at the same time and when the differential locks are engaged, the warning lamps on the console light up.

The vacuum supply line is connected to the boost gauge vacuum line.

One-way valve

The one way valve closes, trapping vacuum in the system, as soon as boost pressure rises.

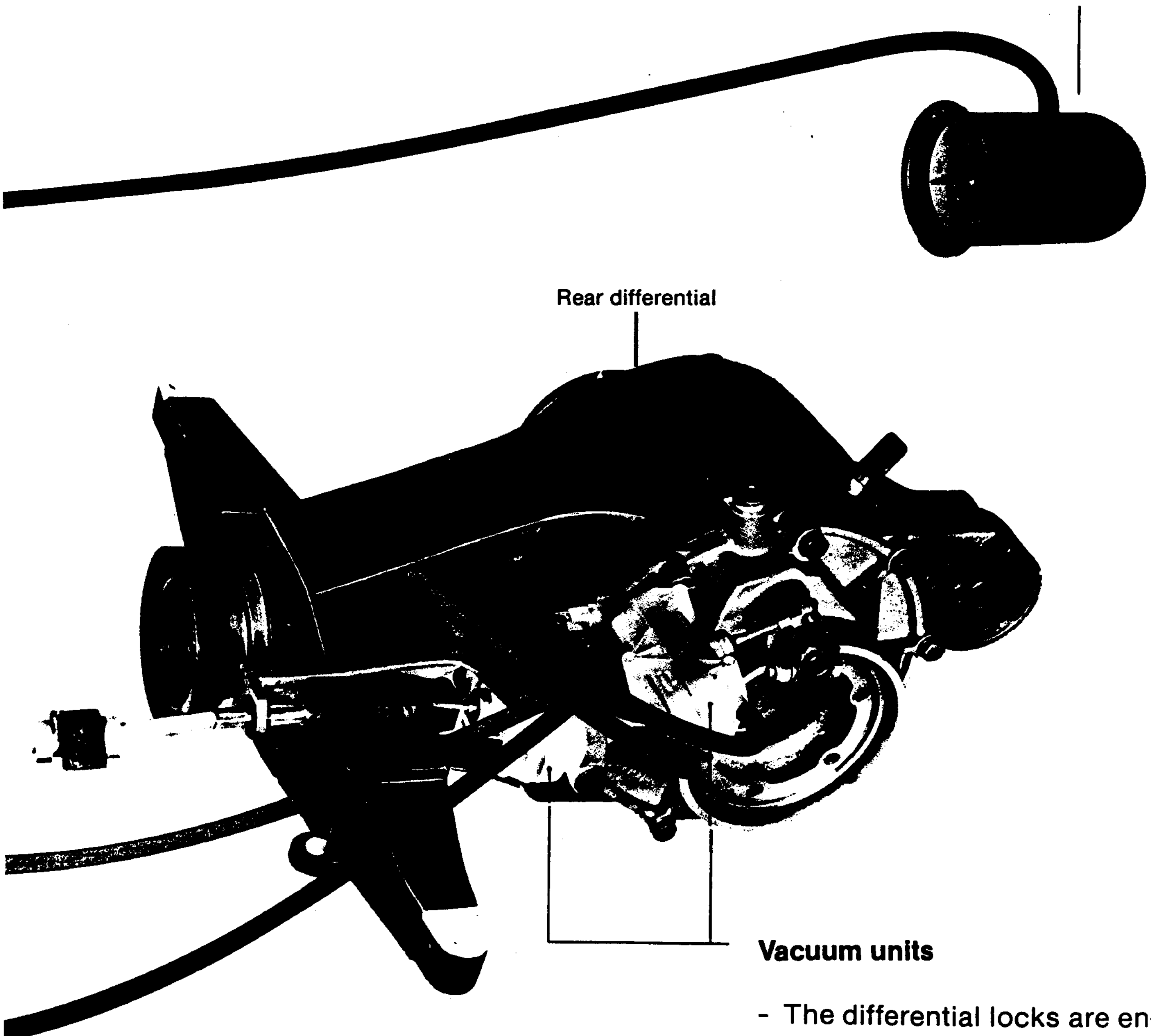


- When the operating knob is pulled, vacuum is supplied to the engagement side of the vacuum units by way of the supply line.

- When the operating knob is pushed in, the vacuum is transferred to the opposite side of the vacuum unit and the differential locks are disengaged.

Vacuum reservoir

A vacuum reserve, for 2 to 3 operations of the differential locks, is stored in the reservoir.

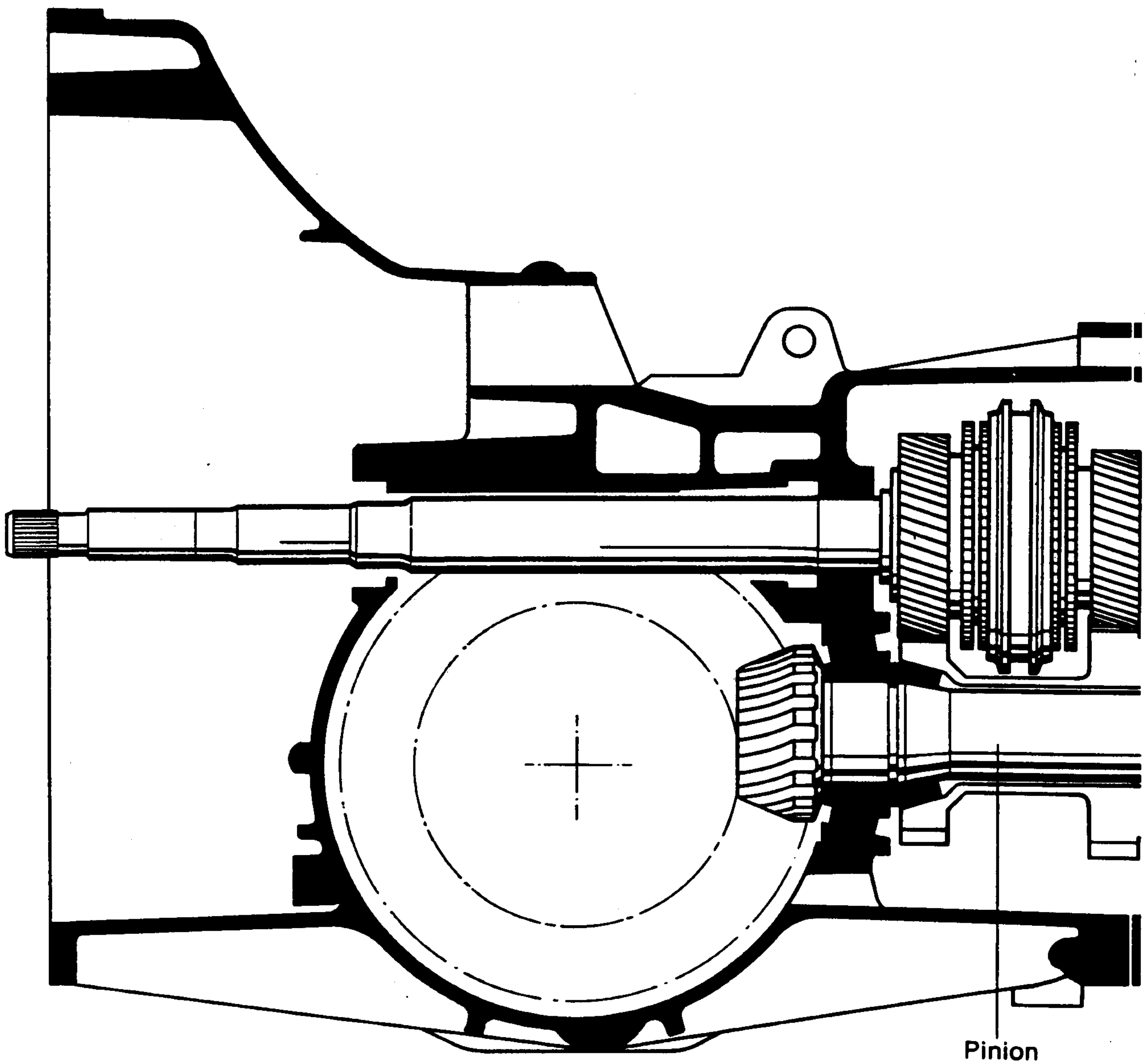


Vacuum units

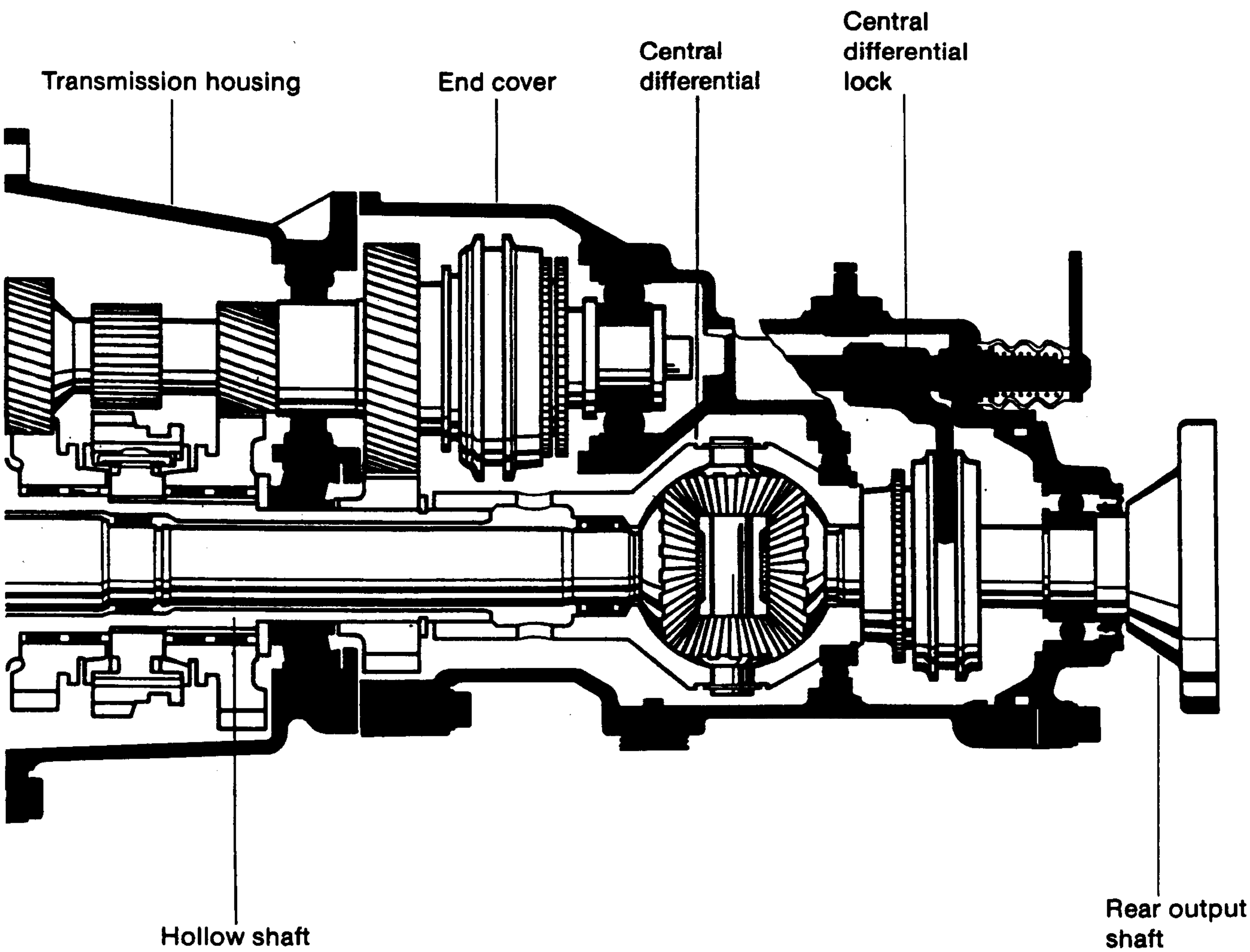
- The differential locks are engaged/disengaged by vacuum units.

5 Speed Four Wheel Drive Manual Transmission

The 5 speed four wheel drive manual transmission is based on the 5 speed manual transmission from the Audi Coupe.



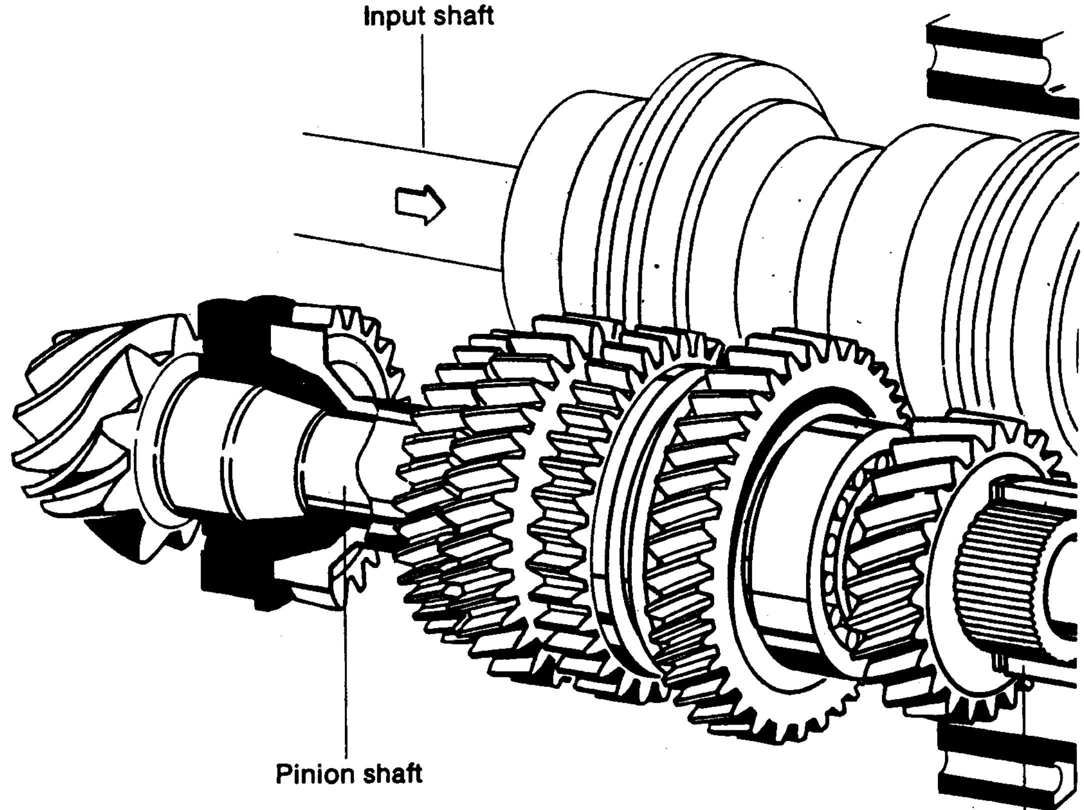
The central differential is located in the end cover. A hollow shaft is installed in place of the normal type pinion shaft.
This hollow shaft drives the central differential. The pinion shaft extends from the central differential, through the hollow shaft, to the front axle differential.
The pinion shaft is located by the taper roller bearing in the transmission housing and with two needle roller bearings; one in the hollow shaft and one in the differential housing.



The central differential housing is pushed over the hollow shaft. The pinion shaft and the rear output shaft are splined to the differential side gears.

·entral Differential

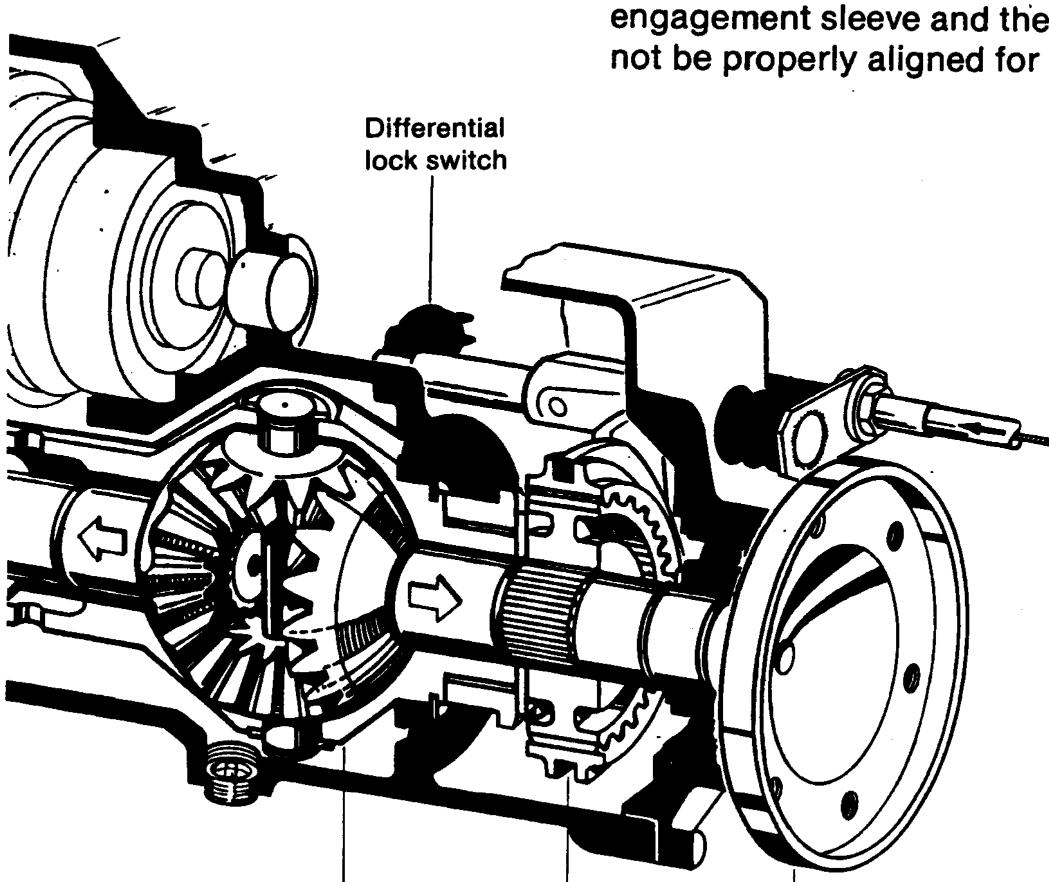
'he central differential transmits the driving ɔrces equally to the pinion and to the rear ·utput shaft.



Power is transmitted from the input shaft to the hollow shaft through the appropriate gear set.
The hollow shaft drives the central differential. This in turn transmits power through the differential bevel gears to the pinion shaft and to the rear output shaft. The differential bevel gears in the central differential balance out the differences in revolutions between the front and rear axle drives.
These differences in revolutions occur, for example, when the car turns a corner. When cornering, the front and rear wheels turn at different speeds. That is, the rear output shaft will turn at a different speed than the pinion shaft. However, if the differential is locked, the rear output shaft and pinion shaft turn at the same speed.

To engage the central differential lock, the operating cable has to be pushed toward the front of the car. When this happens, the shift fork moves forward and presses the operating sleeve into engagement with the teeth on the differential housing.

The central differential lock will not always instantly engage. For example, if the car is being driven in a straight line, the rear output shaft, the pinion shaft and the central differential will all be turning at the same speed. Under these circumstances, the teeth on the engagement sleeve and the differential housing may not be properly aligned for engagement.

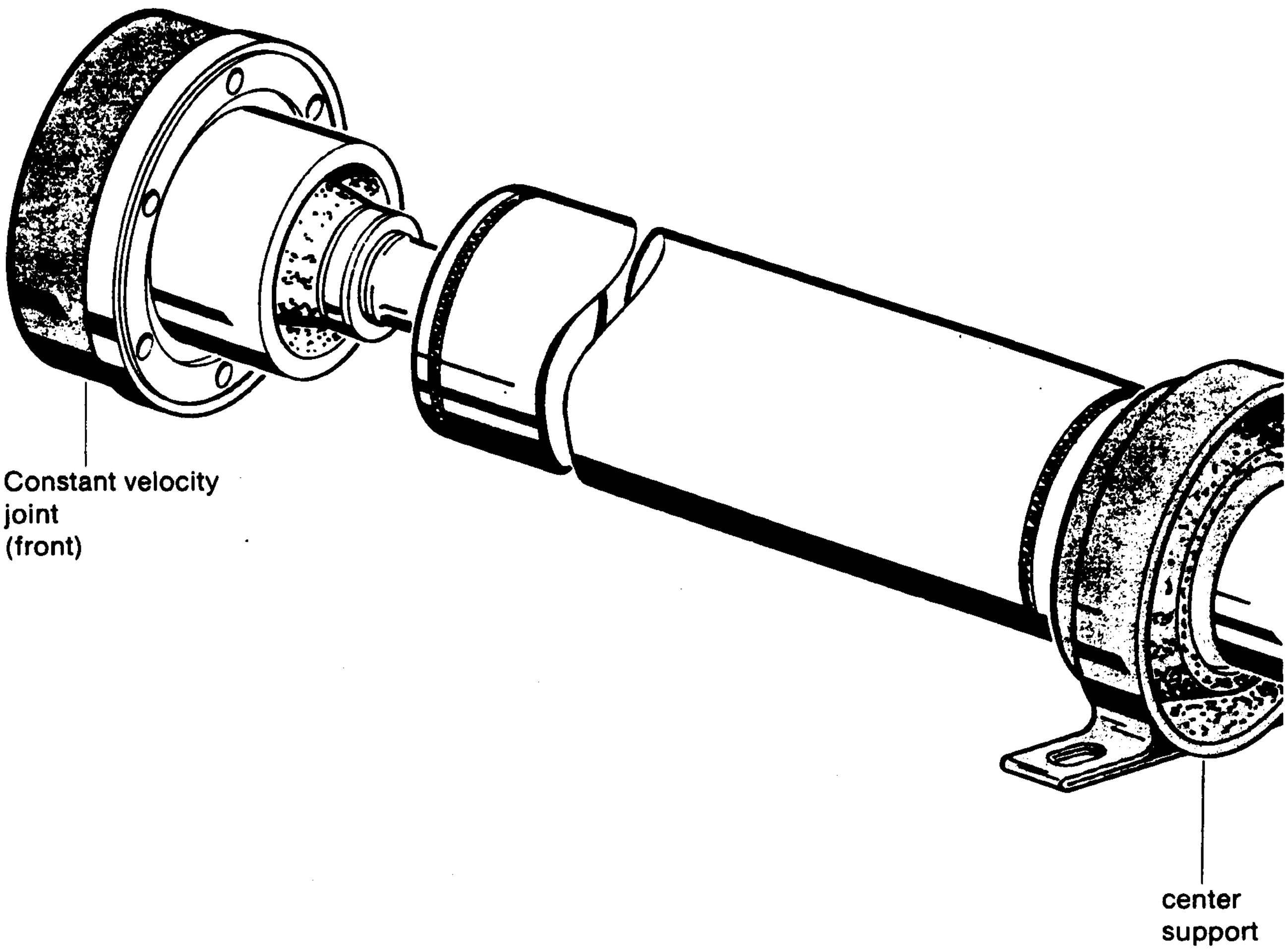


As soon as a difference in speed between the shafts and differential housing occurs, (turning a corner for example) the engagement teeth will rotate slightly and the sleeve will be pressed into engagement, locking the differential.

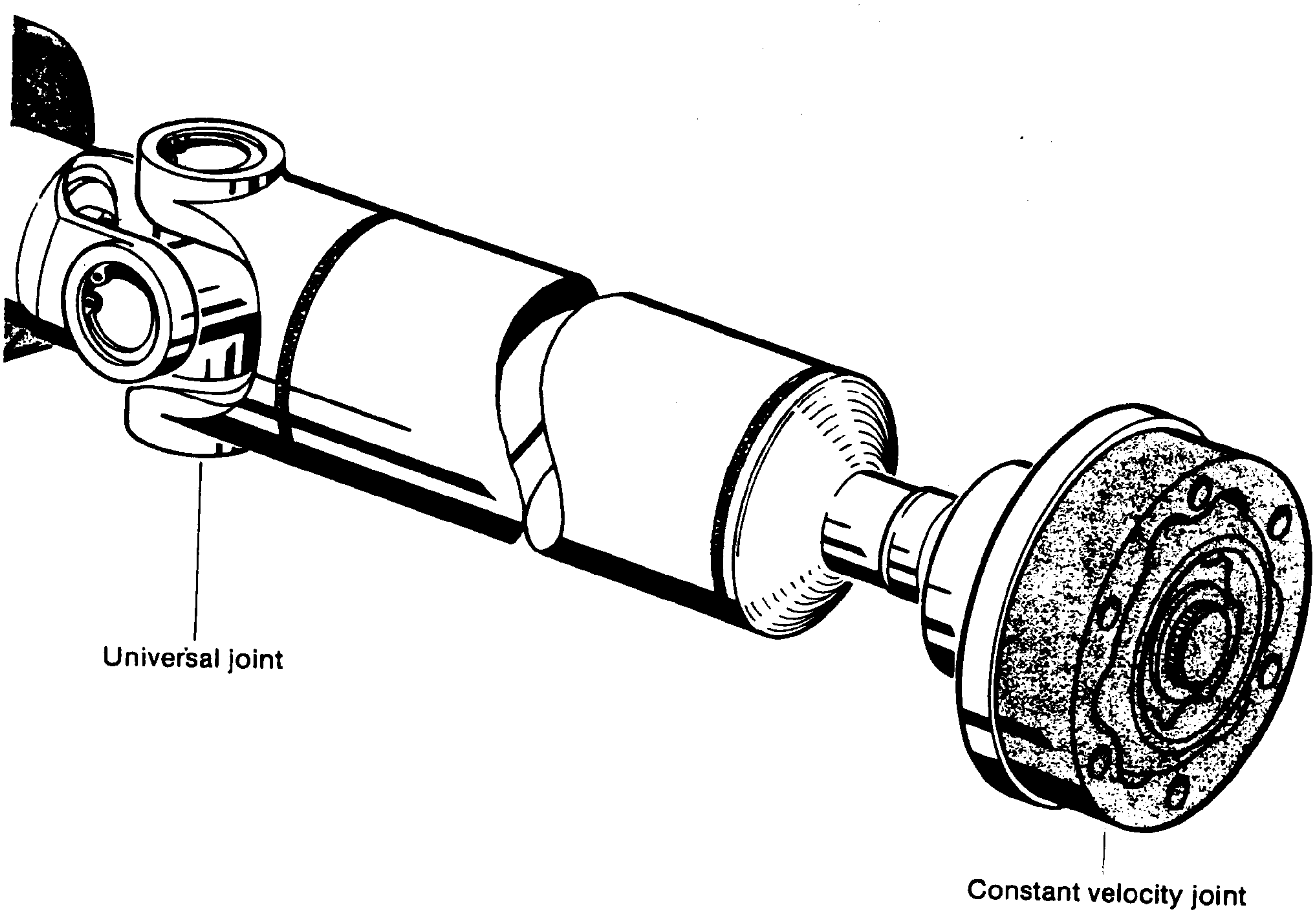
When the central differential is locked,the chamfer on the shift rod will press the differential lock switch and the console warning lamp will light up.

Driveshaft

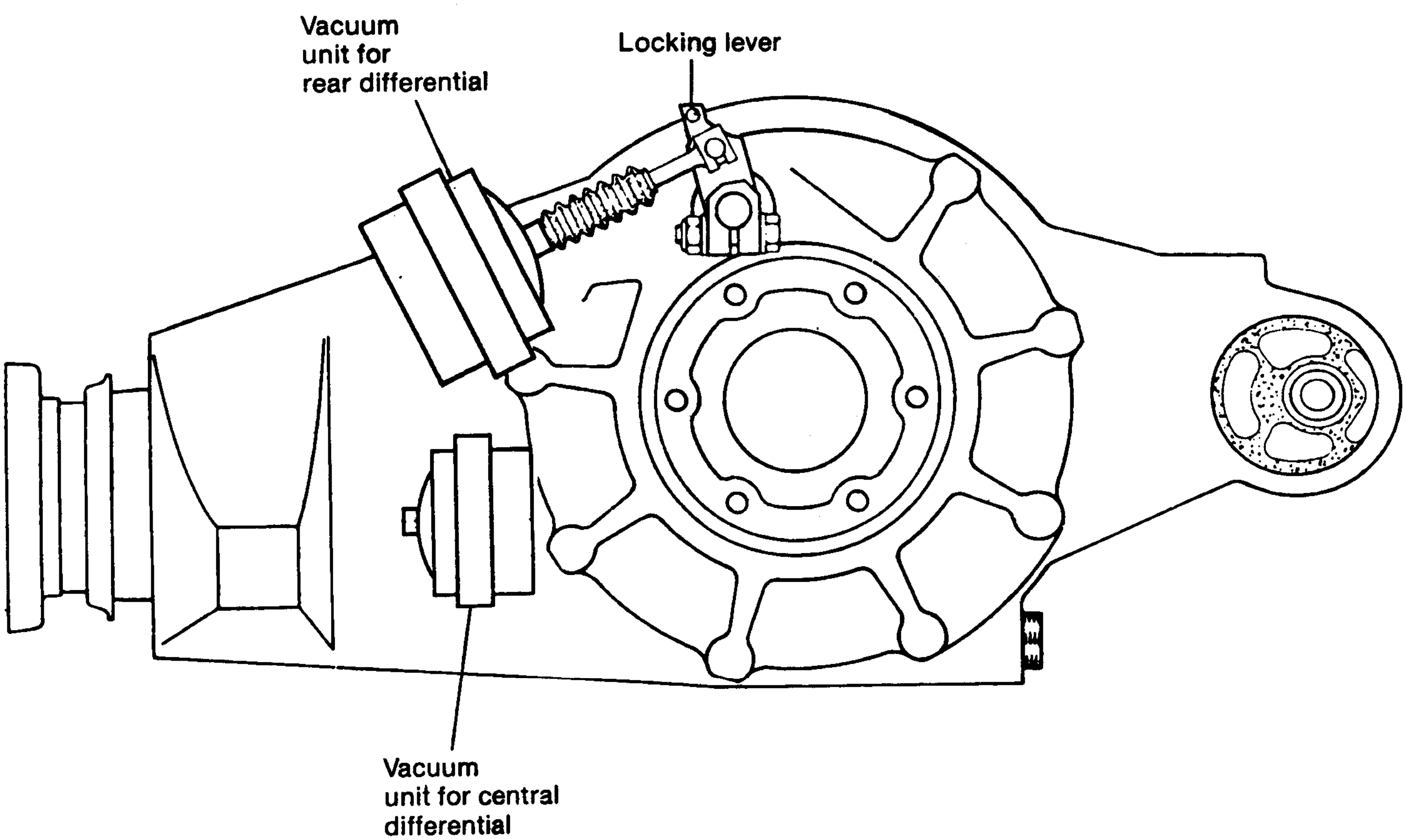
The driveshaft transmits the driving forces from the central differential to the rear axle final drive.

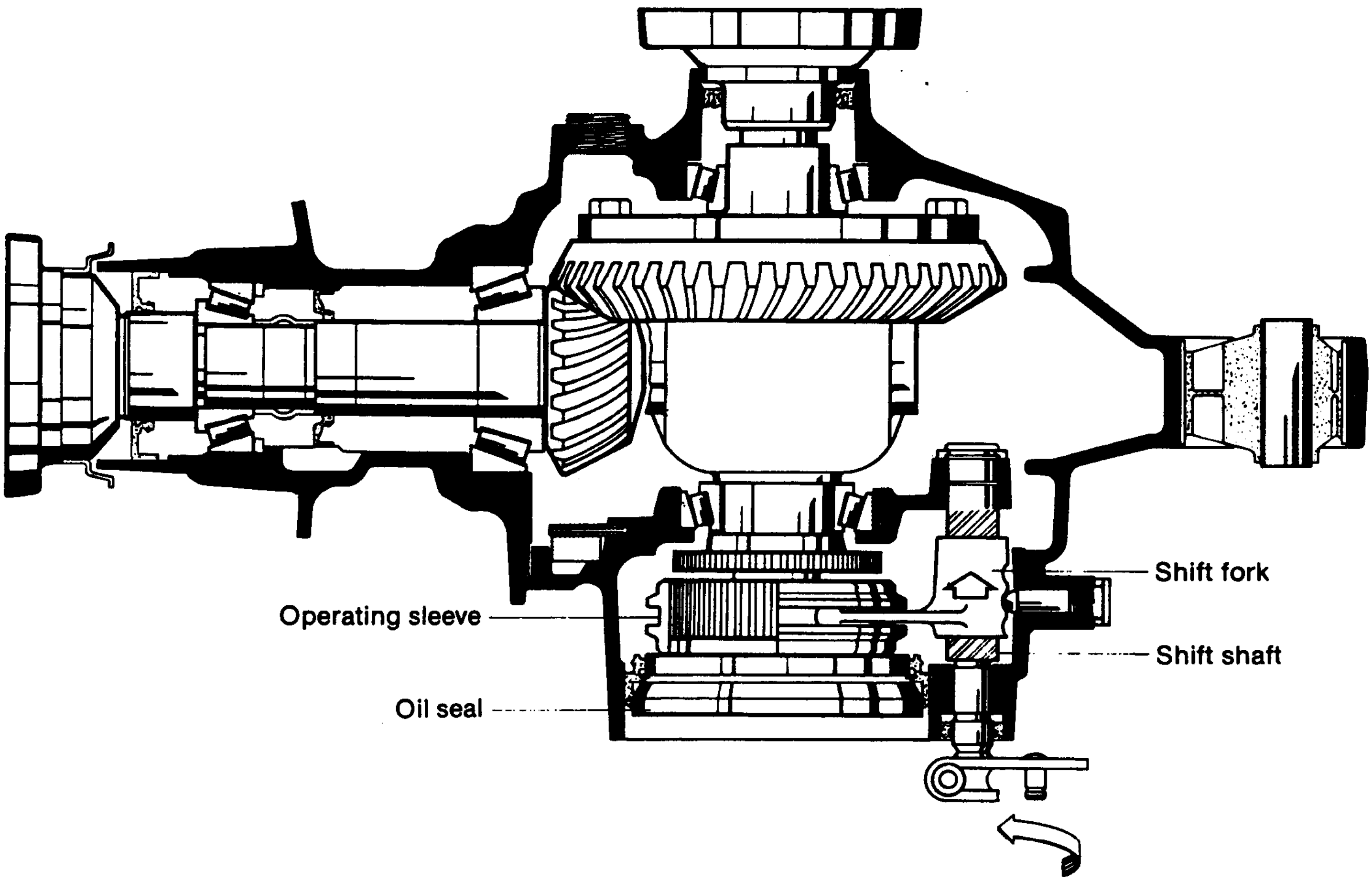


To ensure quiet operation, the driveshaft is divided in the center by a universal joint. The center support serves as an intermediate bearing and prevents the shaft from "whipping". The constant velocity joints take up the manufacturing tolerances and also any movements of the assemblies which might occur.


Universal joint
Constant velocity joint
(rear)

Rear Axle Final Drive with Differential Lock



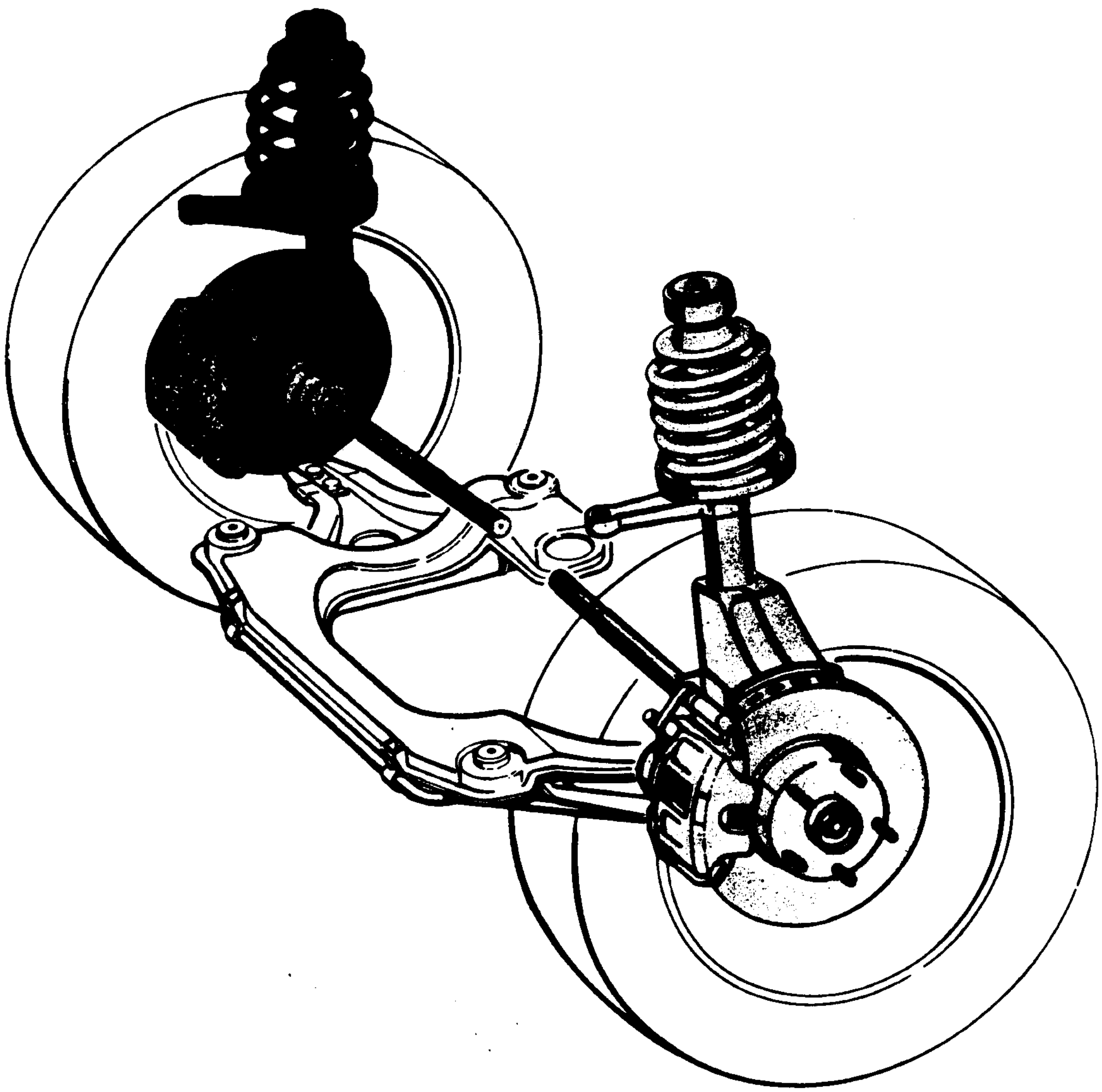


When the locking lever is pulled forward it rotates the threaded shift shaft. The shift fork then moves along the threaded shift shaft and presses the operating sleeve into engagement with the teeth on the rear differential housing. The rear axle differential will then lock. At the same time, the shift fork operates the differential lock switch and the console warning lamp will light up.

Just like the central differential, the rear axle differential lock may not engage instantly.

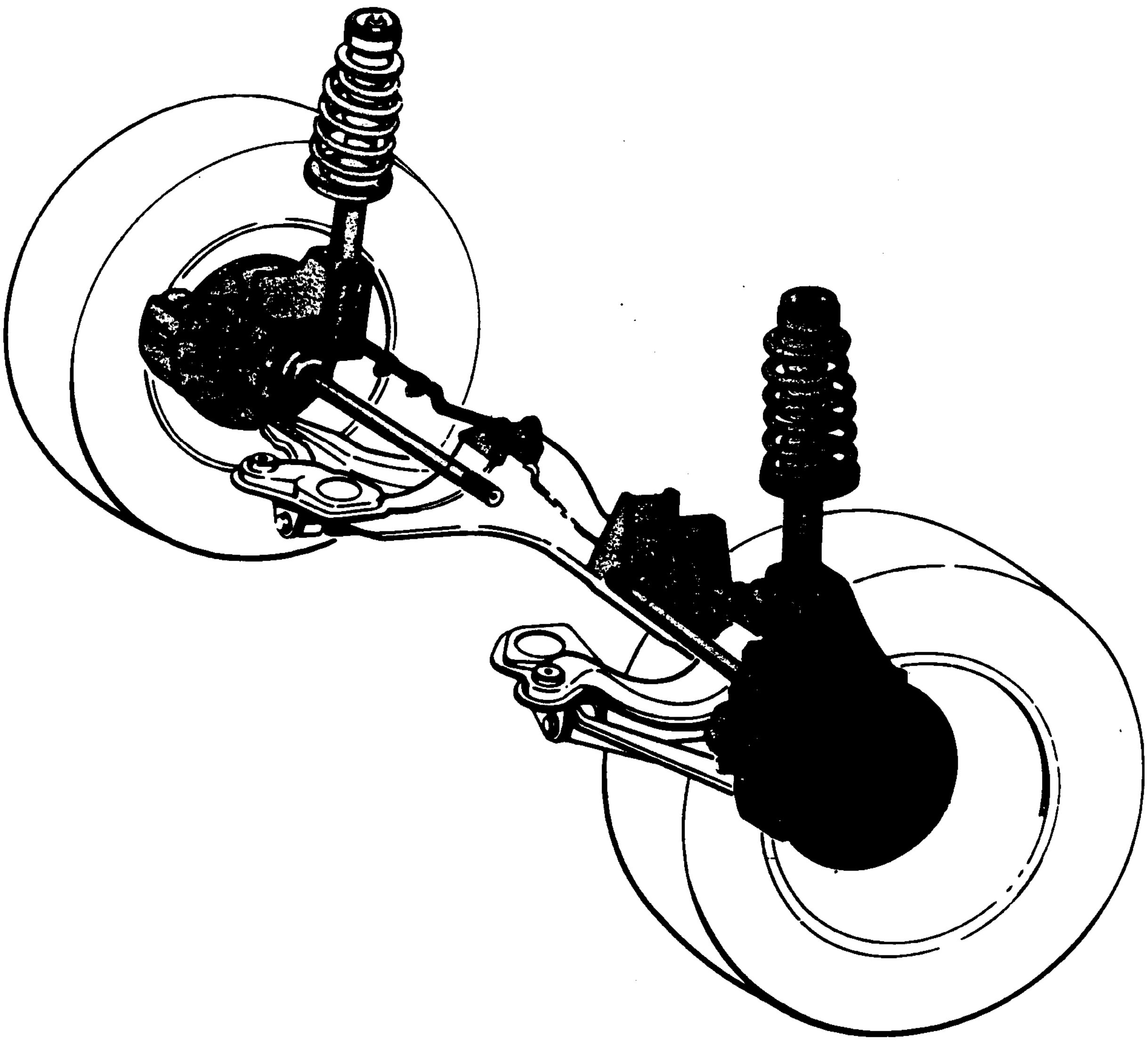
Suspension

The Audi Quattro suspension was developed using components from the Audi 4000 Coupe and the high performance Audi 5000 Turbo.



The front axle is a combination of front axle components from the Audi 4000 and the Audi 5000 Turbo.

The large Mark II caliper disc brakes from the 5000 Turbo have been used.



The design of the rear axle is the same as the Quattro front axle, but it has been rotated 180°. On the sub-frame additional mountings have been welded on; one for the rear axle final drive and one for each of the tie rods.

The anti-roll bar on the rear axle has a smaller diameter than the front axle anti-roll bar.

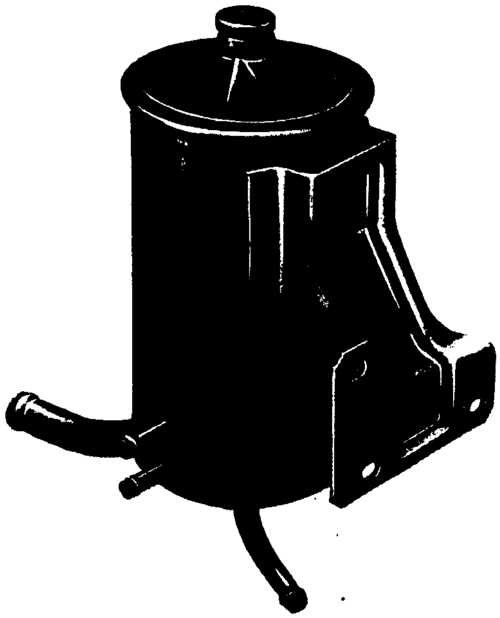
The rear axle suspension struts are a combination of parts from the Audi 4000 and Audi 5000 Turbo. The "steering arms" are welded onto the bottom of the wheel bearing housings.

The Mark II disc brakes with mechanical parking brake from the Audi 5000 turbo have been installed on the Quattro.

The brake cable guide has been modified and a second operating lever has been installed because the Mark II calipers are mounted at the front side of the brake disc.

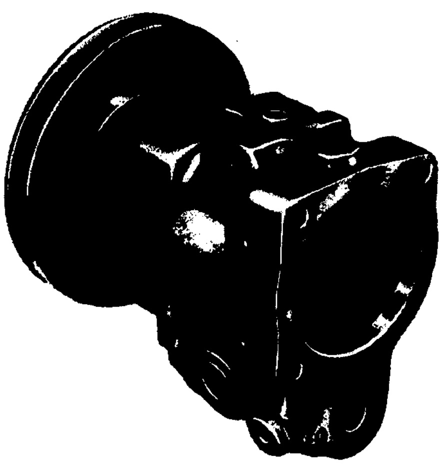
Hydraulic Power Brake Unit and Power Assisted Steering

The hydraulic power brake unit uses hydraulic pressure from the power assisted steering system.
The power assistance system consists of the following individual units.



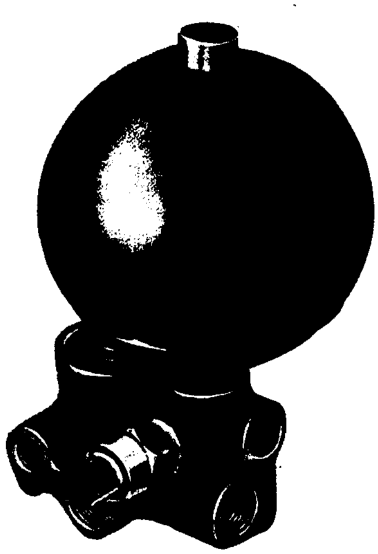
Hydraulic oil container

It stores the hydraulic oil required for operation of the system.
A filter is incorporated to clean the oil.



Vane type pump

The vane type pump produces the working pressure for the power assisted steering and the power brake unit. It is the same type of pump as the one used on the Audi 5000

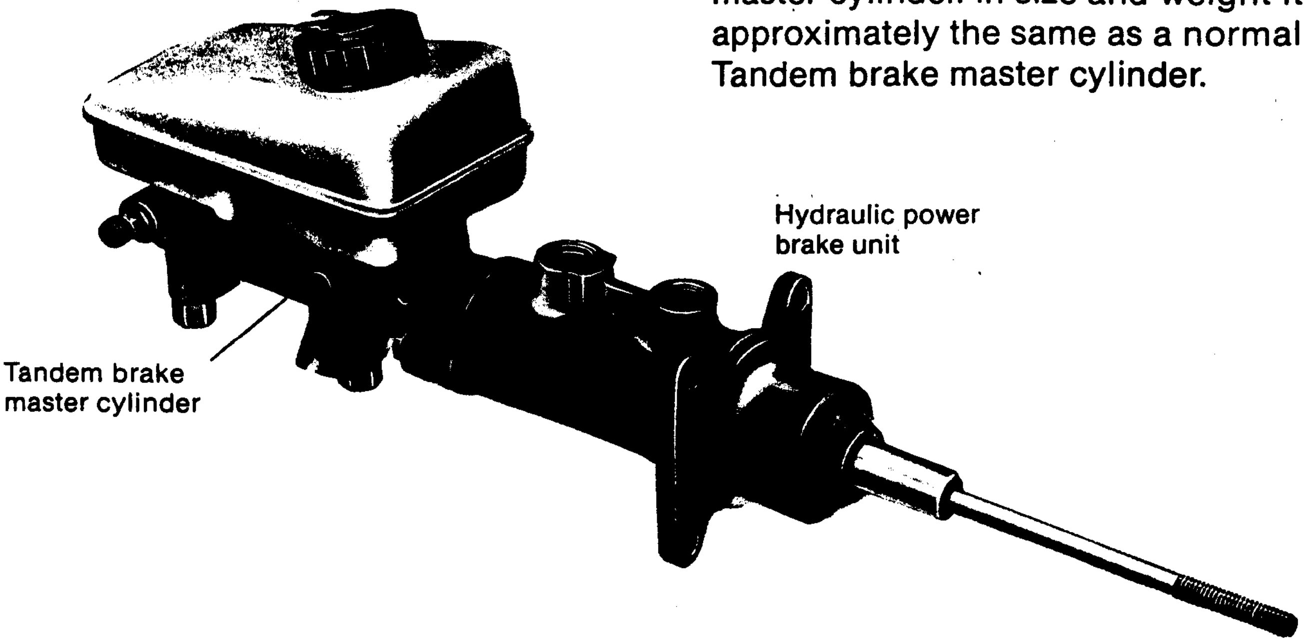


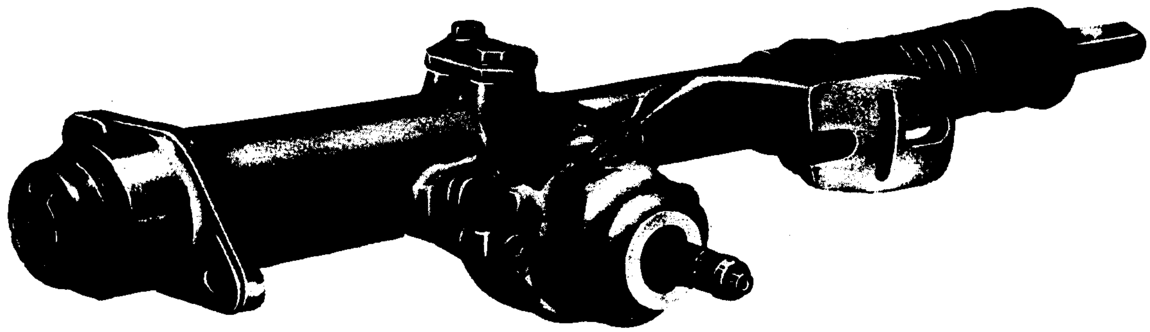
Flow regulator with Pressure accumulator

The flow regulator directs the oil supply from the vane type pump to the power assisted steering. It also charges the pressure accumulator. The pressure accumulator supplies the pressure for the hydraulic power brake unit.

Hydraulic Power Brake unit

The hydraulic power brake unit produces the "assist" pressure for the Tandem brake master cylinder. In size and weight it is approximately the same as a normal Tandem brake master cylinder.





Power assisted steering

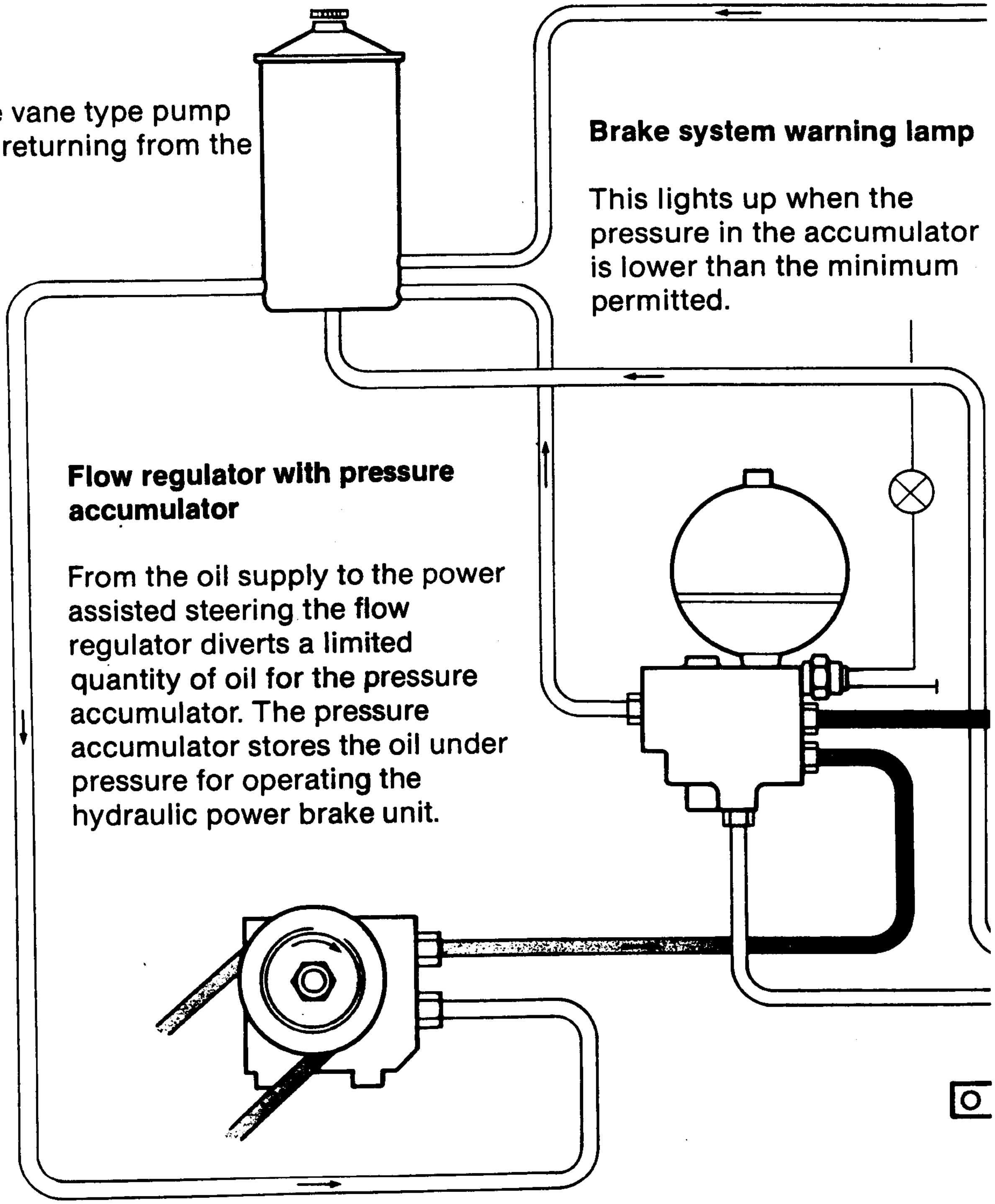
The working cylinder for the power assistance is an integral part of the steering housing.
This enables a compact design and results in a weight reduction.

Operation

The hydraulic assist system is operated with ATF hydraulic oil. The hydraulic brake system operates with brake fluid.

Oil container

It supplies oil to the vane type pump and collects the oil returning from the individual units.



Brake system warning lamp

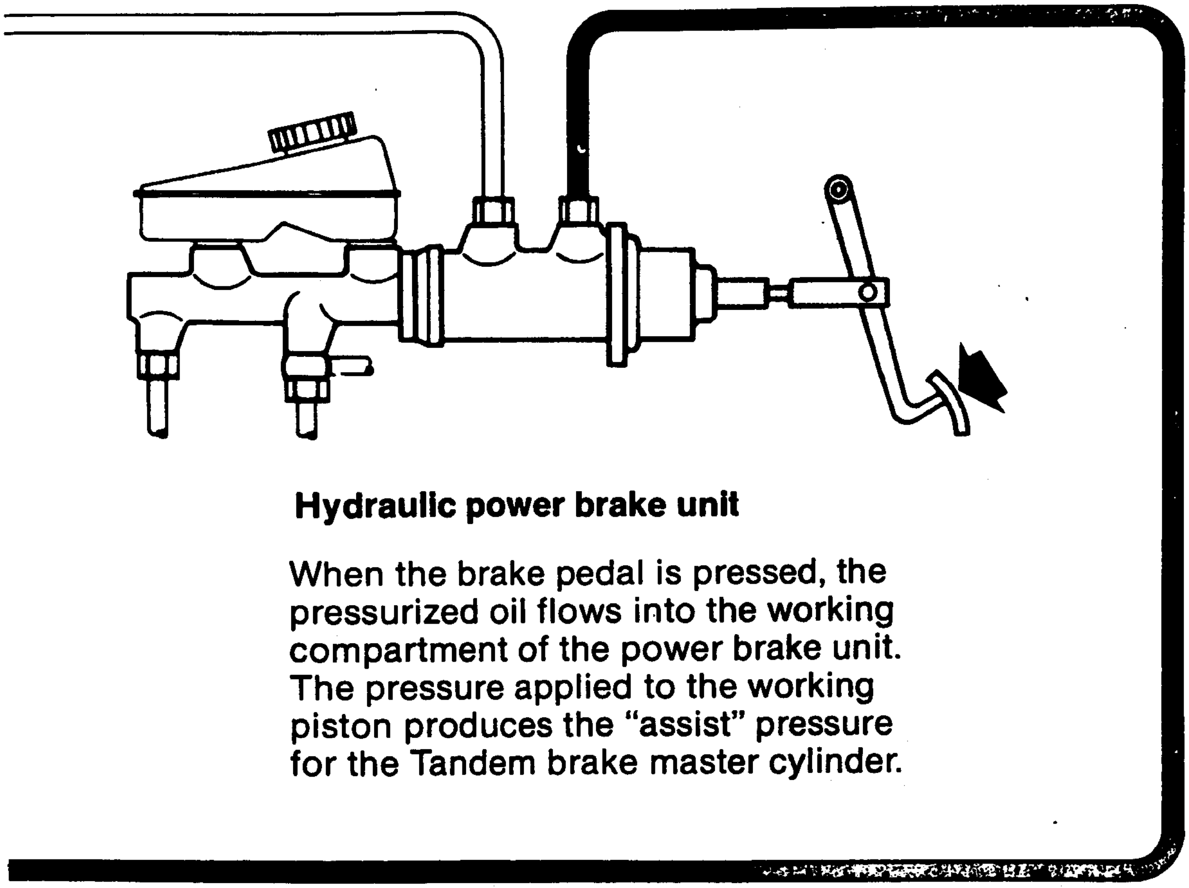
This lights up when the pressure in the accumulator is lower than the minimum permitted.

Flow regulator with pressure accumulator

From the oil supply to the power assisted steering the flow regulator diverts a limited quantity of oil for the pressure accumulator. The pressure accumulator stores the oil under pressure for operating the hydraulic power brake unit.

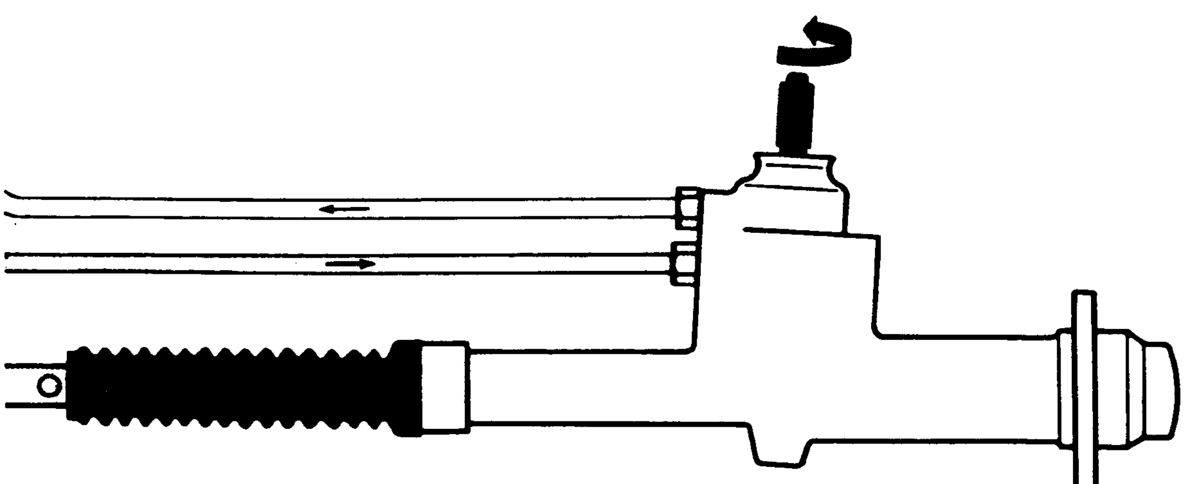
Vane type pump

When the engine is running it draws in oil and supplies pressurized oil to the power assisted steering and to the pressure accumulator.



Hydraulic power brake unit

When the brake pedal is pressed, the pressurized oil flows into the working compartment of the power brake unit. The pressure applied to the working piston produces the "assist" pressure for the Tandem brake master cylinder.



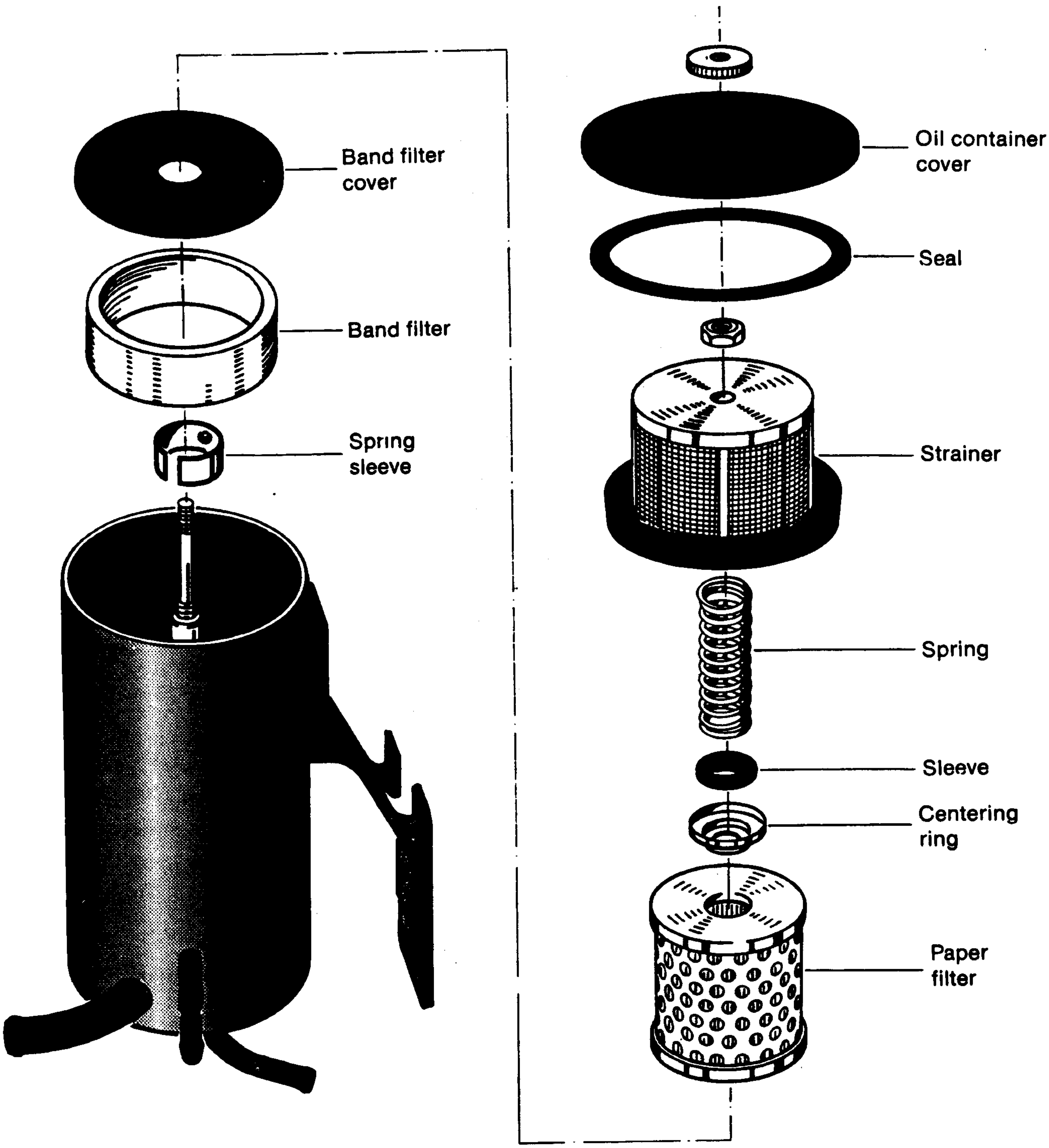
Power assisted steering

When the steering wheel is turned to the left or right, operating pressure is fed to the appropriate side of the work cylinder, through the rotary piston valve.

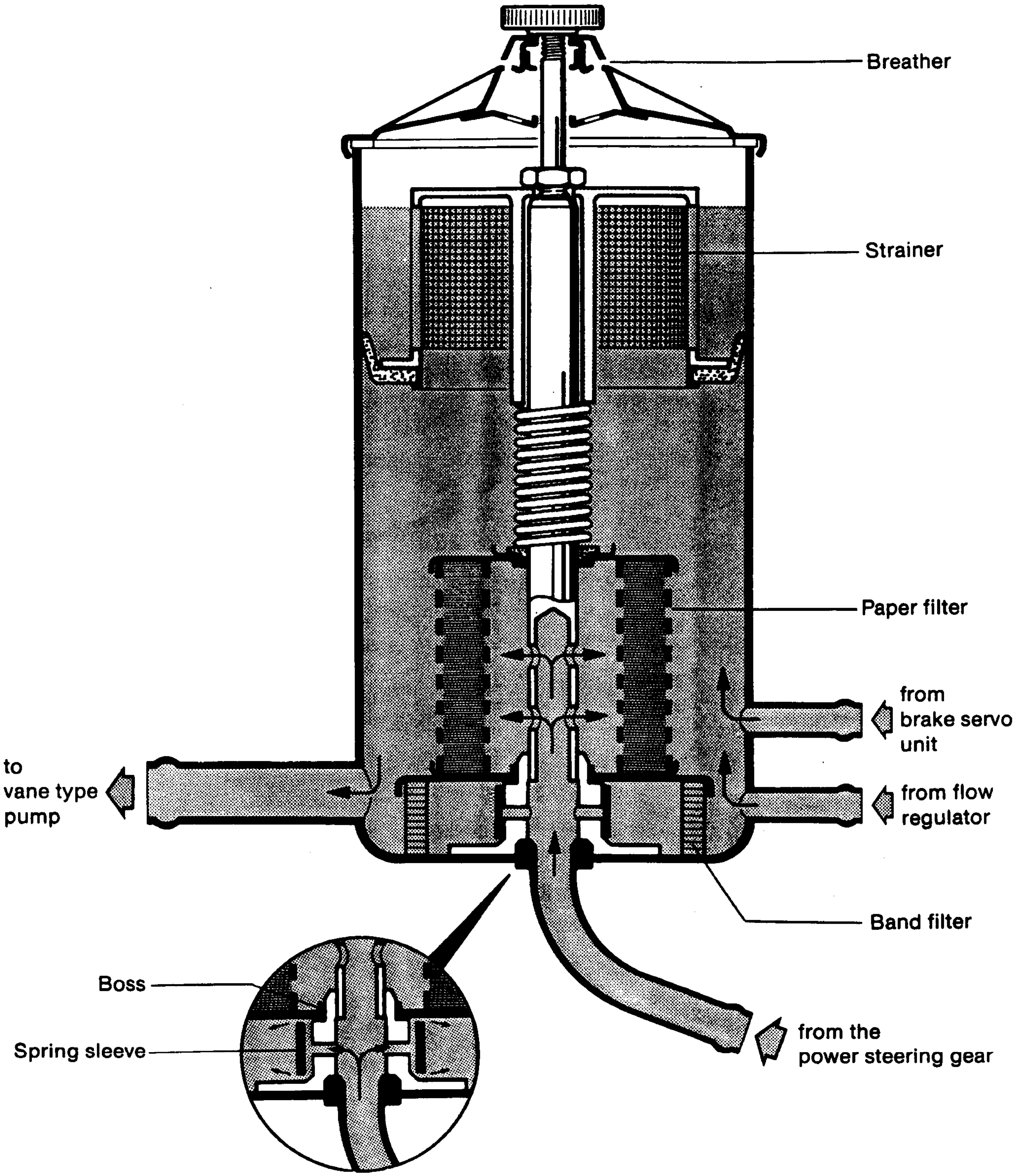
The pressure applied to the work piston produces the "assist" force for the steering movement.

Oil Container with Filter

The oil container stores the hydraulic oil required for operating the system. The strainer traps dirt which may enter the system when it is filled or "topped up."



The filters clean the oil as it flows back from the steering rack.
The spring sleeve which is mounted on the lower boss acts as a valve when the paper filter is blocked.



The oil from the power assisted steering rack flows through the paper filter back into the oil container and from there it is drawn out by the vane type pump.

When the paper filter is blocked the spring sleeve is opened by the pressure in the system. The oil then flows through the lower band filter back into the oil container.

The limited amounts of oil from the flow regulator and the brake servo unit flow back into the oil container unfiltered.

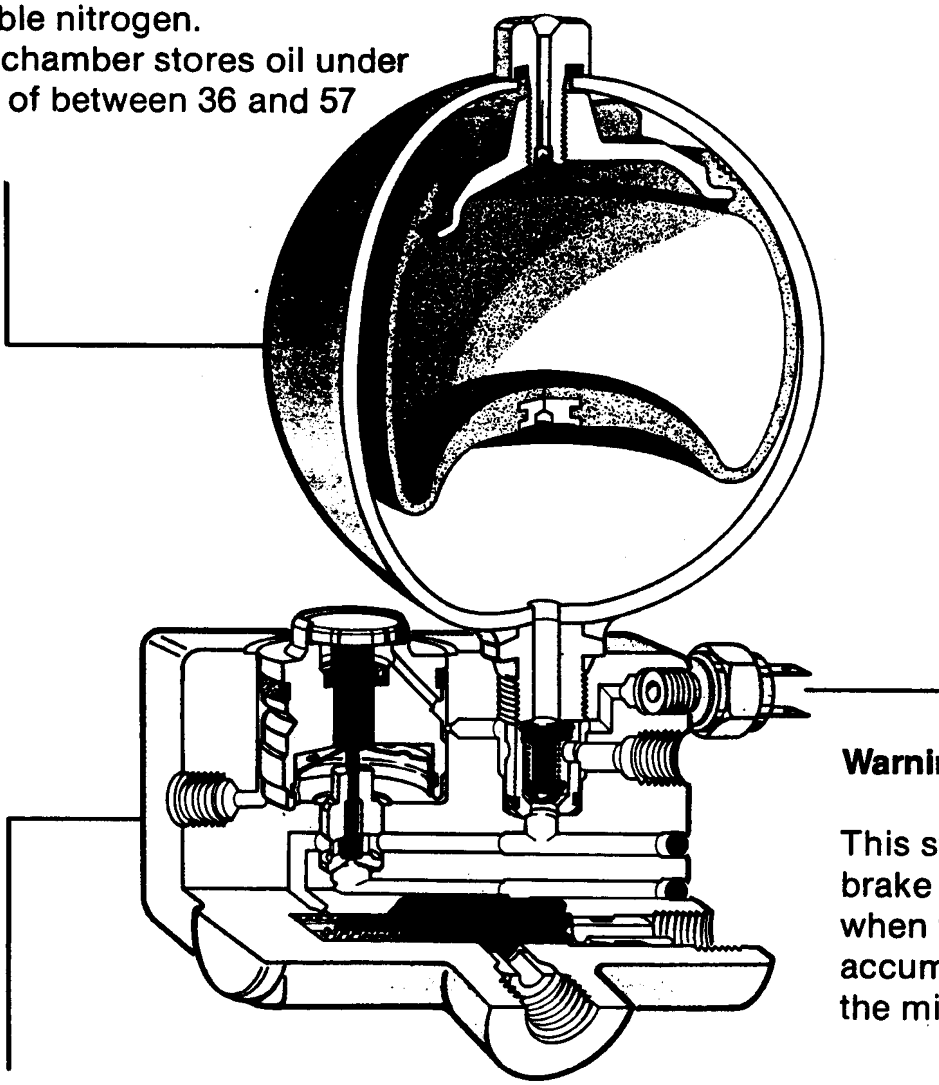
The fluid level in the oil container can only be checked with the engine off and after the accumulator has been discharged by pressing the brake pedal 20 times.

Flow Regulator with Pressure Accumulator

The flow regulator directs the oil supply from the pump to the power assisted steering.
The flow regulator also charges the pressure accumulator.
The pressure accumulator supplies the pressure for the hydraulic power brake unit.

Pressure accumulator

The pressure accumulator is divided into two compartments by a diaphragm.
The upper chamber is filled with compressible nitrogen.
The lower chamber stores oil under a pressure of between 36 and 57 bar.

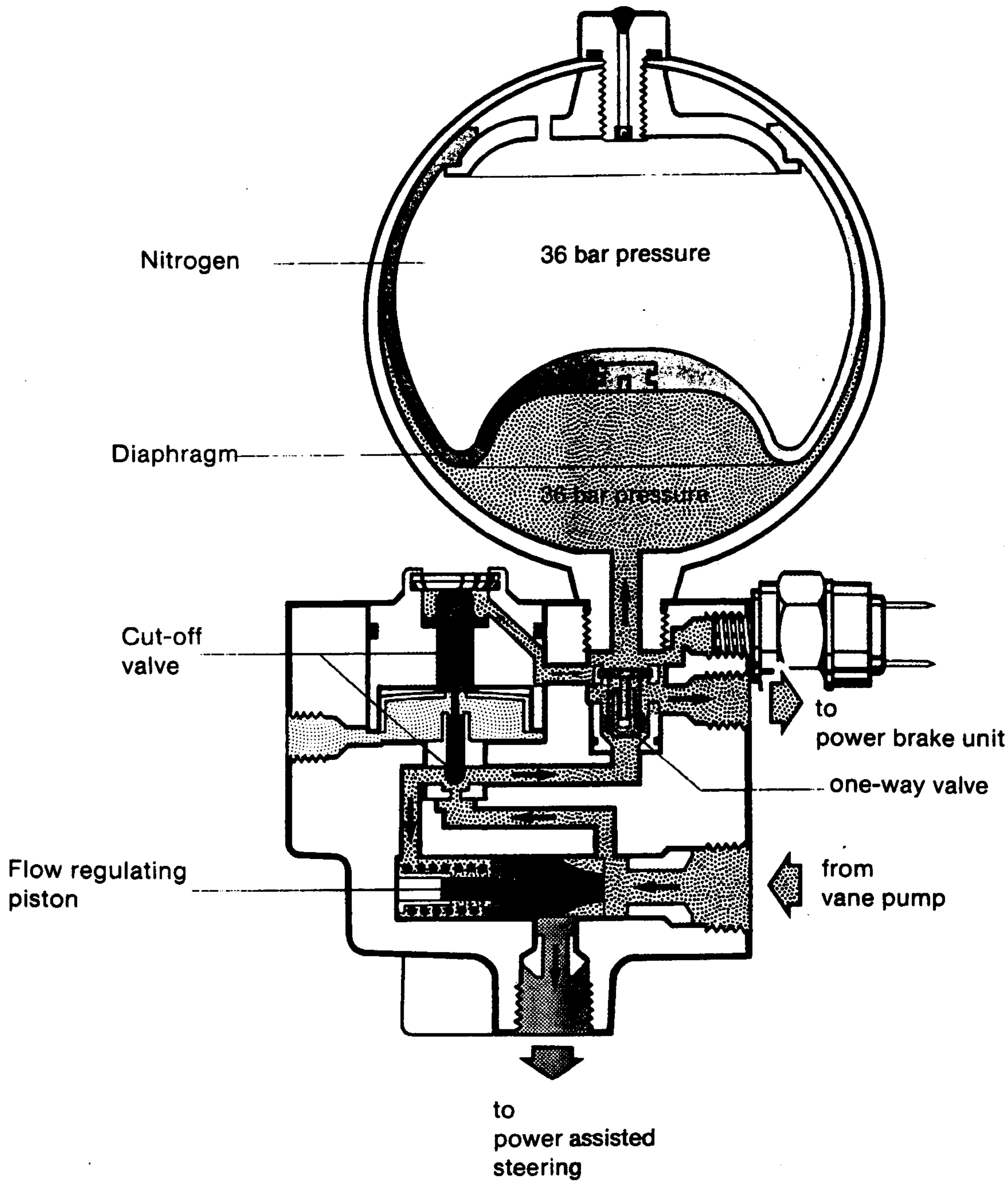


Warning switch

This switch switches on the brake system warning lamp when the pressure in the accumulator is lower than the minimum.

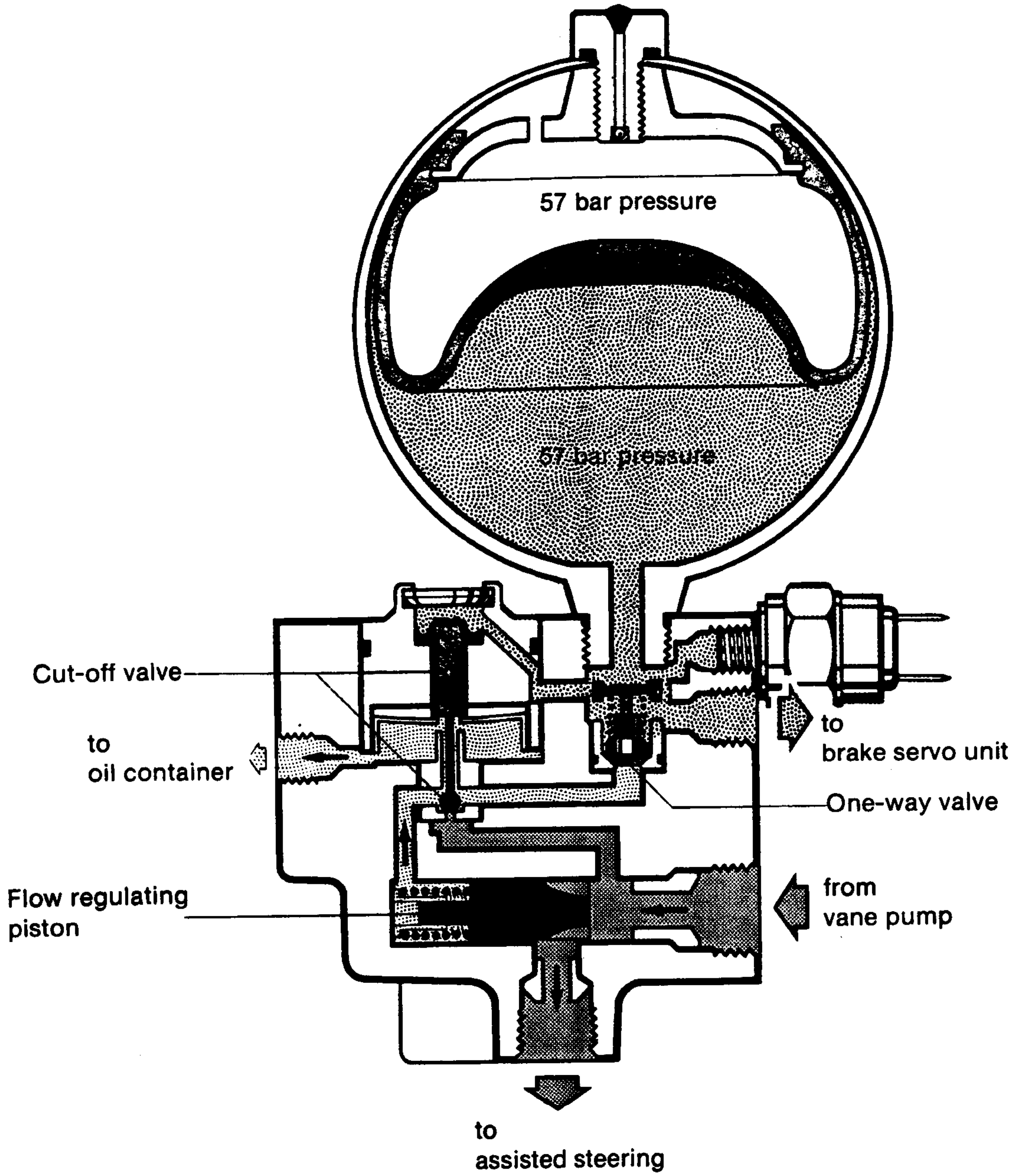
Flow regulator

From the oil supplied to the power assisted steering, the flow regulator diverts a limited quantity (max. 0.7 ltrs./min.) for the pressure accumulator. The cut-off valve opens and closes the supply line to the pressure accumulator.



Supplying the power assisted steering and charging the accumulator

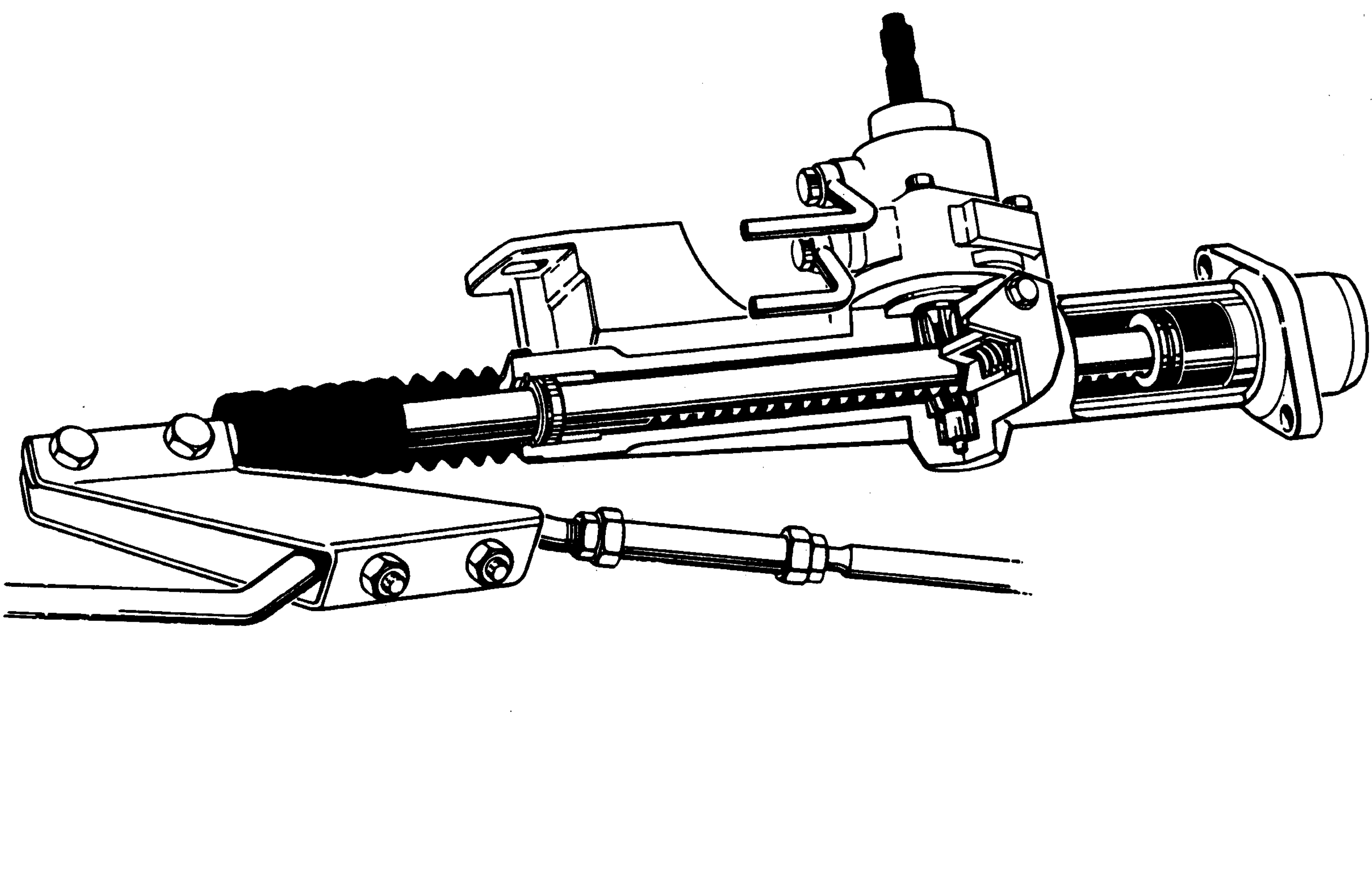
The pressure controlled flow regulating piston diverts a limited amount of the oil supply to the pressure accumulator. This oil is directed to the accumulator by way of the cut off valve and the one way valve.
The oil pushes against the diaphragm, deforms it, and compresses the nitrogen gas.
The compressed nitrogen presses on the oil via the diaphragm and produces the stored, or reserve energy for the hydraulic power brake system. The major part of the oil supply is, however, routed into the power steering system via the lower control edge of the flow regulating piston.



Supplying the power assisted steering with the pressure accumulator charged

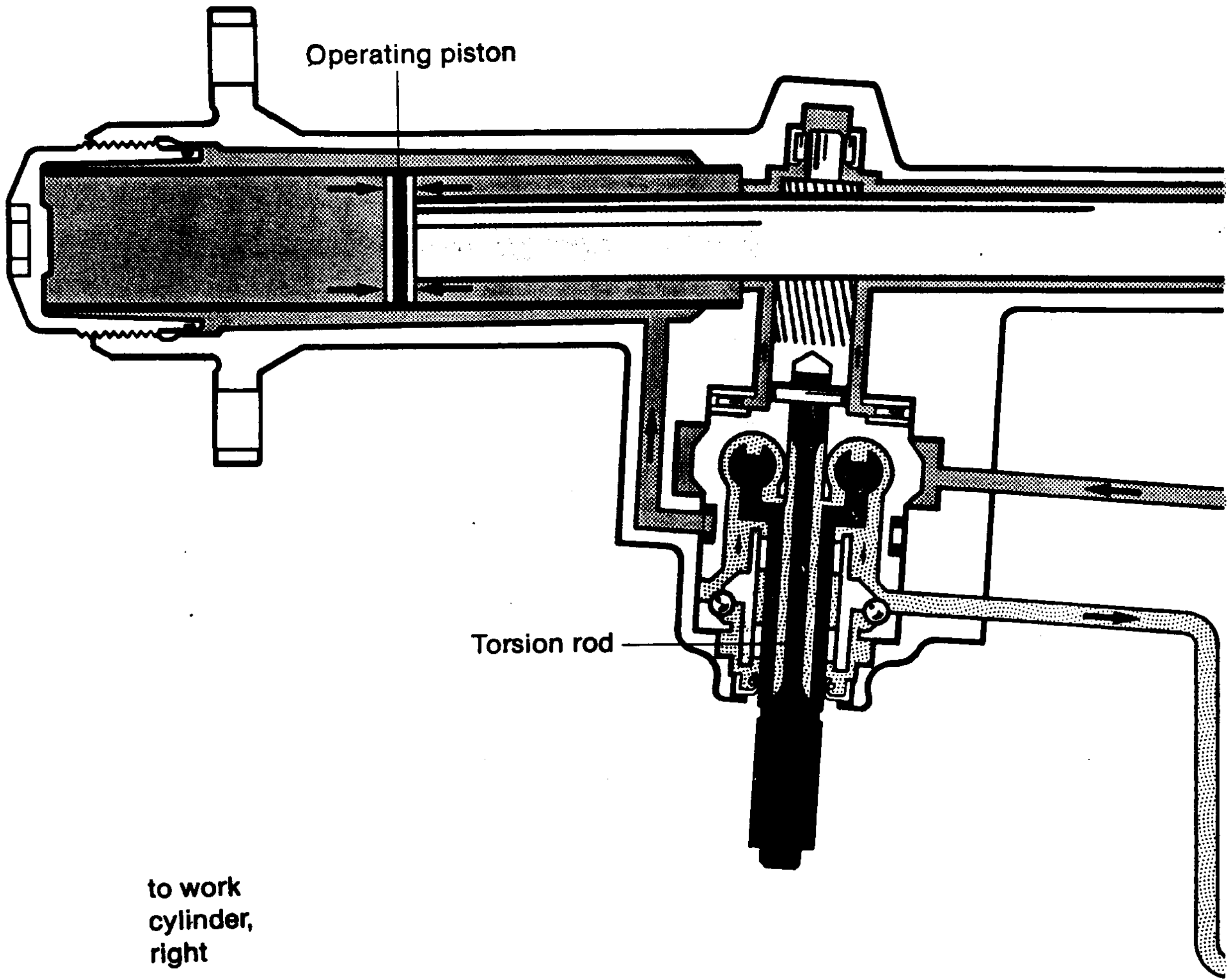
Once the cut-off pressure of 57 bar has been reached the cut-off valve closes and seals off the oil supply to the pressure accumulator.
The pressure accumulator is now charged.
At the same time, the spring chamber behind the flow regulating piston is linked to the oil container return line because the cut-off valve is now closed.
The pressure in the spring chamber is reduced and the flow regulating piston is pressed to the left against the spring force by the circulating pressure. In this condition, all the oil which is delivered by the pump can now be routed to the power assisted steering.

Power Assisted Steering Rack

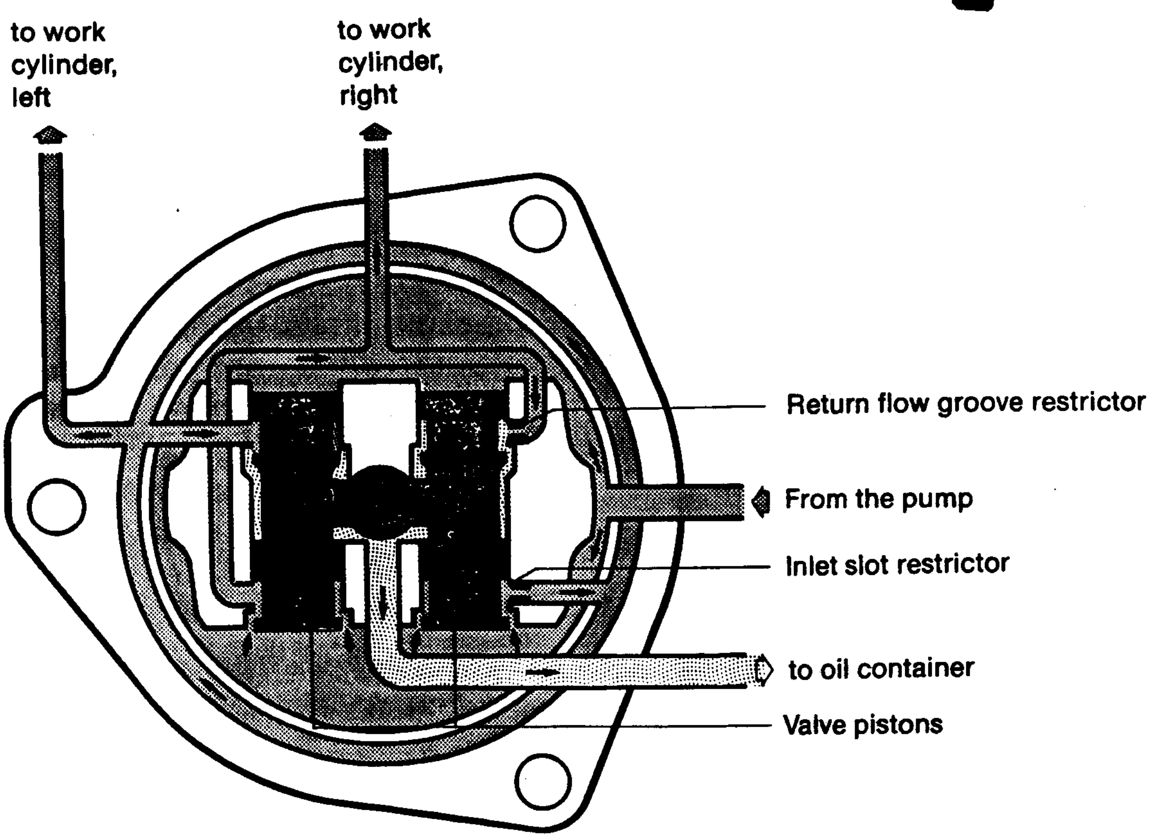


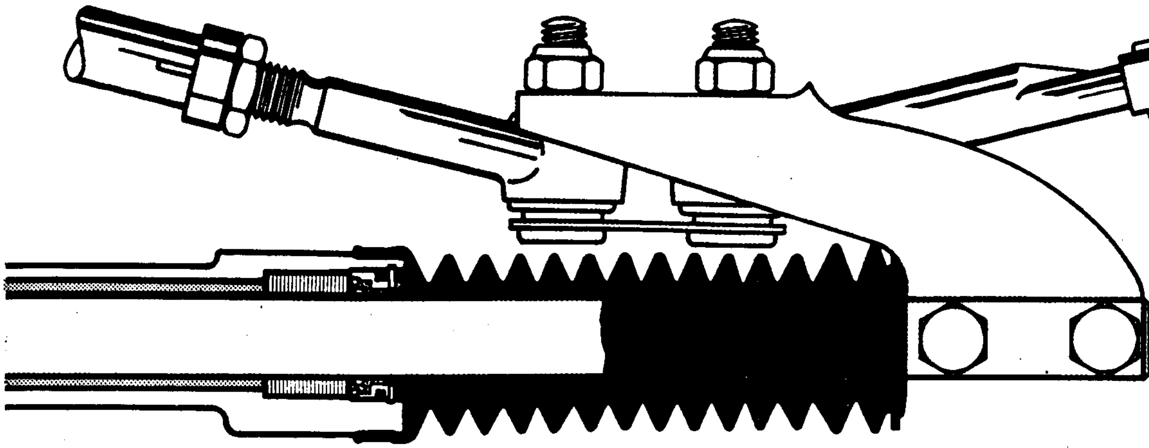
The rear flange acts as a bracket for mounting the steering gear to the body.
The work cylinder is integrated into the steering gear housing and the operating piston is attached directly to the steering rack.
The opposite end of the steering rack has a special seal because lubrication for the steering rack assembly is provided by hydraulic oil.

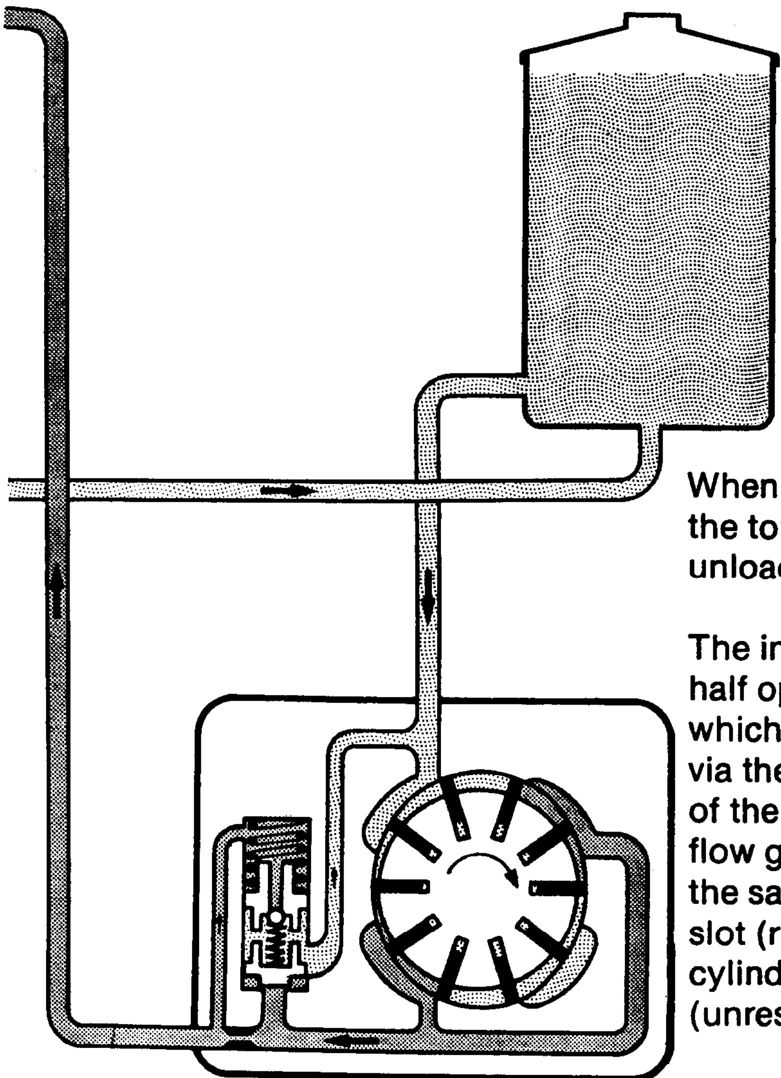
Operaton in the Neutral Position



Rotary piston valve





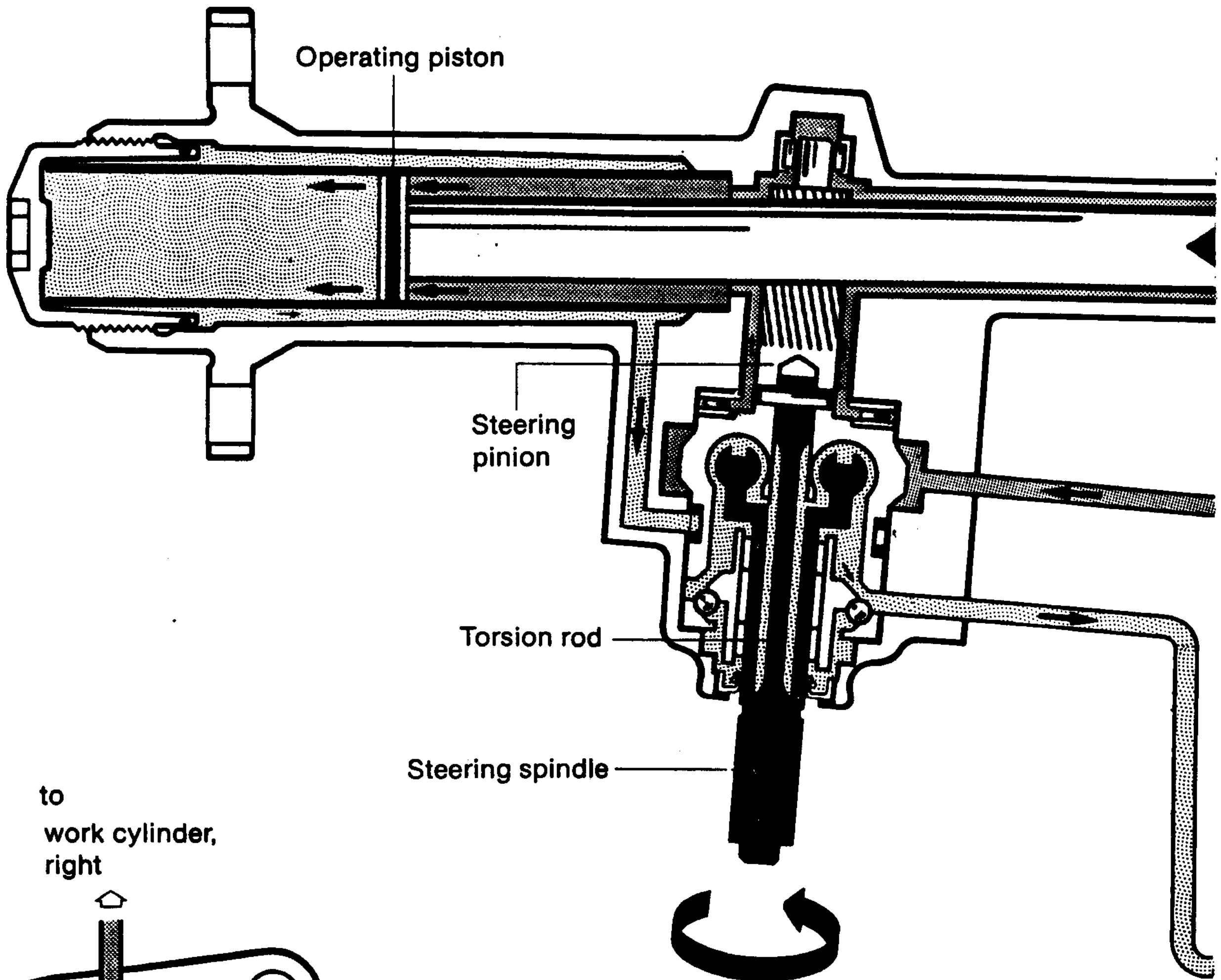


Vane type pump

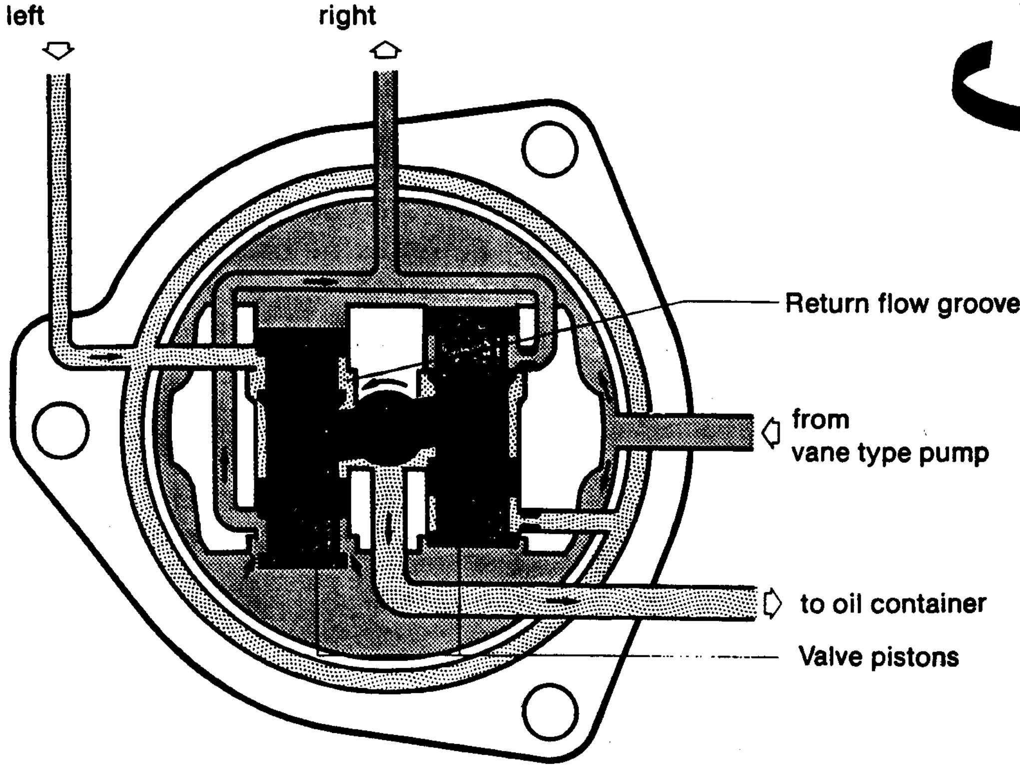
When no force is applied to the steering wheel, the torsion rod in the rotary piston valve is in an unloaded state.

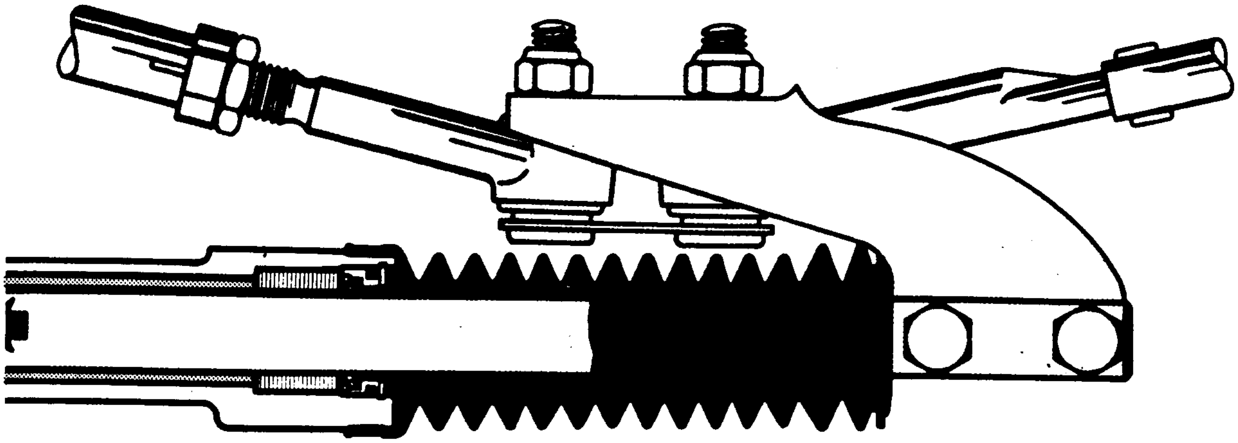
The inlet slots and the return flow grooves are half opened by the two valve pistons. The oil, which is under low pressure, flows unrestricted via the left hand inlet slot into the right hand side of the work cylinder and via the right hand return flow groove restricted back to the oil container. At the same time, oil flows via the right hand inlet slot (restricted) into the left hand side of the work cylinder, and via the left hand return flow groove (unrestricted) back to the oil container.

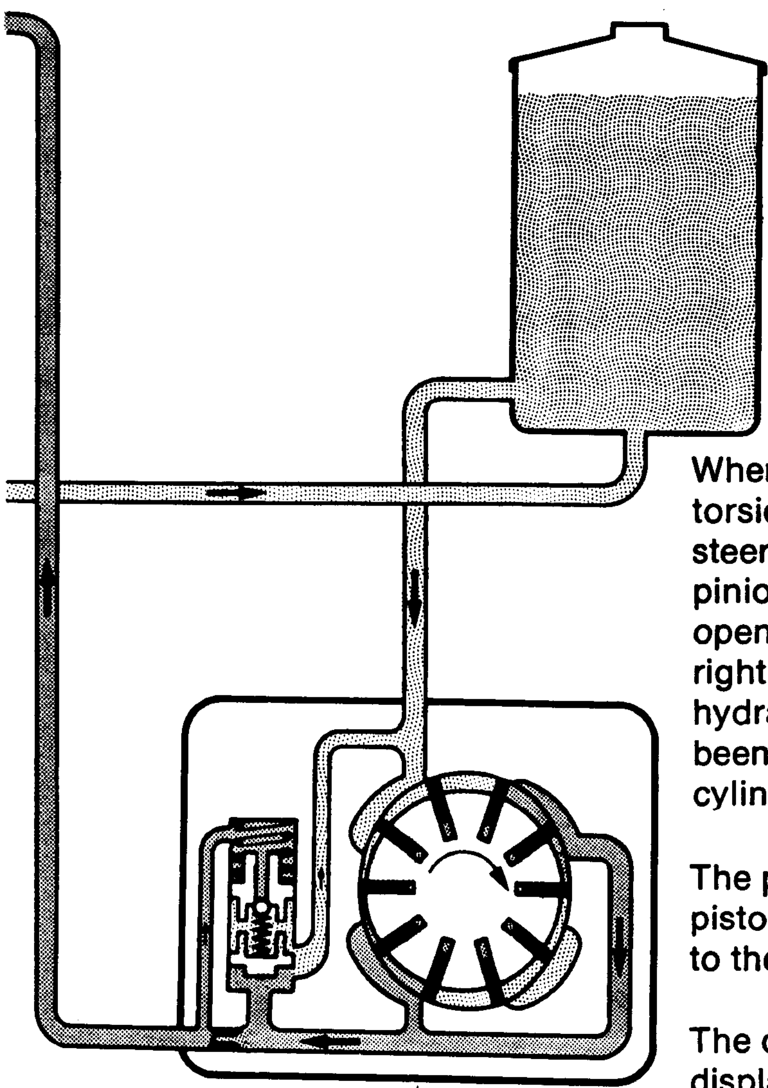
Operation on left hand lock



Rotary piston valve







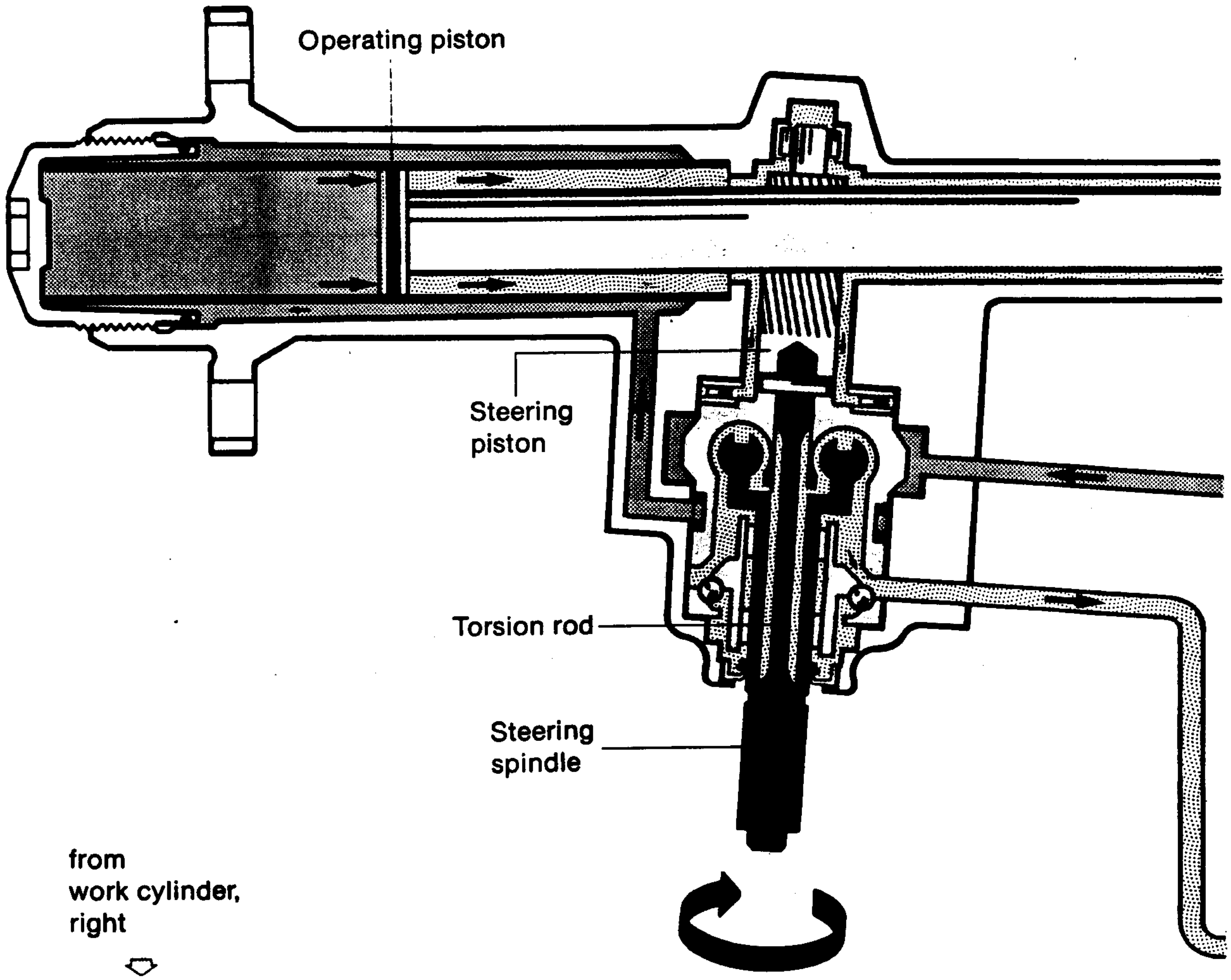
Vane type pump

When the steering wheel is turned to the left, the torsion rod is tensioned to the left, and the steering spindle is rotated more than the steering pinion. This causes the left hand valve piston to open the inlet slot, while at the same time, the right hand valve piston closes the inlet slot. The hydraulic oil flows through the slot which has been opened, into the right hand side of the work cylinder and into the steering gear.

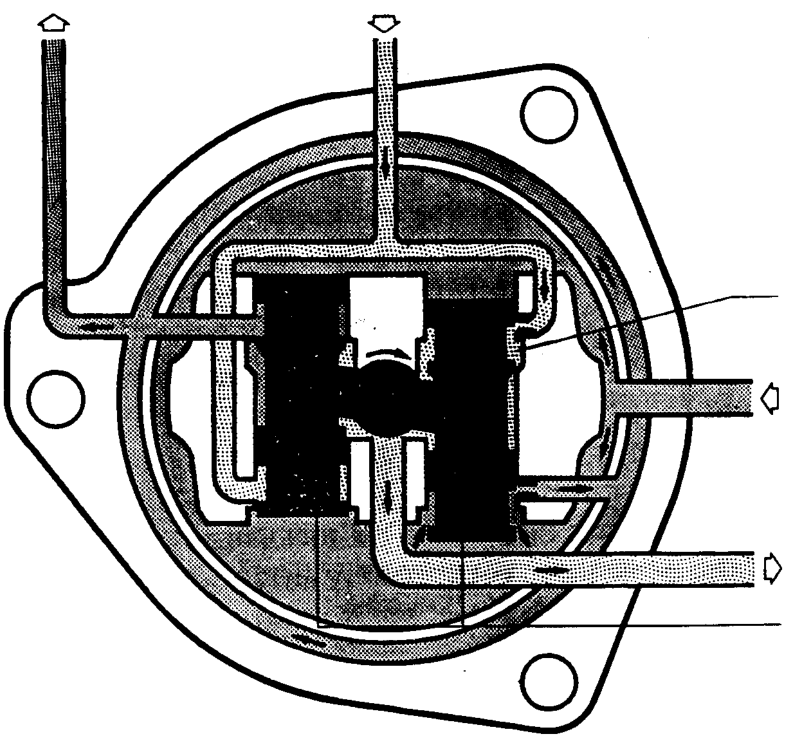
The pressure on the right side of the operating piston thus supplements the steering movement to the left.

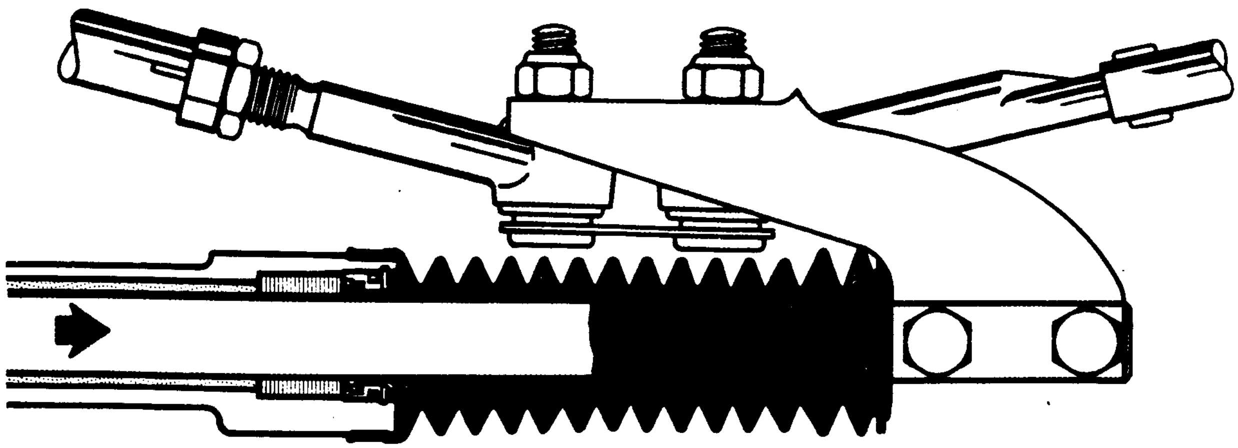
The oil in the left hand side of the work cylinder is displaced by the operating piston and flows back to the container via the fully opened return flow groove.

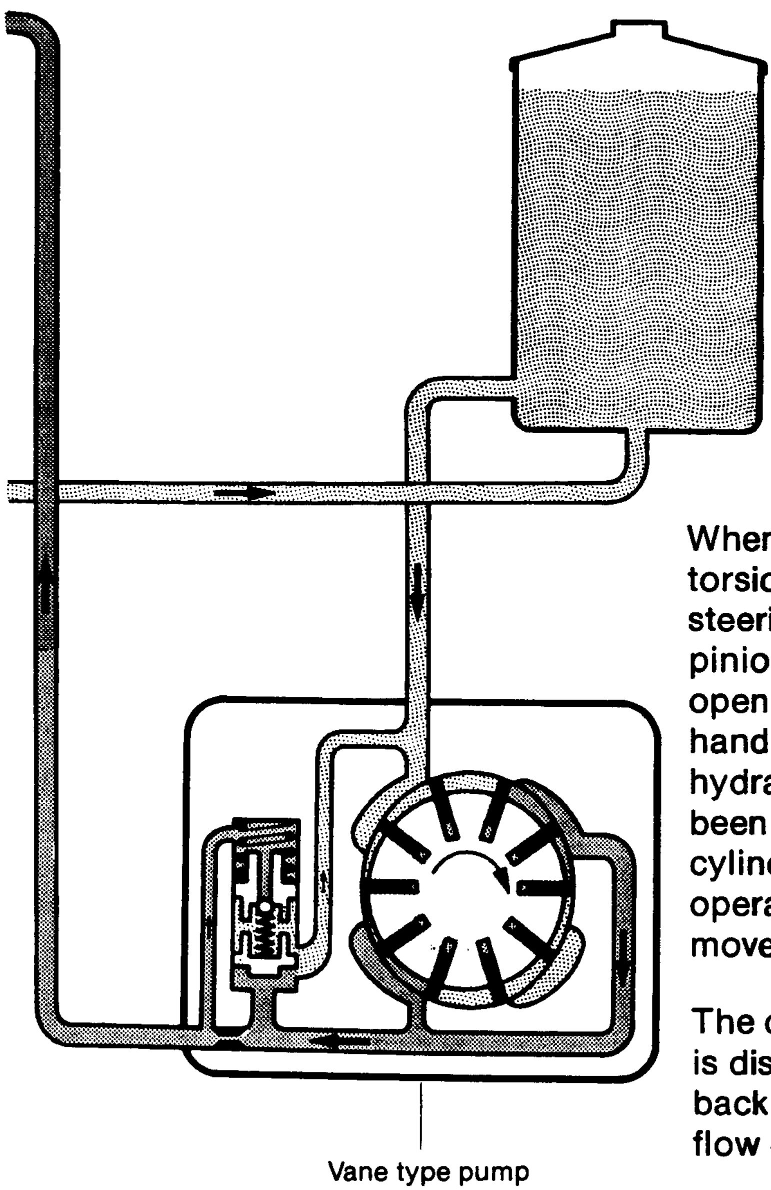
Operation on right hand lock



Rotary piston valve





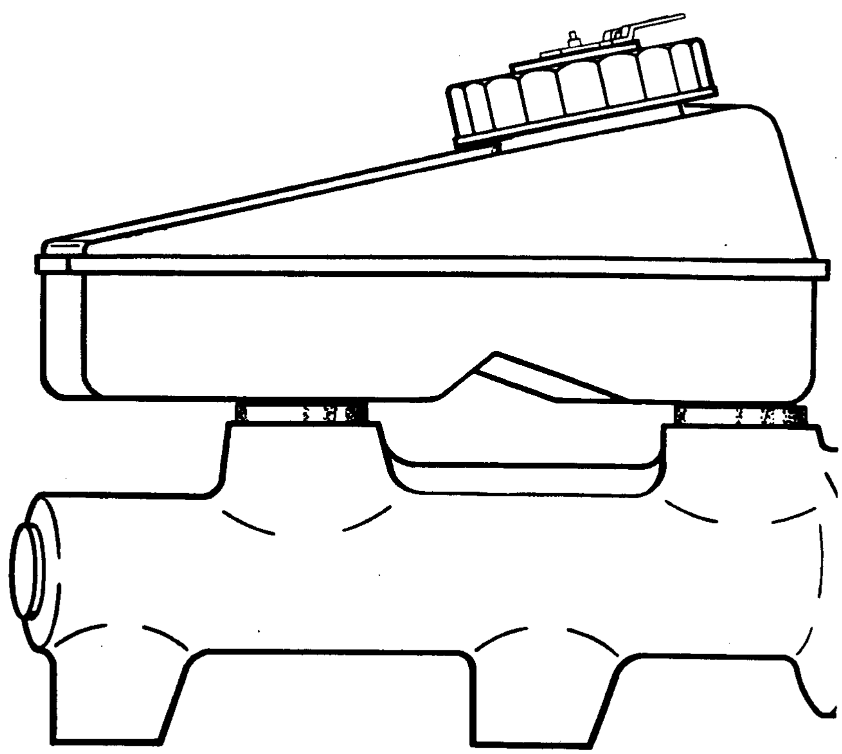


When the steering wheel is turned to the right, the torsion rod is tensioned to the right and the steering spindle is rotated more than the steering pinion. This causes the right hand valve piston to open the inlet slot, while at the same time, the left hand valve piston closes the inlet slot. The hydraulic oil flows through the slot which has been opened into the left hand side of the work cylinder. The pressure on the left side of the operating piston thus supplements the steering movement to the right.

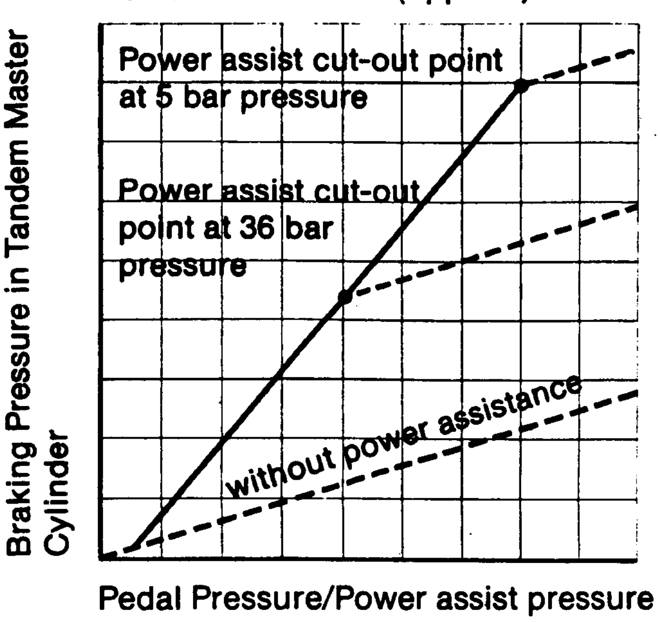
The oil in the right hand side of the work cylinder is displaced by the operating piston and flows back to the container via the fully opened return flow groove.

Hydraulic power brake unit

The hydraulic power brake unit produces the "power assist" force for the Tandem brake master cylinder. It operates with a much higher pressure than the vacuum type brake servo unit and has shorter activating times.



Power Assist curve (approx.)



Operating piston

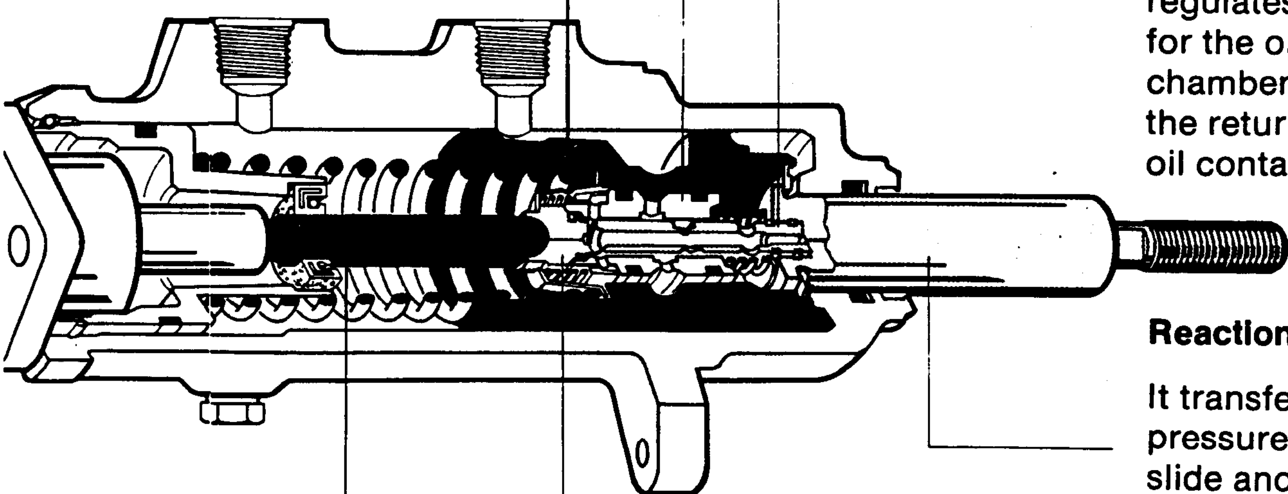
This produces the additional force required by the Tandem brake master cylinder; depending on the pressure in the operating chamber.

Control valve

It contains a supply drilling to the operating chamber and a return flow drilling to the oil container.

Control slide

In conjunction with the control valve it regulates the pressure for the operating chamber and controls the return flow to the oil container.



Reaction piston

It transfers the pedal pressure to the control slide and produces the reaction force for the brake pedal.

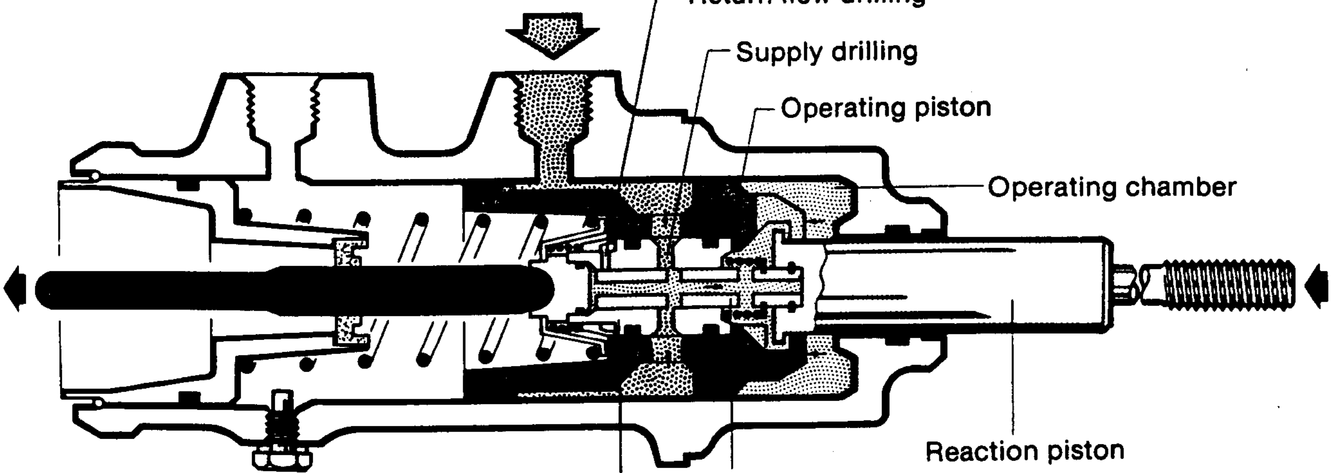
Pressure plug

It seals off the operating chamber and transfers power assist pressure from the operating piston to the push rod.

Push rod

This transmits the power assist pressure from the operating piston, to the Tandem brake master cylinder.

Operation

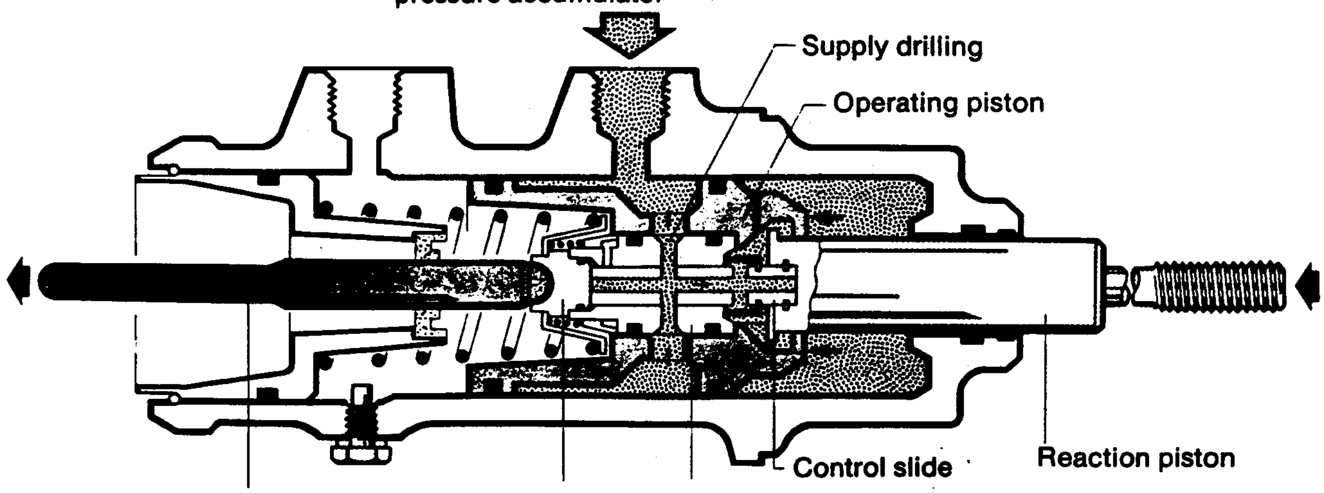


Partial braking

When the brake pedal is depressed the reaction piston pushes the control slide to the left against the spring pressure.

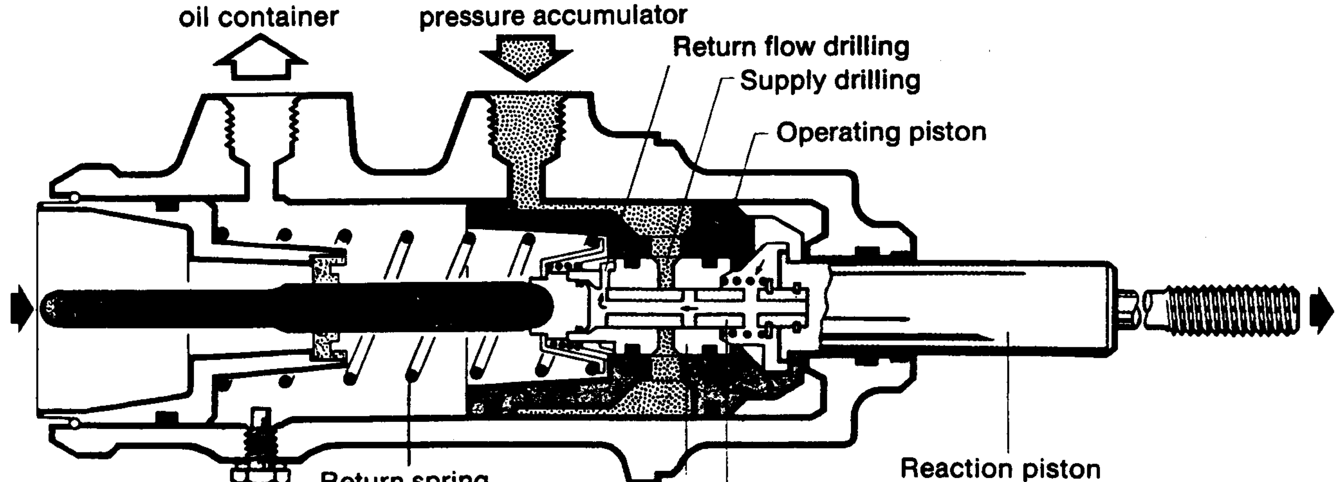
This movement of the control slide first closes off the return flow drilling to the oil container and then it opens the supply drilling to the operating chamber. The oil, which is under pressure, flows via the control slide into the operating chamber and keeps pushing the operating piston to the left as long as the brake pedal is moving the control slide. If the brake pedal stops moving, the control slide also stops. Any oil which now flows in pushes the operating piston further to the left until the supply drilling is closed off and a balance is reached between the pressure being supplied by the operating piston and the pressure existing in the Tandem brake master cylinder.

Because the pressure in the operating chamber is also felt on the reaction piston, the reaction force for the brake pedal is produced. It gives the driver an idea of the force being applied for braking.



Braking beyond the power assist cut-out point

When the power assist cut-out point is reached the control slide is resting against the pressure plug. The supply drilling is fully opened. The accumulator pressure which is effective on the operating piston is thereby supplying its greatest possible power assistance. Any increase in the pressure on the Tandem brake master cylinder is now only possible by increasing the pressure on the brake pedal itself. This pressure is transferred via the control slide, directly onto the pressure plug.



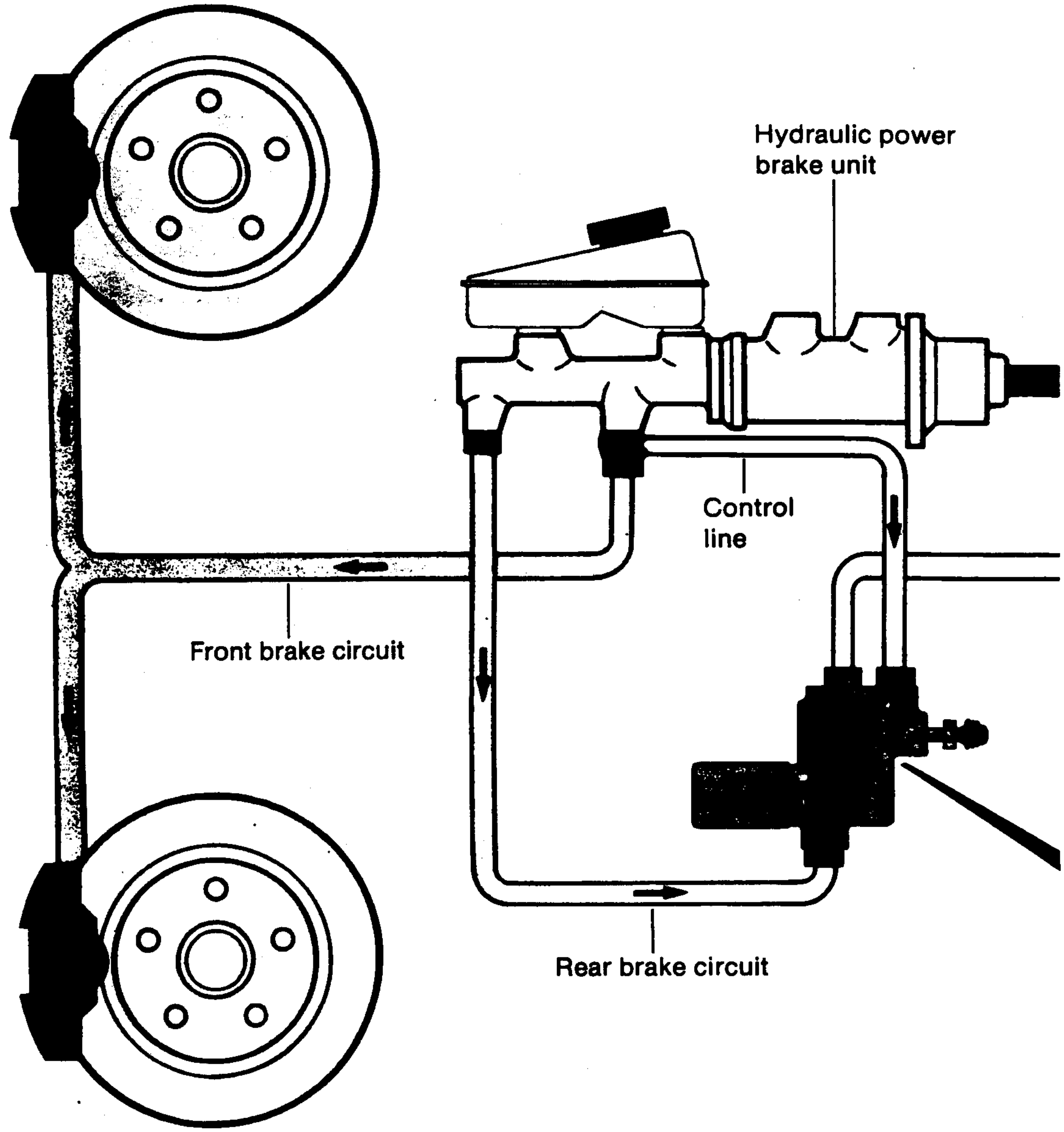
Releasing the brakes

When the driver takes his foot off the brake pedal the reaction piston pulls the control slide back. When this happens, the control slide closes off the supply drilling to the operating chamber thereby separating the operating chamber from the pressure accumulator.

The control sleeve opens the return flow drilling to the oil container and the oil then flows back to the oil container through the control sleeve.

Spring pressure then presses the operating piston back against its stop.

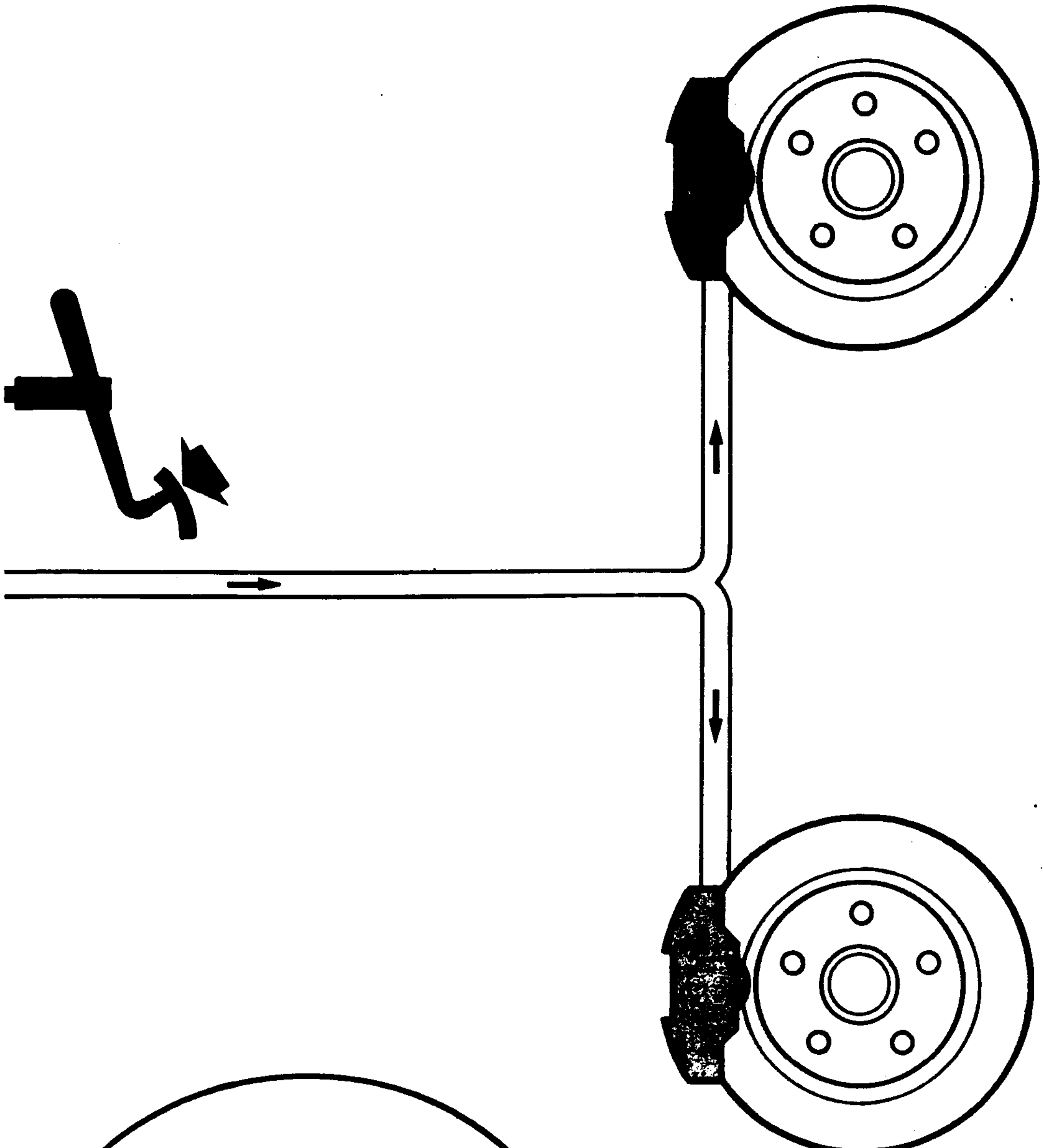
Pressure dependent brake pressure regulator

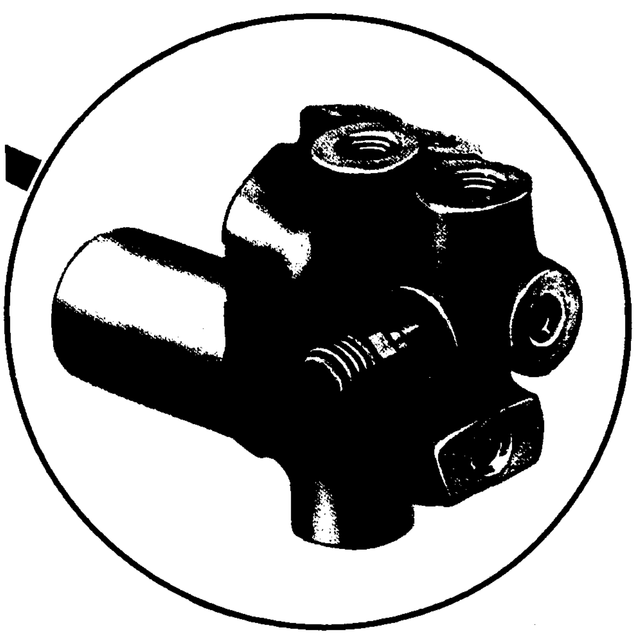


It has been proven that on vehicles with four wheel drive it is more advantageous to split the brake circuits into a front axle circuit and a rear axle circuit rather than having a diagonal division.

For this reason a dual circuit brake, which is split front to rear, has been installed on the Audi Quattro.

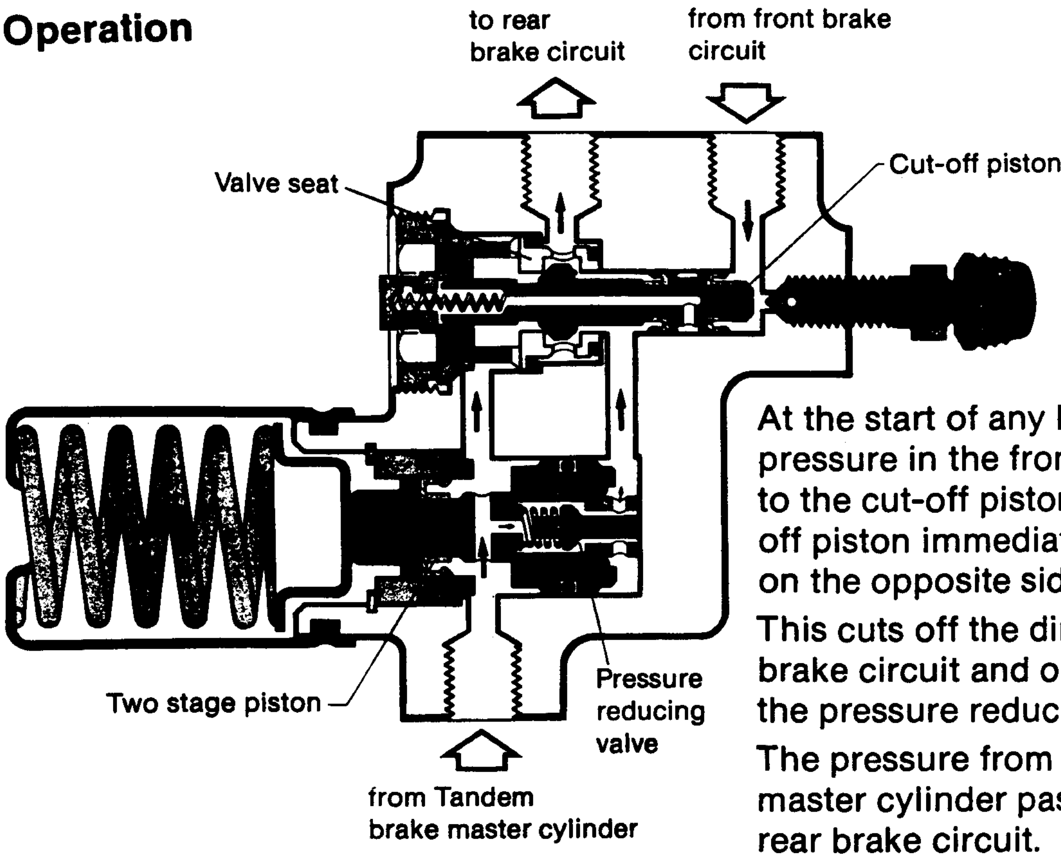
In the rear brake circuit a pressure dependent brake pressure regulator has been installed.





With the pressure dependent brake pressure regulator the brake pressure to the rear brake circuit is reduced in a specified ratio to the front brake circuit. The pressure reduction is cancelled in the event of a front brake circuit failure.

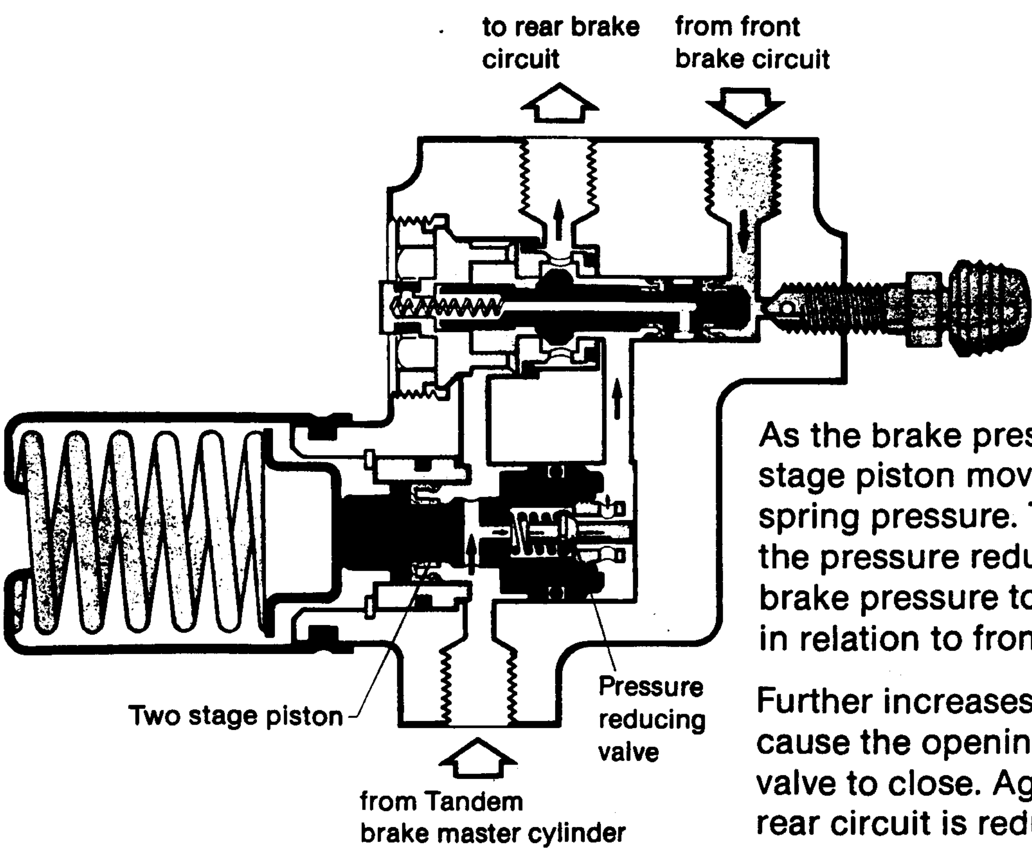
Operation



At the start of any braking operation the pressure in the front brake circuit is applied to the cut-off piston. This pushes the cut-off piston immediately onto the valve seat on the opposite side.

This cuts off the direct passage to the rear brake circuit and opens the passage from the pressure reducing valve.

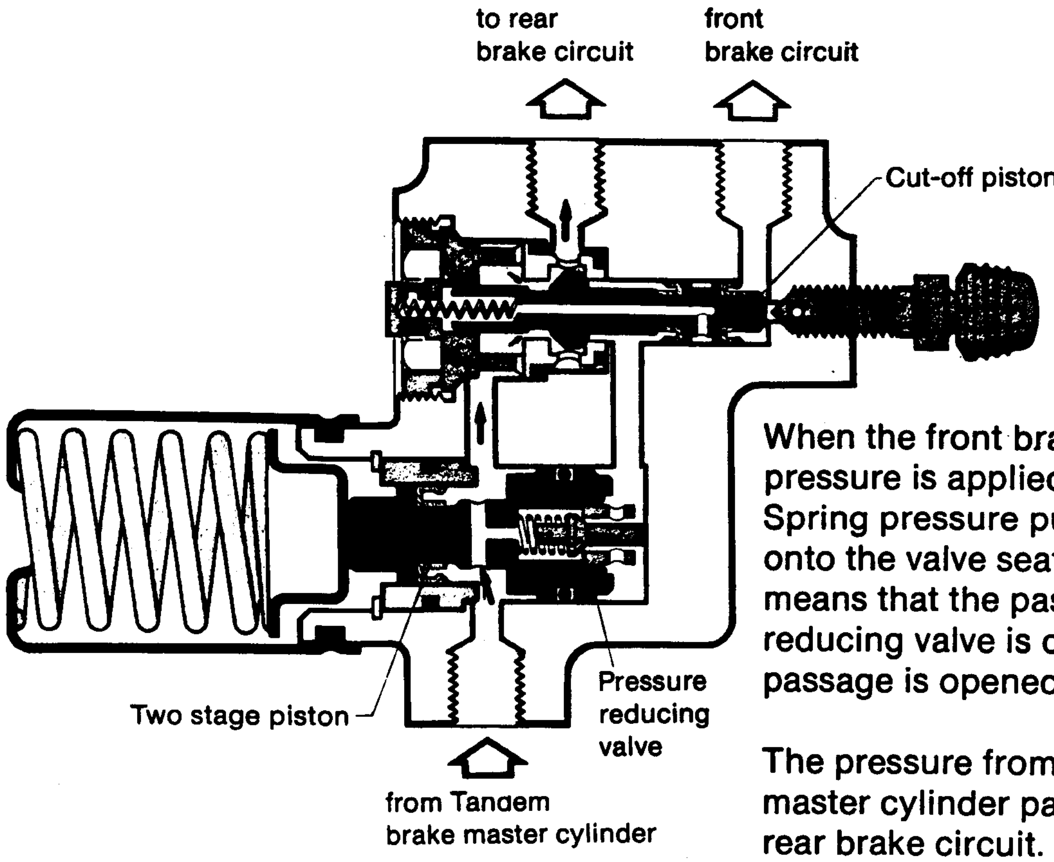
The pressure from the Tandem brake master cylinder passes unrestricted into the rear brake circuit.



As the brake pressure increases, the two stage piston moves to the left, against the spring pressure. The size of the opening at the pressure reducing valve decreases and brake pressure to the rear circuit is reduced in relation to front brake pressure.

Further increases in brake pressure will cause the opening at the pressure reducing valve to close. Again, brake pressure to the rear circuit is reduced relative to front brake pressure.

Brake pressure to the rear circuit is never cut off entirely. As soon as the pressure reducing valve closes the two stage piston moves to the right and acts to "adjust" brake pressure.



When the front brake circuit fails no pressure is applied to the cut-off piston. Spring pressure pushes the cut-off piston onto the valve seat on the right side. This means that the passage via the pressure reducing valve is cut off and the direct passage is opened.

The pressure from the Tandem brake master cylinder passes unrestricted, to the rear brake circuit.

Regulator characteristic curve (approx.)