EMISSION CONTROL

GROUP 23

INDEX

FOREWORD

ENGINE EXHAUST EMISSION CONTROL SYSTEMS

The Engine Exhaust Emission Control Systems fitted to Ford vehicles are designed to comply with the Emission Control requirements of ADR–27A (Australian Design Rule). To ensure continuing compliance it is imperative that the Engine/Emission System is serviced according to the specified service procedure.

If it is required that a component, which affects vehicle emissions, be replaced:

IT IS MANDATORY THAT THE REPLACEMENT PART BE OF THE CORRECT CALIBRATION.

HOW POLLUTANTS ARE EMITTED

The three areas of a petrol engined vehicle from which undesirable emissions can be released into the atmosphere are:

(a) The fuel system where it is vented to the atmosphere, i.e. fuel tank and carburettor (Called evaporative emissions).

(b) The exhaust system as a result of incomplete combustion (Called exhaust emissions).

(c) The crankcase ventilation system as a result of 'piston blow-by' (Called crankcase emissions).

Reduction or elimination of emissions from these locations is obviously the objective of both legislation and emission research. The emphasis is biased towards exhaust emission as this is where pollution levels are highest and therefore, where the application of emission controls is most effective.

DESCRIPTION AND APPLICATION OF IMPROVED COMBUSTION EMISSION SYSTEM COMPONENTS

1. Inlet Air Temperature Control.

With a conventional air cleaner, the air drawn into an engine is subject to temperature variations. This can give rise to exhaust emission and driveability problems as a result of poor fuel atomization, changes in the air/fuel ratio and insufficient air/fuel mixture filling at full load.

Fuel atomization: If the temperature of the air being drawn into the carburettor is low, the atomization process (mixing of air and fuel supply) will not be complete and will result in small globules of fuel entering the combustion chamber. This fuel will not be fully burnt and will be subsequently emitted to atmosphere through the exhaust system.

Air/fuel ratio changes: Air, in common with other gases expands as its temperature rises. This in turn reduces its density (mass of air in a given volume). Consequently, the actual mass of air in relation to the mass of fuel (air/fuel ratio) is reduced as the temperature rises. Therefore it can be seen that the ideal air/fuel ratio can only be achieved over a limited range of air inlet temperatures.

Insufficient air/fuel mixture filling at full load: This problem is indirectly involved with air inlet temperature as it is related to the need on some vehicles for revised carburettor jet calibrations. Some carburettors are calibrated to give a lean mixture at part throttle. This improves economy and helps reduce emissions. However, the objective, at full load, is to achieve maximum charge density, by introducing colder more dense air, in order to obtain maximum performance. Under these conditions satisfactory mixture quality is restored by incorporating a full load enrichment system in the carburettor.

In summary, to achieve the ideal situation, we require the air intake to be controlled at a specific temperature irrespective of the ambient temperature. Also during wide open throttle conditions some vehicles require cooler air to maintain performance and driveability.

The heat sensor unit is located inside the air cleaner and senses the temperature of the air actually entering the carburettor. The unit consists of two vacuum take off points, a bi-metal strip and a ball valve. When air flow past the sensor is **cold** the ball valve in the sensor unit will be closed allowing full manifold vacuum to be available at the diaphragm unit (see Fig. 1).

As the temperature increases above a pre-determined figure, the ball valve opens allowing air to bleed through the unit and into the vacuum line. This reduces the effect of manifold vacuum at the vacuum diaphragm. (See Fig. 1a).

The combined effect of manifold vacuum with the heat sensor, vacuum diaphragm unit, and flap valve is; to control the blend of hot and cold air under closed or part throttle conditions thereby maintaining a constant air intake temperature; and to provide colder air at or near full throttle to achieve good performance.

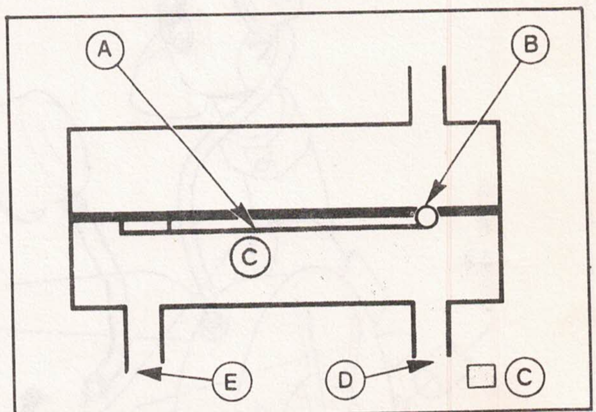


Fig. 1 —
Heat sensor — cold

A – Bi-metal strip.
B – Ball valve closed.
C – Vacuum.
D – Diaphragm unit connection.
E – Manifold connection.

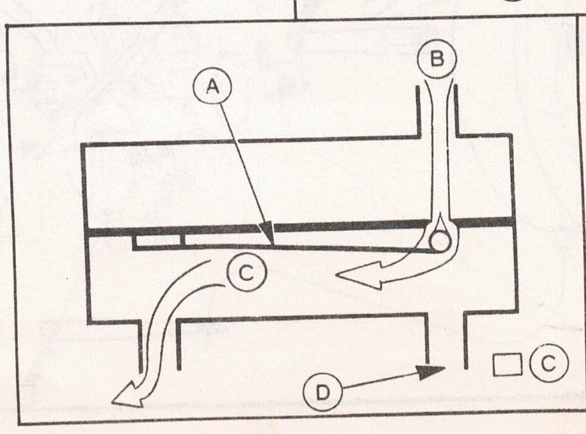


Fig. 1a —
Heat sensor — hot

A – Bi-metal strip.
B – Air bleed past ball valve.
C – Air bleed to manifold.
D – Low vacuum at diaphragm unit

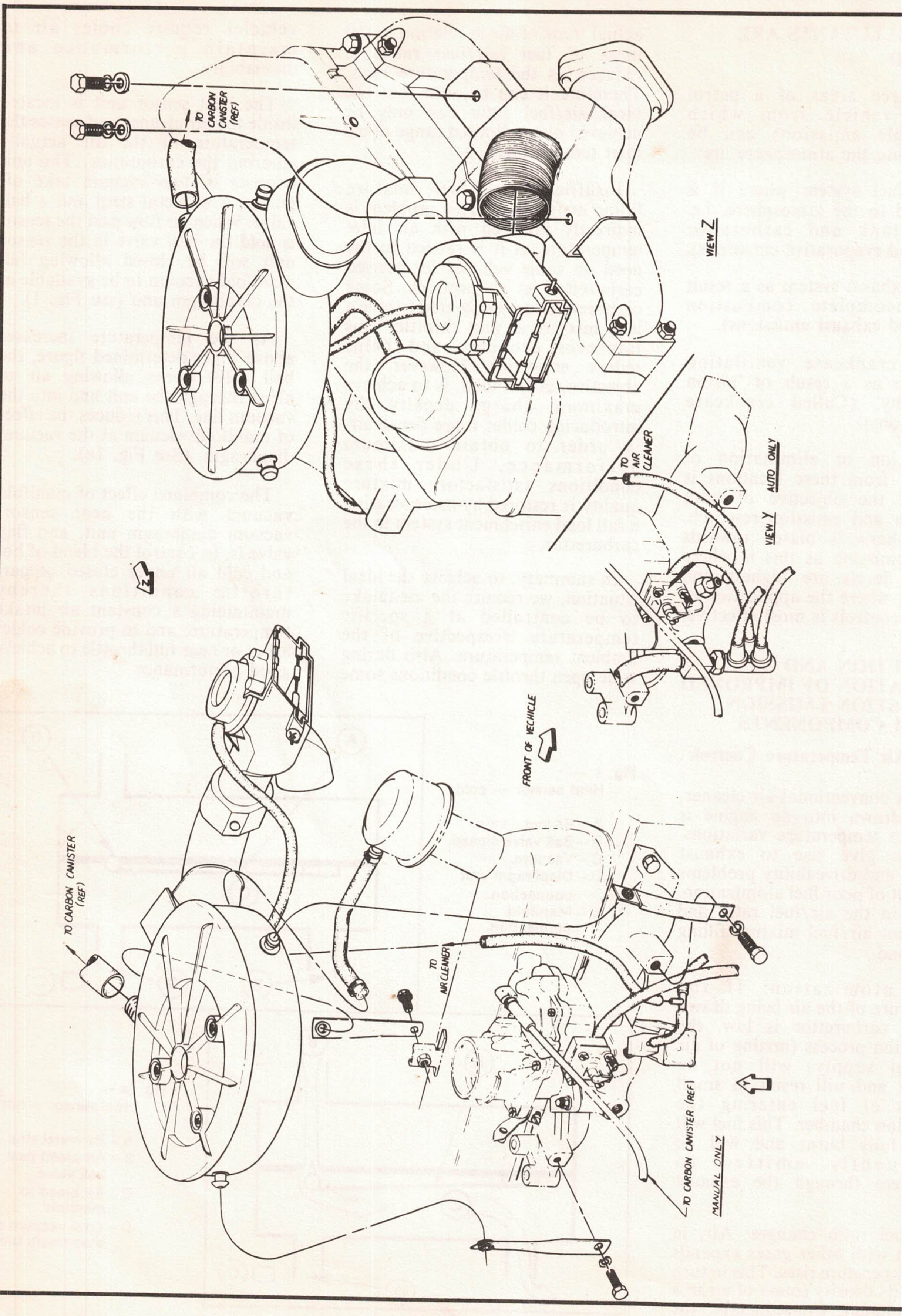


Fig. 2 — Air Cleaner Installation — 1.6 litre

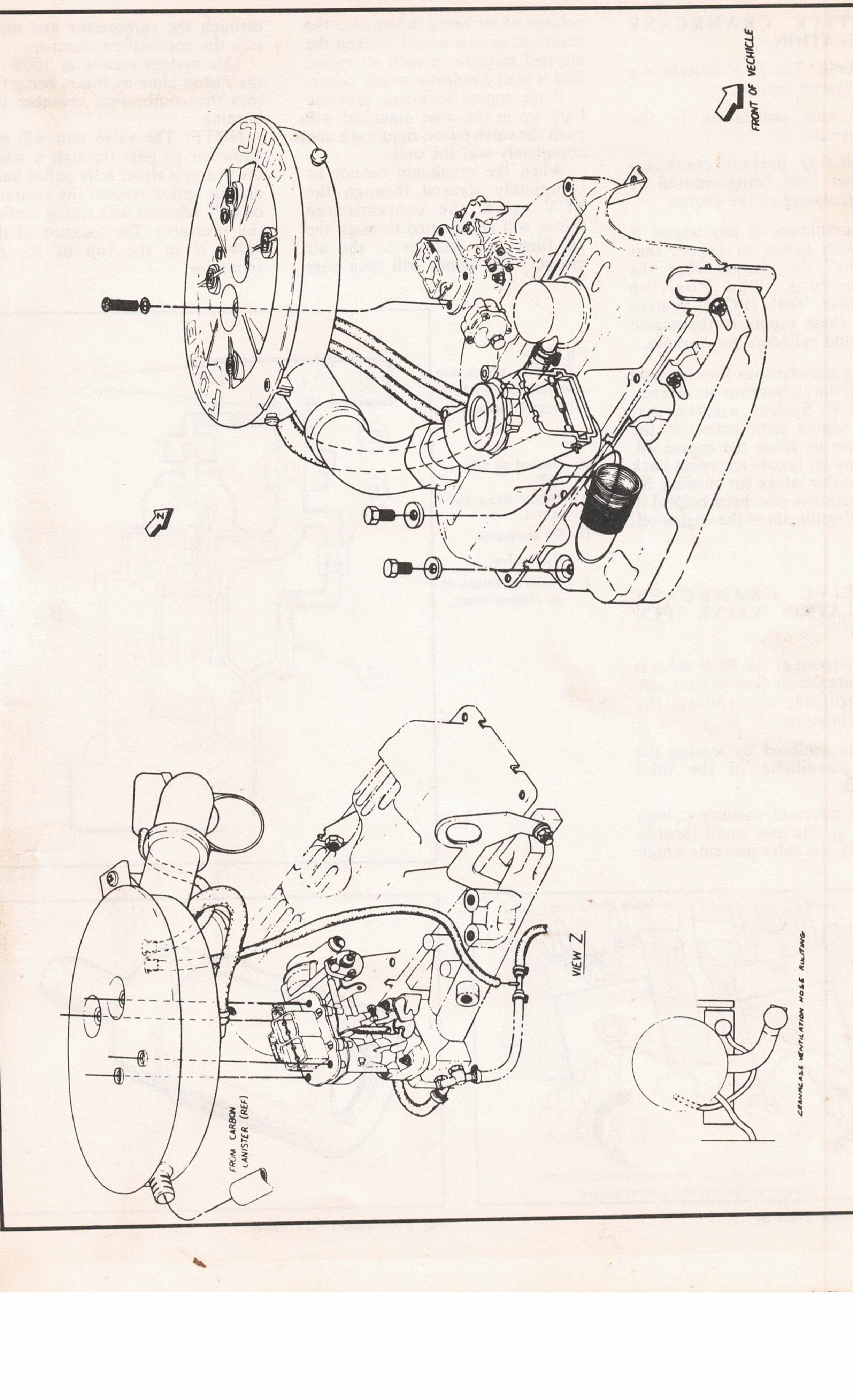


Fig. 3 — Air cleaner installation 2.0 litre.

POSITIVE CRANKCASE VENTILATION

PURPOSE: The PCV System is a closed system used to:

- Maintain ventilation in the crankcase.
- Positively prevent crankcase vapors from being emitted by recirculating to the engine.

The crankcase in any engine is filled with gasses or vapors that "blow-by" the pistons when the engine runs. The Positive Crankcase Vent (PCV) System returns these vapors to the engine intake and cylinders for burning.

Using a continuous flow of clean air from the carburettor air cleaner, the PCV System assures that engine vapors can't collect in the crankcase to dilute the engine oil. Also, any oil vapors are swept back to the engine intake for burning. So the system has also been helpful in prolonging the life of the engine oil.

POSITIVE CRANKCASE VENTILATION VALVE (PCV VALVE)

The purpose of the PCV valve is to regulate the air flow passing into the manifold, controlling the air/fuel mixture.

This is achieved by sensing the vacuum available in the inlet manifold.

When manifold vacuum is high (mainly at idle and small throttle openings), the valve prevents a high volume of air being drawn into the manifold as this would weaken the air/fuel mixture to such an extent that a stall condition would occur.

If the engine backfires, pressure built up in the inlet manifold will push the valve piston right back and completely seal the unit.

When the crankcase cannot be completely cleared through the PCV valve, the contaminated fumes will be directed through the oil filler cap and up to the air cleaner. The fumes will then pass through the carburettor and back into the combustion chamber.

This system results in 100% of the Piston blow-by fumes being fed into the combustion chamber for burning.

NOTE: The valve unit will **not** allow air to pass through it when the piston is either fully pulled back against spring tension (by vacuum) or fully released with spring tension (by pressure). The location of the valve is in the top of the oil separator.

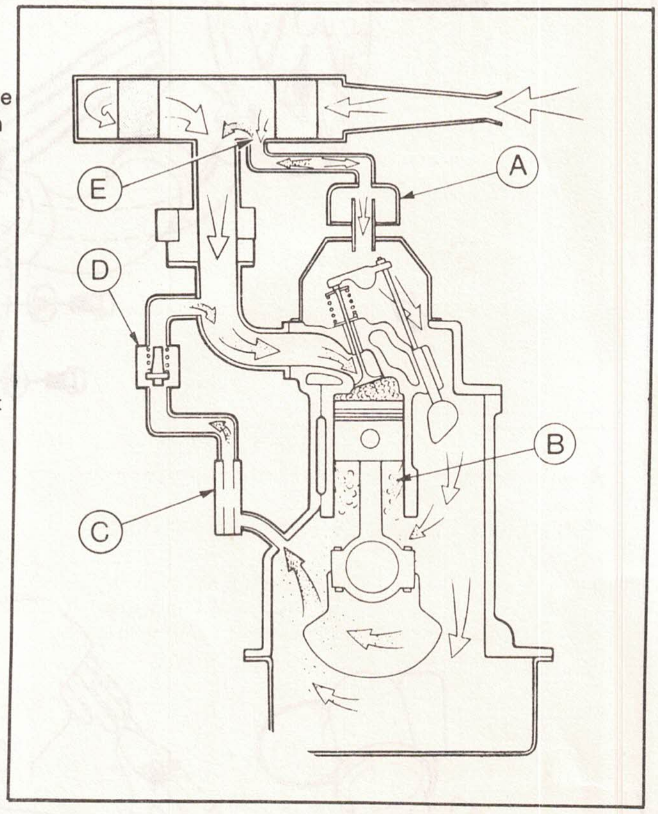
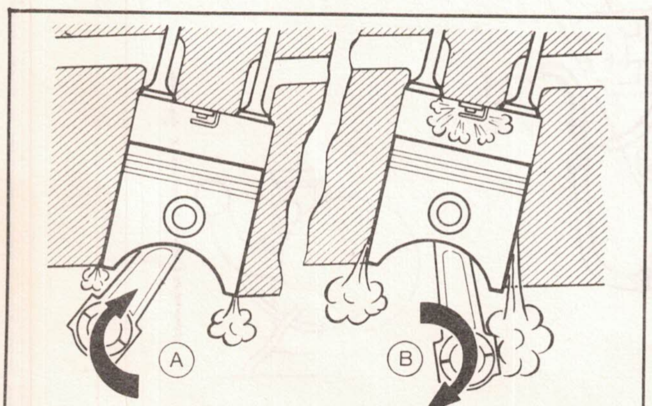


Fig. 5 — Positive crankcase ventilation system (Closed system)

A – Sealed oil filler cap.
B – Piston 'Blow-by' fumes.
C – Oil separator.
D – PCV valve.
E – Fresh air intake at air cleaner body.



A – Blow-by during the compression stroke.
B – Blow-by during the power stroke.

Fig. 4 — Piston Blow-by

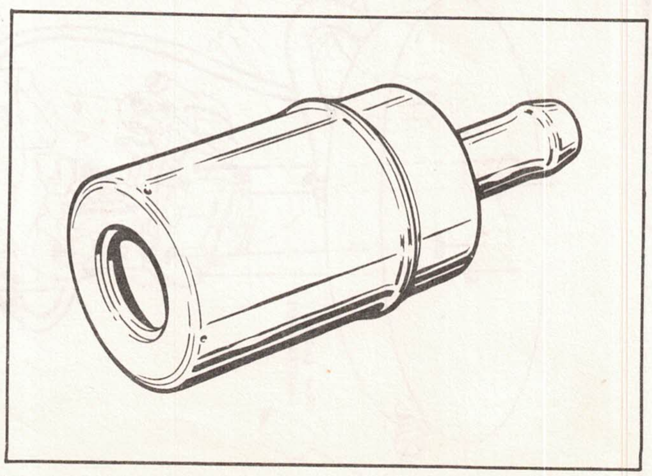


Fig. 6 — Sealed PCV valve

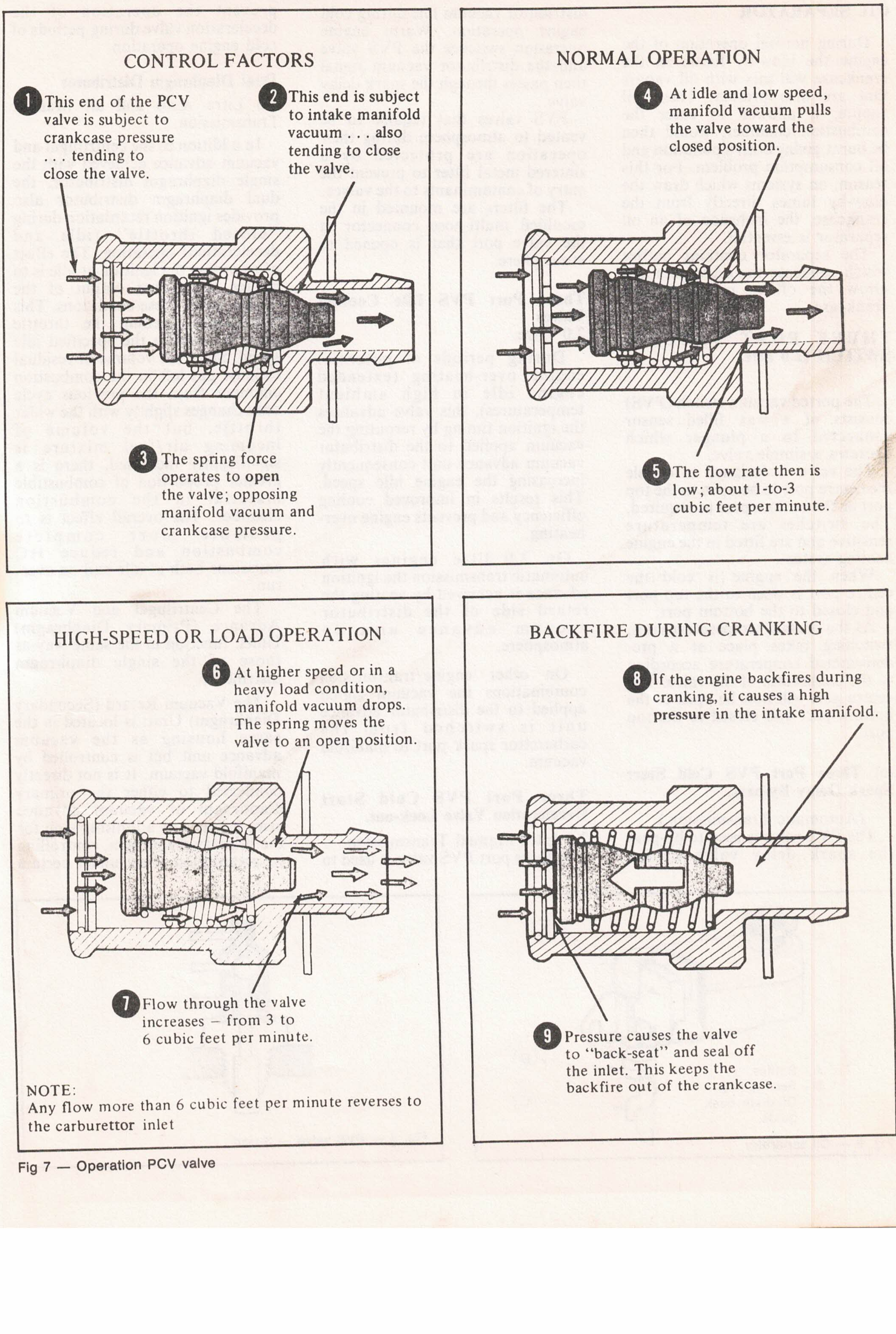


Fig 7 — Operation PCV valve

OIL SEPARATOR

During normal operation of the engine the blow-by fumes in the crankcase will mix with oil vapors that are also present. These oil vapors, if allowed to enter the combustion chamber, would then be burnt giving both a pollution and oil consumption problem. For this reason, on systems which draw the blow-by fumes directly from the crankcase, the inclusion of an oil separator is essential.

The separator contains baffles which condense the oil vapors and allow the oil to return to the crankcase.

THREE PORT VACUUM SWITCH (2.0 litre)

The ported vacuum switch (PVS) consists of a wax filled sensor connected to a plunger which operates a simple valve.

The valve is designed to enable the centre port to be open to the top port **or** the bottom port as required. The switches are temperature sensitive and are fitted in the engine cooling system.

When the engine is cold the centre port is open to the top port and closed to the bottom port.

As the coolant temperature rises, switching takes place at a pre-determined temperature according to the calibration of the valve. The centre port will now be open to the bottom port and closed to the top port.

(c) Three Port PVS Cold Start Spark Delay By-pass.

(Automatic Transmission.)

The PVS valve is used to by-pass the spark delay valve in the distributor vacuum line during cold engine operation. Warm engine operation switches the PVS valve and the distributor vacuum signal then passes through the spark delay valve.

PVS valves that require to be vented to atmosphere during their operation are protected by a sintered metal filter to prevent the entry of contaminants to the valves.

The filters are mounted in the moulded multi-hose connector at the valve port that is opened to atmosphere.

Three Port PVS Idle Cooling Valves

2.0 Litre.

During periods of potential engine over-heating (extended engine idle in high ambient temperatures), this valve advances the ignition timing by rerouting the vacuum applied to the distributor vacuum advance unit consequently increasing the engine idle speed. This results in improved cooling efficiency and prevents engine over-heating.

On 2.0 litre engines with automatic transmission the ignition advance is achieved by venting the retard side of the distributor vacuum advance unit to atmosphere.

On other engine/transmission combinations the vacuum signal applied to the distributor advance unit is switched from the carburettor spark port to manifold vacuum.

Three Port PVS Cold Start Deceleration Valve Lock-out.

2.0 Litre Manual Transmission.

A three port PVS valve is used to prevent the operation of the deceleration valve during periods of cold engine operation.

Dual Diaphragm Distributor

2.0 Litre Auto and all Manual Transmission.

In addition to the centrifugal and vacuum advance achieved with the single diaphragm distributor, the dual diaphragm distributor also provides ignition retardation during "closed throttle" (idle and deceleration) operation. The effect of retarding the ignition at idle is to reduce the power output of the engine under these conditions. This necessitates opening the throttle more to achieve the specified idle speed. Since the volume of residual exhaust gas left in the combustion chamber from the previous cycle only changes slightly with the wider throttle, but the volume of incoming air/fuel mixture is significantly increased, there is a greater proportion of combustible material in the combustion chamber. The overall effect is to promote more complete combustion and reduce HC emissions both at idle and on over-run.

The Centrifugal and Vacuum Advance (Primary Diaphragm) Units: function in the same way as those of the single diaphragm distributor.

The Vacuum Retard (Secondary Diaphragm) Unit: is located in the same housing as the vacuum advance unit but is controlled by manifold vacuum. It is not directly connected to either the primary diaphragm or vacuum advance arm, but acts as a limiting stop for the primary diaphragm, controlling its retardation effect under certain

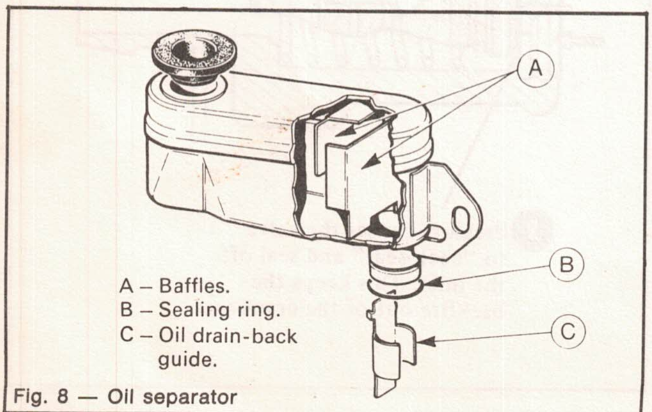


Fig. 8 — Oil separator

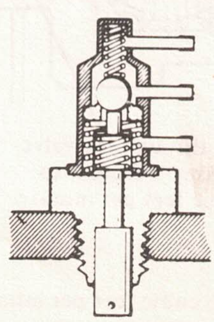


Fig. 9 — PVS valve — 3-port

conditions. The vacuum advance characteristics of the dual diaphragm unit in relation to throttle opening are as follows:

With the throttle closed, the carburettor spark port vacuum is low and the inlet manifold vacuum is high. This causes the secondary diaphragm to be pulled back against its return spring. As there is virtually no vacuum being applied to the primary diaphragm, its return spring is allowed to extend (until the primary diaphragm contacts the stop on the secondary diaphragm), causing the ignition timing to be retarded.

With the throttle slightly open (up to approximately ¼ throttle) the carburettor spark port vacuum is high. This causes the primary diaphragm to compress its return spring advancing the ignition. Although under these conditions manifold vacuum may also be high and the secondary diaphragm is pulled back against its return spring, it does not affect the degree of advance as it is not directly connected to the primary diaphragm or advance and retard arm.

As the throttle is opened further, both the carburettor spark port and manifold vacuums gradually drop. The diaphragm return springs are calibrated so that the secondary diaphragm returns to its static position while the primary diaphragm continues to provide vacuum advance. This vacuum advance is gradually reduced as full throttle is approached.

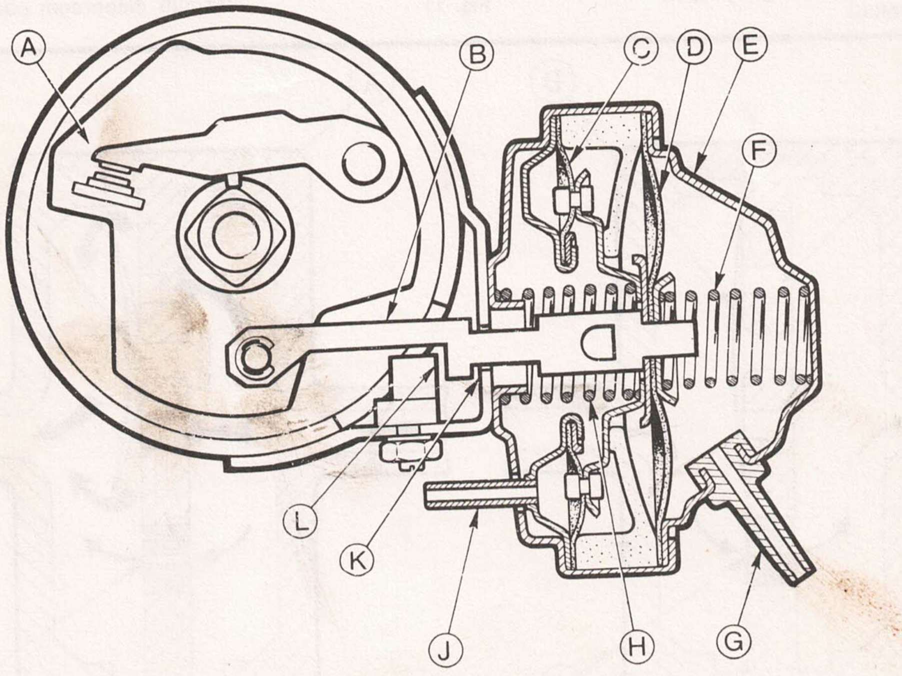
At full throttle both carburettor and manifold vacuums are relatively low. Hence, both the primary and secondary diaphragms are returned to their stops. Under full throttle conditions at all engine speeds above idle, the ignition timing is controlled solely by the centrifugal advance system.

SPARK PORT VACUUM (Except 1.6 litre Auto.)

It should be noted that the location of vacuum take-off point at the carburettor is critical, if correct vacuum characteristics are to be achieved. This take-off point, known as the vacuum spark port, is adjacent to the throttle butterfly in this closed position. The vacuum characteristics achieved as a result of the spark port location are: almost zero vacuum at idle, rapidly increasing to maximum at small throttle openings; then steadily decreasing to almost zero at full throttle.

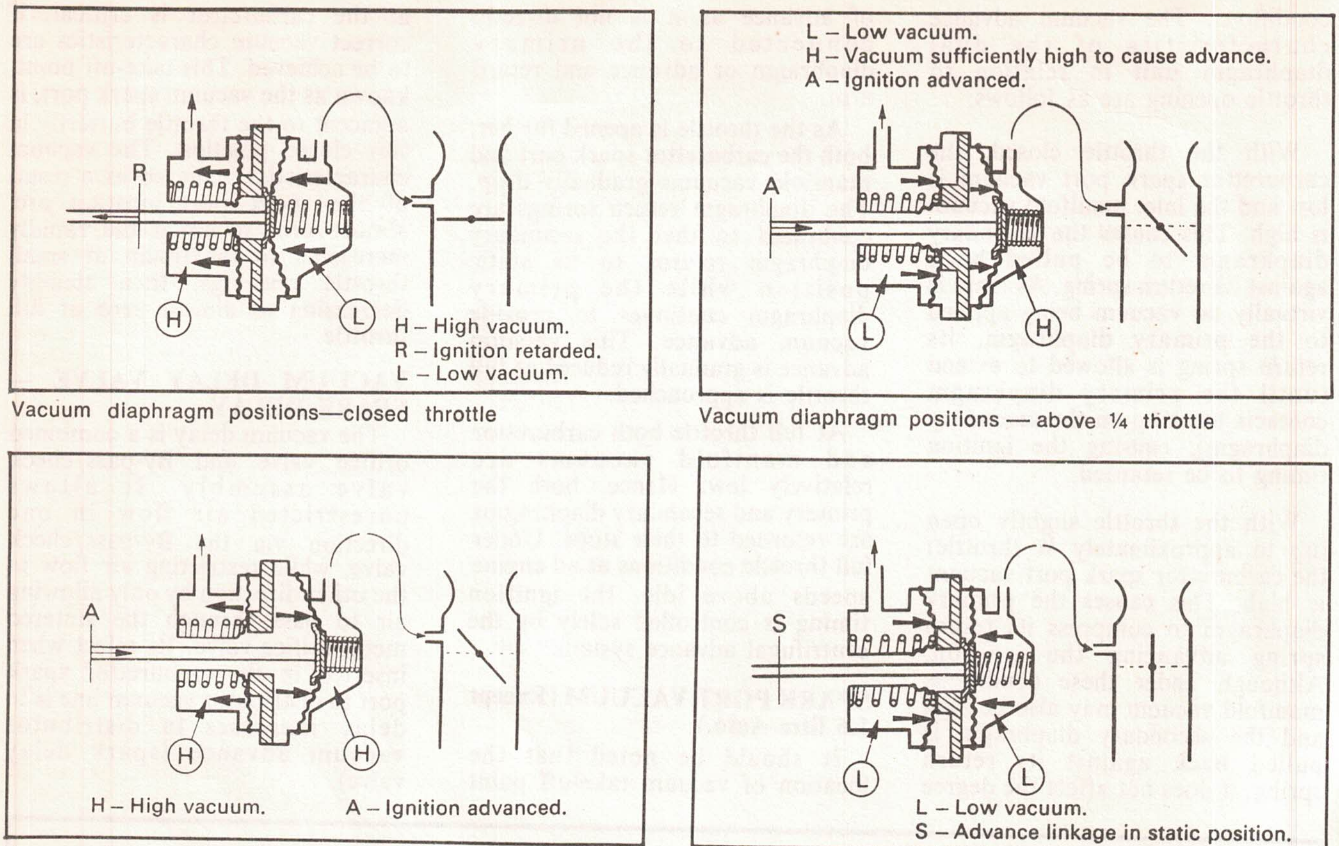
VACUUM DELAY VALVE — SPARK DELAY

The vacuum delay is a combined orifice valve and By-pass/check valve assembly. It allows unrestricted air flow in one direction via the By-pass/check valve, while restricting air flow in the other direction by only allowing air to pass through the sintered metal orifice valve. Its effect when inserted in the carburettor spark port to distributor vacuum line is to delay increases in distributor vacuum advance (spark delay valve).



A – Contact breaker plate.
B – Vacuum advance arm.
C – Secondary diaphragm.
D – Primary diaphragm.
E – Vacuum unit.
F – Primary return spring.
G – Primary vacuum connection.
H – Secondary return spring.
J – Secondary vacuum connection.
K – Advance stop.
L – Retard stop.

Fig. 10 — Dual diaphragm distributor



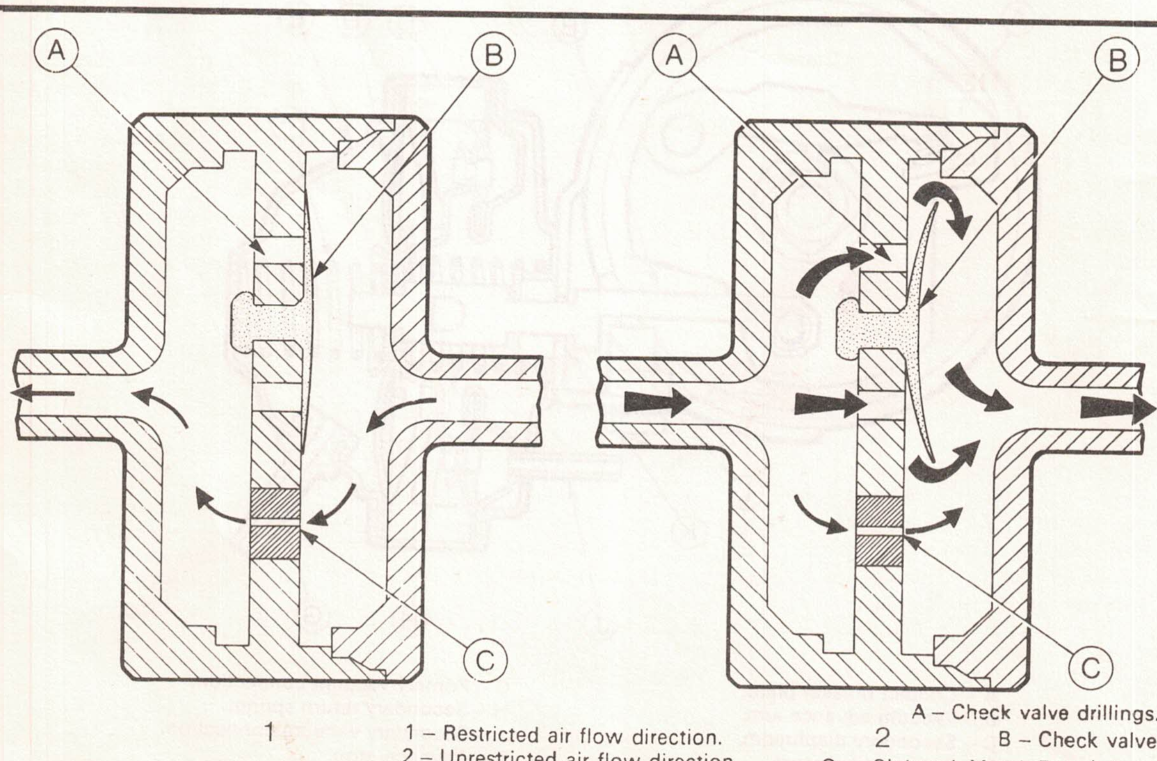
Vacuum diaphragm positions—closed throttle

Vacuum diaphragm positions — above ¼ throttle

Vacuum diaphragm positions—slightly open throttle (up to ¼ throttle)

Fig. 11

Vacuum diaphragm positions—full throttle



NOTE: ALL VALUES ARE COLOUR CODED TO INDENTIFY THEIR CALIBRATION. ALWAYS REPLACE A VALUE WITH ONE OF THE SAME COLOUR.

Fig. 12 — Vacuum Delay Valve

SPARK DELAY VALVE (SDV) SYSTEMS

1.6 litre (Manual Transmission)

For good driveability, vacuum advance is required under part throttle conditions, to allow time for the air/fuel mixture to burn. However, when spark port vacuum increases, due to a change in throttle position, the distributor advances quickly, but additional time is required to stabilize the air/fuel mixture flow. These transient conditions can result in more rapid and erratic combustion and consequent high HC and NOx levels.

Introducing a spark delay valve in this system slows the rate of vacuum advance when changing to a part throttle condition. This ensures the vacuum advance and the change in air/fuel mixture flow are more compatible, resulting in more complete combustion and lower emissions.

Care is taken to ensure the spark delay valve calibration achieves the required emission levels without seriously adversely affecting driveability during part throttle acceleration.

NOTE: WHEN USED FOR SPARK DELAY THE VALVE MUST BE FITTED WITH THE COLOURED SIDE OF THE VALVE TOWARD THE DISTRIBUTOR.

To summarise, the spark delay valve is used to reduce emissions by modifying the transient spark control characteristics at normal operating temperatures. The basic objective is to achieve good driveability during warm-up while maintaining low emissions. It should be apparent that this objective is more easily attainable if the spark delay valve can be brought in or out of use as the engine temperature changes. The simplest way of doing this is to control the operation of the valve using a three port PVS (ported vacuum switch) and a dual vacuum circuit.

NOTE: ALL VALVES ARE COLOUR CODED TO IDENTIFY THEIR CALIBRATION. ALWAYS REPLACE A VALVE WITH ONE OF THE SAME COLOUR.

SPARK SUSTAIN VALVE (SSV) SYSTEMS

(2.0 Litre Manual and Automatic Transmission.)

To ensure low emission levels, vacuum advance under part throttle conditions is kept to a minimum. This results in lower combustion pressures and a more satisfactory rate of combustion for emission control, but may be achieved at the expense of some deterioration in throttle response. Although, at normal operating temperatures, the loss of performance is not very great, when starting from cold, driveability can be noticeably affected. To overcome this condition a spark sustain valve is introduced into the system. The valve maintains vacuum advance for a longer period of time during transient throttle operating conditions. The effect of holding the vacuum advance under these conditions is to stabilize the combustion process, improving driveability. This is particularly important when the engine is cold.

NOTE: WHEN USED FOR SPARK SUSTAIN, THE VALVE MUST BE FITTED WITH THE BLACK SIDE OF THE VALVE TOWARD THE DISTRIBUTOR.

To summarise, the spark sustain valve is used to improve driveability during warm up. The basic objective is to achieve good driveability during warm-up while maintaining low emissions. It should be apparent that this objective is more easily attainable if the sustained valve can be brought in or out of use as the engine temperature changes. The simplest way of doing this is to control the operation of the valve using a two or three port PVS (ported vacuum switch) and a dual vacuum circuit.

A 3 port PVS is used for manual transmission.

A 2 port PVS is used for automatic transmission.

DECELERATION (DECEL) VALVES

(2.0 Litre Manual Transmission.)

A lean air/fuel mixture can cause a high level of unburnt fuel (hydrocarbon) emissions. To explain this situation we must consider what happens in the combustion chamber when a lean mixture is introduced. With the correct air/fuel ratio, the spark ignites the mixtures and a flame front spreads evenly throughout the combustion chamber. If the mixture is significantly weakened, the flame front cannot progress smoothly, and small pockets of unburnt air/fuel mixture are left in the extremities of the combustion chamber. This unburnt air/fuel mixture is emitted during the exhaust stroke with a consequent rise in the hydrocarbon emission level.

The leanest air/fuel mixture is produced during deceleration as, under these conditions, the mass of air entering the engine is relatively high compared with idle conditions because of the high engine speed, while the mass of fuel, which is only being supplied at closed throttle by the idle system, is relatively low. On some engine systems the mixture is weakened to such an extent that the hydrocarbon emissions would be unacceptable. To overcome the problem these engines are fitted with a deceleration (decel) valve.

The decel valve is a device, regulated by manifold vacuum, which introduces sufficient additional fuel into the inlet manifold to assist the combustion process. The valve is designed to come into effect when the inlet manifold vacuum is high. At normal operating temperatures this will only occur under deceleration. Therefore, the valve does not affect the air/fuel ratio under other normal driving modes. However, when an engine is first started from cold and is idling at fast idle (approximately 2000 rev/min), the manifold vacuum can, on some vehicles, be sufficiently high to bring the valve into operation. This would result in the mixture becoming over-rich causing high emissions with the added possibility of the engine stalling.

A ported vacuum switch (PVS) is fitted in a decel valve system to control this aspect of the decel valve operation.

The PVS is designed to react to engine coolant temperature and will only allow the decel valve to come into operation when the engine has reached a pre-determined temperature.

The decel valve is shown in Fig. 13 used in conjunction with a three port PVS (ported vacuum switch).

Decel Valve Operation

The decel valve is mounted directly onto the inlet manifold and consists of a spring loaded diaphragm unit, a control valve and three ports.

Under conditions of initial engine warm-up, manifold vacuum is applied to both sides of the diaphragm via the decel valve outlet and the PVS vacuum connection. Since the vacuum applied to each side of the diaphragm is equal, the valve remains shut.

As the engine warms up the PVS opens the lower side of the decel valve diaphragm to atmosphere. High manifold vacuum, (achieved during deceleration) applied to the upper side of the decel valve diaphragm, overcomes the return spring pressure, opening the valve. This allows air/fuel mixture from a tapping on the carburettor to be drawn through the valve and into the inlet manifold.

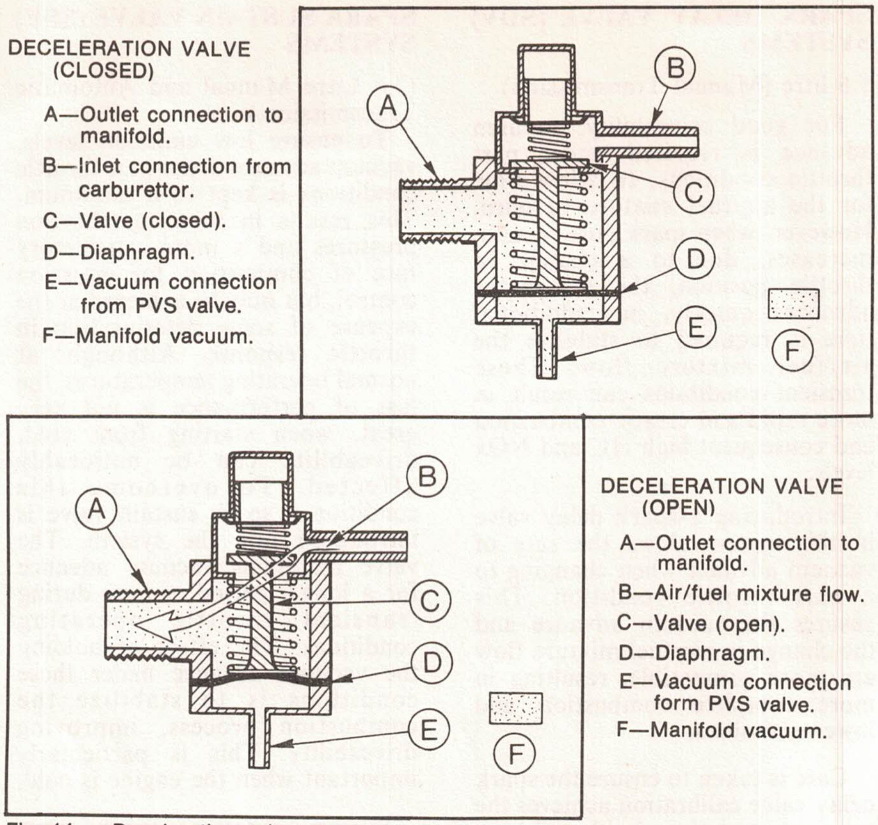


Fig. 14 — Deceleration valve.

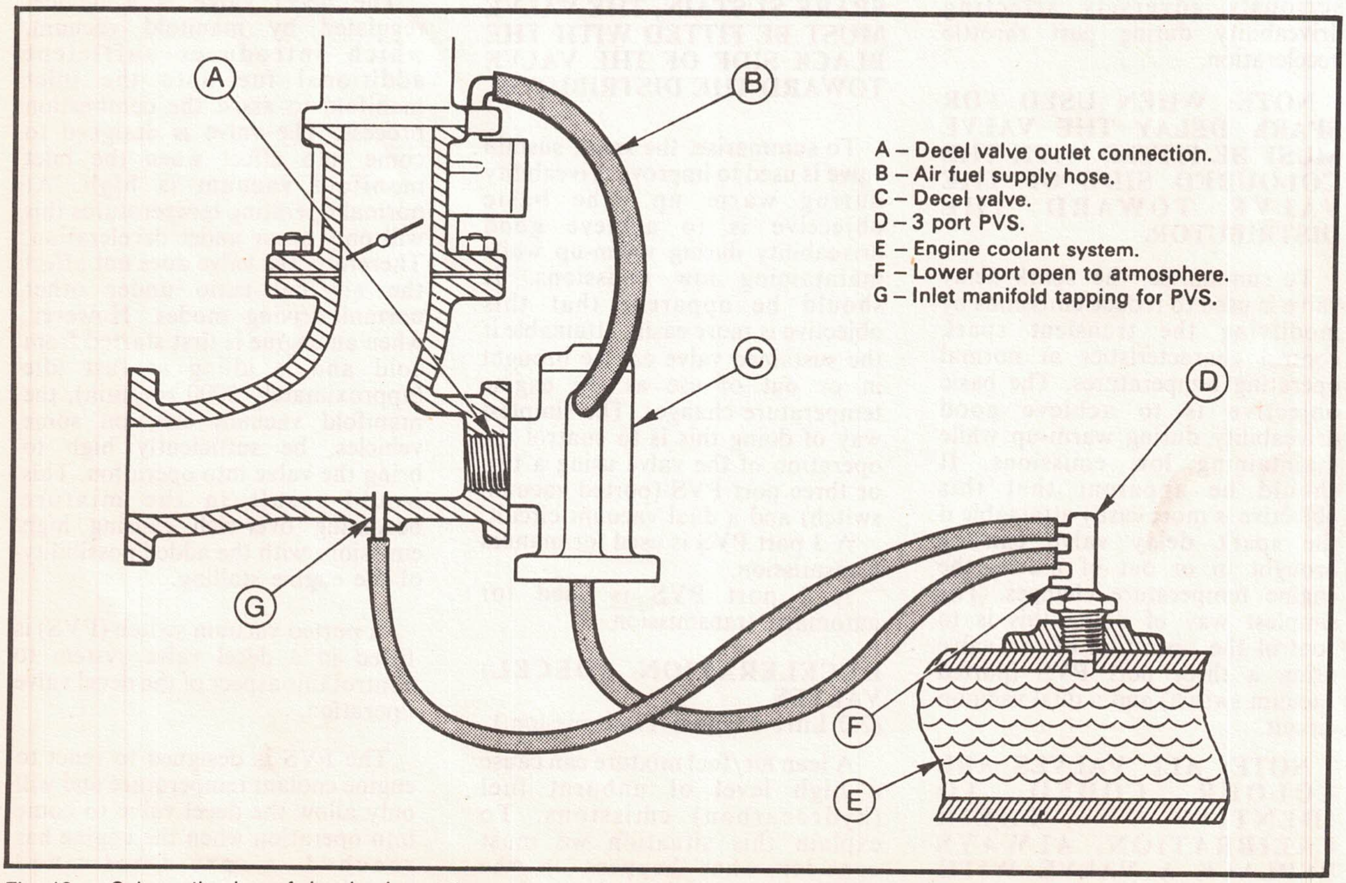


Fig. 13 — Schematic view of decel valve system.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM (2.0 Litre)

The air intake into the combustion chamber contains oxygen and a high percentage of nitrogen. Nitrogen at high temperatures and pressures reacts with oxygen to form oxides of nitrogen (NOx). In the internal combustion engine small amounts of these oxides are formed and emitted to atmosphere through the exhaust system. One way of reducing NOx is by lowering the peak temperatures reached in the combustion chamber and this can be achieved by recirculating up to 15% of the exhaust gas back into the inlet manifold. Recirculating exhaust gases has a two-fold effect on the combustion process:

(a) It reduces the overall amount of air/fuel mixture which can enter the combustion chambers for a given engine speed and throttle opening.

(b) Since the exhaust gases are incombustible, they do not create heat in themselves but rather absorb some of the heat from the burning air/fuel mixture.

Both of these effects reduce the combustion chamber peak temperatures and pressures, and hence NOx emissions.

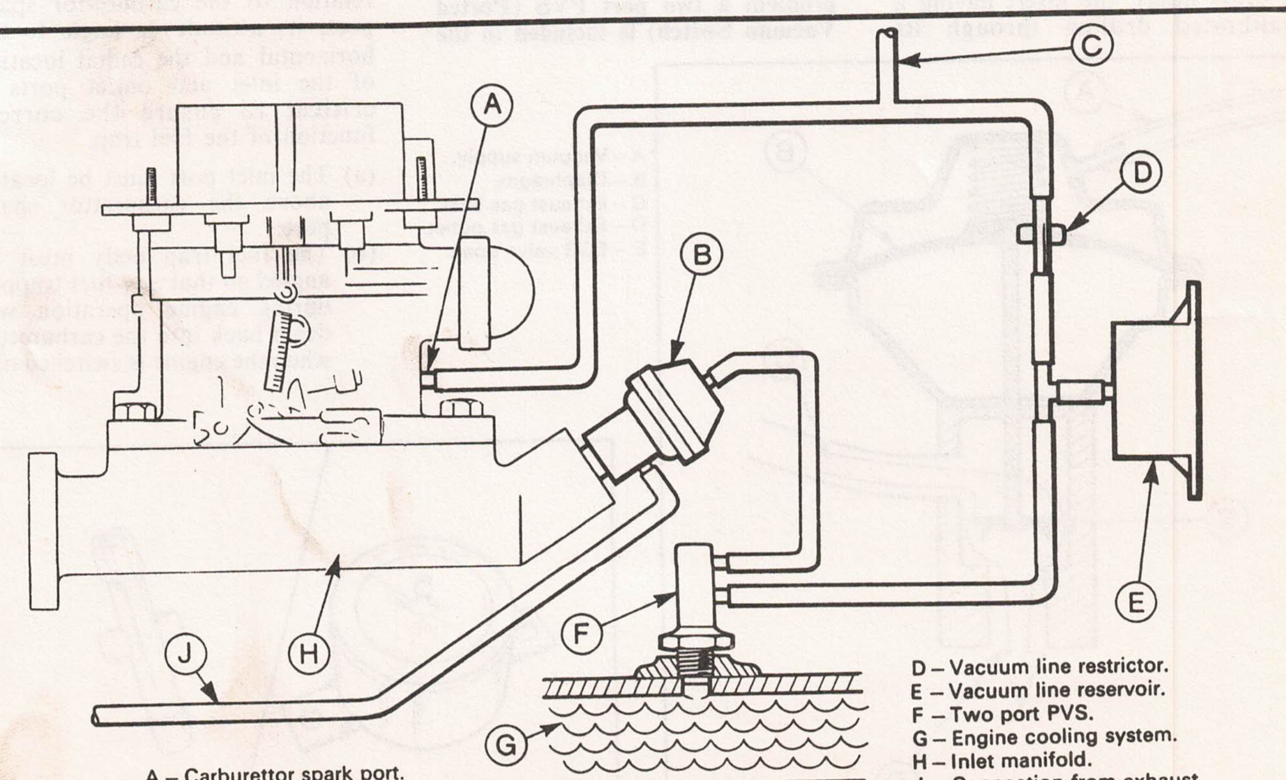
PRINCIPLES OF OPERATION

The basic EGR system consists of an EGR valve connected between the inlet and exhaust manifolds. This valve is vacuum operated and controls the flow of exhaust gas into the inlet manifold. The vacuum source used to control the EGR valve is, in the case of 2.0 litre engines, obtained from the vacuum connection on the carburettor used to control the distributor vacuum unit. This take-off point, known as the vacuum spark port, is adjacent to the throttle butterfly in its closed position. The vacuum characteristics achieved as a result of the spark port location are — almost zero vacuum at idle, rapidly increasing to maximum at part throttle openings; then steadily decreasing to almost zero at full throttle. The EGR system does not operate when the vacuum is almost zero, i.e. at idle or full throttle.

2.0 litre EGR systems incorporate a vacuum line reservoir and a restrictor, These components have the effect of slowing the rate of vacuum build up and decay at the EGR valve. This prevents the valve from responding too quickly as a result of changes to throttle position. This effect is, in some instances, necessary as the sudden introduction of a large volume of exhaust gas into the inlet manifold can cause driveability problems.

Additionally, driveability problems can be experienced if exhaust gas is introduced into the inlet manifold before the vehicle has reached normal operating temperature. This is overcome using a two Port PVS (Ported Vacuum Switch). This switch prevents the EGR valve from opening until a pre-determined engine temperature is reached by blocking off the vacuum line to the valve.

Fig. 15 shows a typical EGR system incorporating both a vacuum line restrictor and reservoir, and a two port PVS. A more detailed description of the individual components which make up the system illustrated follows.



A – Carburettor spark port.
B – EGR valve.
C – Connection to distributor.
D – Vacuum line restrictor.
E – Vacuum line reservoir.
F – Two port PVS.
G – Engine cooling system.
H – Inlet manifold.
J – Connection from exhaust manifold.

Fig. 15 — Schematic of EGR system 2.0 litre automatic shown.

EGR Valve

The EGR valve consists of a vacuum operated, spring loaded diaphragm which controls a gas flow valve. The valve assembly is mounted directly onto the inlet manifold.

Operation is as follows:

Vacuum from the carburettor port is directed onto the upper side of the diaphragm.When the vacuum reaches a pre-determined level, the diaphragm overcomes spring pressure and the valve begins to open. This allows previously burnt gases from the exhaust manifold to be drawn into the inlet manifold. As the applied vacuum increases, the valve opens progressively allowing a greater volume of exhaust gas to be drawn into the cumbustion chambers to suit the particular operating conditions.

Vacuum Line Restrictor and Reservoir

(2.0 litre automatic only)

The vacuum line restrictor consists of a small tube containing a brass insert, the insert having a calibrated drilling through its centre. The restrictor, when connected in the EGR system vacuum line, slows the rate of air flow from the EGR valve when vacuum is applied at the carburettor spark port. It also slows the rate at which the vacuum at the valve decays when the spark port vacuum signal is reduced.

The reservoir is simply a plastic container which effectively adds to the volume of the system on the EGR valve side of the restrictor. It therefore increases the amount of air which must pass through the restrictor before the EGR valve opens or closes.

Both the reservoir and restrictor slow the rate at which the spark port vacuum signal is transferred to the EGR valve thereby damping the action of the valve and controlling the exhaust gas flow.

PVS (Ported Vacuum Switch)

When an engine is first started from cold and is operating with the choke fully or partially closed, injection of exhaust gases can affect the mixture strength to an extent that a misfire could occur.

To overcome this potential problem a two port PVS (Ported Vacuum Switch) is included in the system. The switch cuts off the vacuum supply when the engine is cold and so prevents operation of the EGR valve. The two port PVS is mounted in the cooling system and is activated by the engine coolant temperature.

2.0 LITRE EGR SYSTEM

The EGR valve is mounted directly on the intake manifold and an insulated steel pipe is used to convey the exhaust gas from the exhaust manifold to it.

Control vacuum is routed from the carburettor through the fuel trap, restrictor and two port PVS to the EGR valve. The vacuum reservoir is located between the restrictor and the PVS valve. See Vacuum circuit schematics.

FUEL TRAP (1.6 litre manual)

(2.0 Litre Manual and Automatic Transmission.)

The purpose of the fuel trap is to prevent fuel contamination of the vacuum system.

The location of the fuel trap in relation to the carburettor spark port, its attitude or angle to the horizontal and the radial location of the inlet and outlet ports is critical to ensure the correct function of the fuel trap.

(a) The inlet port must be located above the carburettor spark port.

(b) The fuel trap body must be angled so that any fuel trapped during engine operation will drain back into the carburettor when the engine is switched off.

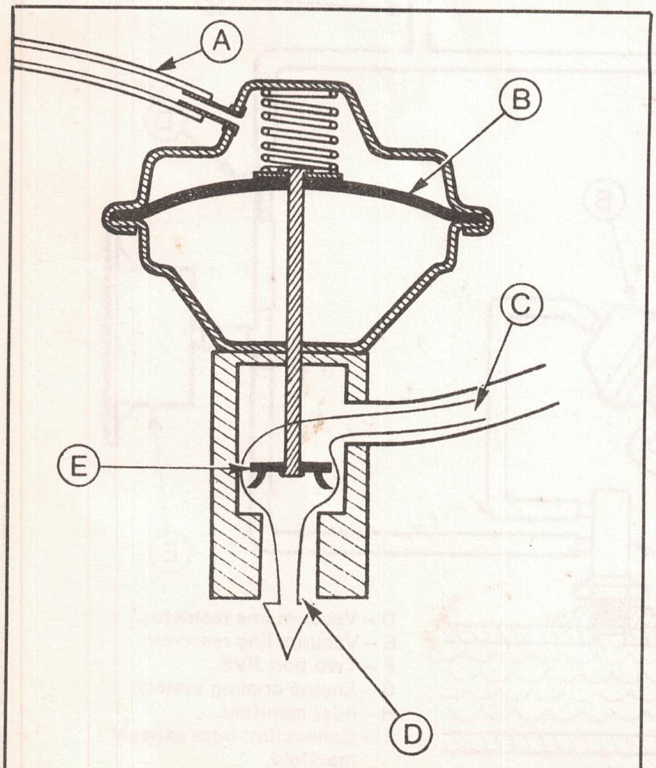


Fig. 16 — EGR valve assembly

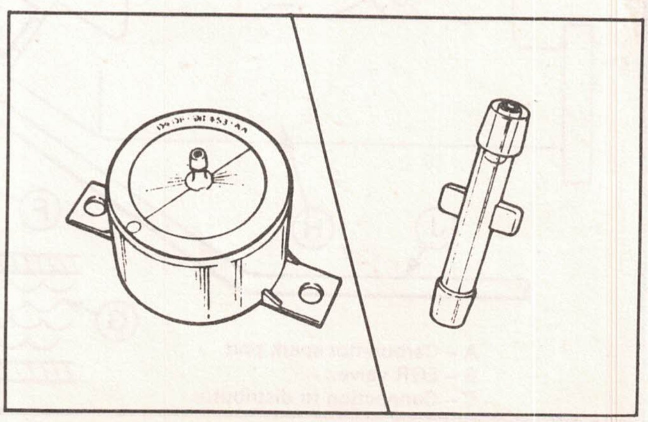


Fig. 17 — Vacuum reservoir (left hand view) and restrictor (right hand view)

(c) The inlet port must be radially located at the bottom of the fuel trap body.

The ends of the fuel trap are marked "CARB" and "DIST" respectively, ensure that it is fitted in the right direction.

VACUUM LINE FILTERS.

(2.0 Litre Manual Transmission.)

PVS valves that require to be vented to atmosphere during their operation are protected by a sintered metal filter to prevent the entry of contaminants to the valves.

The filters are mounted in the moulded multi-hose connector at the valve port that is opened to atmosphere.

ENGINE STOP CONTROL SOLENOID

The 1.6 litre engine is equipped with a solenoid operated air valve designed to prevent engine "run-on" or "dieseling" when the engine is switched off.

The solenoid is mounted on the right hand inner fender panel and is connected by hose to the crankcase emission vacuum line between the PCV valve and the intake manifold. When the engine is switched on the solenoid valve closes preventing the entry of air. The engine will start and run normally.

When the engine is switched off the solenoid valve opens and admits air to the intake manifold.

This additional air weakens the air/fuel mixture from the carburettor so preventing engine "run-on" or "dieseling".

CARBURETTOR DESIGN

The function of a carburettor is to atomise and mix fuel with atmospheric oxygen in the proportions necessary to ensure optimum combustion. Recent

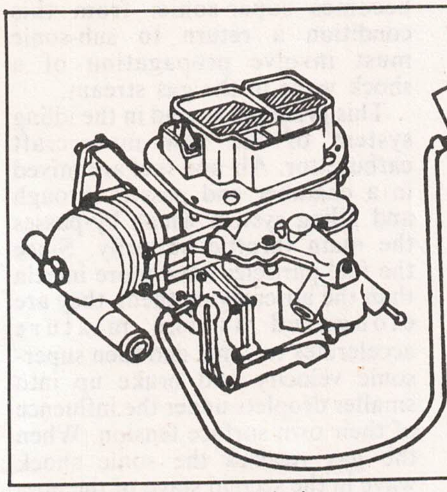


Fig. 18 — Fuel trap — typical

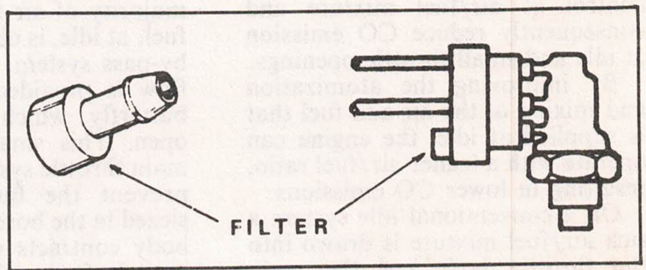


Fig. 19 — Vacuum line filters — 2.0 litre.

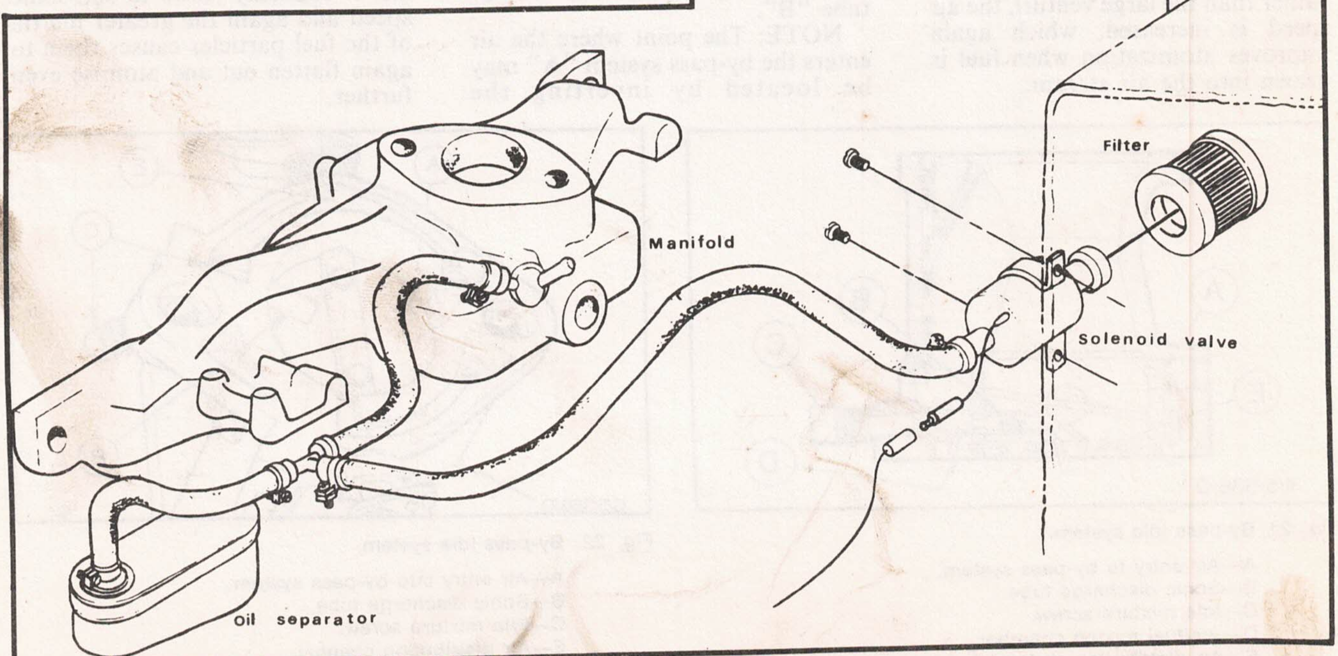


Fig. 20 — Engine Stop Control Solenoid

developments in conventional carburettor design have resulted in substantial improvements being achieved in overall combustion efficiency. However, due to the precise metering and combination of the air/fuel mixture necessary to meet the increasing requirements of emission control, several completely new design features have been developed for carburettors.

MOTORCRAFT — "BY-PASS" (SONIC) IDLE SYSTEM (1.6 litre)

The purpose of the By-Pass idle system is to allow an improved control of air/fuel mixture and consequently reduce CO emission at idle and small throttle openings.

By improving the atomization and mixing of the air and fuel that is supplied at idle, the engine can operate with a leaner air/fuel ratio, resulting in lower CO emissions.

On a conventional idle system a rich air/fuel mixture is drawn into the throttle bore and the main atomization mixing process takes place in the inlet manifold. The by-pass system improves this situation by partially atomizing the fuel in internal galleries within the carburettor before the mixture is drawn into the inlet manifold. Also, because the idle air flow passes through small by-pass channels rather than the large venturi, the air speed is increased, which again improves atomization when fuel is drawn into the air stream.

Externally the "by-pass" carburettor looks similar to the conventional carburettor, however the unit can be easily identified by noting the number of screws securing the carburettor upper body. (Six screws on conventional carburettor and seven screws on the by-pass unit). Also the vacuum pick up pipe is much longer. (Conventional carburettor is 14.2 mm (0.52 in.) long, by-pass unit 34.8 mm (1.37 in.).

By-Pass Idle System — Principle of Operation

The by-pass system differs from the conventional system in that the majority of air flow and all of the fuel, at idle, is obtained through the by-pass system. The remaining air flow is provided past the throttle butterfly which is held slightly open. This small opening of the main throttle system is necessary to prevent the butterfly becoming siezed in the bore as the carburettor body contracts during the cooling period after engine switch off.

During idle the throttle butterfly is almost closed and air is drawn into the by-pass system at point "A" Fig. 21. The air travels along the channel "E", mixes with the rich air/fuel mixture obtained via the mixture screw "C" and the air/fuel mixture is drawn into the engine through the sonic discharge tube "B".

NOTE: The point where the air enters the by-pass system "A" may be located by inverting the carburettor and holding the throttle open. (See Fig. 22).

Principle of Sonic Idle Discharge

When gas flows through a nozzle, its pressure falls, its velocity increases and a jet is formed. When the pressure ratio (pressure at entry/pressure at throat) of a convergent nozzle reaches a critical value (for air this is approximately 0.528) the nozzle chokes: that is, the flow has reached a maximum value and the velocity at the throat is sonic.

If further controlled expansion from the throat is allowed, the gas continues to accelerate and velocity becomes super-sonic: from this condition a return to sub-sonic must involve propagation of a shock wave in the gas stream.

This principle is used in the idling system of the new motorcraft carburettor. Air and fuel are mixed in a chamber and passed through and idling system which by-passes the main throttle butterfly. Since the fuel particles have more inertia than the air carrying them, they are elongated as the mixture accelerates to sonic and then super-sonic velocity and brake up into smaller droplets under the influence of their own surface tension. When the gas reaches the sonic shock wave in the second stage of the nozzle, it suddenly slows to sub-sonic speed and again the greater inertia of the fuel particles causes them to again flatten out and atomise even further.

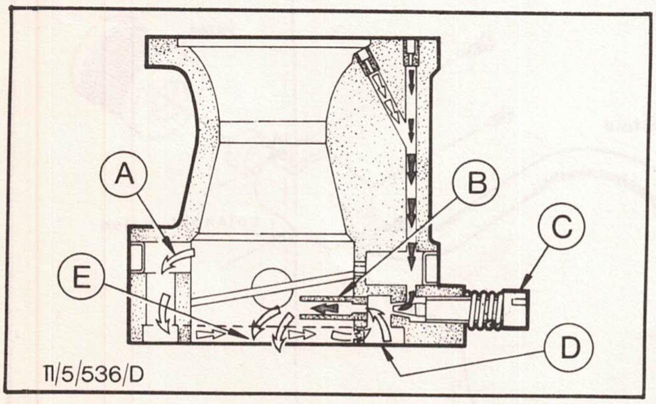


Fig. 21 By-pass idle system.

A—Air entry to by-pass system.
B—Sonic discharge tube.
C—Idle mixture screw.
D—Air/fuel mixing chamber.
E—Air distribution channel.

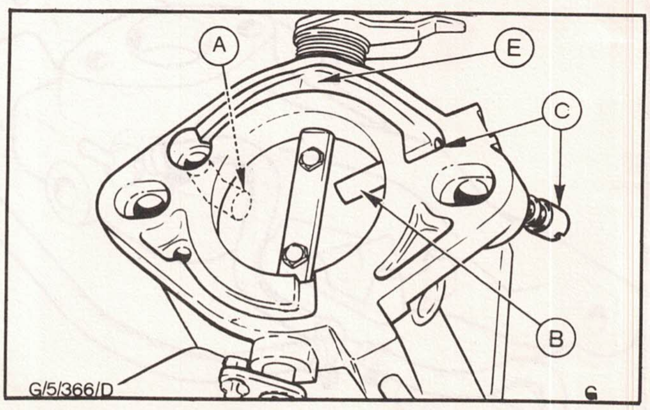


Fig. 22. By-pass idle system.

A—Air entry into by-pass system.
B—Sonic discharge tube.
C—Idle mixture screw.
E—Air distribution channel.

Downstream turbulence aids the distribution and provides a highly uniform and combustible mixture for the inherently low velocity and difficult-to-control idling charge being drawn into the engine.

Reduced carbon monoxide and hydrocarbon emissions at idle result, giving a steady idling speed without stalling or fluctuation during extended stops and even with a cold engine without choke enrichment.

The carburettor also features a booster venturi for improved response during acceleration. The booster consists of a smaller edition of the main venturi positioned with its outlet in the throat of the main venturi.

The vacuum provided by the main venturi, instead of acting directly at the discharge nozzle, is used to generate an even higher vacuum at the waist of the inner venturi. The higher air velocity thus produced at the discharge nozzle gives better fuel atomisation with consequent improvements in consumption, mixture distribution between cylinders and driveability.

The opportunity has been taken whilst incorporating the booster venturi to improve the profile of the main venturi to give a more streamlined entry. This gives approximately 10 per cent more gas flow for an equivalent venturi throat area, which effectively offsets the reduction in area caused by the booster casting.

On engines equipped with a deceleration valve (manual transmission) an additional fuel/air supply is provided from the carburettor.

The deceleration valve fuel/air supply system is located in the upper body of the carburettor. It consists of an air tube located in the air horn, a fuel pick up pipe incorporating a metering jet which is submersed in the fuel channel in the fuel bowl cover and a discharge tube connected to the decel valve.

When manifold vacuum is applied to the discharge tube via the decel valve air is drawn through the tube in the air horn. The velocity of the air drawn from the air horn syphons an air/fuel mixture from the fuel pickup tube. This air/fuel mixture is discharged into the intake manifold through the decel valve to control combustion during periods of engine deceleration.

WEBER CARBURETTOR 2.0 litre engine

LOW VACUUM ENRICHMENT SYSTEM (ANTI-STALL DEVICE)

To achieve low emission levels at idle it is necessary to calibrate the idle system with a leaner mixture setting. This leads to a tendency to stall under certain operating conditions.

To overcome this problem the carburettors incorporate a low vacuum enrichment system (anti-stall device). The device senses imminent stall condistions and injects fuel directly into the venturi, preventing the stall from occurring.
imminent stall conditions and injects fuel directly into the venturi, preventing the stall from occurring,

Principle of Operation

Under normal operating conditions a vacuum, obtained from the inlet manifold, is available at the device and pulls a diaphragm back against spring tension. This in turn draws fuel, through internal passages, from the accelerator pump reservoir which enters the device at point "B" in Fig. 24. If the engine is about to stall, the vacuum drops and the spring tension operates the diaphragm, pumping the reserve of fuel back into the internal passages and up to the discharge tubes ("A" in Fig. 24). This enrichment of the air/fuel entering the engine prevents the stall from occurring.

NOTE: The fuel enters and is discharged from the device at the same point and is correctly directed by means of two one-way valves. One at the accelerator pump, allowing fuel to be drawn from the pump but not return and the other located at the discharge tubes.

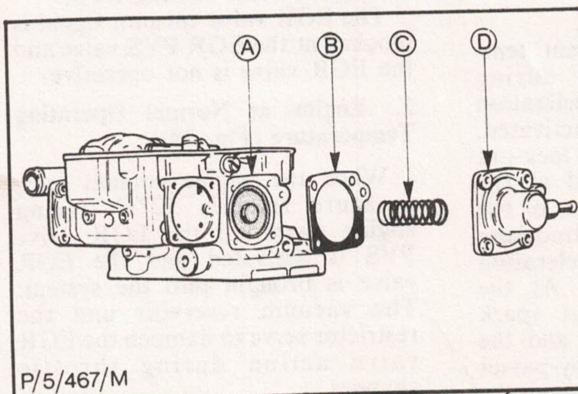


Fig. 23. — Anti-stall device

A—Diaphragm

B—Gasket

C—Return spring.

D—Housing.

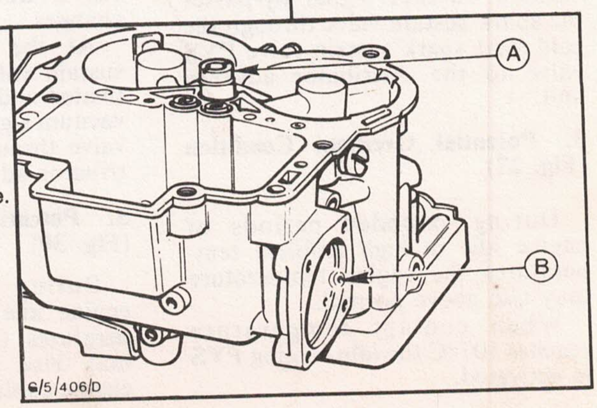


Fig. 24. — Anti-stall device

A — Discharge tube.

B—Fuel entry into unit.

VACUUM CONTROL CIRCUITS

2.0 LITRE ENGINE WITH MANUAL TRANSMISSION

The 2.0 litre engine with manual transmission is equipped with:
(a) Dual diaphragm distributor
(b) Idle cooling distributor advance PVS
(c) Spark sustain valve
(d) Cold start spark sustain PVS
(e) Deceleration valve
(f) Cold start deceleration valve lock-out PVS
(g) A fuel trap to prevent fuel contamination of the vacuum system.

The combination of these components gives three distinct phases of operation:

1. Cold Engine (Fig. 25)

Spark port vacuum is routed through the spark sustain PVS and the spark sustain valve to the distributor advance unit to maintain driveability with a cold engine.

The deceleration valve is locked out by the application of manifold vacuum through the deceleration valve lock-out PVS to the bottom of the deceleration valve diaphragm.

2. Engine at Normal Operating Temperature (Fig. 26)

When the engine coolant temperature reaches 52°C during engine warm-up the deceleration valve lock-out PVS is activated. The deceleration valve lock-out vacuum signal is blocked at the PVS valve and the bottom of the diaphragm is vented to atmoshere at the PVS valve. The deceleration valve is now functional. At the same time the cold start spark sustain PVS is activated and the vacuum advance signal by-passes the spark sustain valve through the cold start spark sustain valve PVS valve to the distributor advance unit.

3. Potential Overheat Condition (Fig. 27)

During extended periods of engine idle in high ambient temperatures the engine temperature may rise above normal.

When coolant temperature reaches 107°C the idle cooling PVS is activated.

Manifold vacuum is now routed through the idle cooling PVS valve direct to the distributor advance unit, consequently ignition timing is advanced and engine speed is increased giving better cooling efficiency.

2.0 LITRE ENGINE WITH AUTOMATIC TRANSMISSION

The 2.0 litre engine with automatic transmission is equipped with:
(a) Dual diaphragm distributor
(b) Idle cooling distributor advance PVS
(c) Spark sustain valve
(d) Cold start spark sustain valve PVS
(e) E.G.R. valve
(f) Cold start EGR valve lock-out PVS
(g) EGR vacuum reservoir
(h) EGR vacuum line restrictor
(i) Fuel trap.

The combination of these components gives three distinct phases of operation.

1. Cold Engine (Fig. 28)

Spark port vacuum is routed through the spark sustain valve to the distributor advance diaphragm.

Manifold vacuum is applied to the distributor retard diaphragm through the idle cooling PVS.

The EGR valve vacuum signal is blocked at the EGR PVS valve and the EGR valve is not operative.

2. Engine at Normal Operating Temperature (Fig. 29).

When the engine coolant temperature reaches 52°C during engine warm up the EGR valve PVS is activated and the EGR valve is brought into the system. The vacuum reservoir and the restrictor serve to dampen the EGR valve action during throttle changes.

At the same time the spark sustain valve lock-out PVS is activated and the distributor advance vacuum signal by-passes the sustain valve through the PVS to the distributor advance unit.

3. Potential Overheat Condition (Fig. 30)

During extended periods of engine idle at high ambient temperatures the engine temperature may rise above normal. When engine coolant temperature reaches 107°C the idle cooling PVS is activated. Manifold vacuum to the retard diaphragm is now blocked at the PVS valve and the diaphragm is vented to atmosphere at the valve. Ignition timing is advanced and engine speed increased giving better cooling efficiency.

1.6 LITRE ENGINE WITH MANUAL TRANSMISSION (FIG. 31)

The 1.6 litre engine with manual transmission is equipped with:

DECELERATION VALVE

The deceleration valve has no over-riding control and is functional at all engine temperatures.

DUAL DIAPHRAGM DISTRIBUTOR ADVANCE UNIT

The advance diaphragm of the dual diaphragm unit receives a vacuum signal directly from the carburettor spark port and is functional at all engine temperatures.

The retard diaphragm receives a vacuum signal directly from the intake manifold and is functional at all engine temperatures.

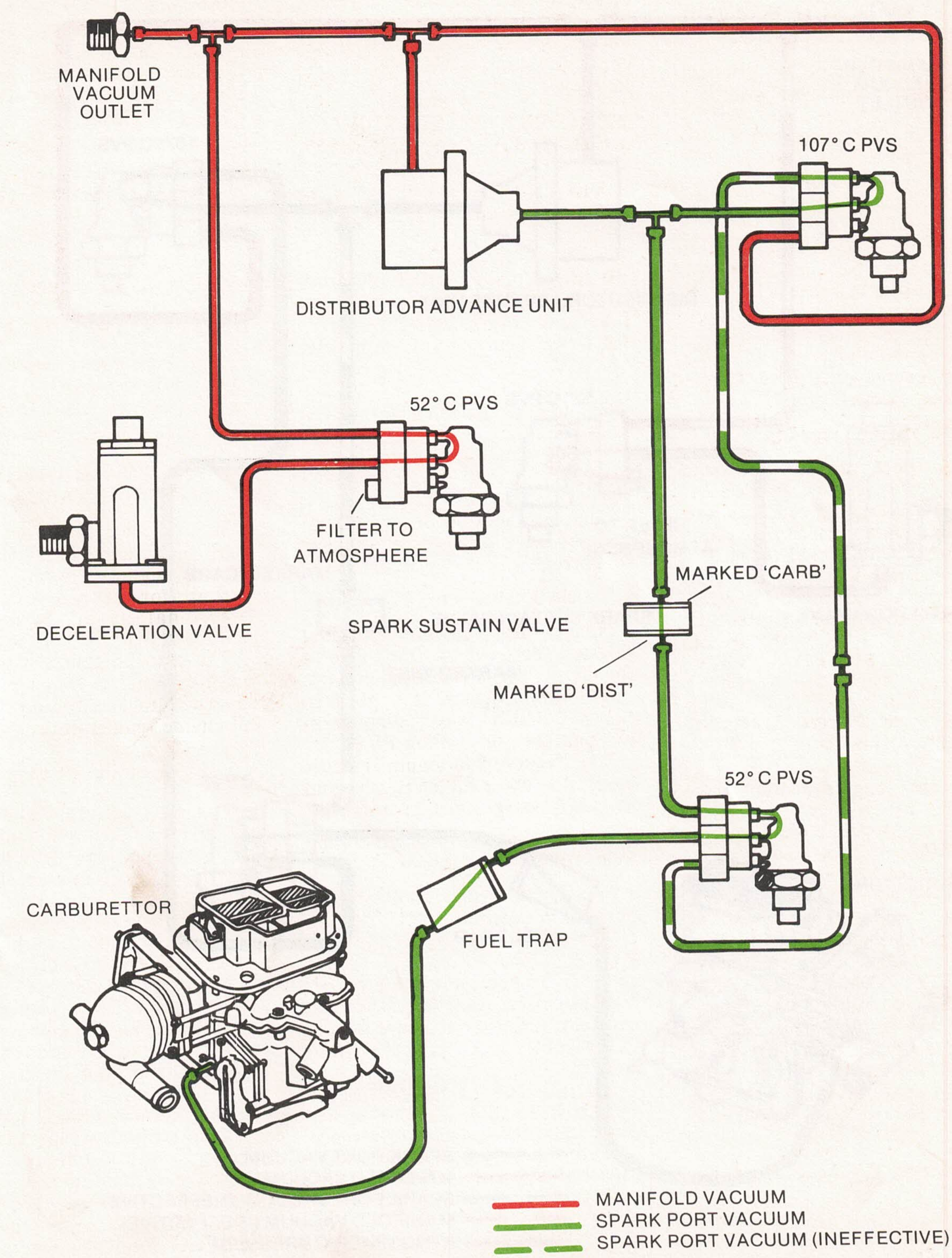
SPARK DELAY VALVE

For good driveability, vacuum advance is required under part throttle conditions, to allow time for the air/fuel mixture to burn. However, when spark port vacuum increases, due to a change in throttle position, the distributor advances quickly, but additional time is required to stabilize the air/fuel mixture flow. These transient conditions can result in more rapid and erratic combustion and consequent high HC and NOx levels.

Introducing a spark delay valve in this system slows the rate of vacuum advance when changing to a part throttle condition. This ensures the vacuum advance and the change in air/fuel mixture flow are more compatible, resulting in more complete combustion and lower emissions.

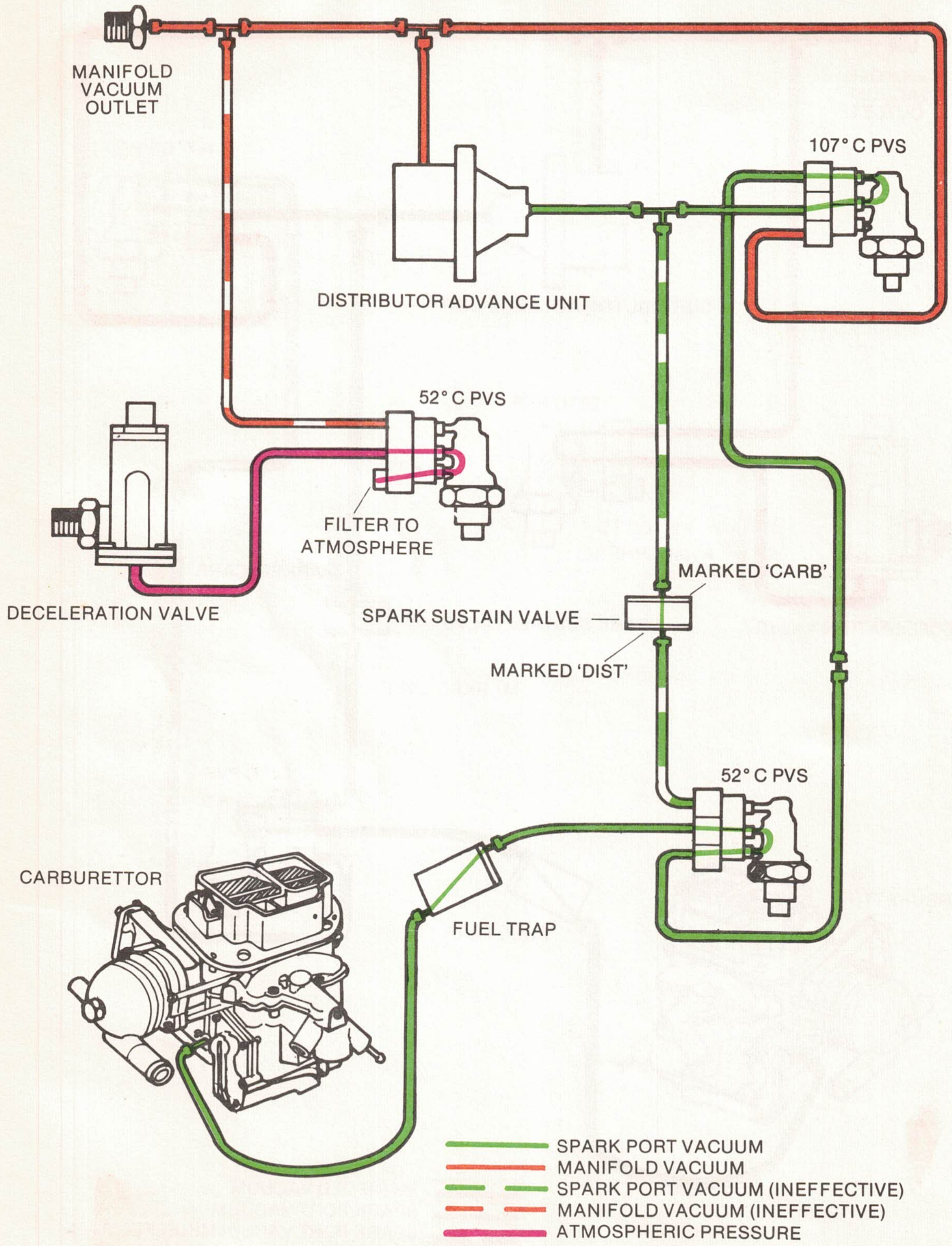
FUEL TRAP

This component is used to prevent fuel contamination of the vacuum system.



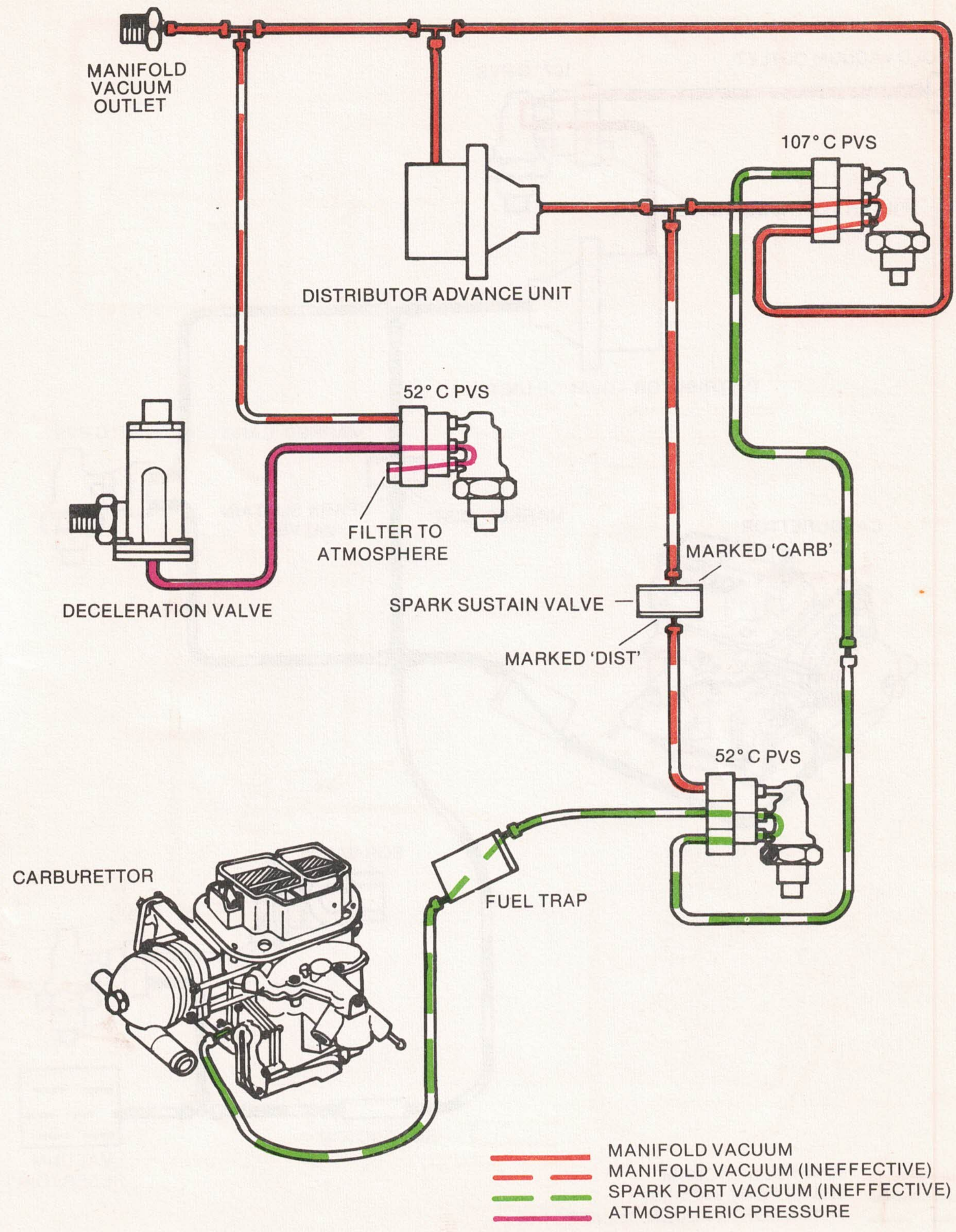
2.0 Litre Manual COLD ENGINE

Fig. 25.



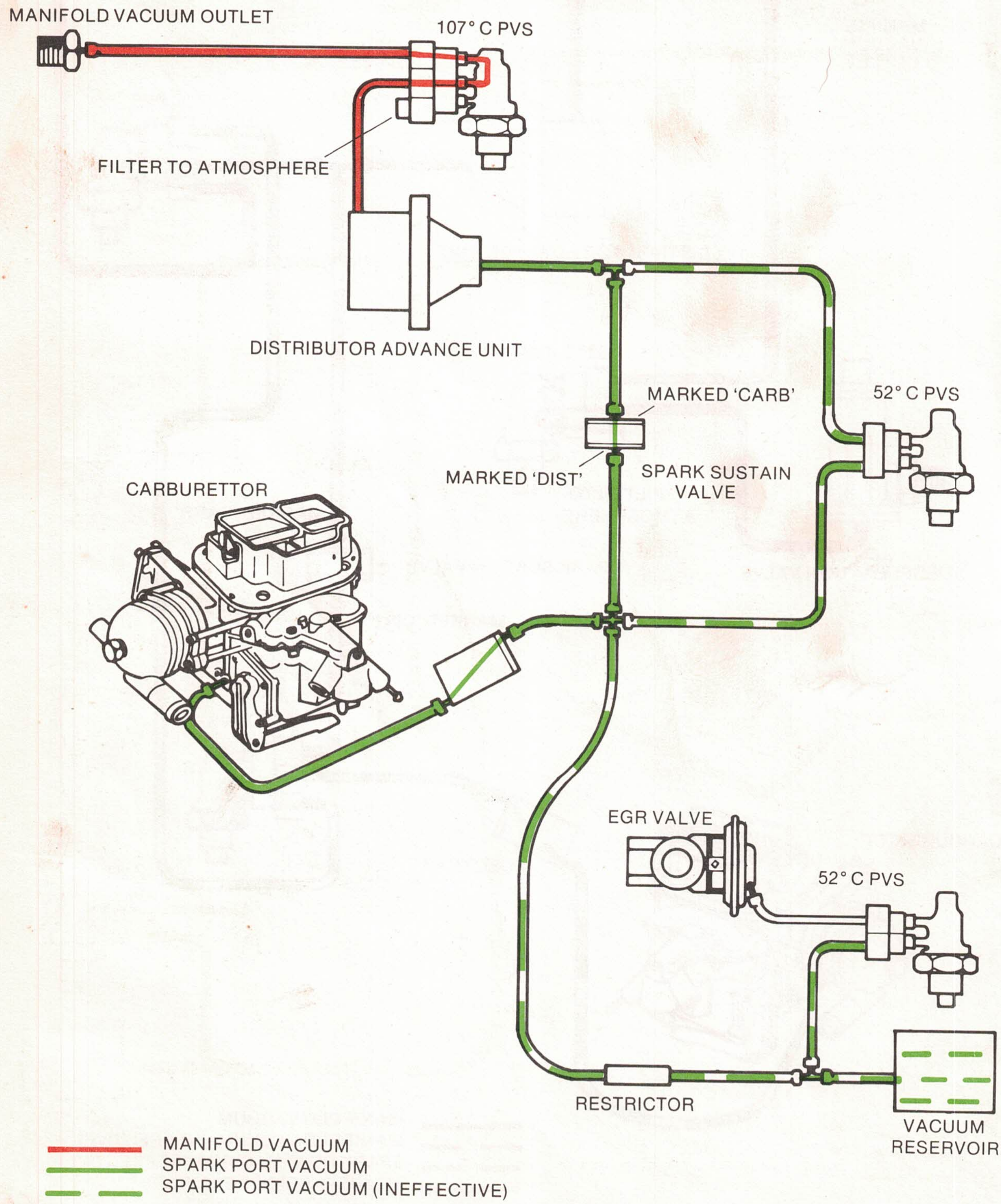
2.0 Litre Manual ENGINE AT NORMAL OPERATING TEMPERATURE

Fig. 26.



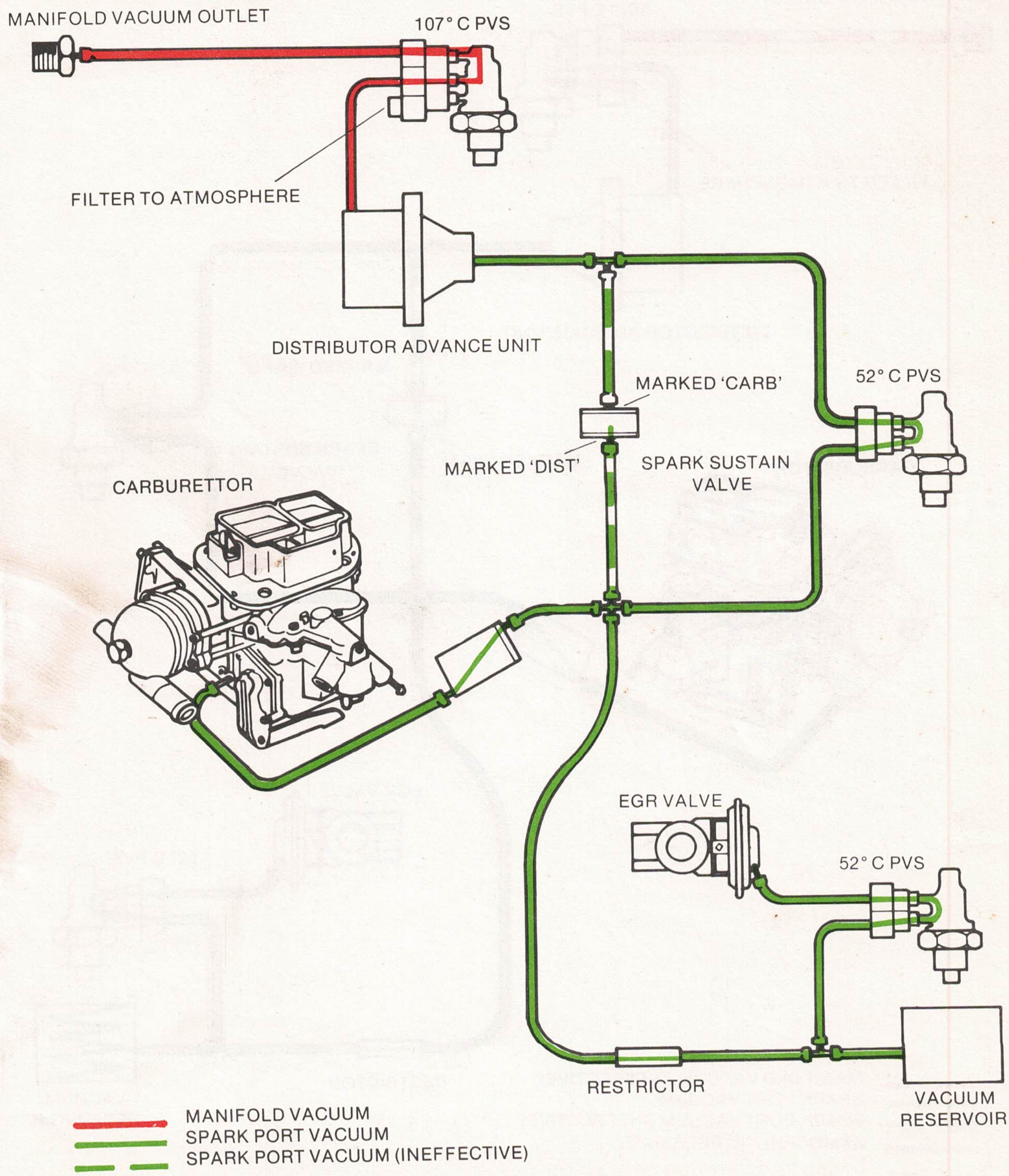
2.0 Litre Manual POTENTIAL OVERHEAT CONDITION

Fig. 27.



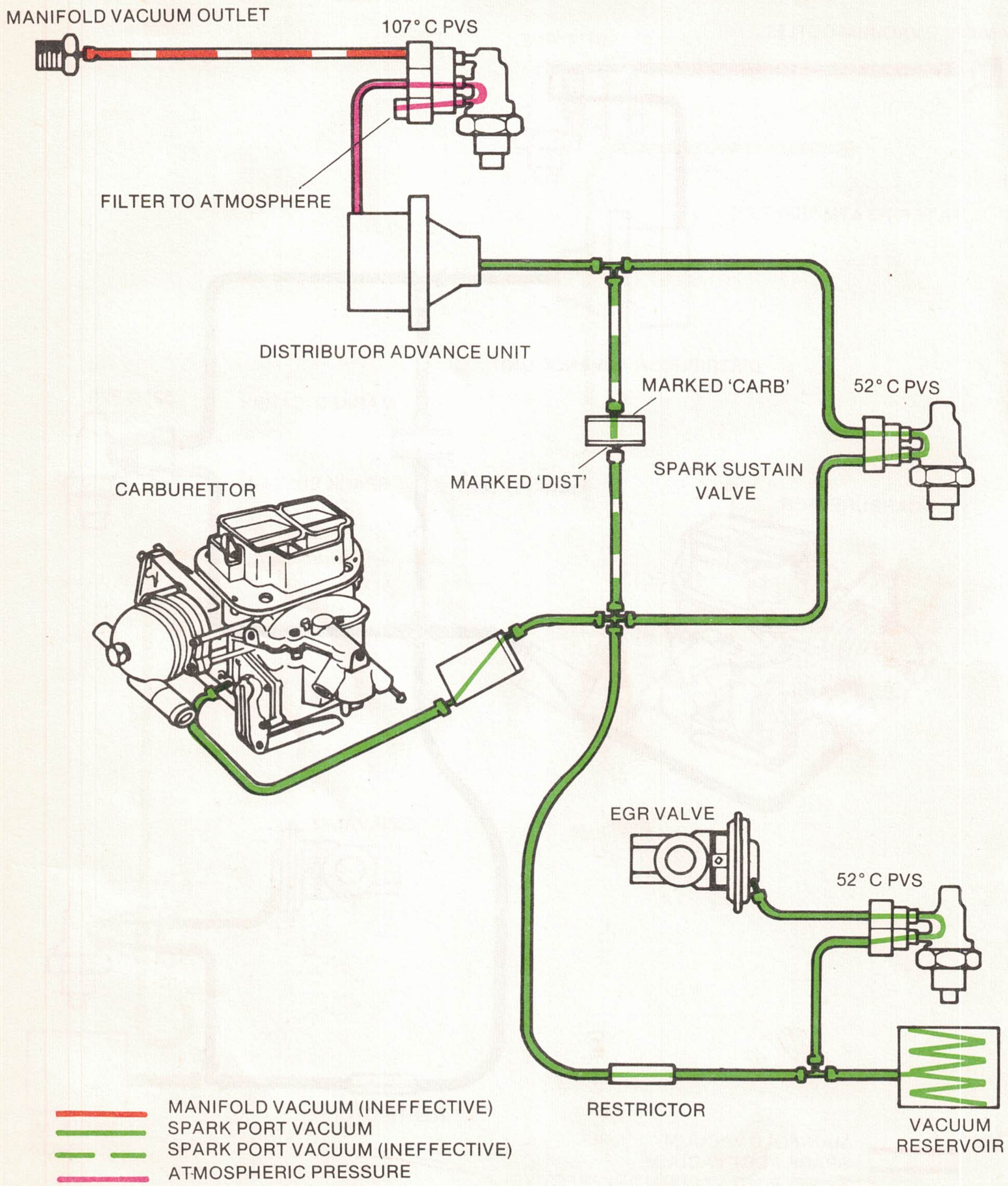
2.0 Litre Automatic COLD ENGINE

Fig. 28.



2.0 Litre Automatic ENGINE AT NORMAL OPERATING TEMPERATURE

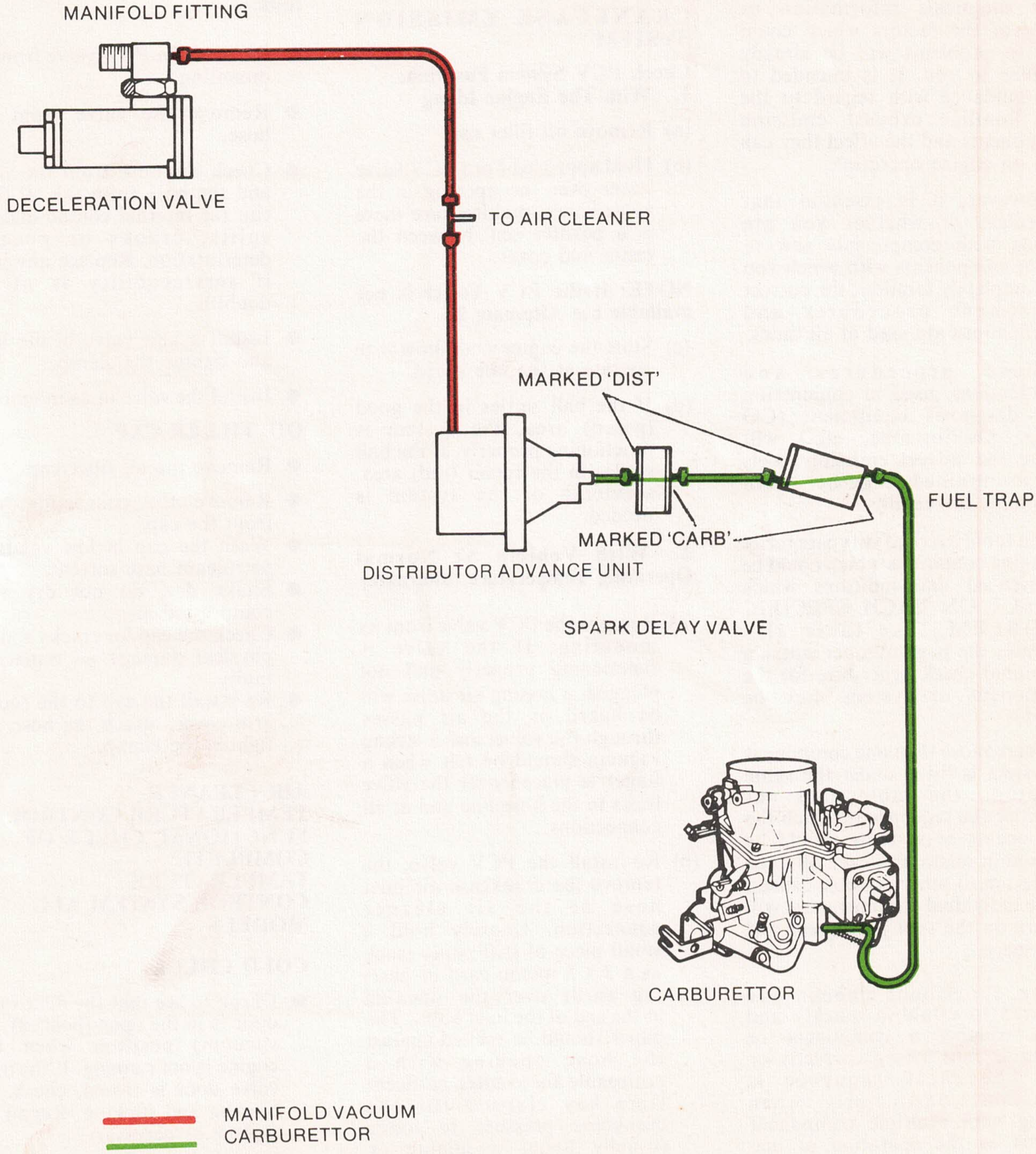
Fig. 29.



2.0 Litre Automatic POTENTIAL OVERHEAT CONDITION

Fig. 30

VACUUM CIRCUIT SCHEMATICS



1.6 Litre Manual ENGINE UNDER ALL OPERATING CONDITIONS

Fig. 31 — New modified current Escort to latest level.

EMISSION SYSTEM FAULT DIAGNOSIS AND FUNCTIONAL CHECKS

Fault diagnosis requires a methodical, logical approach if effective low cost repairs are to be achieved. This section does not attempt to provide detailed engine fault diagnosis information as many of the factors which could lead to problems will be already familiar to you. It is intended to give guidance with regard to the less familiar exhaust emission components and the effect they can have on engine operation.

However, it is essential that regardless of whether you are dealing with components new to you or components with which you are completely familiar, the correct adjustment procedures and specifications are used at all times.

These procedures and specifications, used in conjunction with diagnosis equipment (CO meter, Oscilloscope, etc.) will ensure the correct emission levels are maintained together with acceptable driveability.

The table overleaf lists categories of engine conditions which could be experienced and indicates which EFFECT ON EACH SPECIFIC PROBLEM. The table also indicates the page number where a functional check procedure for the component or system may be found.

Where more than one component or system is listed under the same symptom, the table does not prioritise the sequence in which the components or systems should be checked in relation to each other or in relation to other possible causes, as the individual circumstances will require on the spot judgement and experience.

The functional checks are designed to establish quickly and easily whether a component or system is functioning correctly or not. The check sequence is important, particularly when dealing with multiple component systems as the operation of one component is, in many cases, dependent on the correct operation of another component in the system. The majority of components dealt with in this section are sealed units which, if malfunctioning, can only be renewed. Where adjustments can be made, (as in the case of carburettor idle settings) the correct adjustment procedure is contained within the functional check.

CRANKCASE EMISSION SYSTEM

Check PCV System Function:

1. With The Engine Idling

(a) Remove oil filler cap.

(b) Hold approved Ford PCV valve tester over the opening in the valve cover, making sure there is a positive seal between the tester and cover.

NOTE: If the PCV Tester is not available use Alternate 2.

(c) Start the engine and allow it to operate at the idle speed.

(d) If the ball settles in the good (green) area, the system is functioning properly. If the ball settles in the repair (red) area, servicing of the system is needed.

2. With Vehicle At Normal Operating Temperature (alternate)

(a) Remove the PCV valve from its mounting. If the valve is functioning properly and not plugged, a hissing air noise will be heard as the air passes through the valve, and a strong vacuum should be felt when a finger is placed over the valve leaks in the hose line and at all connections.

(b) Re-install the PCV valve, the remove the crankcase air inlet hose at the air cleaner connection. Loosely hold a small piece of stiff paper (such as a 3 x 5 memo card or parts tag card) over the opening at the end of the inlet holes. The paper should be sucked against the hose opening with a noticeable force **after** sufficent time has elapsed for the crankcase pressure to lower (usually about a minute or more).

3. With The Engine Stopped

(a) Remove the PCV valve from its mounting and shake it. A metallic clicking noise should be heard, indicating the valve is free.

If the ventilation system passes the above tests, the system is functioning and no further service is required. If it fails any of the tests:—

- Remove the PCV valve from its mounting.
- Remove the valve from the hose.
- Check the hose from the valve and the hose from the oil filler cap for internal contamination, splits, cracks or general deterioration. Replace any hose if serviceability is at all doubtful.
- Install a new valve in the hose and tighten the clamp.
- Install the valve in its mounting.

OIL FILLER CAP

- Remove the oil filler cap.
- Remove the connecting hose from the cap.
- Wash the cap in low volatility petroleum base solvent.
- Shake dry, do not dry with compressed air.
- Check the cap for cracks and/or physical damage — replace if faulty.
- Re-install the cap to the rocker arm cover, attach the hose and tighten the clamp.

AIR CLEANER TEMPERATURE CONTROL FUNCTIONAL CHECK OF COMPLETE TEMPERATURE CONTROL SYSTEM ALL MODELS

COLD CHECK:

- Check to see that the duct valve door is in the open (heat off, no vacuum) position when the engine is not running. If the duct valve door is closed, check for binding and sticking. Repair or replace as necessary.
- With the engine and inlet system cold and the engine at idling speed, the duct valve door should be closed or in the full heat-on position. If the duct

FAULT DIAGNOSIS CHART

PROBLEM SYMPTOM	Engine Operating Temperature	EMISSION SYSTEM COMPONENTS ASSOCIATED WITH SYMPTOM															
		PCV valve	Air cleaner and vacuum delay valve	Carburettor — idle speed/mixture	— fast idle speed	2.0 L only — low vacuum enrichment device	Deceleration valve system — manual only	Exhaust gas recirculation system 2.0 L only	Spark control system — static timing	—centrifugal advance	— vacuum advance	All 2.0 Litre and 1.6 L Manual — vacuum retardation	1.6 L manual only — spark delay valve	2.0 Litre only — spark sustain valve	2.0 Litre only — coolant spark control system	Cold start distributor retard vent system — 2.0 L	Ignition coil. spark plugs, breaker points condition — dwell.
Poor starting	Cold								x							x	x
	Hot		x						x								x
Engine stalling – at idle	Cold	x		x	x		x	x	x								
	Hot	x	x	x			x	x	x								
– on drive away	Cold		x			x		x	x		x		x	x			
	Hot		x			x		x	x		x		x	x			
Poor idle quality	Cold	x	x	x	x		x	x	x								x
	Hot	x	x	x				x	x						x		x
High idle speed at fast idle	Cold				x		x		x			x			x		
at slow idle	Hot			x			x		x			x			x		
Excessive CO emissions at idle	Hot	x		x			x		x			x			x		x
Hesitation and/or flat spots – on acceleration	Cold		x					x	x	x	x			x		x	
	Hot		x					x	x	x	x		x				
– at low speed cruise	Cold	x		x			x	x	x	x	x					x	
	Hot	x		x			x	x	x	x	x						
High fuel consumption	N/A		x					x	x	x	x						x
Loss of power	Cold		x					x	x	x	x			x			x
	Hot		x					x	x	x	x						x
Engine overheating	N/A								x						x		x
Detonation	Hot		x						x						x		x

valve door is not closed, turn off the engine, Cool the temperature sensor artificially using an air line, dry ice, etc.

- Restart the engine. The duct valve door should now be closed with the engine idling. If the valve door is still open check the related vacuum system.

HOT CHECK:

- With the engine at normal operating temperature and correct idling speed, the duct valve door should be open to cold air (under hood ambient). If the duct valve door does not open as the engine reaches normal operating temperature replace the temperature sensor switch.

VACUUM MOTOR TEST

- With the engine idling in a cold condition, i.e. duct valve door closed (heat on), disconnect the vacuum at the vacuum motor. The valve door should "snap" open to the cold air position indicating correct operation of the vacuum motor.

DECELERATION VALVE — CHECK AND ADJUST

2.0 Litre and 1.6 litre manual

Preliminary Checks:

1. With the engine at normal operating temperature, be sure that the idle RPM and initial ignition timing are to specification. Excessive initial timing and/or too rich a fuel mixture can cause the decel valve to "hang" open.
2. Remove the carburettor air cleaner and check the decel valve hoses, connections and valve for anything not normal. Replace any parts that do not pass inspection.
3. Check for a leaking diaphragm by placing a finger over the hole in the bottom of the valve. If the idle improves noticeably the diaphragm is leaking, replace.
4. Disconnect and plug the hose from the carburettor and cap the open nipple on the decel valve.

Operate the engine in neutral for 5 seconds at 3000 RPM.

Release the throttle and note if the engine returns to idle immediately. If the idle does not return, check for any linkage hangup before proceeding to vacuum check.

DECELERATION VALVE — CHECK AND ADJUST

1. Disconnect the deceleration valve to carburettor hose at the deceleration valve end and connect a vacuum gauge between the hose and the valve.

NOTE: The inside diameter of any connections and hoses must not be less than the deceleration valve intake diameter, and the length of hose must not exceed 1.5 m (60 in.).

2. Start the engine and increase its speed to 3000 RPM. Hold this speed for two or three seconds. Then release the throttle.

3. Observe the time interval between throttle release and the deceleration valve closing.

NOTE: When the throttle is released vacuum will be indicated on the gauge. This vacuum will gradually decrease with engine speed until it reaches zero, at which time the valve will be closed. The time interval should be as specified for the vehicle.

4. If the time interval is outside the specified limits, remove the plastic sealing plug from the top of the valve and adjust the timing as necessary.

NOTE: If the time interval is less than specified, back off the adjusting screw. If the time interval is more than specified screw in the adjusting screw. The limits of travel for the adjusting screw are shown in Fig. 33. Under no circumstances should these limits be exceeded.

5. Fit a new sealing plug.

6. Remove the vacuum gauge and re-connect the carburettor to deceleration valve hose.

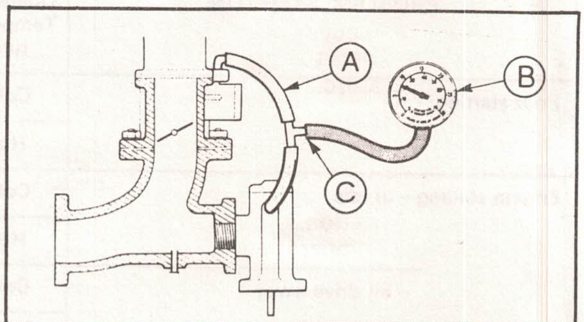


Fig. 32 — Test layout for the Deceleration valve

A – Fuel/air supply hose.
B – Vacuum gauge.
C – 'T' connection.

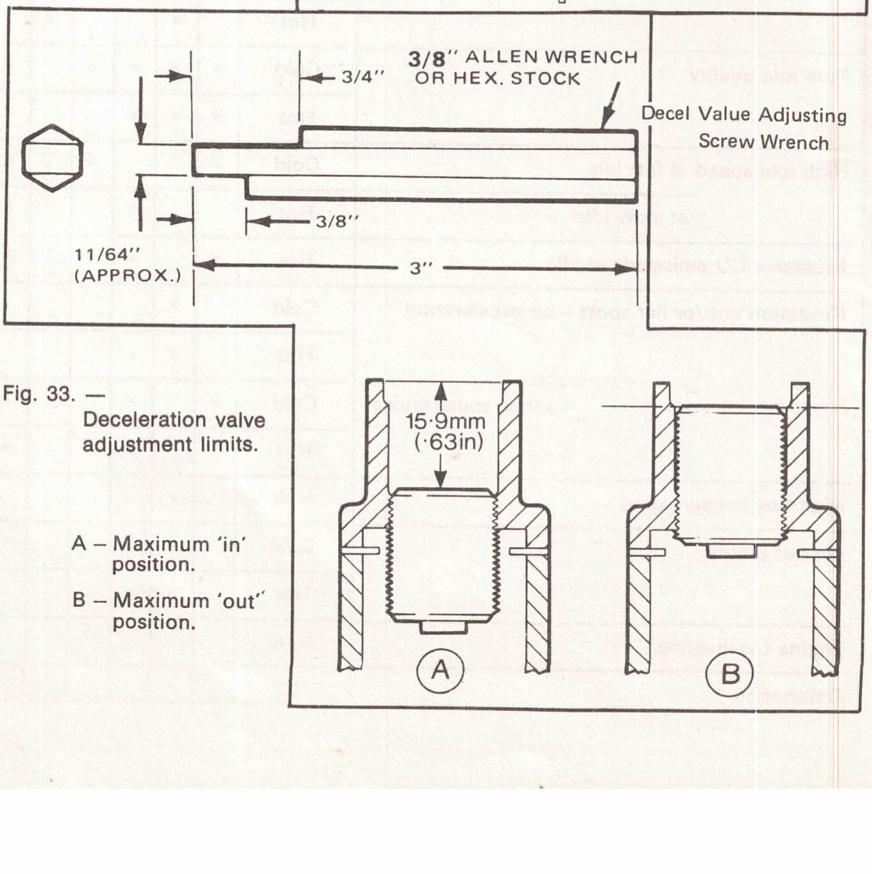


Fig. 33. — Deceleration valve adjustment limits.

A – Maximum 'in' position.
B – Maximum 'out' position.

2.0 LITRE EGR (EXHAUST GAS RECIRCULATION) SYSTEM

(a) EGR Valve — Check

The EGR valve may be checked off the vehicle or in-situ using the appropriate procedure as detailed below:

(i) Valve removed. Connect a hand vacuum pump directly to the valve and operate the pump to achieve 200 mm (8 in.) of mercury, visually noting the operation of the valve. At this vacuum, the valve should be fully open and should remain open for at least 30 seconds.

(ii) Valve in installed position.

1. Disconnect and plug the EGR valve vacuum supply pipe and connect a hand vacuum pump shown in Fig. 34.

2. Operate the pump to achieve a vacuum of 200 mm (8 in.) of mercury. Assuming the vacuum pipe and gauge are in good working order, the EGR valve should hold the vacuum for at least 30 seconds.

3. Release the vacuum, start the engine, warm up to normal operating temperature, and allow the engine to idle.

4. With the engine at idle, operate the hand pump to achieve 200 mm (8 in.) of mercury and note any idle speed variation.

If the valve is operating, the engine idle speed should drop and the idle quality become lumpy. If the idle speed and quality remain unchanged the valve should be renewed.

5. Switch off the engine, disconnect the hand pump and reconnect the vacuum line. Fig. 35.

CLEAN EGR VALVE AND CHECK PERFORMANCE (includes remove and install)

- Unscrew the pipe nut and disconnect the exhaust gas pipe at the E.G.R. valve.
- Detach the vacuum hose at the EGR valve.
- Unscrew the adaptor nut and detach the E.G.R. valve from the manifold.
- Clean the restrictor port at the bottom of the valve using a wire brush or a non-ferrous scraper taking care not to open out the restrictor hole diameter.
- The valve seat may be cleaned by utilising a spark plug abrasive cleaner.
- Apply vacuum to the diaphragm to open the valve to facilitate cleaning. Introduce the abrasive blast to the valve port.
- Maintain vacuum on the diaphragm and blast the valve with clean air to remove all traces of abrasive from the ports.
- Using a hand operated vacuum pump, apply a vacuum of 50 to 250 mm (2 to 10 in.) Hg to the diaphragm. The valve must move evenly and quietly through its stroke. Renew the valve if it is sticky, jerky in motion or noisy.

Note:— Stem should start to move at approx. 25—50 mm (1-2 ins.) Hg applied vacuum. The valve should be fully open at 127 mm (5 ins.) Hg applied vacuum giving a stem travel of approx. 4 mm (0.16 ins.). Maximum stem travel should be 7.5 mm (0.3 ins.)

- Remove adaptor from inlet manifold and clean outlet ports if necessary.
- Connect the exhaust gas pipe and the vacuum hose, to the EGR valve.
- Check the operation of the PVS.

Vacuum reservoir and restrictor — Check

1. Visually inspect the restrictor to ensure the unit is not split and the brass restrictor is correctly positioned.

2. Disconnect the reservoir vacuum supply pipe and connect a vacuum hand pump.

3. Apply a vacuum of 250 mm (10 in.) of mercury to the reservoir. The reservoir should hold the vacuum for at least 30 seconds. Should the vacuum drop, the reservoir should be renewed.

(c) Check the operation of the PVS Fig. 35.

DISTRIBUTOR CENTRIFUGAL ADVANCE

1. Connect a timing light and tachometer in accordance with the manufacturers instructions.

2. Disconnect and plug the distributor vacuum line(s).

3. Start the engine, and with the engine speed set at that specified for ignition setting, note the ignition timing.

4. Increase the engine speed to 2000 rev/min. and recheck the ignition timing. The difference between this figure and the figure obtained in operation three corresponds to the amount of centrifugal advance.

5. Compare the centrifugal advance figure with the figure for the distributor under test. If it is within specification the centrifugal advance is functioning correctly. If

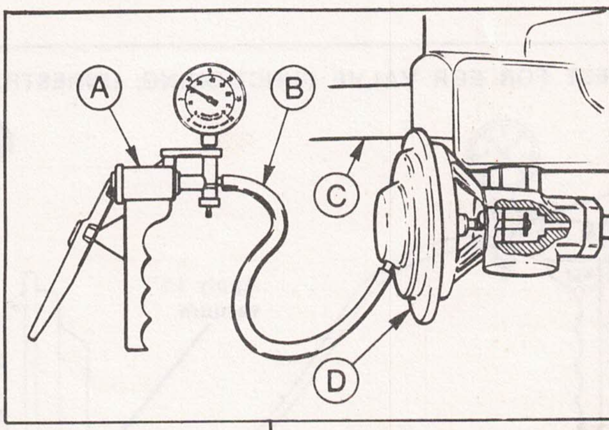


Fig. 34. — EGR Test lay-out.

A – Vacuum hand pump.
B – Vacuum hose.
C – Inlet manifold.
D – EGR valve.

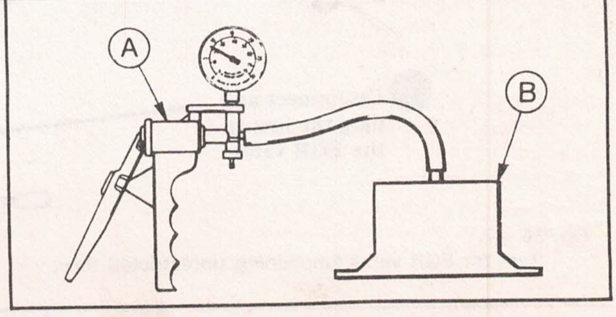


Fig. 35. — Reservoir test layout.

A – Vacuum hand pump.
B – Reservoir.

not the centrifugal advance mechanism should be examined for sticking weights and broken return springs.

6. Switch off the engine, disconnect the test equipment and reconnect the distributor vacuum line(s).

VACUUM ADVANCE — CHECK

1. Connect a timing light and tachometer in accordance with the manufacturers instructions.

2. Disconnect and plug the distributor vacuum line(s).

3. Start the engine and with the engine speed at 2000 rev/min. note the ignition timing.

4. Reconnect the vacuum advance line to the distributor vacuum advance connection, and again with the engine speed at 2000 rev/min. note the ignition timing.

5. The difference between the ignition timing figures measured in operations three and four corresponds to the amount of vacuum advance. Compare this figure with the figure for the distributor under test. If the vacuum advance figure is within specification the vacuum advance unit is functioning correctly. If not, the unit should be examined and if necessary renewed.

6. Switch off the engine, disconnect the test equipment and for dual diaphragm distributors reconnect the distributor secondary (retard) diaphragm vacuum line.

VACUUM RETARDATION — CHECK (DUAL DIAPHRAGM DISTRIBUTOR ONLY)

1. Disconnect and plug the distributor vacuum lines and connect a hand vacuum pump to the vacuum retard connection of the distributor.

2. Connect a timing light in accordance with the manufacturers instructions.

3. Start the engine and note the ignition timing.

4. Using the hand vacuum pump apply a vacuum of 400 mm (16 in.) of mercury to the vacuum retard connection of the distributor and note the ignition timing.

5. The difference between the timing obtained in operations three and four should be the amount specified for the distributor on test. If it is inside specification the vacuum retard mechanism is functioning correctly. If not, the vacuum unit should be examined and if necessary renewed.

6. Switch off the engine, disconnect the test equipment and reconnect the vacuum lines.

VACUUM DELAY VALVE TEST

Vacuum delay valves are used in two applications:—

(a) as a Spark Sustain valve (2.0 auto. and manual trans.)

(b) as a Spark Delay valve (1.6 manual trans.)

The same test procedure is used for both valves.

CHECKING SPARK SUSTAIN AND VACUUM DELAY VALVES

1. Remove the valve from the vacuum circuit.

2. Connect the valve into the test circuit illustrated, with the black side of the valve towards the vacuum source and the coloured side towards the vacuum gauge. (see Fig. 37).

NOTE: It is necessary to have a vacuum reservoir of sufficient volume to maintain a reasonable vacuum level at the vacuum source. This can be achieved using two EGR vacuum reservoirs (Part No. 75EB-9E453-CA) and a double "T" piece (Part No. 75TF-12224-AA) as illustrated. Also for correct results the length of hose between the valve and vacuum gauge must be 600 mm (24.0 in.).

3. With the on/off valve or clamp closed, use the hand vacuum pump to apply a vacuum of 250 mm

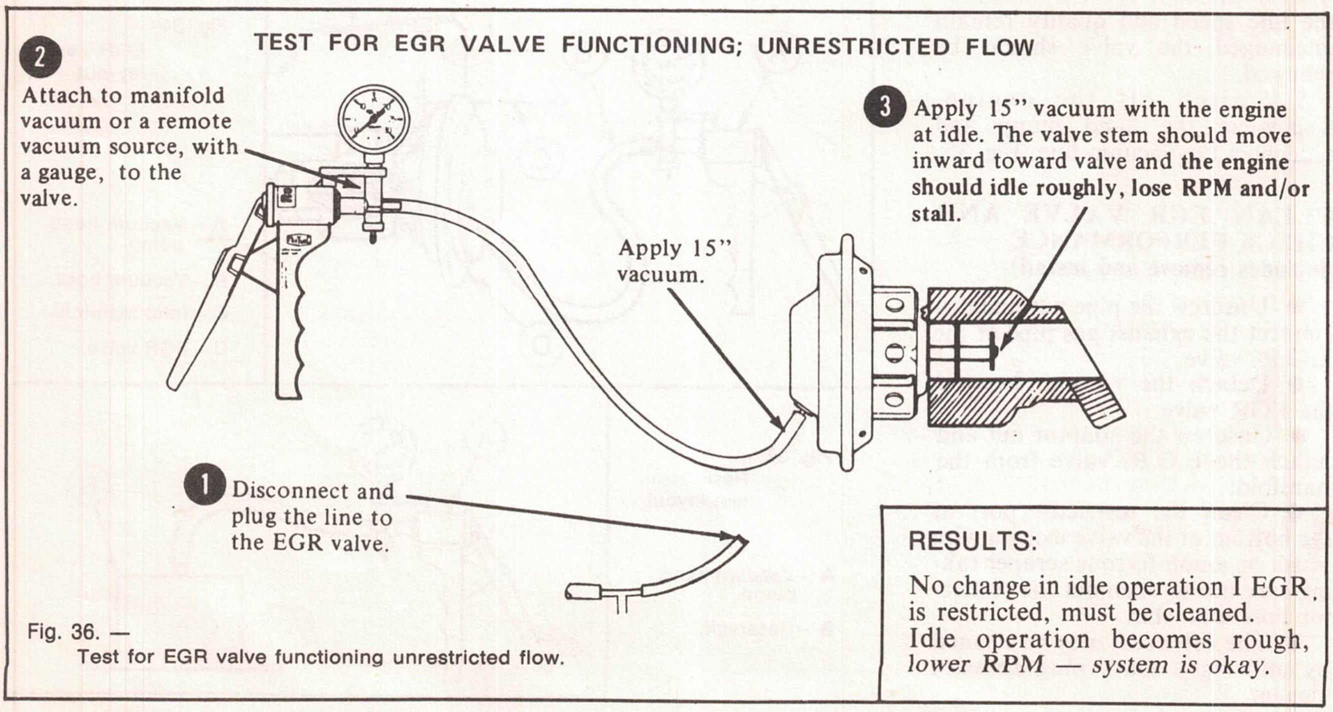


Fig. 36. — Test for EGR valve functioning unrestricted flow.

(10 in.) of mercury to the reservoir side of the test circuit.

4. Open the valve or clamp and note the time taken for the vacuum gauge reading to reach 200 mm (8.0 in.) of mercury. The time should be as specified for the valve under test.

5. If the results of the checks are satisfactory refit the valve.

NOTE: Fit spark sustain valve with "carb" (black) side towards the distributor.

Fit vacuum delay valve with 'carb' (black) side towards the vacuum motor on the air cleaner.

6. Check all vacuum lines and connections for security and damage.

TWO PORT PORTED VACUUM SWITCH

2.0 Litre Auto Transmission.

- Ensure that the engine coolant temperature is at least 10°C below the specified operating temperature of the valve.
- Connect a hand operated vacuum pump to the lower port of the PVS.
- Operate the pump. The valve should be closed (i.e. it should maintain the vacuum applied).
- Start the engine and bring it to normal operating temperature. Stop the engine.
- Operate the pump. The valve should be open (no vacuum can be obtained).
- Remove the vacuum and re-connect the vacuum hose connector.

THREE PORT PORTED VACUUM SWITCH

2.0 Litre Auto and Manual

- Ensure that the engine coolant temperature is at least 10°C below the specified operating temperature of the valve.
- Disconnect the vacuum hose connector from the PVS.
- Connect a hand operated vacuum pump to the centre port of the PVS. Operate the pump. The valve should be open to the upper port. Check by blocking the upper port with a finger.
- Start the engine and bring it to normal operating temperature.
- Operate the vacuum pump. The valve should now be open to the lower port. Check by blocking the lower port with a finger.
- Remove the vacuum pump and re-connect the vacuum hose connector to the PVS.

NOTE: When checking an idle cooling PVS it will be necessary to warm the engine past the normal operating temperature by restricting the air flow through the radiator to achieve the required temperature to activate the PVS.

The idle cooling PVS has a nominal operating temperature of 107°C (225°F).

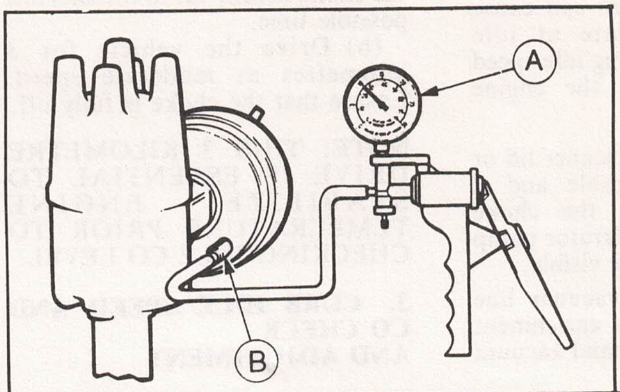


Fig. 37. — Checking vacuum retardation

(Surrounding components omitted for clarity)

A – Hand vacuum pump.

B – Vacuum retard connection.

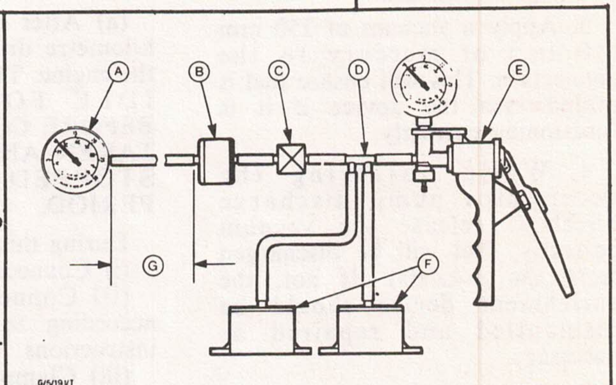


Fig. 38 — Spark sustain/delay valve test circuit.

A—Vacuum gauge.
B—Spark sustain/delay valve.
C—On/off valve or clamp.
D—T piece 75TF-12224-AA
E—Hand vacuum pump.
F—Reservoir 75EB-9E453-CA 2 off.
G—60.0 mm (24.0 m).

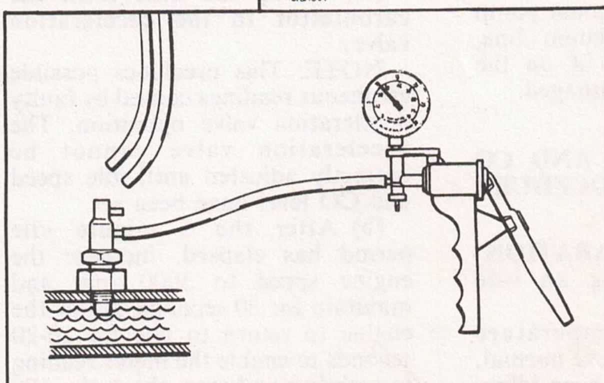


Fig. 39 — Testing the two port PVS.

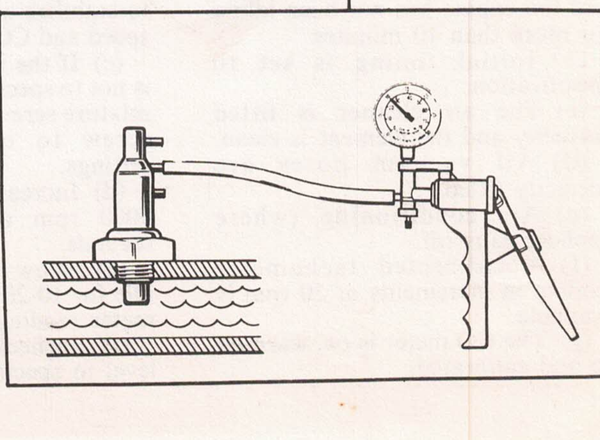


Fig. 40 — Testing the three port PVS.

LOW VACUUM ENRICHMENT (ANTI-STALL) DEVICE — 2.0 Litre only.

NOTE: Before checking the operation of the low vacuum enrichment device, it is essential that the idle speed and mixture adjustment is checked. Incorrect idle speed and mixture can cause the device to operate at idle resulting in a fluctuating idle speed and, in some cases, the engine stalling.

1. Remove the air cleaner lid or air cleaner as applicable and if necessary hold open the choke plates so that the accelerator pump discharge nozzle(s) are visible.

2. Disconnect the vacuum line from the low vacuum enrichment device and connect a hand vacuum pump to the device.

3. Apply a vacuum of 250 mm (10 in.) of mercury to the connection. This will ensure fuel is pulled into the device if it is functioning correctly.

4. While observing the accelerator pump discharge nozzle(s) release the vacuum correctly, fuel will be discharged from the nozzle(s). If not, the enrichment device should be dismantled and repaired as necessary.

5. Disconnect the vacuum pump and reconnect the vacuum line, ensuring it is a good fit on the connector and is not damaged.

CURB IDLE SPEED AND CO LEVEL SETTING PROCEDURE ALL ENGINES

1. PRE-TEST PREPARATION

Before commencing an idle check, ensure that:

(a) The engine temperature gauge is not reading above normal, and the engine has not been idling for more than 10 minutes.

(b) Initial timing is set to specification.

(c) The air cleaner is fitted correctly and the element is clean.

(d) All vacuum hoses are correctly fitted.

(e) Air conditioning (where applicable) is off.

(f) A calibrated tachometer reading in increments of 20 rpm is available.

(g) The CO meter is on, warmed up and calibrated.

2. ENGINE WARM UP

(a) If the engine is not already at normal operating temperature start the engine and allow it to idle until the thermostat opens.

NOTE: If the vehicle is fitted with a manual choke ensure that the choke is fully off in the shortest possible time.

(b) Drive the vehicle for 3 kilometres at moderate speed. Ensure that the choke is fully off.

NOTE: THIS 3 KILOMETRE DRIVE IS ESSENTIAL TO STABILIZE ENGINE TEMPERATURE PRIOR TO CHECKING IDLE CO LEVEL.

3. CURB IDLE SPEED AND CO CHECK AND ADJUSTMENT

(a) After returning from the 3 kilometre drive **do not** switch off the engine. THE ENGINE MUST IDLE FOR 5 MINUTES BEFORE CO READINGS ARE TAKEN AND MUST NOT BE STOPPED DURING THIS PERIOD.

During this Period:—

(i) Connect the tachometer.

(ii) Connect the CO meter according to the manufacturer's instructions.

(iii) Clamp the hose from the carburettor to the deceleration valve.

NOTE: This precludes possible erroneous readings caused by faulty deceleration valve operation. The deceleration valve cannot be correctly adjusted until idle speed and CO level have been set.

(b) After the 5 minute idle period has elapsed, increase the engine speed to 3000 rpm and maintain for 30 seconds. Allow the engine to return to idle for 10-20 seconds to enable the meter reading to stabilize and then check the idle speed and CO level in neutral gear.

(c) If the idle speed or CO level is not to specification adjust the idle mixture screw and/or the idle speed screw to obtain the required settings.

(d) Increase the engine speed to 3000 rpm and maintain for 30 seconds.

(e) Allow the engine to return to idle for 10-20 seconds to enable the meter reading to stabilize.

(f) Recheck idle speed and CO level to specification.

(g) If further adjustment is required repeat operations (c) to (f) until the correct specifications are achieved.

CAUTION: if total idle time exceeds 12 minutes the engine temperature must be restabilized by driving the vehicle for a further 3 kilometres and then allowing the engine to idle for 5 minutes before continuing adjustment.

(h) When the correct settings have been achieved remove the clamp from the deceleration valve hose and disconnect the tachometer and CO meter.

FAST IDLE SPEED

Check and re-set if not to specification — 2.0 Litre — Automatic Choke.

- Ensure that the engine is at normal operating temperature.

- Remove the air cleaner and plug the vacuum line.

- Locate the fast idle cam in the phase point position as follows: Hold the throttle partially open and position the fast idle cam so that the fast idle adjusting screw locates on the mid-section of the snail cam. Release the throttle to hold the cam in this position and manually push the choke plates down until the step on the cam jams against the adjusting screw. Release the choke plates.

- Connect a tachometer to the engine.

- Without touching the throttle, start the engine, allow it to stabilize and note the fast idle speed.

- Adjust as necessary by screwing the fast idle adjustment screw in or out.

NOTE: After adjusting the screw, ensure that the cam has not moved by pushing down the choke plates until the step on the cam jams against the adjusting screw.

- Stop the engine and re-fit the air cleaner and vacuum tube.

- Start the engine and re-check the curb idle speed. Open the throttle slightly to release the fast idle cam before checking the curb idle speed. Stop the engine and remove the tachometer.

CARBURETTOR FAST IDLE SPEED CHECK AND RESET IF NOT TO SPECIFICATION

1.6 Litre (Manual Choke.)

● Ensure that the engine is at normal operating temperature.

● Remove the air cleaner and plug the vacuum line. Connect a tachometer to the engine.

● Manually hold the choke plate fully open and operate the choke mechanism as far as possible without altering the choke plate position. This will be approximately one-third of the total choke control travel.

● Using a screwdriver to hold the choke fully open, start the engine, allow the speed to stabilize and note the speed.

● Stop the engine and adjust the linkage as required by bending the throttle lever tag.

● Start the engine and recheck the fast idle speed.

● Stop the engine and refit the air cleaner. Correct the vacuum line.

● Open the throttle slightly to release the fast idle cam. Start the engine and recheck the curb idle speed, readjust if required.

● Stop the engine and remove the tachometer.

CARBURETTOR FAST IDLE SPEED CHECK AND RESET IF NOT TO SPECIFICATION

1.6 Litre (Automatic Choke.)

● Ensure that the engine is at normal operating temperature.

● Remove the air cleaner and plug the vacuum line. Connect a tachometer to the engine.

● Partially open the throttle, locate the fast idle cam in the fast idle position and release the throttle. The "V" mark on the cam should line up with the throttle lever tag.

● Check that the choke is fully open, start the engine without altering the throttle position and note the fast idle speed.

● Stop the engine and adjust as necessary by bending the tag on the throttle lever.

● Start the engine and recheck the fast idle speed.

● Stop the engine. Refit the air cleaner and connect the vacuum line.

● Open the throttle slightly to release the fast idle cam. Start the engine and recheck the curb idle speed, readjust if required.

● Stop the engine and remove the tachometer.

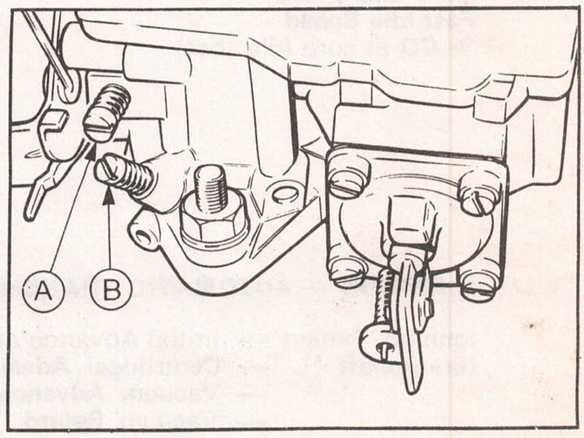


Fig. 41 — Motorcraft (1V) carburettor

A – Idle speed adjusting screw.

B – Mixture adjusting screw.

EXHAUST EMISSION SPECIFICATIONS

1.6 LITRE ENGINE — AUTOMATIC TRANSMISSION

Ignition Timing — Static	6° ± 2° BTDC @ 500 ± 50 RPM
(Crankshaft °) — Centrifugal Advance	12° ± 2° @ 2000 Engine RPM
— Vacuum Advance	6° ± @ 203 mm (8 in.) Hg.
Spark Delay Valve (Yellow No. 10)	6-14 seconds
Spark Delay Valve Cold Lock-out PVS	28°C (82°F)
Curb Idle Speed	800 ± 20 RPM
Fast Idle Speed	1700 ± 100 RPM
% CO at curb idle (hot)	0.5-1.0

SPECIFICATIONS

1.6 LITRE ENGINE — MANUAL TRANSMISSION

Ignition Timing — Static	12° ± 2° BTDC @ 500 ± 50 RPM
(Crankshaft °) — Centrifugal Advance	12° ± 2° @ 2000 RPM
— Vacuum Advance	11° ± 3° @ 254mm (10 in) Hg
— Vacuum Retard	12° ± 2° @ 432mm (17 in) Hg
Curb Idle Speed	800 ± 20 RPM
Fast Idle Speed	1100 ± 100 RPM
% CO at curb idle (hot)	0.5-1.0
Deceleration Valve Timing	2.5-3.5 seconds (from 3000 RPM to curb idle)

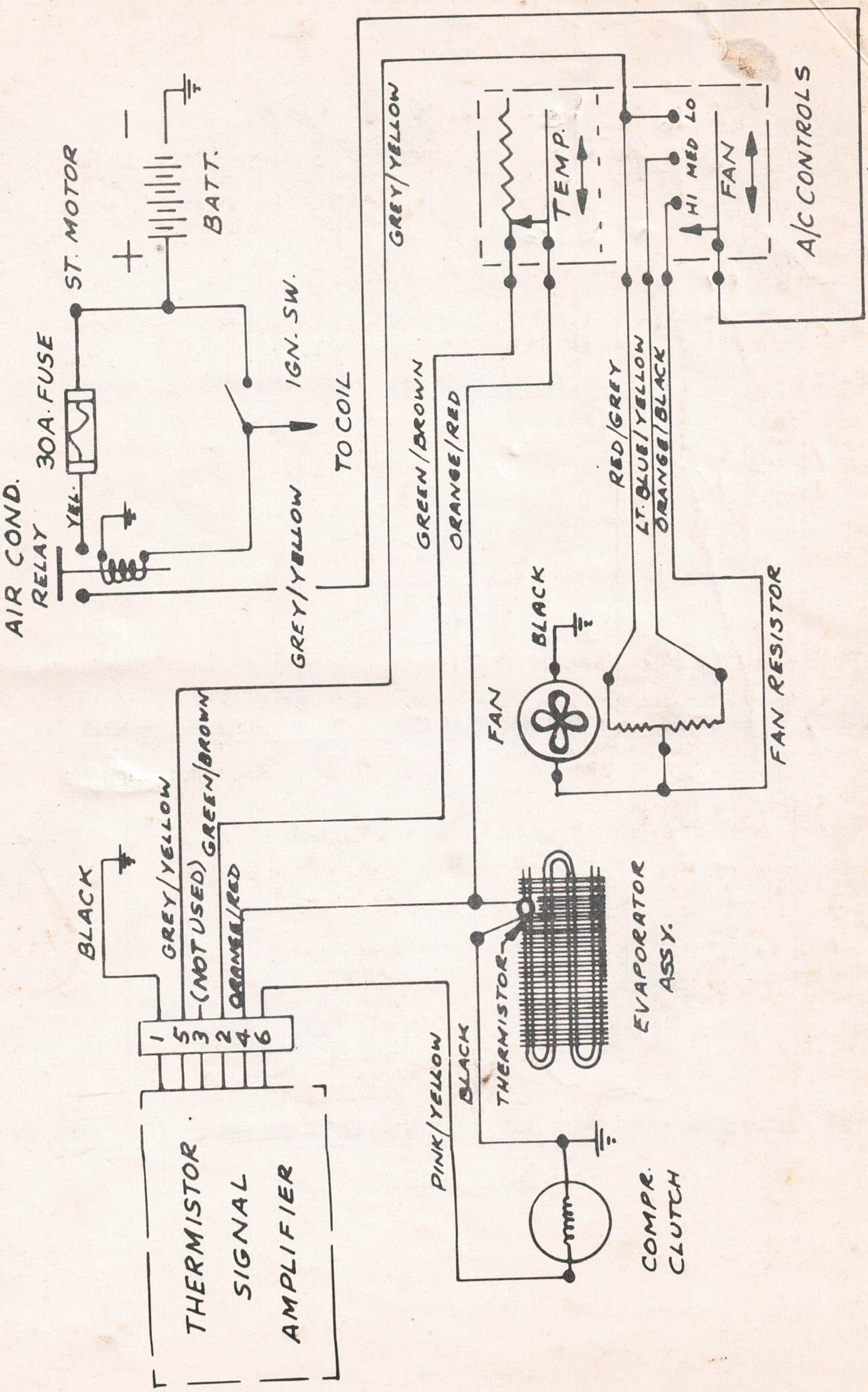
EXHAUST EMISSION SPECIFICATIONS

2.0 LITRE ENGINE — MANUAL TRANSMISSION — H.C.

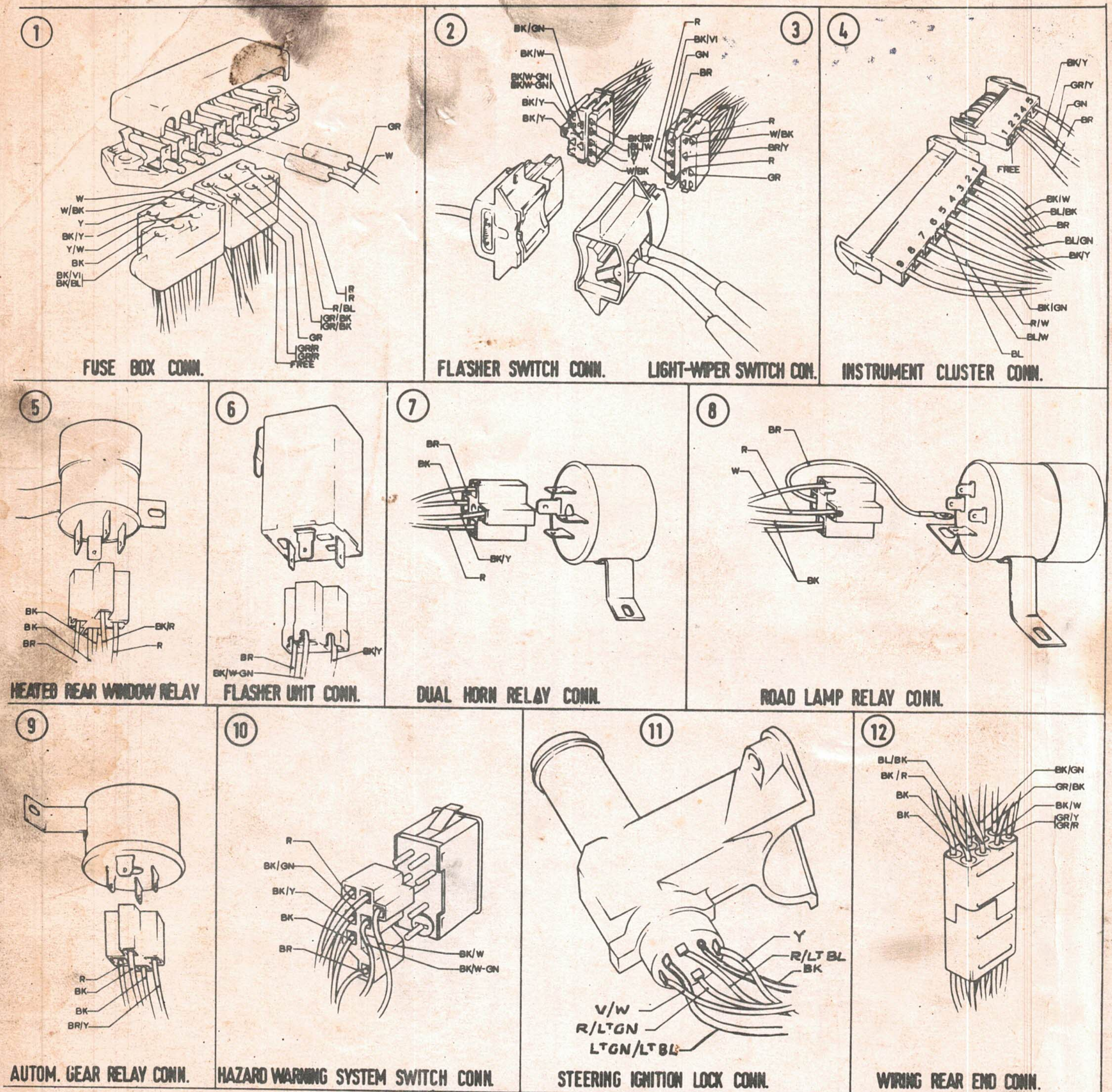
Ignition Timing (crankshaft °)	— Initial Advance at Crankshaft	6° ± 2° BTDC @ 700 ± 50 RPM
	— Centrifugal Advance	11°–15° @ 2000 engine RPM
	— Vacuum Advance	3.5°–7.5° @ 178 mm (7 in.) Hg.
	— Vacuum Retard	4°– 8° @ 330 mm (13 in.) Hg.
Spark Sustain Valve (white)		4–12 seconds
Cold Spark Sustain Valve PVS		53°C (128°F)
Deceleration Valve Timing		2.5-3.5 seconds from 3000 RPM to idle
Deceleration Valve Cold Lock-out PVS		53°C (128°F)
Idle Cooling PVS		107°C (225°F)
Curb Idle Speed		800 ± 20 RPM
Fast Idle Speed		2200 ± 100 RPM
% CO at curb idle (hot)		0.75 — 1.25

2.0 LITRE ENGINE — AUTOMATIC TRANSMISSION — L.C.

Ignition Timing (crankshaft °)	— Initial Advance at Crankshaft	6° ± 2° BTDC @ 700 ± 50 RPM
	— Centrifugal Advance	11°–15° @ 2000 engine RPM
	— Vacuum Advance	3.5°–7.5° @ 178 mm (7 in.) Hg.
	— Vacuum Retard	4°– 8° @ 330 mm (13 in.) Hg.
Spark Sustain Valve (white)		4–12 seconds
Cold Spark Sustain Valve PVS		53°C (128°F)
EGR Valve fully open at		203 mm (8 in.) Hg.
EGR Valve PVS		53°C (128°F)
Idle Cooling PVS		107°C (225°F)
Curb Idle Speed		800 ± 20 RPM
Fast Idle Speed		2100 ± 100 RPM
% CO at curb idle (hot)		0.75 — 1.25



AIR CONDITIONER WIRING SCHEMATICS



LOOM CONNECTIONS