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Information for LPG as ‘today's’ and ‘the future’s’ fuel



But first, what is LPG?

LPG stands for **Liquefied Petroleum Gas**

The most important reasons for using LPG fuel are as follows:

- **Environmental and pollution issues**
LPG is a world-wide, environmentally friendly, fuel and is comparatively clean both from the standpoint of carbon emissions and low hydrocarbons (70% of those of petrol), but equally importantly contains no PM10 toxic pollution/poison (smuts) most often ignored when comparisons are made with diesel engines (it's the black stuff that you see coming from even the newest diesel vehicle tail pipes).
- **Your engine**
Internal engine deposits are less for all new, or at least healthy, petrol engines, so engine life is substantially increased due to reduced wear and tear on your engine.
- **LPG is otherwise a waste by-product**
As it is a by-product of oil production it would otherwise be burned off in the refining process and be wasted as an energy source.
- **The Knock or octane rating**
The octane rating for LPG is very high compared to other fuel (LPG ± 110 octane. Regular-grade petrol ± 92 octane and premium-grade petrol ± 95 octane).
- **Storage.**
LPG is easy to store as a liquid at ± 6 bar. (relatively low pressure and relatively very safe). This makes low cost tank options available, and allows good levels of fuel storage capacity.
- **Oh and it's a lot cheaper too !!**
And it's most likely to remain that way for some considerable time as the governments of the world face higher and higher pollution taxes and environmental pressures. Last year hundreds of thousands of vehicles were converted world-wide, and in the UK 20,000 were converted. This year is set to see this figure rise by at least ten fold.

The essential components and basic understanding of an LPG system

The required components of an LPG system are:

- **An (R6701 certified) LPG storage tank with all installed 4 hole fittings**
(Ellipsoid or Cylinder) available for boot/load-space mounting or under floor mounting (petrol tank area with additional petrol tank in inner wing). Spare-wheel tanks are also available. We do not recommend the under-sill tanks (offered by others) due to ground clearance problems, fitting difficulty, bracketing costs, filling and gauge accuracy issues and the high addition to conversion costs coupled with their poor capacity.
- **3 separate electronic cut-off valves**
These default to being closed unless powered up, so shutting off supply when the engine stops or the vehicle is not in use (standard in most good systems), and thus prevent gas seepage over time.
- **A regulator/vaporiser**
Regulator to vaporise the liquid gas and regulate the amount of LPG that goes to the engine. (the regulator working principal is not dissimilar to the basic functions of a Divers Breathing Mask (demand valve) in operational terms (for V8 the Tandem one is essential to give passive (economic) fuelling at low rpm and cruise, plus full capacity flow/power when the occasional kick down is required).
- **A mainline flow adjuster**
To adjust the LPG system to the engine (can also be further Lambda & throttle -pot controlled via a stepper motor for further efficiency).
- **A mixer (supply ring)**
To mix the LPG fuel with air before it enters the engine. Normally mounted on the carb or injection plenum intake.
- **A petrol delivery shut-off system**
At its most basic for carburettor models, or at injection levels, an injector simulator system for Efi Models which has the additional ability to fool the engine management (when on LPG) rather than shut it down which would cause engine management problems and default situations, especially with later engine management types and sequential for Thor applications (chipping is needed in all Gems applications).
- **An 'LED' indicator and switch**
To give a displayed indication of fuel level and to allow switching between LPG and Petrol use, also to offer the ability to choose between LPG or Petrol start (both options available).
- **Idle and mixture adjustment ability**
These are located on the Vaporiser, with computer hook-up ability for basic system settings and emissions criteria adjustments.
- **All fittings, nuts and bolts and instructions**
Brackets, stainless steel tank straps (where appropriate), tubing , LPG supply, filling lines and gas -type tubing, filler, instructions, adapter's code of practice details, and additional details regarding our installation expectations to exceed the safety levels and issues of the LPG COP 11.



<i>Solenoid Valve & LPG Filter</i>	<i>80 Ltr. Space saving North / South Tank</i>	<i>Dual Vaporiser, Essential for V8's</i>	<i>Fuel Control Valve (Stepper)</i>	<i>LPG Mixer. 40, 45, & 50 mm</i>
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LPG (Rover V8) How does it work?

Many would have you believe it is 'highly technical', 'beyond comprehension' and not for those less than fully trained. I have found the opposite to be true. Indeed, even the training offered - for a price - is often no more than a further gimmick to gain even more of your money. Many so-called specialists are unconcerned with what standards are being met after you have left. We on the other hand keep checking till you get it right. This is even before the 'single' importer/system-monopolising mentality of LPG conversions is considered.

Good training and assistance plus continued attention to standards is of paramount importance for all our installers, and full assistance for all 'Self Fit' systems is essential and an expectation of our highest standards and on-going support.

We also endeavour to make sure that you are fully aware of any other aspects of your engine (especially ignition system related components) are at least appropriate or in upgraded condition, to further ensure that none of the, otherwise avoidable, minor niggles of LPG use will be an issue for you.

Unlike those offering less than completely appropriate systems, we offer the best upgrade system and advice uniquely for the Rover V8, to significantly increase your engine's performance over that of most pre-conversion levels. This, instead of the power losses, excuses and backfiring problems that so many others often deliver.

In this document, I have attempted to expose the simplicity of LPG conversion for the V8 engine in all its guises, and while I am happy to offer 'Self fit kits', it is an essential requirement that the system you fit is checked out (and possibly completed if need be) by us to appropriate standards, or by an LPG installer in your local area approved by us who is preferably also a Rover V8 proficient. Unless, of course, you have previous experience and training with other LPG Systems.

We would never suggest you disconnect Sports mode, close up your plug gaps, drive more slowly, avoid kick down or rapid acceleration. We would, however, address relevant upgrades required to avoid such issues.

Our unique advantage with the Rover V8, is that it's also imperative to realise that full knowledge of the engine and vehicle type and its fueling/ignition systems is just as important as knowledge of the LPG system conversion itself. This is why travelling to us is often your better option, ensuring you get the most from your conversion and in most cases more than you have already, even if it takes a day or two in worst case scenarios.

The Rover V8 engine is our speciality and this is why our systems not only use the best quality and most appropriate components available (Italian systems, imported from Belgium and Holland) and therefore are not reliant or tied by the difficulties experienced when trying to obtain stocks from UK-based, single-option supplier. Plus our own unique range of Rover V8 ignition and injection upgrades, ensures we have all the most appropriate parts for this specific engine's type and needs.

While we can supply for all other vehicle engines, we do not have the same in-depth knowledge that we offer with V8 based LPG installations.

We offer exclusive LPG conversion equipment for all vehicles powered by the Rover V8 from 1968–2002, with all carb and injection types covered including the Gems Management types, the more recent Thor injection and even provide 'Active Mixers' for the 4 Barrel Carb models (Holly & Weber).

Higher fuel consumption

LPG engines are using more fuel on LPG than on petrol. This is partly explainable by the lower calorific value of LPG and is partly compensated for by the more complete combustion, and by other ignition upgrades. Also careful appropriation of the correct vaporiser type and mixer size give savings still in the region of 50% due to the far lower fuel cost. 10-20 % extra fuel consumption on LPG is therefore considered reasonable with the obvious running cost ...MISSING TEXT?

Power loss? ... what power loss?

Many would say engines running with a dual fuel system have less power than before conversion to dual fuel. The truth is not so clear cut.

- The lower calorific power of LPG is partly compensated for by more complete combustion.
- The higher octane of LPG allows engine and ignition modifications with obvious advantages in power.

This is not however the bottom line on the subject as LPG does indeed have the added advantage of being a much higher octane fuel. To understand this it is important to realise that over the years our petrol engines have had their compressions lowered and their timing advance amounts continuously reduced year by year to cope with ever-lower fuel grades. A good example of this is when we were told all fuel was to be changed to unleaded about 5 years ago, the short term solution was to alter (reduce) your engine's ignition advance yet again. However, with LPG being 110 octane the exact opposite is true and can be used to your advantage. While most petrol engines are happy enough to run on LPG, the truth is, this slower burning fuel needs a bigger spark voltage and an advanced spark timing (usually around +10deg) otherwise by the time the combustion process is completed, this 10deg loss would effectively reduce each power stroke by the same amount.

Basic ignition issues

- LPG can indeed be as economical and powerful as fuel with the main issue/improvement with the ignition timing and spark intensity.
- Due to the slower flame front of LPG, Either upgrade to a Mallory dual point as above (carb type only with nearly double spark output and about 6 degrees of added internal timing).
- Or fit our unique new retard by advance system (electronic ignition types only). We have just released this device which replaces the original ignition amp on your distributor (we can also supply a brand new distributor if required) and allows you to set base timing to 18 degrees, thus giving a healthy 38-40 degrees of advance when on LPG. This will be the answer to all LPG prayers, and, what's better, when running on petrol it retards the ignition back to std 8 idle -28 deg. @4000.

Added spark Intensity

- As well as the ability to offer the most appropriate timing for your engine when running on LPG, another important function of our ignition amp upgrade is that it delivers a far higher spark voltage. Unlike others, we do not tell you to reduce plug gaps or other strange methods, indeed we actively encourage a V8 spark gap to be opened to 0.8-to09mm Spark intensity is so much better that it will show up the worst in poor quality plug leads.

Magnacor leads

- Any weakness in your ignition system will cause a misfire under load, and the consequence to an LPG powered engine is normally a backfire, this in itself is not a big problem but certainly is a compromise you don't need to live with. When it comes to ignition leads you can consider them to be not dissimilar in importance to perhaps speaker leads. Would you fit your £5000 Hi fi with £20 speaker leads? While we don't want to encourage you to go wild and buy gold plated ones, there is a big difference in signal loss and quality between high street plug leads and quality ones.

LPG tanks (Single hole or 4 Hole)

Although there are many shapes of LPG tanks, there are 2 other issues more often ignored.,
An LPG tank, in addition to its ability to store LPG also has to achieve four other basic functions. By definition, the 4-hole tanks allow for all four of these additional features to be better controlled.

All LPG tanks are R6701 approved and LPG COP 2 std., and incorporate safety valves and the following connections:

- Filling-hose connection with an 80% shut off.
- Over-pressure relief valve which opens at ± 30 bar.
- A shut-off to close the tank electronically (solenoid) or in cheaper tanks by hand.
- A Fuel Gauge, which gives an indication of the amount of LPG in the tank.
- Enclosed with an air/gas-tight cover vented to fully avoid the possibility of LPG entering the car.

Our 4-hole tanks (our preferred LPG tank type) offer:

- Large filler hole/feed to allow refuelling as fast as with petrol.
- Separate fuel-level indicator.
- Electronic, solenoid type shut off
- Separate fuel to engine supply outlet.
- Larger and separate over-pressure relief valve.
- Supplied with all the above fitted and pre-pressurised to avoid contamination and ensured with perfect sealing.
- Unique stainless steel tank straps (cylinder tank types) and appropriate mounting frames (all types).
- Greatly reduced fitting time by simplifying installation and supplying a more complete system .

All the above aspects are preferred by professional installers.

Single hole tanks (supplied & used only by specific request) offer:

- All of the above fittings, but in one multi-valve configuration. So smaller fill-feed pipe and smaller relief valve only are available (some would say too small).
- Cheaper, & LPG shut-off is normally by thumb screw rather than the (preferred) electronic solenoid way as with 4-hole tanks.
- Because supplied without any of the multi-valves fitted, open to atmosphere and so often pre-stored outside, these tanks are also prone to being internally contaminated with damp, causing constant filter blockages and possible future leaks. Also the tanks tend to be factory paint-sprayed without the multi-valve hole-threads being covered, which can cause considerable difficulty in cleaning out threaded sections to fit the multi-valve.



Our Unique Twin Tank, 135 liter uniquely 4 hole and quick fill.	Taking up almost no boot space, and looking good too.	The option of slim in the tyres or this spare wheel bracket and cover
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The LPG tanks we stock exclusively for Rover application (other types are often available):

- **Cylindrical Tanks:** the most common straight round tanks from 80ltr to 120ltr are all 4-hole type and are designed to fit under the parcel shelf behind the rear seats of a Range Rover (both Classic and New shape). The 80 litre can go north to south to minimise load space loss.
- **Ellipsoid Tanks** which we designed exclusively to fit conveniently into the petrol tank area - underneath, behind the tow bar, and safely between the under-body chassis sections of Classic Range Rover, Land Rover and Discovery models. Furthermore, now conveniently suited to the Spare Wheel of 'new shape' Range Rovers by using our unique mounting cassette.
- We are also **further developing**, our 80 litre ellipsoid tank, with a Petrol 'combined tank' for the 'new shape' Range Rover, to be used in conjunction with the above, giving a massive 160litre capacity with no lost load space.

LPG shut off solenoids and vaporisers

(Ultimate system safety is ensured by defaulting to the system being shut down as installed default, with the LPG solenoids shut unless all three are supplied with voltage. Only available with ignition on, with engine running and with input - both electrical and engine vacuum - required).

- **Tank solenoid.**
Electronic and default is closed. If required allows simple disconnection of feed and fill pipes (to engine bay and LPG filler) without Fuel escape and is only open when engine is running and switched fuel mode is LPG.
- **LPG Filter Solenoid.**
Electronic and default is closed. If required allows simple disconnection of LPG pipe from tank to filter in the engine bay and is only open when engine is running and switched fuel mode is LPG.
- **Vaporiser Solenoid**
Electronic and default is closed. If required allows simple disconnection of LPG pipe from filter to vaporiser in the engine bay and is only open when the engine is running and switched fuel mode is LPG.

Vaporiser/regulator (Simply the demand valve part of the system)

The vaporiser/regulator has two basic functions:

- **Vaporiser.** This is achieved by being plumbed into the car's water system, thus simply controlling its working temperature to ensure the liquid LPG won't freeze as it becomes a vapour. This is done by making the appropriate twin connections via supplied T-pieces for connecting into the car's water cooling circuit.
- **Regulator** The second function is to regulate the amount of LPG supplied to the engine. Just like a carburettor it tries to keep the mixture of LPG and air at the optimum proportion. This is achieved by default as engine vacuum and fuel demand is very much linked. Therefore the **vaporiser/regulator** delivers LPG pressure to the engine at a rate, controlled mostly by engine demand. This can be further regulated by means of Lambda, throttle position and stepper motor control, an issue covered later in this document.

Vaporisers come in 3 types

- **Single-stage Vaporisers** (suitable for smaller capacity engines)
- **Two-stage Vaporisers** (suitable for engines with big demand but essentially passive use)
- **Direct line** (suitable for injection)

Single-stage vaporisers (mostly suited to smaller engines)

The relationship between vaporiser and mixer size/type is an issue often disregarded. The fact is that with bigger single-stage vaporisers which have to be big to supply the higher fuel demands of a V8 engine, they create unwelcome inefficiency at low- to mid-range torque, when considering most V8 applications, which also demand good cruise, passive and economy. Also, when employing a big single-stage vaporiser, there is a need for a restrictive size mixer, thus causing poor engine performance both at the upper end of petrol and LPG power expectations.

Two-stage vaporisers (essential for all V8's and larger engines)

It's probably the most essential part that makes our system the best for Rover V8 applications. The two-stage vaporisers are just what the V8 Rover Engine needs, with improved and controlled fuelling at low engine demand, and big fuelling ability for those V8 moments.

Direct line (Suitable for EFI Gems and Thor)

Direct injection suitable for direct draw K&N filters and non re-circulating plenum breathing. Essential for Thor with over-run spark. My 5.2 Range Rover has no problem keeping up with the fastest of street cars, but also offers superb controlled torque and economy at lower speeds and passive driving. (as well as BMW-beating attitude).

The two-stage, tandem vaporiser's basic functioning is almost the same as all vaporisers except it is further and more accurately controlled by engine demand

The primary stage is operating when smaller quantities of LPG are required by the engine. Because of the small internal size of the valve the LPG release pressure is very stable. at this level.

The Secondary Stage (high power stage) will be actuated when the required amount of fuel has reached the maximum capacity of the primary stage (generally when you have just put your foot down). Best suited to larger capacity engines



Reducer/Vaporizer

Calibrated to deliver fuel at a pressure of about 0.95 bar, which is greater of the pressure present in the manifold. Its task is also to vapourize the gas, this would happen with the circulation, in itself, of cooling liquid taken from the engine cooling system.

Two main LPG mixture adjustment types (fine tuning)

Appropriation The main LPG adjuster is installed between the vaporiser and the mixer. Its basic function is to adjust the LPG fuel flow appropriate to engine demand. The LPG system in return must create an LPG/Air mixture of a constant ratio. While this issue is mainly taken care of by demand (simply actuated by engine vacuum), additional control is often advantageous/needed to compensate for varying engine demands.

We offer 2 different types of main LPG mixture adjusters:

- an **electronic controlled main flow adjuster** (basically Lambda and actuator controlled).
- a **fixed main flow adjuster** (mainly for carb. and early injection types).

Electronic controlled main flow adjusters (exclusively for later Efi type applications)

With input from the lambda probe in the exhaust providing a voltage signal output relevant to weak or rich emissions, and throttle potentiometer (throttle position information) relating to full throttle power requirement or part throttle cruise (plus all variants between) combine to activate a stepper motor that enables further control of LPG delivery between the vaporizer and LPG mixer for optimum economy.

This system is supplied with all Hot-wire and Gems type Rover Efi systems included. An additional supply of separate lambda probes if required is available and recommended.

The Software system we use (Millennium/Leonardo) also offers unique advantages with the ability of self-learning, and can further minimise fuel consumption and power losses compared with other manual, fixed main-flow adjusters (see below) or lesser lambda-controlled systems.

The LPG peak flow controller/solenoid (stepper) receives its information from the Lambda sensor and throttle position sensor to compensate for and adjust to relevant fuel flow requirements, both for cruise passive driving and the more demanding load pulling or hurried acceleration times.



Manual controlled main flow adjusters

Appropriate for Carb. and early injection (flapper type) models. And for non Efi and early injection engines

Because the engine you have will provide its fuel demand (by vacuum) requirements as accurately as a deep sea diver's regulated and appropriate oxygen supply, LPG is also demand-regulated via engine demand, indeed very accurately, without always having the need of additional electronic devices. So don't feel left out, as the right combination of mixer, size, vaporizer and filter can gain all the required results without the more expensive EFI issues and upgrades of later engines.

LPG mixers/injectors

The LPG mixer has two main functions

- Generating a vacuum signal to the vaporizer instigating movement and subsequent LPG supply (achieved by the creation of unequalled atmospheric pressure (reduced) to supply side of the vaporizer diaphragm working on the principal of atmospheric pressure being on both sides of vaporizer diaphragm when non supply is relevant.
- Offer efficient supply of appropriate amount of LPG fuel with regards to peak efficiency and performance. Normally positioned close to the throttle butterfly on both Efi intakes and between Carb and air filter. Components, of carburettor application as with our new Weber Active Mixer, discreetly contained within the air filter of 4-Barrel carb. systems.

- The vacuum signal must be as constant as possible compared with the amount of air that is going through the venturi of the mixer. To achieve this the mixer must be carefully designed and one of the most important components is the venturi.
- The LPG/air exit of the venturi must have an ± 8 degrees angle to achieve a constant ratio of LPG with air. One of the problems of this mixer will be its length (± 30 CM) which makes it almost impossible to install.





Rail Injectors

The electro-injectors are situated on a common (RAIL). When alimentated they, provide fuel (L.P.G) to the manifold situated before the inlet valves. The actual injection happens individually according to the order of the strock of the engine and is controlled by the C.P.U.

Not only is the shape of the mixer important, but also the size of the venturi. The smaller the diameter, the higher the vacuum signal to the vaporiser and the more accurate the LPG flow. The disadvantage is that the engine gets less mixture because of the smaller diameter. This is why for V8 application we supply the most appropriate mixer up top, 50mm and suited to our V8s from 3.5 to 5.2 ltr.

Therefore we supply and recommend that:

- The venturis must be at least 75% of the superficial measure of the carburettor's venturi or butterfly valve if it's an EFI engine.
- The venturi's superficial measure must be 7.5mm and if possible 10mm for every 1HP.
- It is important to have a mixer that has suitable diameter to create the vacuum needed for the vaporiser to work (hence we only use the 'Tandem' vaporiser on V8's) but of a big enough diameter to offer minimum air-flow restriction for the occasional higher rpm use. Our mixers are available from 40mm to 50mm and have no plastic insert/parts (unlike some systems where these can perish and be drawn into the engine).

Other Mixer types

The Rover V8 is often fitted with the Holly, or more recently the Weber/Edelbrock 4-barrel carburettor. This type of large bore carburettor creates big problems for LPG dual fuel use as the air flow is far too free to create a worthwhile vacuum signal to the vaporiser. So although mixers are available for this type of carburettor, petrol use becomes impossible due to the need to restrict nearly 80% of air flow for the LPG to work (until now, that is)

To overcome this problem, we have designed what we call an 'Active Mixer' which, whilst on LPG, closes off 80% of air flow by means of an internal plate which is neatly hidden inside the filter housing.

When switched back to petrol, the plate rises automatically (vacuum controlled) and restores the 80% of air flow to allow petrol performance without power loss.



Internal View of the unique Weber 4 Barrel "Active Mixer", note just how much air flow is restricted for LPG use (default) and how it all fits neatly into the Air Cleaner

Modern cars are filled with electronics.

These electronics provide the driver with information when one of the measurements is out of tolerance. When an LPG system is installed, the motor management system detects that the fuel injection has stopped, the lambda signal has changed etc.

The modern LPG system has to cope with these problems.

According to the car there will be installed:

- injection simulation
- lambda simulation
- auto petrol start (can default to starting on gas if required)

Injection simulation

The injection simulator has 3 functions

- shut down the need for petrol injection by blocking off the signals to the injectors (includes simulated feedback)
- Ensure the engine management system (ECU) does not go into default by giving a simulated signal as if it were the injectors, thus keeping the ECU happy
- avoid the chance of getting a back-fire by delaying shutting down of the petrol injection by several seconds after activating the LPG system

Lambda simulation

If an engine has a constant-learning motor management system (later Efi types) a Lambda simulator has to be installed.

This type of engine management system will try to reduce the amount of fuel constantly until it gets the correct mixture reading out of the lambda probe.

Because the LPG computer is regulating the fuel mixture (LPG) the Lambda will give a Lambda '1' read out to the Engine ECU, which in turn will mistakenly continue to lower the assumed injected amount of petrol and still get a lambda '1'. This will result in further lowering of the amount of petrol until the system goes into default.

The reason for this is the LPG ECU is running the engine fuel management and the Petrol ECU only thinks it is, but switching back to petrol means it has lowered itself so weak on fuel it can take some miles for the system to re-calibrate itself, hence the need for Lambda simulation

For later gems type injection systems chipping is also an essential part of the conversion and to get over this problem it does it by removing the robust security that is at present unhelpfully protecting the ECU from being fooled.

Auto Petrol Start

There are many rumours that a dual fuel vehicle has to start on petrol and then be switched over to LPG. Whilst this is the default scenario as petrol starting is preferred, it is completely automatic, and in most cases almost instant. However, it is possible to override this and starting and running completely on LPG is not a problem.



LPG Simulators and Millennium/Leonardo stepper motor (actuator) control and software are just part of our unique Rover V8 LPG Kits. All wiring is included and installation is simple with piggy back type connections and full instructions.

Unique V8 Equipment, for the best results

Flap opener back-fire safety protection.

For all Rover injection engines pre-1990 (flapper type)

- Offer active back-fire protection
- Improved power efficiency and response

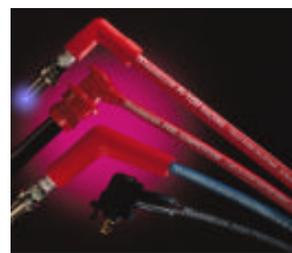
Without the need to draw the 'flap open' your engine will gain significant power.



The chance of getting a back-fire is the highest during the starting procedure. And only to be expected if plug leads, coil, distributor output (voltage or correct timing advance ability) or throttle potentiometer faulty, & this issues are not uncommon with most V8's over 3 years old.

Ignition system condition check list (very important for any amp upgrade to function correctly)

- First remove advance vacuum pipe from intake and check for positive vacuum when throttle is applied. Check (if fitted) that the vacuum delay module is not blocked.
- Check positive vacuum will pull distributor advance while also checking vacuum module is not holed. (when sucking the pipe, the base plate of the distributor should rotate anti-clockwise about 15 deg.).
- Check condition of rotor arm for signs of damage or arcing, also check the cap and clean the contacts (better still, fit new).
- Check rotor for free play, there should be none, both rotationally and side to side.
- Check rotor will turn clockwise through about 20 deg. and smartly retracts back to it's home position under good spring tension.
- Distributor output is known to be weak so upgrading with our spark amp is recommended. (see below). Replace plug leads, preferably with Magnecor. Use good quality plugs such as NGK BP6ES, but avoid fancy plugs, as they don't normally last long.



A & R Duel Timing Power amp & Magnecor Plug Leads the best choice.