WORKSHOP MANUAL

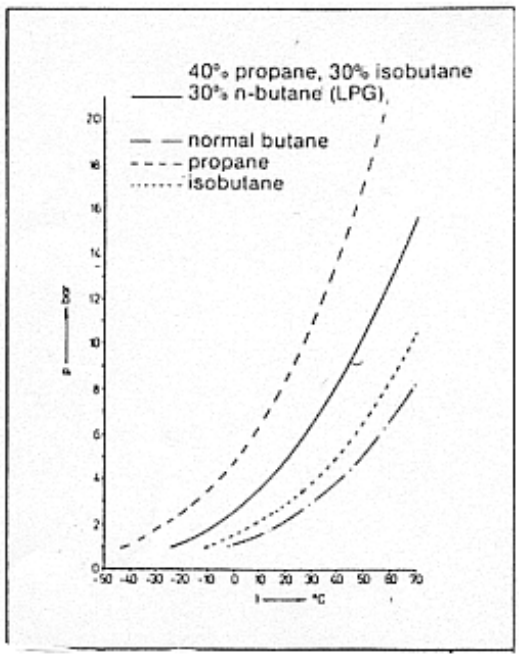
FOR GMS9OE-TYPE EVAPORATOR PRESSURE REGULATOR

Summary:

GMS Groot's Handelsonderneming,
Alkmaar, Holland.
2000

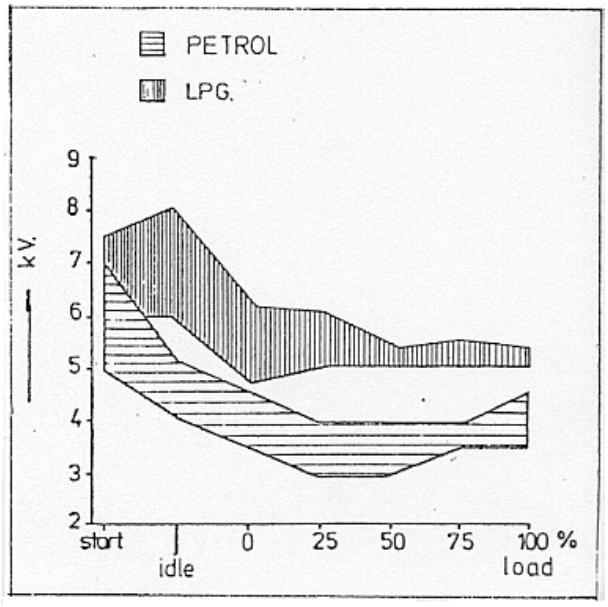
LPG AS AN AUTOMOTIVE FUEL.

LPG is a natural gas and is available from two sources. It is an associated gas and exists. Wherever crude oil is to be found and therefore the greatest source of this energy is directly at the oil wellhead. Its second source is at the refinery where LPG is released from crude oil during the "cracking" process.

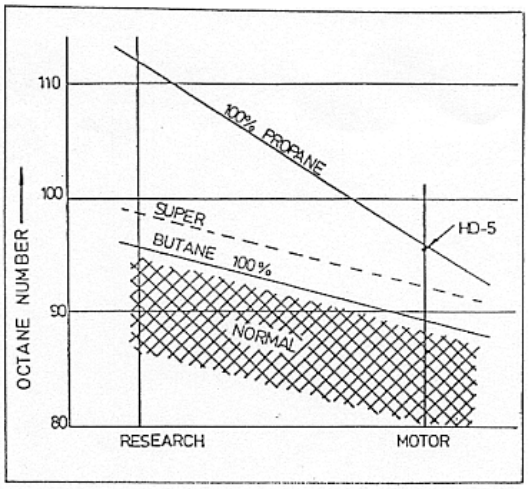


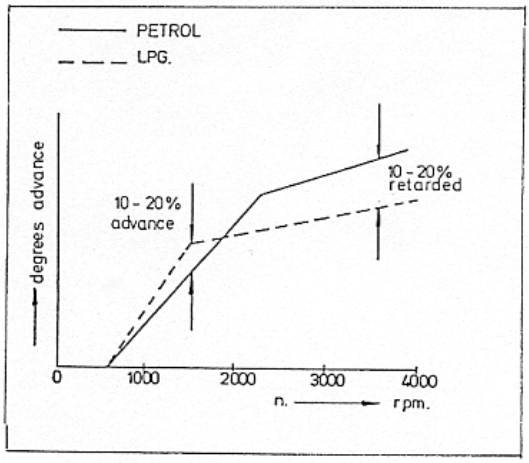
LPG consists of two individual gases each with own properties and uses. The two gases, propane and butane, can be used individually or mixed together as a blend and due to the fact that LPG is comparable with fully vaporised patrol in general no alterations are necessary to a vehicle's engine.
LPG can be introduced directly to an engine with little or no difficulties.

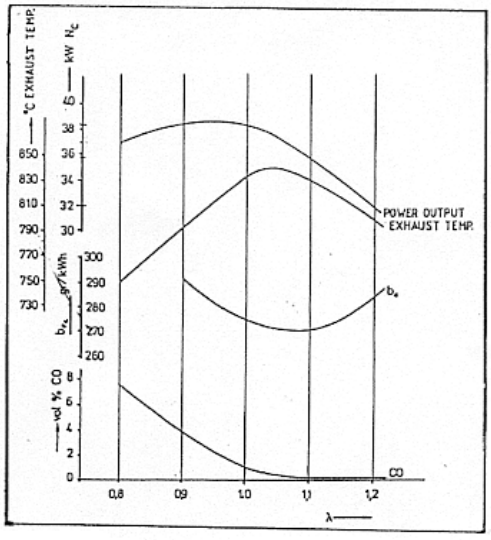
LPG is transported as a liquid in order to gain the best advantage with regard to the vehicle range. To achieve this is carried in a pressure vessel, the pressure inside the storage tank under normal ambient conditions being approximately 3 to 8 bar. When released into the atmosphere, LPG has an expansion factor of 250 times the volume of the storage tank in actual energy terms.



The LPG properties vary slightly from those normally associated with petrol. LPG is a dry gas and as such it has certain insulating properties. It will be found therefore that a higher voltage is necessary at the spark plug in order to generate a spark.
This increase in voltage can be as high as 10 – 15% above the level required for petrol operations. Modern ignition systems are kept in good working order to faciliate good running and starting characteristics on LPG.







LPG has a high octane number and slower combustion speed compared to petrol.

It is usually assumed that the engine's ignition needs greater advance when running on LPG. This is not the case. The ignition advance curve for LPG is different from that required by petrol. At low rpm- figures LPG requires approximately 10% more advance, whilst at high rpm-figures 10 – 20% less advance is required.

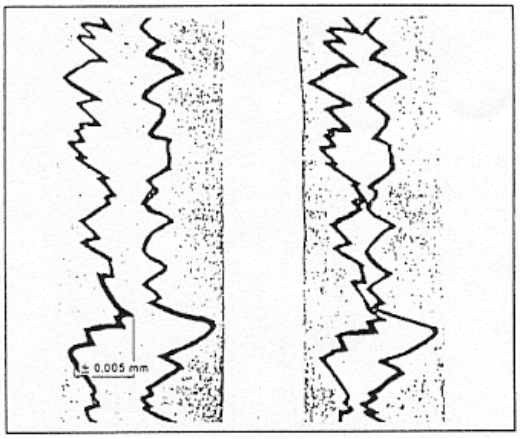
The advance curve for LPG is less critical that for petrol. Due to the fact that most vehicles operate with a dualfuel capability, it would be unwise to make any alterations that would effect the performance of the engine during petrol-operation.

Because LPG is a gaseous fuel, sophisticated mixing devices offer the possibility to maintain all operating conditions, allowing lean air/fuel mixtures to be burnt under part load conditions. Carbon monoxide and hydrocarbon release from the exhaust is therefore greatly reduced.

As a dry gas, LPG can never enter the cylinders as a liquid and therefore a wash condition can never arise. Top end cylinder wear is therefore reduced and the life expectancy of an engine increased.

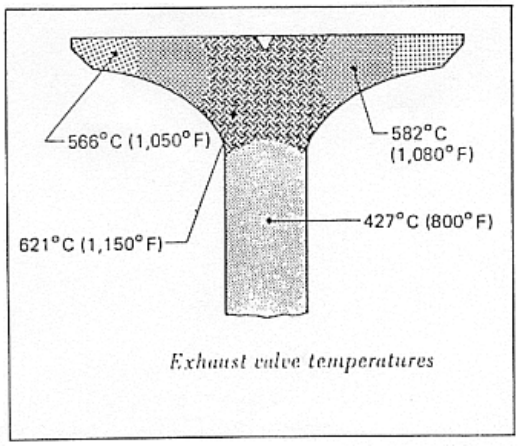
However should LPG be used in a new engine, it should be noted that the bedding-in process will be lengthened. It is recommended to run a new engine on petrol exactly in accordance with the car manufacturer's or car importer's advice.

LPG is an unleaded fuel, which is advantageous for the environment,



But lack of lead can cause valve seat recession on some engines. Recession bears a direct relationship with speed and load conditions and therefore a high-speed motorway conditions certain vehicles will suffer excessive recession which would be insignificant with an in-town delivery vehicle.
Whilst the vehicle is operating on petrol the lead content of the fuel (added to increase octane ratings)
Forms a protective film between the valve and the seat, preventing metal to metal contact.

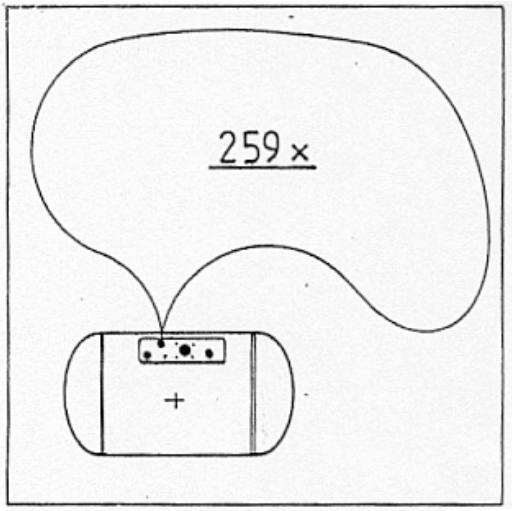
Removal of this film results in the valve recessing into the seat due to the constant hammering effect of the valve on the seat. Most engine manufacturers have anticipated the reduction and eventual elimination of the lead-additives, and have constructed cylinderheads with valve-inserts with a sufficient hardness value to withstand the effects of unleaded fuels.



Exhaust valve temperatures

In cases where valve seat recession is a known problem, it is recommended that the cylinder head is removed, and that the original valve inserts are replaced by hardened inserts.

SAFETY CONSIDERATIONS FOR LPG.



In general propane is used for automotive purposes. Propane has a very low boiling point (-42 degree C) and as such evaporates immediately if released into the atmosphere.

As it evaporates, it draws heat from the surroundings and – should sufficient heat not be available – it will stay and under cooled liquid. Should liquid LPG come in contact with any part of the human body, it will draw heat from the body and thus cause severe dry burns. It is important that anybody dealing with liquid LPG, should wear protective clothing such as gloves and, if necessary, face and eye protection.

LPG is heavier than air and should not be released in a workshop containing any6 type of inspection pit. As previously described, liquid LPG will increase the volume by a factor of +/- 250 if vaporisation takes place. Therefore the release of a small volume of liquid will lead to a much larger volume of evaporated gas. Only release LPG into the open air, well away from anything that could generate a spark.

Caution!

If carrying our conversations please take care that good, gastight seals are achieved at all connections. This is of particular importance where storage tanks are concerned. Correct attention while converting will prevent leakage problems later on.

The only safe way of evacuating LPG is to drive the vehicle and burn the LPG by using the engine. Should leakage occur on components other that the fuel tank shut-off the service valve on the tank and operate the engine to empty the fuel lines. Any maintenance can then be carried out with the maximum of safety.

HOW DOES A LPG-SYSTEM OPERATE?

In general a complete LPG-system consists of:

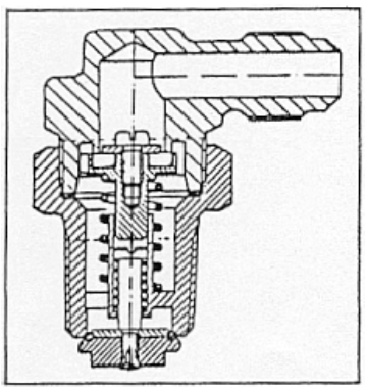
A) The LPG-tank complete with fittings and gastight valvebox.
B) Petrol- and LPG solenoid valves
C) Evaporator pressure regulator
D) The mixing-unit
E) Mounting material

THE LPG-TANK

The LPG is carried in the car inside a specially designed tank a so-called pressure-vessel. The tank itself can be manufactured in various dimensions with volumes varying from 30 to 120 litres water-capacity. The standards for the material used for the tanks are the responsibility of Governmental bodies.

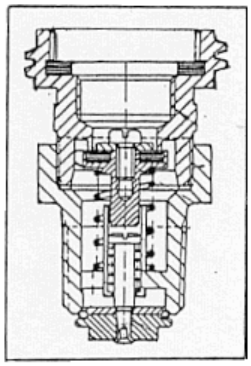
The test pressure of a LPG-tank in Holland for example is 30 Bars.

The LPG-tank is equipped with various fittings.



1) The filling-system.

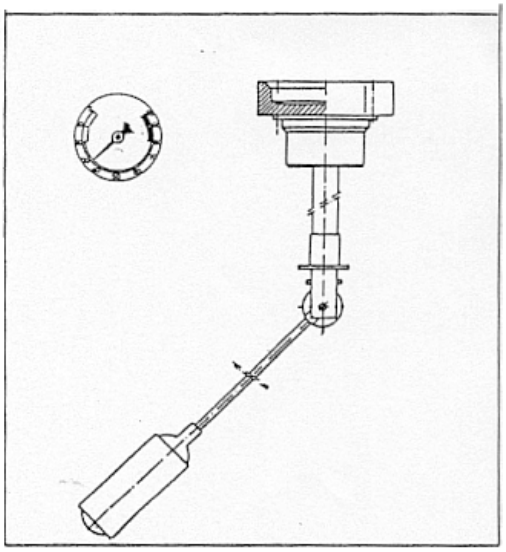
The tank is remotely filled from the outside of the vehicle by using a remote filler valve.
This remote filler valve has a non-return valve incorporated. The remote filler valve and the filler valve on the tank are connected by a special filler hose.



The filler valve on the tank is equipped with 2 non-return valves and from mid-eighties the application of an 80% filler valve is compulsory in most countries. A floaters-systems ensure that the valve will automatically close at the moment that the LPG-tank is filled with liquid for 80%.

2) The test-valve.

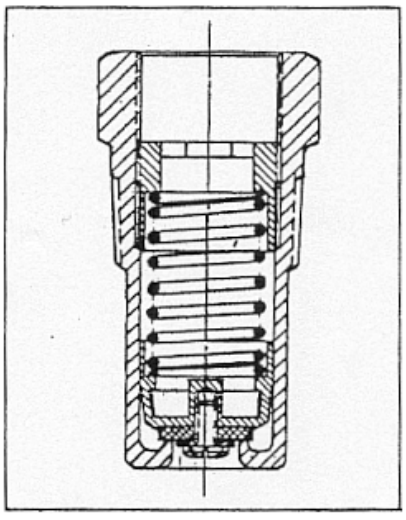
By operating the test-valve the liquid filling of the tank for 80% can be checked.
For this the valve should be opened during the filling of the tank. On the moment that 80% filling has been realised liquid LPG will escape. This is the moment that the filling should be stopped and the test-valve should be closed.
If an automatic 80% filler valve is used is no longer needed and the opening in the tank for the test-valve is either plugged off or not there at all.



3) The level-gauge.

The level gauge shows the volume of available liquid LPG in the tank expressed in a percentage. It works through a floater-system, that drives a magnet under the dial.

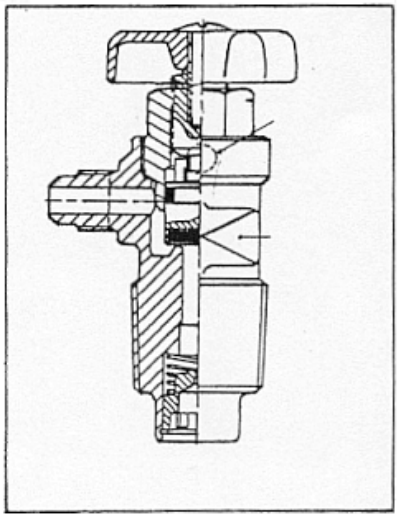
4) The safety relief valve.



If, through eating of the environment of the tank, the pressure inside the tank increases above a previously set value (e.g. 17.5 bar) this valve will open and release as much vapour LPG as needed to reduce the pressure inside the tank to below the value set.

5) Service valve.

This valve is connected in the diving-pipe inside the LPG tank to always ensure liquid withdraw.



The service- or take-off valve has a handwheel through which it can be closed. For extra safety a so-called excessflow mechanism is replaced. In case of rupture of the LPG-fuel line, that in principle could lead the completely emptying of the LPG-tank, excess-flow mechanism will automatically close the valve.

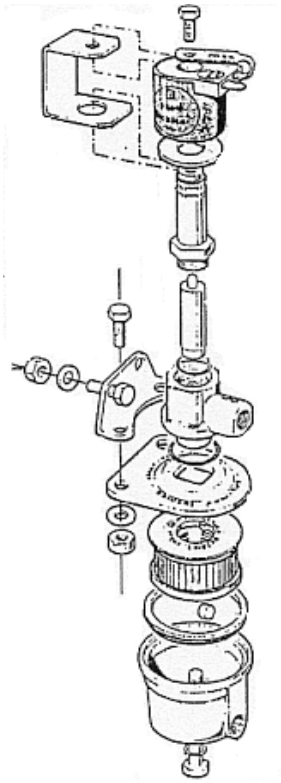
6) The gastight valve box .

All valves fitted on the tank are covered by the valvebox. The valve box has a number of openings through which fuel-lines etc. can be led in a gastight way. The box also has venting openings that are connected to the outside of the vehicle by hoses.

THE SOLENOIDS.

The LPG-Solenoid.

The LPG-solenoid is an electro magnetic device that is wired to the electronic control module for the evaporator pressure regulator.

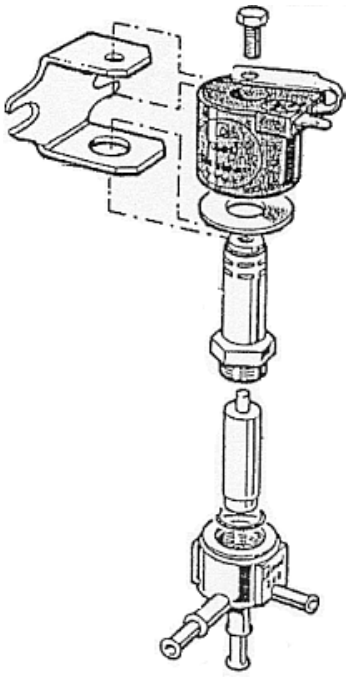


The solenoid valve is designed to be closed if no power is applied, when electrical power is applied the solenoid's coil will open the valve.

The LPG-solenoid has an exchangeable filter on board preventing impurities in the LPG to reach the evaporator or the engine.

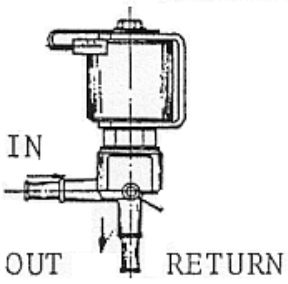
The petrol Solenoid.

The petrol solenoid valve is an electro-magnetic device wired via a 3-way selection-switch on the dashboard to the switched contact on the vehicle.
The solenoid valve is designed to be closed if no power is applied, and in the event of absence of electrical power it will remain closed.



The Petrol-solenoid incorporates integrated 6mm and 8mm hose connections and has a blocked facility to receive a petrol-return line, that can be activated if so desired.

Some types of older petrol solenoids have a little lever. In case of an electrical problem this lever can be used to manually open the petrol solenoid.



THE EVAPORATOR PRESSURE REGULATOR.

The evaporator pressure regulator has the following functions.

1) The conversation of liquid LPG into LPG-vapour
2) The reduction of the variable, temperature depending tank pressure to one particular pressure
3) The supply of LPG-vapour to the LPG-carburettor, depending on the fuel-need of the engine, through the interpretation of suction signals.

The functions mentioned under 1 and 2 are realised in the so-called 1st stage of the evaporator pressure regulator. An exception to this are units for air-cooled engines. The vaporisation of the LPG with this type of engines takes place inside evaporator probes and the evaporator pressure regulator only acts as a pressure regulator.

The functions mentioned under 3 can be split into the delivery of fuel for idling conditions and the delivery of fuel for other rpm-figures and load conditions. This is all realised in the idle-section and 2nd stage of the evaporator pressure regulator. The volume of LPG supplied for idle conditions is set by an adjustment-needle.

Description of operation principle.

The pressure is reduced in two different stages and with this type of evaporator pressure regulator a comparatively low pressure is already realised in the first stage of the unit so that the adjustments in the 2nd stage are more like a detailed fine-tuning. This can be achieved through intensive heating of the LPG during the vaporisation.

In the first stage of the evaporator pressure regulator an absorption pad (sponge) has been placed. This pad has a double function:

1) Under cold start conditions not evaporated liquid parts of the LPG are absorbed by the sponge and later, when sufficient heat for full vaporisation is available, these parts will be released again.
2) If there would be impurities in the LPG in the shape of oil-like components, then these components would be absorbed by this pad.

To avoid over saturation and to exploit the above qualities fully the absorption pad should be replaced each 50.000 km. or 1000 operation hours. Only if using LPG with many impurities a shorter interval should be required. The replacement of an absorption pad is a very simple job if the unit is mounted on a vehicle.

The cooling medium inside the evaporator pressure regulator surrounds the complete LPG-routing in the unit and therefore the depositing of heavy-ends in the LPG is prevented.
Both diaphragms are protected against rupture.

Because of the presence of special protection plates the diaphragm will not be in direct contact with the LPG and in view of this the diaphragm are protected against impurities volume of idle-fuel is adjustable by a needle on the top section of the evaporator pressure regulator.

Operation principle of the idle / coldstart system.

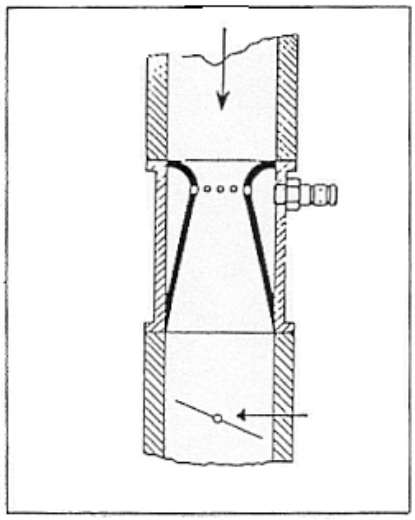
If the contact is switched on both LPG-solenoid valve and the idle-solenoids open for 1.5 second. The fuel supplied in this way is in general sufficient to fill the evaporator pressure regulator and the vapour hose to the mixing unit vapour.

After this impulse, the engine can be started and as soon as the engine runs at 50 rpm. Both solenoids will be opened permanently. It may be happening if using very long LPG-vapourhoses that it necessary to switch the contact off and on a few times so that the volume of the fuel needed to start the engine is increased.

THE MIXING UNIT

In the mixing unit the volume of air needed for combustion is mixed with an exactly metered volume of LPG. Because of the optimal design and construction of the mixing units for various carburettor systems an homogeneous mixture is guaranteed with a minimal influence on petrol operation. There are a number of mixing unit types:

1) Mixing units between the trottlebody-section and the carburettor casing.
2) Mixing units between floatchambres and carburettor casing.
3) Mixing units on top of the carburettor
4) Mixing units between the aircleaner and the carburettor that are located in the airfilter trunking.
5) Mixing units inside the aircleaner
6) Ring-type mixing units also placed inside the aircleaner.



All mixing units make use of the existing carburettor butterfly and incorporate a specially designed venturi which performs the metering of the fuel.

In order to achieve an homogeneous mixture of air and LPG-vapour a number of small holes have been drilled into the throat of the venturi. These holes are linked with evaporator pressure regulator via propane hose.

The construction of the evaporator is such that any variation in depression in the propane hose leads to an adjustment in the volume of vapour LPG supplied by the evaporator.

The position of the venturi in the induction system and the design and construction of the venturi throat and holes assure an intensive mixture of LPG vapour and combustion air.

Measurement of passing combustion air uses the basic venturi principle. It is necessary when using this principle to place a restriction in the airflow.
This restriction is called the “venturi tube”.

The point of maximum restriction in the venturi is called the “venturi" throat. At this point the velocity of passing air increases resulting into a pressure drop at the throat.
The degree of depression generated depends upon the volume of air passing through the venturi tube. More air means a greater depression, less air means a smaller depression.

The actual depression is detected by a number of small holes in the throat of the venturi.

Airflow direction.

If venturis are fitted it is important that the airflow through the venturi is correct.
Failure to achieve this correctly will result into running problems due to the evaporator not receiving the correct airflow signal from the venturi. It will be noted that each venturi has a sharp taper at one end and a gradual taper at the other. The correct is with the sharp taper against the airflow direction and it will be noted that the LPG inlet holes in the casing of the mixer will be on that location.

LPG inlet connections.

The LPG inlet hose connector should be screwed into the mixing unit with just a few threads and then be locked facing the correct direction using the locknut. If the connector is screwed in too far it can cause a restriction in the LPG flow, as this will not allow full circulation of LPG around the venturi. Over-tightening this connector can damage the venturi of even rupture the casing of the mixing unit.

Engine breathers.

Some engines have a breather system from the rocker or cambox cover to the air inlet. If this inlet is positioned after the mixing unit it must be re-routed to upstream of the mixing unit.

Air leaks.

Any air leaks in the induction system will give rise to weakening the air/fuel ratio as well as operational problems even to the extend of backfire-problems. Always ensure that the mixing unit is well sealed at the bottom side if needed use silicon type gasket cement.

Vacuum valves.

Some vehicles have emission vacuum valves mounted inside the air filter pans, that may need to be repositioned to facilitate the fitting of mixers. It is also needed to introduce a second solenoid is isolate the vacuum circuit during LPG-operation, but allowing it to operate correctly for petrol operations.

LPG hoses.

Each mixing unit is connected to the evaporator pressure regulator through a flexible hose, that is kept in position by clips. It is important that this hose has no sharp bends, kinks or restrictions of any kind. Such restrictions lead to operational problems, therefore ensure smooth routing with large loops where necessary.

SPECIAL PRECAUTIONS

If the car is equipped with a thermostatic air-intake/preheating system this device should be switched off for LPG-operation.

The following types are known:

a) Vacuum controlled
b) Mechanical

If a vacuum controlled system is on the vehicle this can be deactivated by a solenoid. If mechanical system is on the engine this should be blocked in the "summer" position.
If pre-heating is blocked mechanically, the blocking should be removed on the moment that the vehicle will operate on petrol again.

In case the engine is equipped with an automatic petrol choke, the setting of the choke should be changed if the LPG mixing unit is located between the trottlebody and the carburettor casing.

In case the LPG mixing unit has been placed on top of the carburettor it is not necessary to change this setting.

MAINTENANCE/SERVICE

Under normal conditions a vehicle with LPG-equipment does not need any more service or maintenance then a car on petrol-operation. Naturally the service/maintenance should be done according to the car-manufacturers specifications.

During service-intervals the LPG-equipment should be checked on:

- Leakage (soap and water)
- Tightness of the petrol-connections
- Removal of the deposits from the evaporator pressure regulator (plug C, warm engine)
- Checking the idle adjustment setting.

POLUTION OF THE EVAPORATOR PRESSURE REGULATOR

It can happen that inside the evaporator pressure regulator an oily-like substance (sludge) is deposited. This substance comes from the LPG-fuel and remains in the evaporator pressure regulator.
In case the operation of the evaporator pressure regulator is hampered by this substance it may be necessary to clean the unit.
The deposits described before can be found in the 1st and 2nd stage of the evaporator pressure regulator.

It is definitely not necessary to use a complete overhaul kit if the evaporator is cleaned.

FUEL CONSUMPTION IN PRACTICE.

The fuel consumption of a vehicle mainly depends on:

- The chosen engine-design
- The shape of the body
- The weight of the vehicle
- The operation conditions.

In various publications fuel consumption data are indicated recorded at 90 km/hr., 120 km/hr. and during city-traffic.

The values are recorder under conditioned circumstances during tests for the benefit of homologation of the car.

In practice, however, it turns out to be so that these values can hardly be realised in daily use.

Therefore use these values only for comparison with other cars and not as a reference for the real consumption under driving conditions.

In order to still stipulate a consumption figure from the published data the following method can be applied (1/4 mix).

We use the fuel consumption at 90- and 120 km/hr. one time and the consumption for city-traffic 2 times. The total consumption found in this way is used for a distance of 400 km. Example.

Consumption 90 km/hr.	6.5 Litre/100 Kms.
Consumption 120 km/hr.	8.5 Litre/100 Kms.
Consumption city traffic	10.5 Litre/100 Kms.

So: 6.5 + 87.5 + 10.5 + 10.5 + 36 Litre per 400 Kms.

Results into 400/36 = 11,1 Km. per 1 Litre of petrol.

For LPG consumption on the same vehicle the additional fuel consumption is about 25%.

So: 36 x 1.25 = 45 Litre per 400 Kms.

Results into 400/45 = 8.9 Litre of LPG.

If it is unknown what the fuel consumption at the above mentioned speed is, the following basic rule can be applied.

In case of a car with a weight of 1000 Kgs. for each 100 Kgs. of car-weight about 1 Litre of petrol is used for each 100 Kms.

So: 1000/100 x 1 + 10 Litres per 100 Kms.

Results into 100/10 = 10 Km. per 1 Litre of petrol.

For LPG the calculation will be

10 x 1.25 = 12,5 Litre of LPG.

Results into 100/12,5 = 8 Kms. Per 1 Litre of LPG.

The above calculation method turns out to be reasonably realistic with the consumption data recorded during driving conditions. If there are large deviations these are normally due to different driving methods.

BACKFIRING.

Backfiring is the ignition burning off the air-fuel mixture inside the engine's intake manifold.

The ignition can be caused by a number of sources, these can be:

a) A leaking inlet valve
b) A worn-out seat of an exhaust valve
c) Sparks striking across
d) Mixture is too lean
e) Glowing spark plug.

Backfiring can cause considerable damage to parts of the engine's inlet system.

Re. a:

If an inlet valve is leaking it will be obvious that easily the air-fuel mixture from the combustion room can be ignited.

Re. b:

In the event that the seat of an exhaust valve is worn out the smooth flow of leaving exhaust gases will be hampered. Because of this, burning gases will still be inside the combustion chamber at the moment that the inlet valve is opening.

These burning exhaust gases will ignite the fresh air-fuel mixture entering the cylinder.
A worn-out exhaust valve lift plunger has the same effect.

Re. c:

With sparks striking across is meant that the "spark" jumps to another cylinder than the one it was meant for originally. This can take place inside the distributor or between the spark-plug cables. In principle the spark will strike to a cylinder that is either on intake- or exhaust position, as the deeded isolation voltage will be lowest at those circumstances.

The sparks strikes across if:

- The distance between sparkplug electrodes is too big
- The distributor's cover is in bad condition
- The sparkplug cables are in bad condition

In order to avoid sparks striking across it is of essential importance to keep the ignition-system in an optimal condition, implying even that sparkplugs have to be replaced or that the distance between the sparkplug electrode have to be inspected and adjusted at more than normal intervals.

Re. d:

In case the air-fuel mixture is too lean the firing-velocity will be reduced resulting into the fact, that the mixture inside the combustion chamber is still burning at the moment that the inlet valve is opened.

The fact that the mixture leans off can be caused by:

- An empty LPG-tank.
- Excess air-intake caused by wrong positioning of the aircleaner opening (RAM-effect).
- Wrong adjustment of the LPG-system.
- Opening the trottle butterfly completely at a low rpm-figure.
- Insufficient suction by the mixing unit.

Re. e:

A spark plug that is still glowing will ignite the air-fuel mixture at the moment that the inlet valve is open. This glowing can be caused by the selection of a woring sparkplug type or by a sparkplug that has not properly been tightened.

ELECTRICAL CONDITIONS.

Red = + wire to LPG solenoid and idle solenoid valve

Blue = Petrol solenoid

Brown = Command wire for idle solenoid and LPG solenoid.

Black = Antenna wire from the control module to high tension coil cable
Ground for control module
+ Wire from selection switch to board-wiring

The so-called antenna wire preferable should be connected to the high-tension coil cable by using a plastic clip.

The + wire for the selection switch should be split from a non-fuse wire from the vehicle (mostly the ignition).

The connections to the selection switch are reverse as oppose of the diaphragm shown on the front-side of the switch.

Remark.
Never try to fit a nut on the connection of the electrical solenoid. This will damage the unit.

EVAPORATOR PRESSURE REGULATOR GMS90E

General principle.

The GMS90E evaporator pressure regulator is a 2-stage pressure-reducing vessel in which a heat exchanger has been incorporated.

Its functions are to reduce the tank-pressure (0.3-1.2 Mpa.) to a stable pressure of 44 Kpa., to fully vaporise the liquid LPG and, finally, to meter the fuel-flow to the engine.

In between these two stages a heat exchanger has been introduced which is usually connected to the heater-circuit, that is part of the engine's cooling system.
Installation in this way allows for full hot coolant circulation through the unit, whereby complete and continuos vaporisation of the liquid LPG is ensured.

The unit is making use of an electronically controlled by-pass idle system that, in combustion with LPG solenoid valves, will prevent LPG to enter into the 2nd stage until such a moment that the engine is cranked.

Technical specifications:

Maximum inlet pressure	3.0 Mpa.
Vaporisation capacity	3.0 Kgs. propane/hour
Nominal 1st stage pressure	44 Kpa.
Water capacity heat-exchanger	70 qubic centimetres
Pulse-time idle solenoid valve	1.2 – 1.5 seconds
Idle solenoid opening frequency	= / < 2 Herz.
Idle solenoid coil resistance	29 Ohms
Idle solenoid voltage	8.5 – 16 V/DC.

Detailed operating principle.

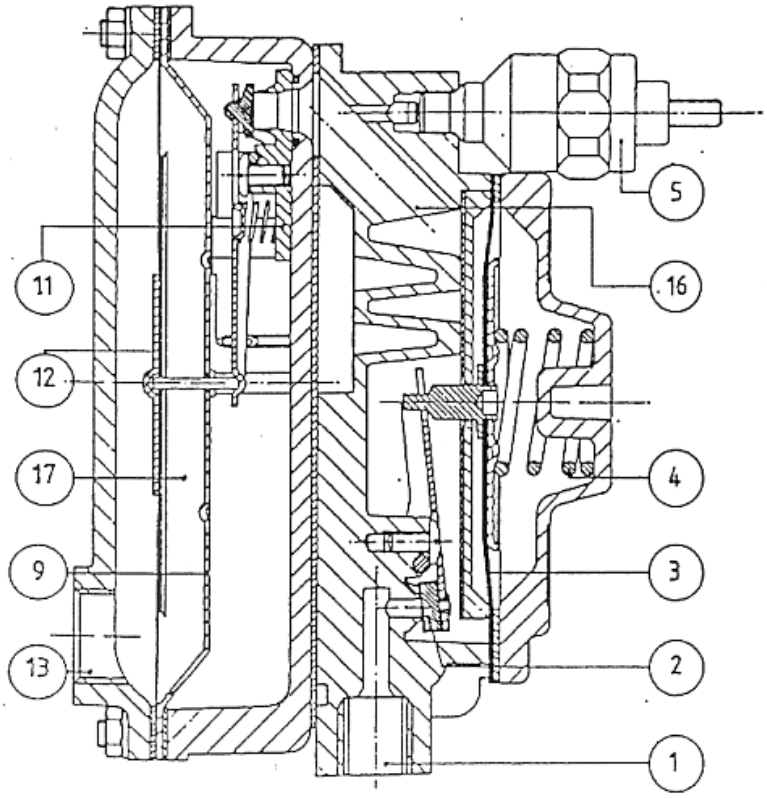
First stage.

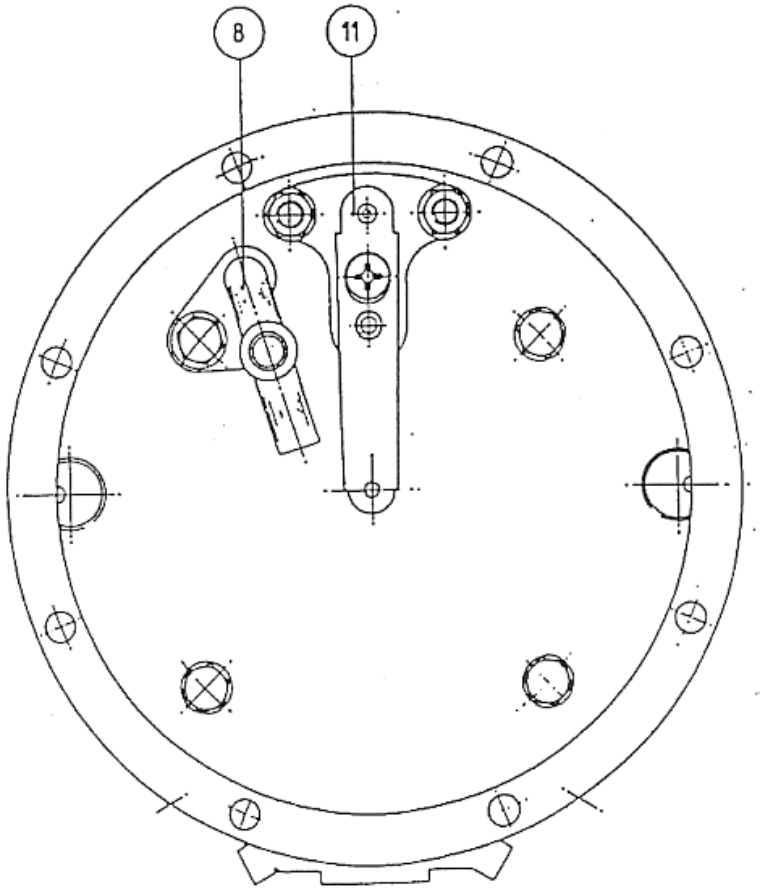
The description should be red in conjunction with the drawings overleaf.

Except in case of air-cooled engines the liquid LPG passes the LPG Solenoid and enters the 1st stage of the evaporator pressure regulator at position (1). Except in case of air-cooled engines.

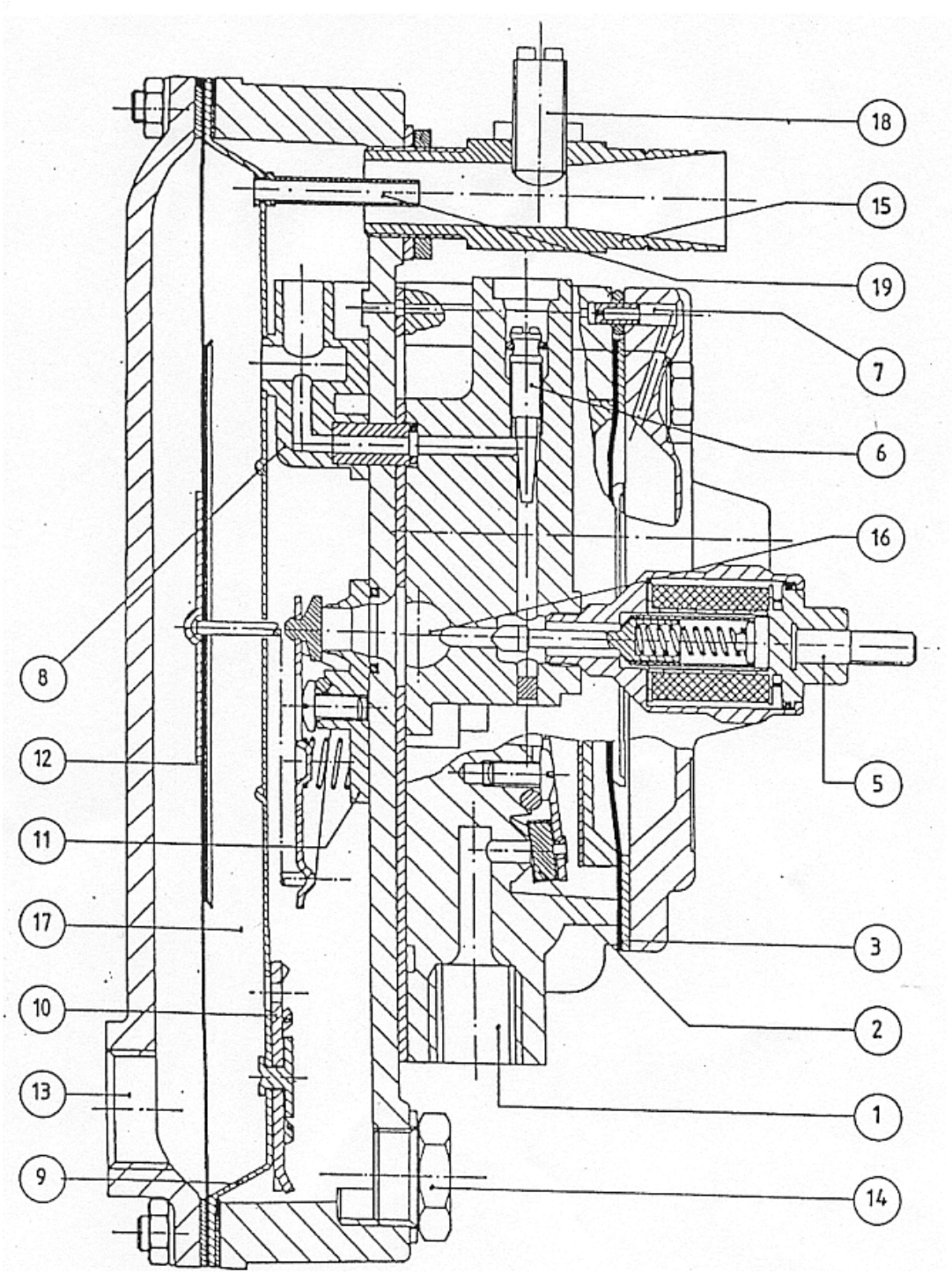
As long as there is no pressure available in the 1st stage chamber the 1st stage valve (2) is held by spring (4).

Cutsection evaporator pressure regulator GMS90E.
(main fuel flow and front-view 2nd stage)

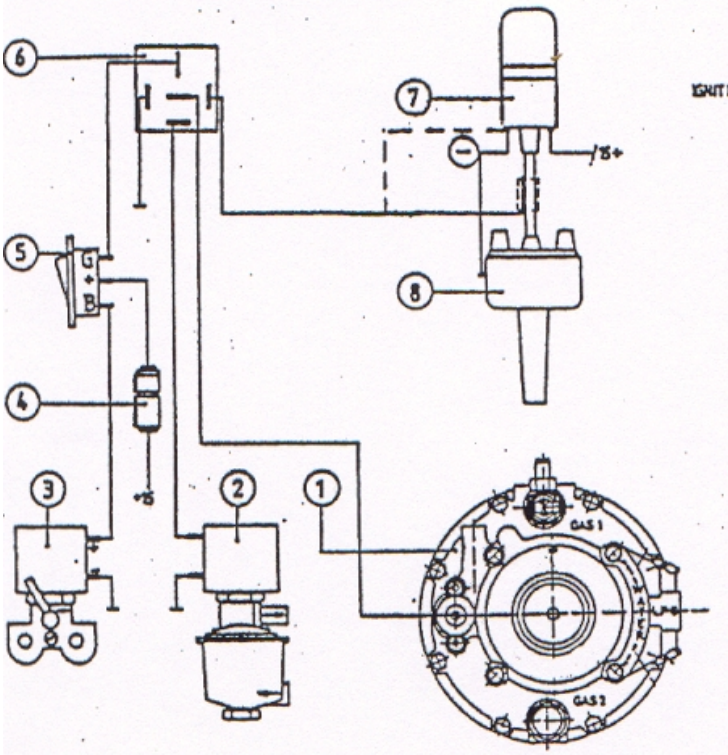


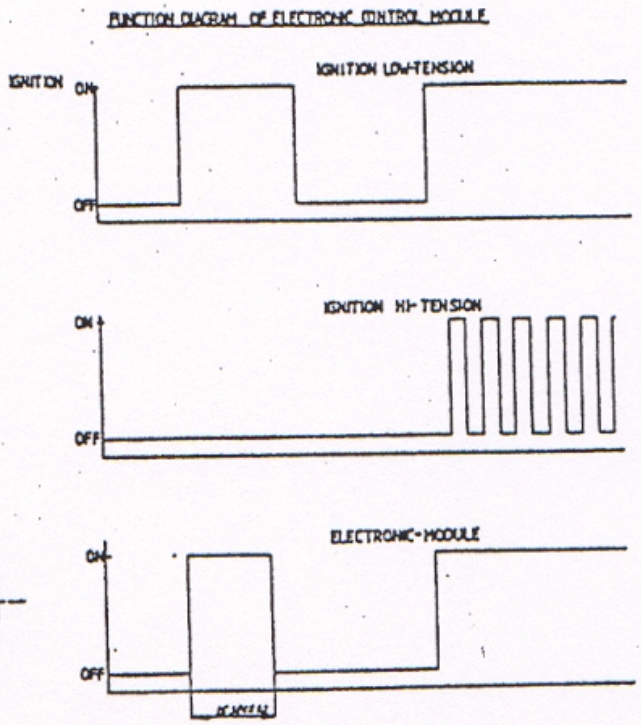


Cutsection evaporator pressure regulator GMS90E
(main and idle fuel flow)



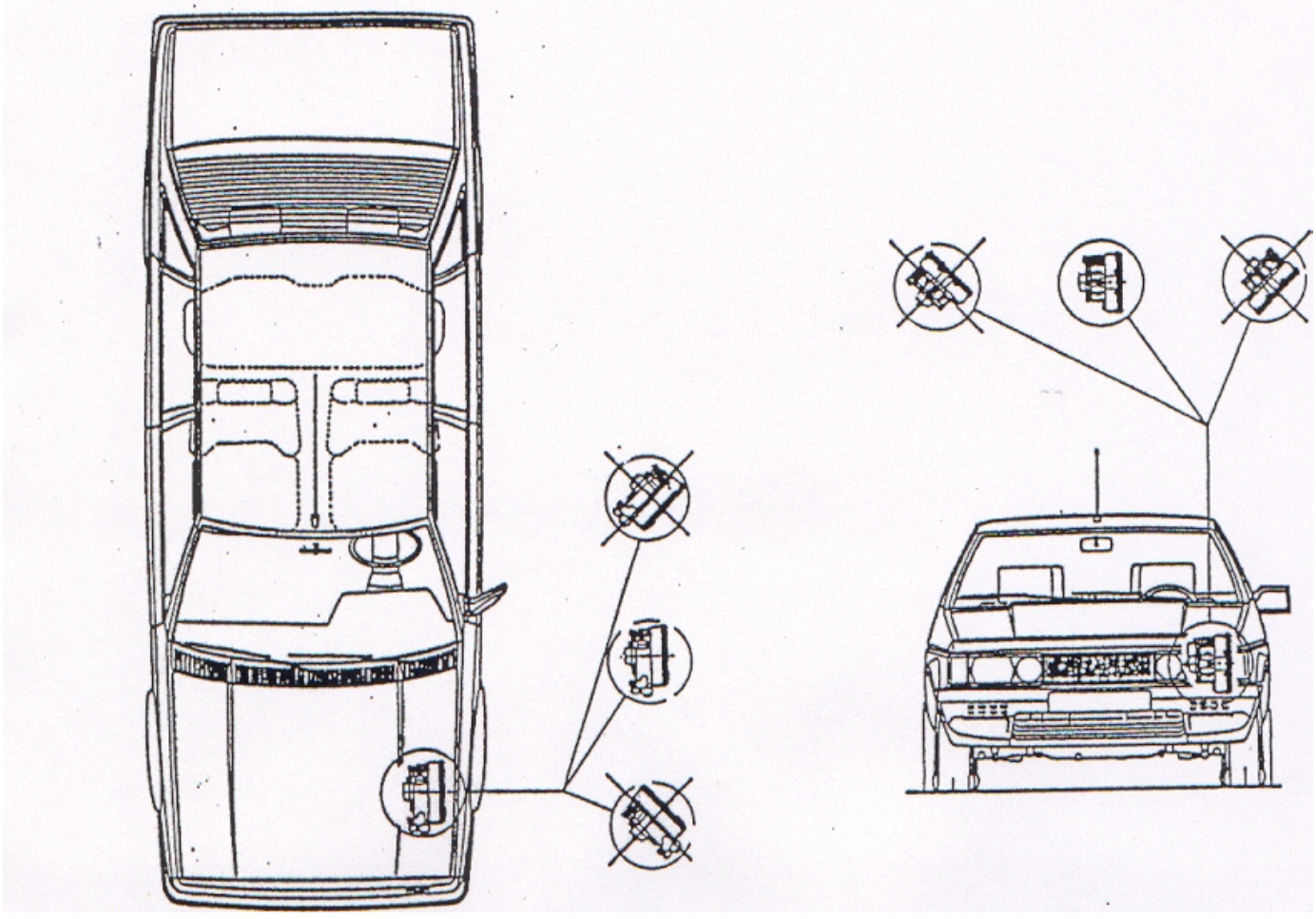
Wiring diagram.





1 Evaporator pressure regulator
2 LPG Stopcock
3 Petrol Stopcock
4 Fuse
5 Fuel selector switch
6 Control Module
7 Ignition coil
8 Distributor

Vaporizer orientation



The 1st stage diaphragm is physically connected to the 1st stage valve (2).

On the moment that liquid LPG passes the 1st stage valve (2) it will start to vaporise in the 1st stage as the pressure in this area is lower that the tank-pressure of the LPG.

When the vaporising liquid has arrived at a pressure of 44 Kpa. This value will be sufficient to overcome the load of the compression-spring (4) and cause the 1st stage (2) to close. When pressure drops to a value below 44 Kpa. Valve (2) will open again; this process repeats itself permanently.

Between the 1st stage diaphragm's protection plate and the vaporising matrix an absorption-pad has been placed in order to absorb liquid parts of the LPG when the unit and the engine are cold; if the temperature rises sufficiently these parts will be released again for total vaporisation.

The liquid LPG's vaporisation required heating which is supplied by coolant in the engine's cooling-circuit; with air-cooled engines the heating is realised by using evaporator-probes that are positioned inside or onto the exhaust system.

The 1st stage is connected with the 2nd stage by an opening (16).

Second stage.

In the 2nd stage main valve (11) has been placed, which is activated by the 2nd stage diaphragm (12). When a pressure-difference is created across diaphragm (12) it will change its position and thus it will move the lever of the main valve accordingly.

A pressure-difference is generated when hose connector (15) is subject to suction from the mixing unit.

When the engine is idling main valve (11) is closed.

The idle system, that is opened or closed by the electromagnetic solenoid valve (5), is located in both the 1st and the 2nd stage of the evaporator pressure regulator.

The required volume of fuel for idling is taken from opening 16 as soon as the idle solenoid opens.

The fuel flow, with over pressure, travels via idle needle (6) through ejector-tube (8) into the 2nd stage chamber, and from here into the direction of the mixing unit.

The afore mentioned over pressure interferes with the correct opening of the main valve (11). In order to eliminate this influence separation-plate (9) has been fitted and thus an additional chamber (17) has been created.

Ejector-tube (8) is linked to this chamber and as a result of the passing fuel-flow inside the ejector-tube a few mm. watercolumn suction is generated at the tube's top opening. This

suction will pre-set diaphragm (12) in such a way, that the diaphragm's central pin will just be in contact with the dimple in the lever of main valve (11).

The eventual total suction created in room (17) will depend on the volume of idle fuel passing the ejector-tube (8) and the leakage. In order to be able to adjust the suction in this chamber disc (10), having leakage-openings of 0, 2, 3, 4, 6 and 7 mm. diameter, has been placed onto separation-plate (9). Rotable disc (10) can be reached after removal of plug (14) and is factory set at 4 mm diameter.

By selecting a particular leakage-opening in all events the proper idle performance as well as the correct engine response can be achieved.

The functioning of the evaporator pressure regulator under various load-conditions.

Starting.

On the moment that the ignition is switched on both LPG solenoid valve and idle solenoid valve (5) will open for 1.5 to 2 seconds and from the 1st stage a volume of gas will flow into the 2nd stage and from here to the mixing unit.
As soon as the engine is rotating at 50 rpm. (4-cylinder) the idle solenoid valve (5) will be kept open permanently.

Idling.

Idle solenoid valve (5) is opened and the volume of fuel set by the idle adjustment needle (6) flows to the engine.

Idling on partload.

The mixing unit will now start to generate under-pressure and as in chamber 17 an under-pressure exists diaphragm (12) opens the main valve (11).

Partload.

The mixing unit exercises suction and across diaphragm (12) a pressure-difference exists, leading to a particular opening of the main valve (11). The volume of fuel supplied depends on the pressure-difference and the setting of main adjustment bolt (18).

Full load.

The mixing unit is generating the maximum under-pressure and the maximum of vapour fuel passes. The increased fuel flow, in comparison to partload conditions, causes additional suction at the end of tube (19) implying the diaphragm (12) and with that main valve (11) take their maximum position.

Deceleration.

The carburettor's throttle valve will be completely closed and because of this very little or no suction is generated by the mixing unit onto the 2nd stage diaphragm (11). Because of this main valve (11) will be closed and only the idle system will supply fuel.

Engine is stopped.

As soon as the engine is stopped the idle solenoid (5) and the LPG Solenoid will be closed and the supply of fuel is stopped completely.

Adjustments.

Before as the engine is adjusted to LPG operation it should be checked whether all settings on petrol operation are according to the specification by the manufacturers of the vehicle.
For this if needed check the factory manual.

Note: the only possible change of this specification could be a change in the type of and the distance between the electrodes of the sparkplug.

Check whether the aircleaner is in the correct position the engine should be warmed-up.

Tools needed:

1) CO-meter (preferably 12 Volts and infrared)
2) Wrench 12 and a screwdriver
3) Rev. Counter

Adjustment for idle operations for GMS90E.

If all conditions like mentioned before for petrol-operation are met the engine can be switched over to LPG-operation. With idle adjustment needle (A) the strength of the mixture can be set. The setting is correct if the CO% is about 1,5 – 0.5 volume % CO.

With this adjustment-screw only the mixture-composition can be adjusted not the rpm.-figure.

If the petrol-carburettor/injection-system was set properly the rpm.-figure on LPG will be similar to the rpm.-figure for petrol operation.

Setting of the main adjustment.

An optimal adjustment can only be realised if various engine-loads would be simulated like those occur during driving the vehicle. This can only be done on a dynameter or during driving the vehicle on the road.

If the main-adjustment screw (18) has been set correctly on the partload (about 80-120 km/hr.) the CO% should be between 1,0 and 1,5 volume % CO.

Before the measurements on the dynameter or on the road can be done a basic setting can given as follows:

1) Turn the main adjustment screw 6 full turns open
2) Connect the rev.counter
3) Check idle CO% (about 1,5 volume % CO.)
4) Raise the rpm-figure of the engine up to 3000 rpm.
5) Close the main-adjustment screw gradually (clockwise) until the rpm.-figure drops.
6) Turn the main adjustment screw ¼ to ½ turn open (anti-clockwise) and secure it.
7) If needed correct the idle CO%.

Departing from this setting it is necessary for an optimal result on the road (or dynameter) to check the CO%:

Part load 0,1 – 0,3 volume % CO.
Full load 1,0 – 1,5 volume % CO.

Checking CO% at 3000 rpm. only does not produce a correct picture of the correct setting.

Setting of the correction disc.

This correction disc is located behind plug (14).
With this disc the transfer from the idle-system to the main system is achieved. This disc has 6 setting possibilities (0,3,4,5,6 and 7). The setting ex-factory is 4.
If the engine shows hesitations in taking over from idle to raise idle rpm.-figure a lower number should be used. If the engine is very sensitive on the idle adjustment screw a higher number should be chosen.

Method of operation:

a) Run the engine at 3000 rpm. during 5 seconds.
b) Set 1,5 volume % CO at idle rpm.
c) Switch off engine
d) Switch engine without touching the accelerator pedal.
e) Read CO%.
f) Run the engine at 3000 rpm. during 5 seconds.
g) Run the engine at idle rpm.
h) Read CO%

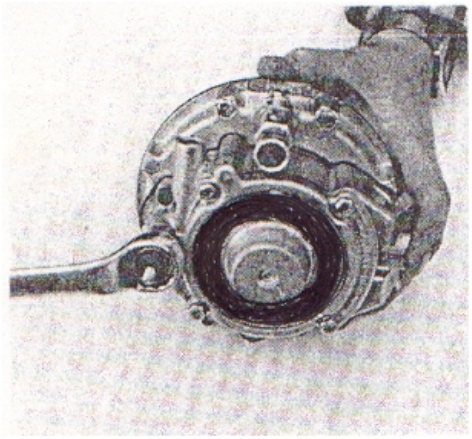
If the CO% in situation (e) is lower than in situation (h) a higher disc-position should be used.
If the CO% at the (e) and (h) are similar the disc-position is correct. In principle the largest possible disc-position should be selected.

If the disc-position is changed the basic setting of the equipment should be redone.

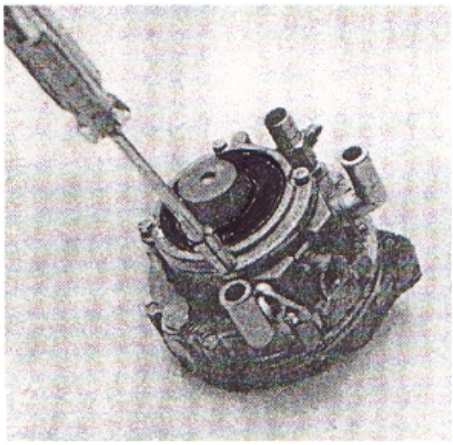
Disassembly of the GMS90E evaporator pressure regulator.

Tools needed.

Wrench 16-17
Wrench 21-21
Screwdriver 4 mm.
Screwdriver crosshead
Screwdriver with socket 8 mm.

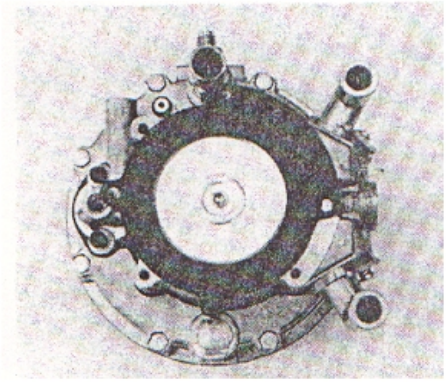


Remove the idle solenoid valve

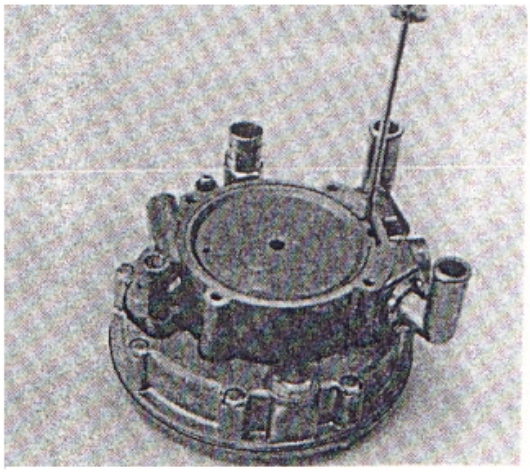


Loosen the 4 bolts of the 1st stage cover carefully

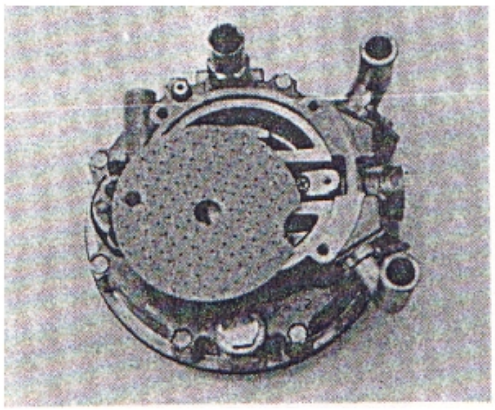
Attention: the cover is pushed out by the compression spring 1st stage.



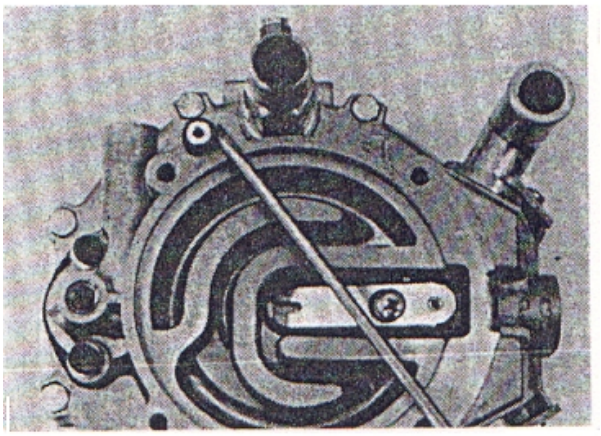
Remove the 1st stage diaphragm turn it ¼ turn anti-clockwise.



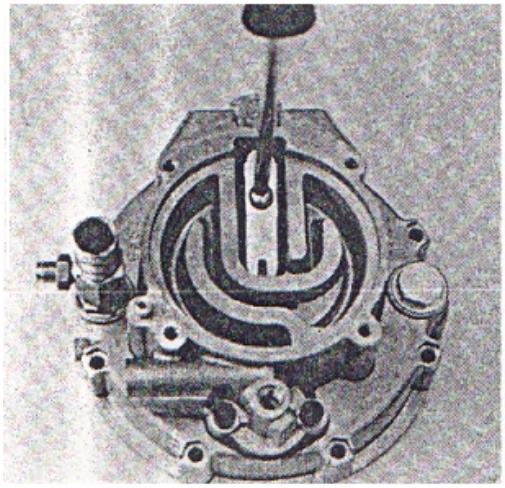
Remove the protection plate



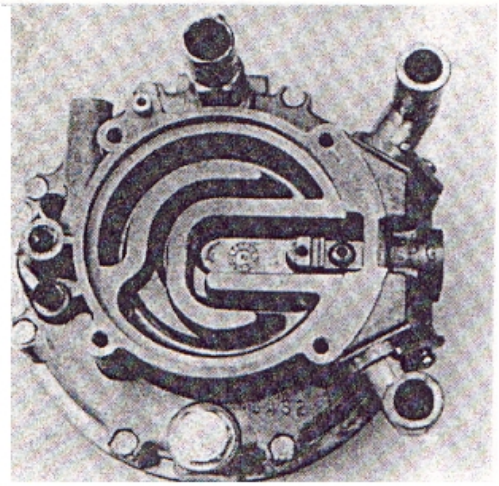
Remove the absorption pad



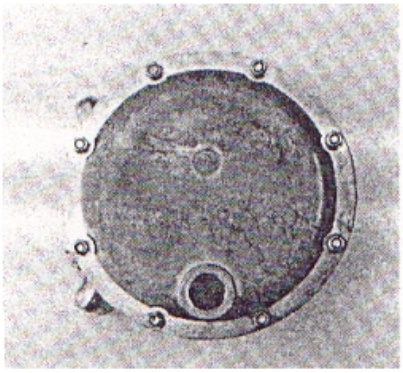
Remove the O-ring and the brass spacer



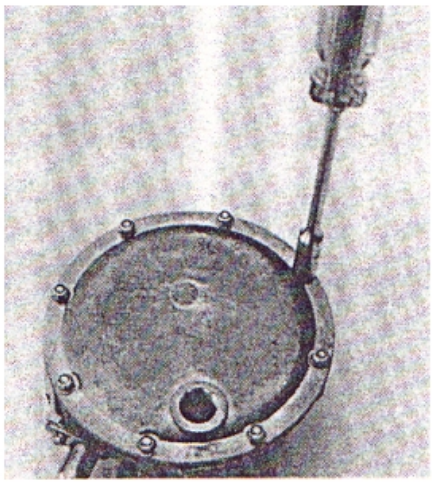
Take out the 1st stage valve after the removal of the screw recurring this valve.



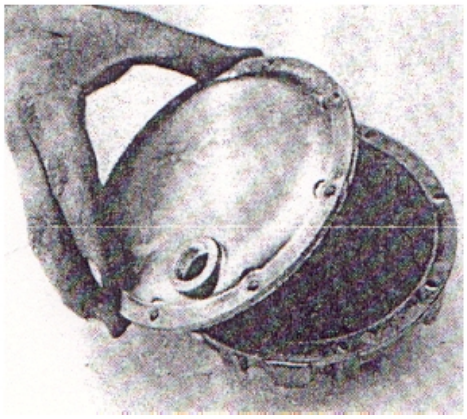
Check the 1st stage valve seat
for damages.



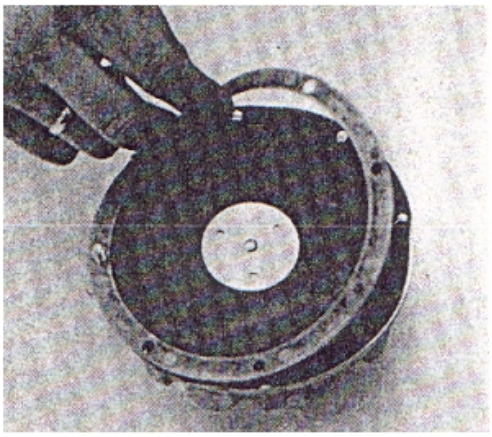
Mark the location of the studbolts on the
back cover.



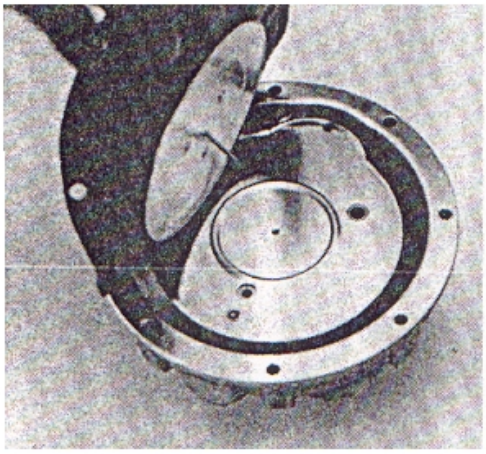
Remove the nuts of the 2nd stage cover.



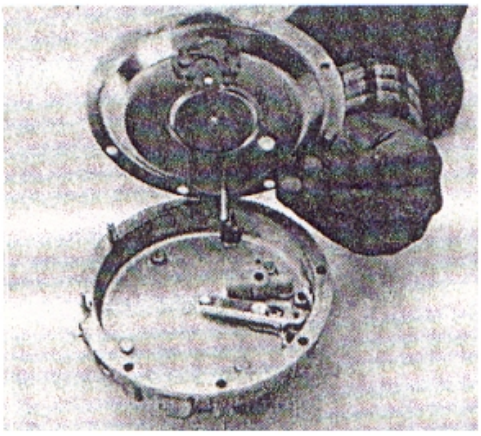
Remove the 2nd stage cover.



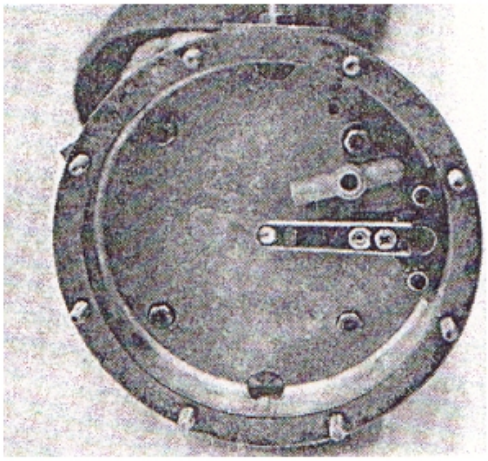
Remove the paper gasket



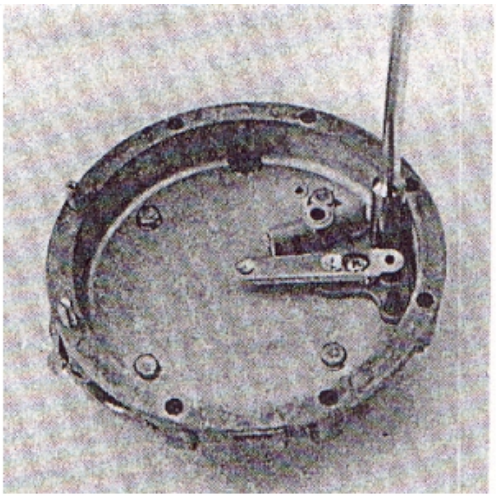
Remove the 2nd stage diaphragm



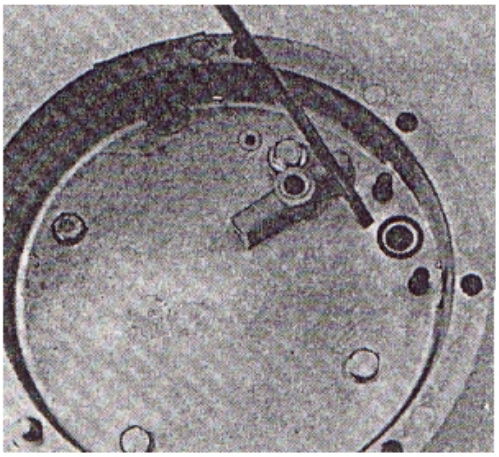
Remove the membrame correction plate and mark the opening used on the sensitivity disk



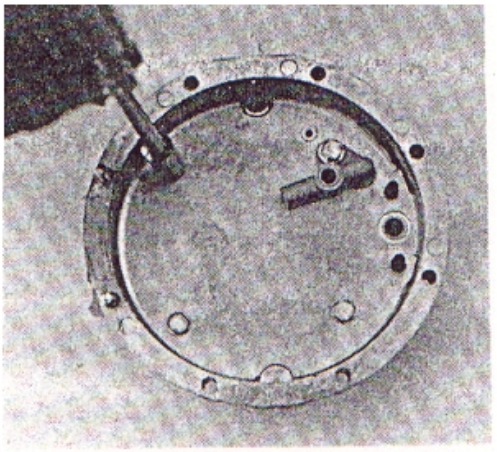
Inspect the 2nd stage for damages



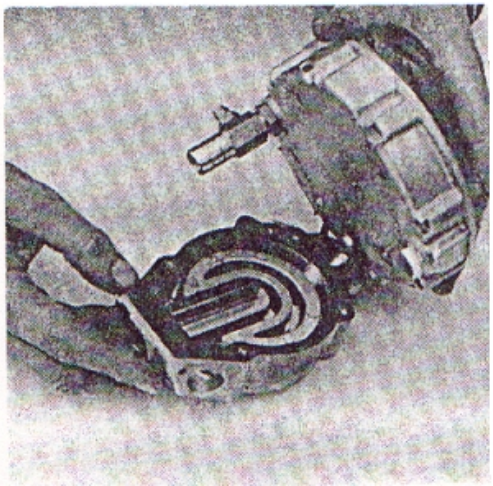
Remove the nuts of the 2nd stage valve and take out this valve



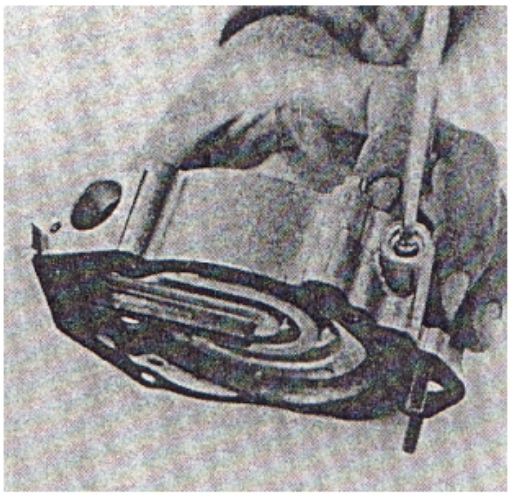
Remove the O-ring



Remove the remaining 4 bolts



Separate the 2nd stage from the 1st stage casing.



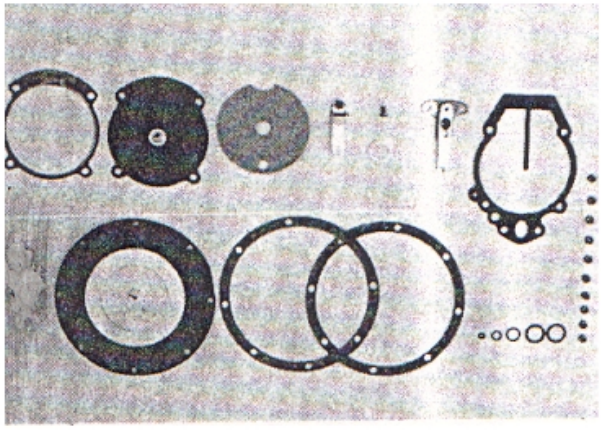
Loosen the idle adjustment needle and remove it.

All components, if polluted, should be cleaned thoroughly before same can be mounted again.

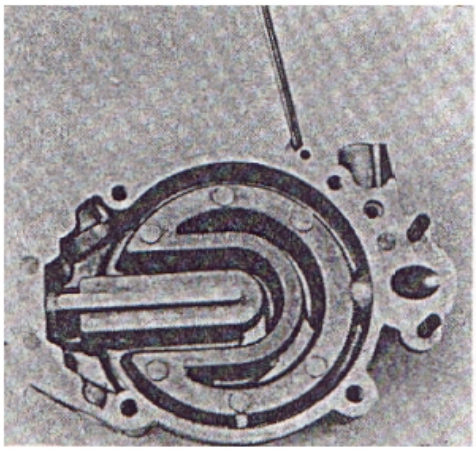
Assembly of the GMS90E evaporator pressure regulator

Start the assembly-procedure by selecting the components that can be used again.

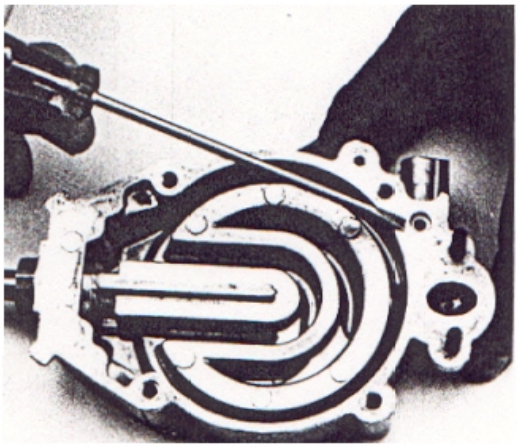
A repair kit for the GMS90E evaporator pressure regulator consists of the components shown below.



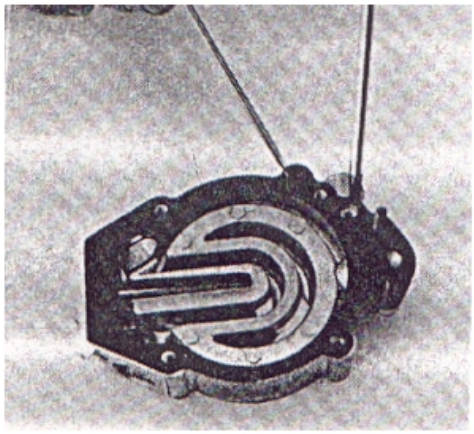
Fit the idle adjustment needle with a new O-ring. Lightly grease the thread and O-Ring.



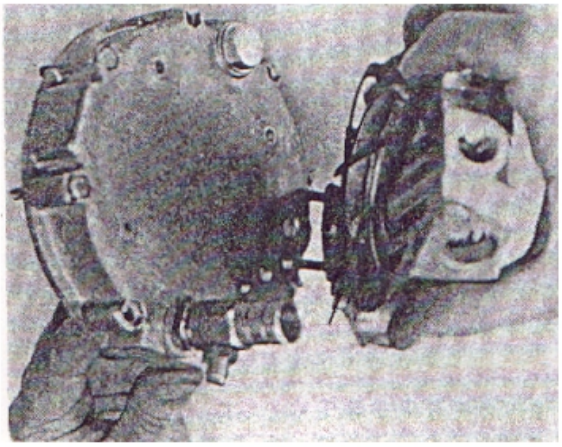
Check if the opening for the passage to the 1st stage is open.



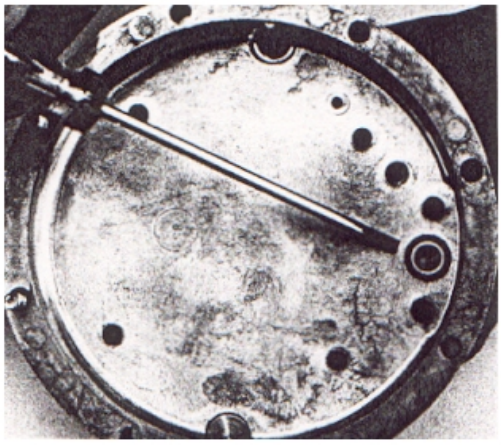
Check if the opening for the idle system is open.



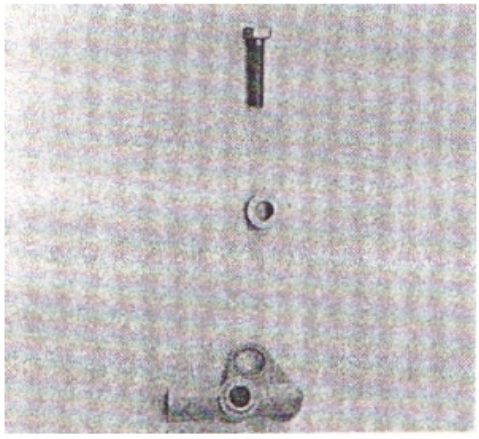
Place the rubber gasket and check whether all openings are free and not blocked.



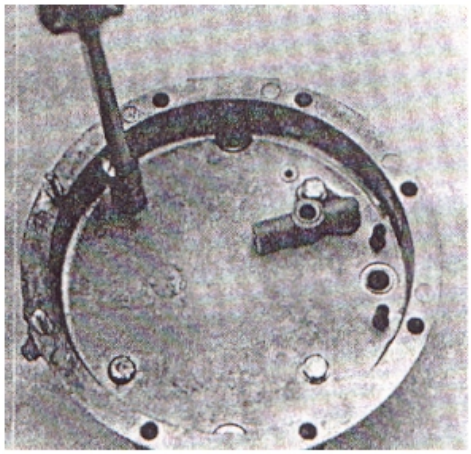
Assemble the 1st and 2nd stage casings.



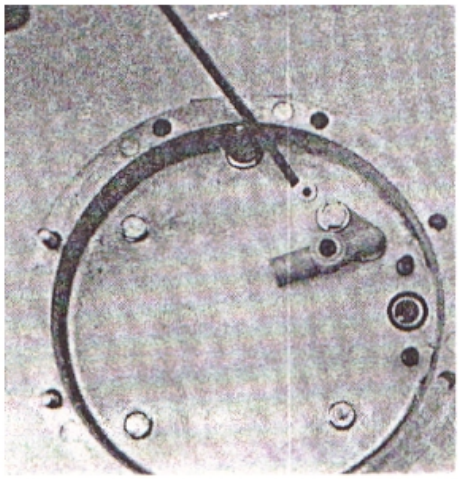
Place the O-ring



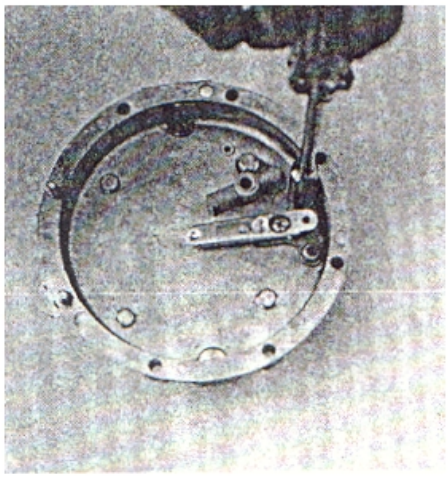
The injector tube is fitted via the connecting bolt for the 2nd stage casing. Make sure that the sealing ring is in proper position.



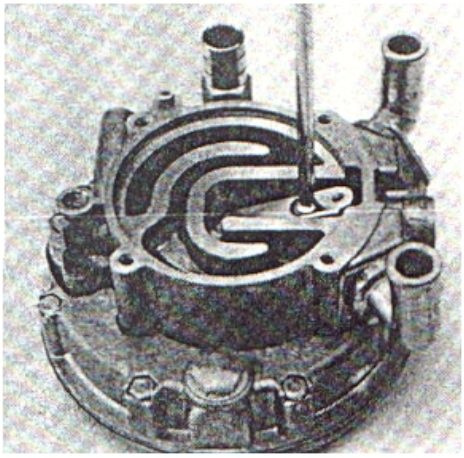
Put the remaining 3 bolts and tighten all bolts crosswise.



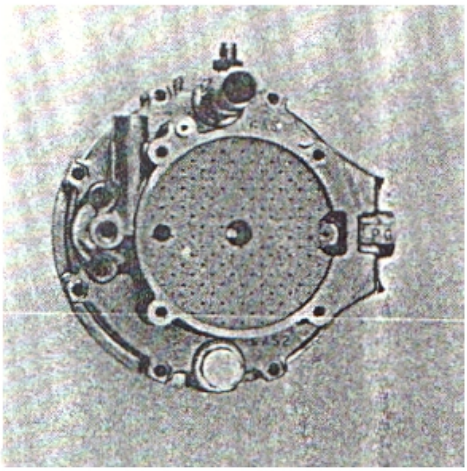
Again check the opening for the 1st stage.



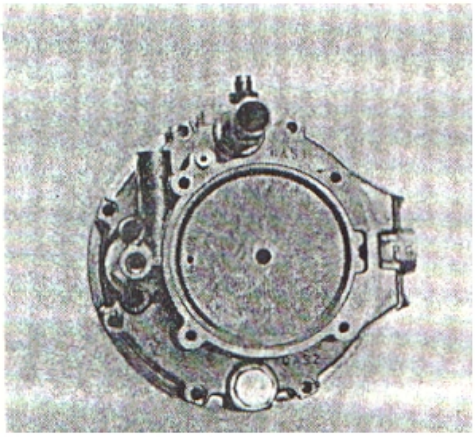
Put the 2nd stage valve in position and fit the nuts.



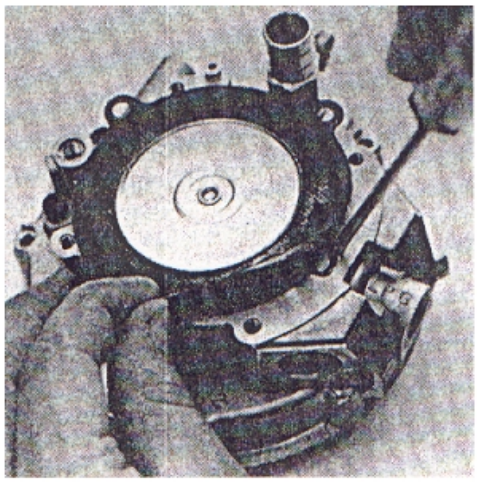
Fit the 1st stage valve.



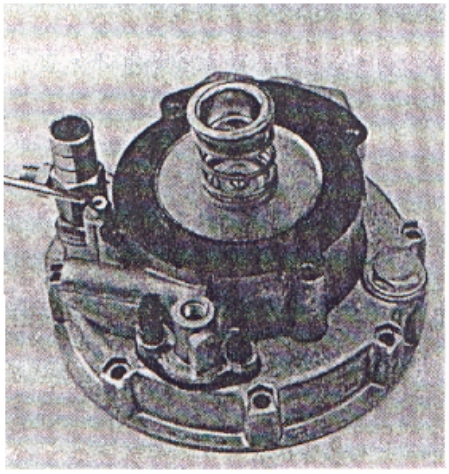
Put the absorption plate into Position.



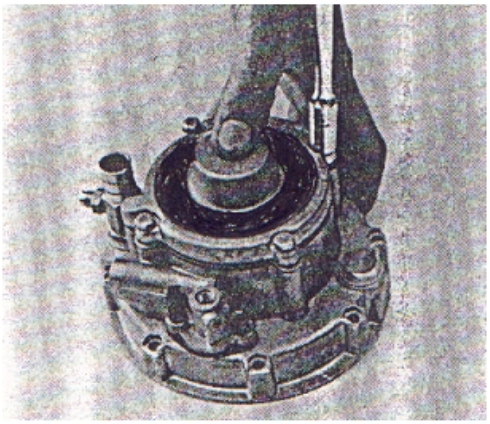
Fit the protection plate.



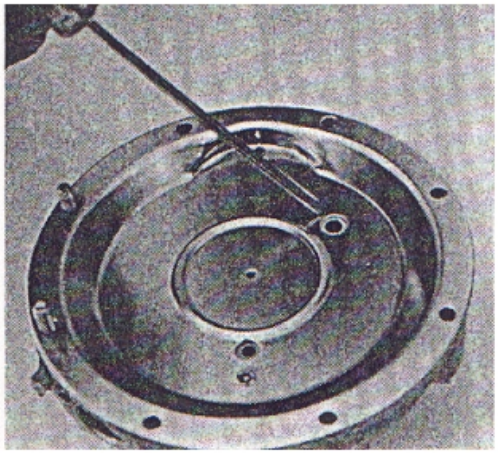
Fit the 1st stage diaphragm. Using a screwdriver press down the 1st stage down, and fit the diaphragm in the positions shown and turn it ¼ turn.



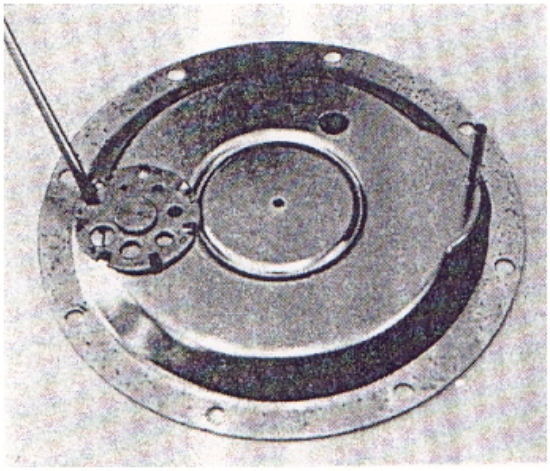
Place the O-ring and the 1st stage spring.



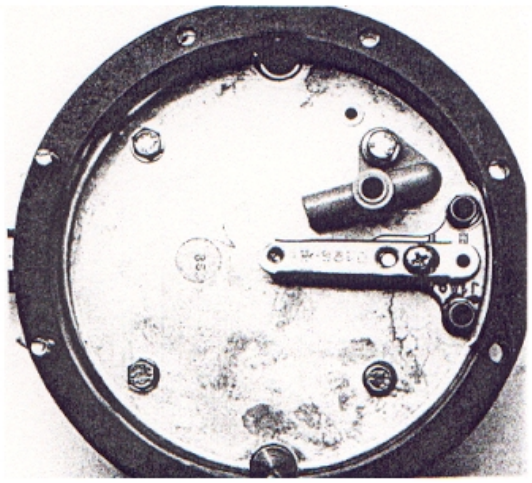
Place the 1st stage cover and tighten the bolts crosswise.



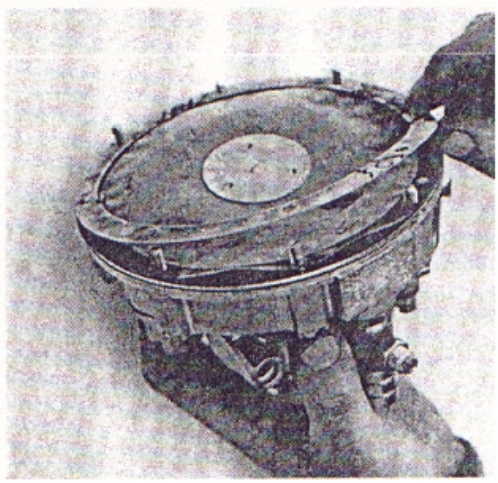
Check with the separation plate if the injector tube is in line with the opening.



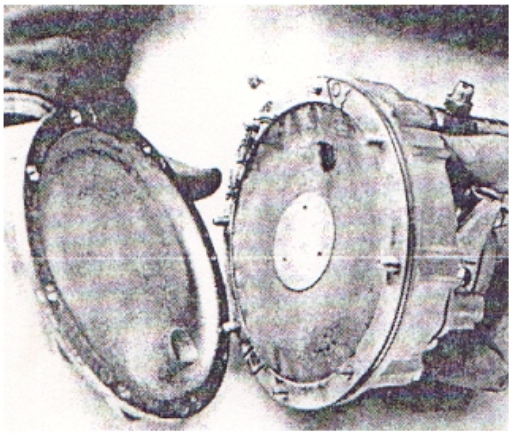
Check the disc position. Position 4 is the standard position. In case the evaporator will be replaced in the same vehicle the disc position remain unchanged.



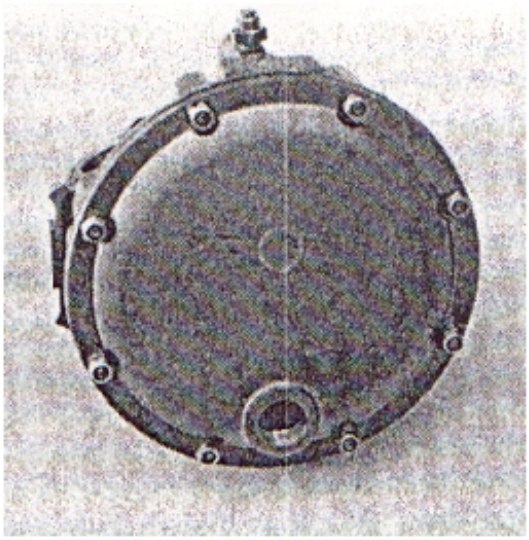
Put the bolts in the 2nd stage casing and put the paper gasket in place.



Fit the 2nd stage diaphragm and the second paper gasket.



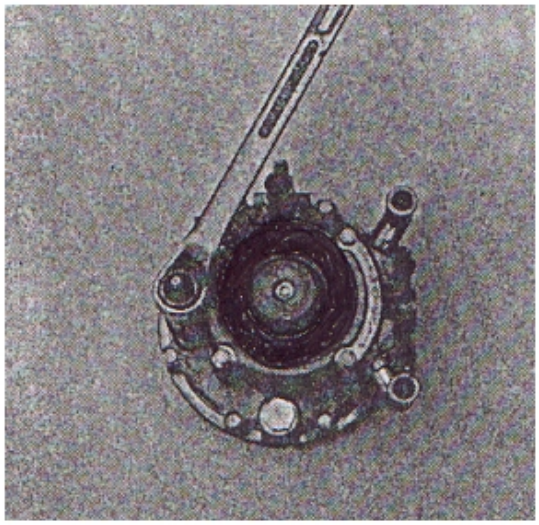
Put the second stage cover in position.



Check the position of the compensation opening in the 2nd stage cover.

IMPORTANT

Before the nut at the 2nd stage cover are tightened it is important to move the diaphragm a few times up and down (by sucking at the main adjustment)



Fit the idle solenoid.

CHECKING THE EVAPORATOR PRESSURE REGULATOR.

A) after an overhaul / repair.

For the correct execution of this check it is necessary that the 2nd stage cover and the diaphragm-separation plate are removed from the unit.

Necessary tools:

- Pressurised air
- Soap and water
- 12 Volt

Procedure:

- Connect the pressurised air into the inlet of the evaporator pressure regulator.
- Seal off the main adjustment and fill the 2nd stage with water.

The following locations should be checked for leakage:

- The connection between the 2nd stage casing and the 2nd stage valve.
- Rubber seal of the 2nd stage valve.
- Ejector-tube.
- Compensation opening.

Check with soap and water:

- Round the cover first stage.
- The idle adjustment needle.

Remove the water from the 2nd stage and dry the evaporator pressure regulator by using pressurised air.

Connect 12 Volt to the idle solenoid and now air should flow out of the injector tube. Turn the idle adjustment needle clock- and anti-clockwise and check whether these movements have an effect on the volume of airflow.

If 12 Volts are taken away the airflow should stop.

In case all functions well the separation plate, diaphragm and the cover can be fitted again.

For the last check pressurised air should be connected to the unit.

By pressing on the 2nd stage diaphragm (through the compensation opening in the back cover) air will flow from the main adjustment opening and will stop flowing if the diaphragm is no longer pressed upon.

Put the unit aside and if after 10 to 15 minutes, air still escapes from it if the diaphragm is pressed upon that unit is o.k.

In the last place we recommend to drop some oil on the idle adjustment needle opening (prevents entrance of water) and the unit is ready to be mounted.

On the vehicle

Necessary tools:

- Soap and water
- Screwdriver
- 1 core wire

Procedure:

Check the idle system

Run the engine on idle. Remove the electrical connection from the idle valve. The engine should stall now.

If the engine does not stall the following might be the case:

a) The idle solenoid does not seal properly.
b) The engine idles on fuel coming from a leaking 2nd stage valve.

If the idle solenoid does not seal properly, the seat must be polluted. The solenoid should be removed and the seat should be cleaned carefully; do not use any sharp tools for this. If the solenoid's seal is damaged the solenoid should be replaced.

In case the engine idles via the 2nd stage valve, the following might be the case:

a) The aircleaner filter is strongly polluted.
b) The opening chosen on the correction disc is too small.
c) The 2nd stage valve is leaking.

FAULT FINDING AND THE PROBLEM DIAGNOSIS

The listing below is only referring to typical problems that can be encountered on the LPG-operation of the car.

Before the problem should be dealt with one should be convinced of the fact that all engine- and carburettor settings are 100% correct for petrol-operation.

Possible problems.

1) An engine does not start or starts with difficulty.
2) A warm engine does not start or starts with difficulty.
3) The engine does not idle.
4) There is a considerable difference between idle rpm-figure on petrol and LPG.
5) The engine responds with hesitation if accelerating.
6) The engine shows a drop in performance if driven or during acceleration.
7) The engine has a drop in performance after filling the LPG-tank.
8) It is impossible or hardly possible to fill the LPG-tank.
9) The evaporator “freezes” or produces condense while driving.
10) The LPG fuel consumption is too high.

In the matrix shown below the figures refer to the problems above whereas the characters refer to the solution for same. (A-L are general items, M-V refer to specific LPG-solutions).

	1	2	3	4	5	6	7	8	9	10
A	x	x								
B	x	x			x	x				
C					x	x	x			
D					x	x				
E	x	x								
F	x	x	x		x					
G					x	x	x			
H						x			x	
I	x	x	x		x			x		
J					x				x	
K				x						
L								x		
M	x	x	x							
N	x	x	x	x	x	x				x
O					x	x				x
P					x	x			x	x
Q	x		x		x	x				x
R					x	x				x
S	x	x	x	x					x	x
T					x	x				x
U					x	x				x
V						x				x

	Possible causes	Solutions:
a)	Fuse or an electrical connection is out of order.	Clean, repair or replace
b)	Empty LPG-tank.	Fill the LPG-tank
c)	The excess-flow mechanism in the service valve of the LPG tank is closed.	Close service valve and open same gradually.
d)	LPG paper filter in the LPG solenoid is clogged.	Replace the paper filter element.
e)	LPG-solenoid has broken down.	Check voltage or replace the solenoid (or the coil).
f)	The engine received two fuels.	- Fault in the electrical system. - Petrol solenoid has broken down. - Petrol return-valve has broken down.
g)	Insufficient supply of LPG.	- Sharp bend in LPG-tubing replace same. - Service valve is nearly closed (open it).
h)	Coolant hose has been separated from connection or the hose-connector leaks.	- Fix, repair or replace
i)	-	See specific LPG-system related problems.
j)	Insufficient engine coolant resp. insufficient coolant flow.	Fill up and check the cooling system.
k)	Basic carburettor- or injector system setting is not correct.	Set the petrol system according to manufacturers specifications.
l)	Filter system is out of order.	Consult the instructions of the manufacturers of the LPG filling station involved.
m)	Idle system has broken down.	Check the complete idle system and replace any faulty parts.
n)	Idle setting is incorrect.	Set according to instructions mentioned earlier.

o)	Sensitivity disc position is incorrect.	Set according to instruction mentioned earlier.
p)	Mainstream adjustment setting in incorrect.	Set according to instructions mentioned earlier.
q)	Polluted evaporator pressure regulator.	Clean or replace evaporator
r)	Thermo valve of the aircleaner has not been modified.	Set according to instruction mentioned earlier.
s)	Clogged aircleaners.	Replace the aircleaner
t)	Mixing unit does not generate sufficient suction.	Check all connection and convince yourself of the application of the correct mixing unit type for the car involved.
u)	Sharp bend in the vapour hoses or applications of a 90 dg. elbow.	Refit the hose in the proper way and remove all super flues bends in the hose.
v)	The air-intake opening of the aircleaner is positioned into the wrong direction (RAM-effect while driving).	Position air-intake in the correct way, if needed fit compensation.

Alkmaar, 2000