Haynes
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Citroën Diesel Engine
Service and Repair Manual

A K Legg LAE MIMI and Finn Deacon

Models covered
This manual covers the Citroën 1769 cc and 1905 cc (1.7 and 1.9 litre) diesel engines used in the Visa, C15/Champ Van and BX models (including the 1.7 litre turbocharged engine used in the BX)

Does not cover specific application to ZX or Xantia models *(1379 -168 - 6Y4)*

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About this manual

The aim of this manual is to help you get the best value from your vehicle. It can do so in several ways. It can help you decide what work must be done (even should you choose to get it done by a garage), provide information on routine maintenance and servicing, and give a logical course of action and diagnosis when random faults occur. However, it is hoped that you will use the manual by tackling the work yourself. On simpler jobs it may even be quicker than booking the car into a garage and going there twice, to leave and collect it. Perhaps most important, a lot of money can be saved by avoiding the costs a garage must charge to cover its labour and overheads.

The manual has drawings and descriptions to show the function of the various components so that their layout can be understood. Then the tasks are described and photographed in a step-by-step sequence so that even a novice can do the work.

Unlike most Haynes manuals, which cover a particular vehicle in different trim levels and engine sizes, this book covers one engine and its associated equipment as fitted to a range of vehicles. Items which are common to diesel and petrol models - e.g. bodywork, transmission and running gear - are not covered in this book.

The vehicles used in the preparation of this manual and which appear in many of the photographs, were a BX diesel, a Visa diesel and a BX Turbo diesel.

Acknowledgements

Thanks are due to Champion, who supplied replacement component information. Certain illustrations are the copyright of Citroën Cars Limited, and are used with their permission. Illustrations denoted by the line '© Robert Bosch Limited' are used by kind permission of that company. Thanks are also due to Sykes-Pickavant Limited, who provided some of the workshop tools, and to all those people at Sparkford who helped in the production of this manual.

We take great pride in the accuracy of information given in this manual, but vehicle manufacturers make alterations and design changes during the production run of a particular vehicle of which they do not inform us. No liability can be accepted by the authors or publishers for loss, damage or injury caused by any errors in, or omissions from, the information given.

Working on your car can be dangerous. This page shows just some of the potential risks and hazards, with the aim of creating a safety-conscious attitude.

General hazards

Scalding

• Don't remove the radiator or expansion tank cap while the engine is hot.
• Engine oil, automatic transmission fluid or power steering fluid may also be dangerously hot if the engine has recently been running.

Burning

• Beware of burns from the exhaust system and from any part of the engine. Brake discs and drums can also be extremely hot immediately after use.

Crushing

• When working under or near a raised vehicle, always supplement the jack with axle stands, or use drive-on ramps. ***Never venture under a car which is only supported by a jack.***
• Take care if loosening or tightening high-torque nuts when the vehicle is on stands. Initial loosening and final tightening should be done with the wheels on the ground.

Fire

• Fuel is highly flammable; fuel vapour is explosive.
• Don't let fuel spill onto a hot engine.
• Do not smoke or allow naked lights (including pilot lights) anywhere near a vehicle being worked on. Also beware of creating sparks (electrically or by use of tools).
• Fuel vapour is heavier than air, so don't work on the fuel system with the vehicle over an inspection pit.
• Another cause of fire is an electrical overload or short-circuit. Take care when repairing or modifying the vehicle wiring.
• Keep a fire extinguisher handy, of a type suitable for use on fuel and electrical fires.

Electric shock

• Ignition HT voltage can be dangerous, especially to people with heart problems or a pacemaker. Don't work on or near the ignition system with the engine running or the ignition switched on.
• Mains voltage is also dangerous. Make sure that any mains-operated equipment is correctly earthed. Mains power points should be protected by a residual current device (RCD) circuit breaker.

Fume or gas intoxication

• Exhaust fumes are poisonous; they often contain carbon monoxide, which is rapidly fatal if inhaled. Never run the engine in a confined space such as a garage with the doors shut.
• Fuel vapour is also poisonous, as are the vapours from some cleaning solvents and paint thinners.

Poisonous or irritant substances

• Avoid skin contact with battery acid and with any fuel, fluid or lubricant, especially antifreeze, brake hydraulic fluid and Diesel fuel. Don't syphon them by mouth. If such a substance is swallowed or gets into the eyes, seek medical advice.
• Prolonged contact with used engine oil can cause skin cancer. Wear gloves or use a barrier cream if necessary. Change out of oil-soaked clothes and do not keep oily rags in your pocket.
• Air conditioning refrigerant forms a poisonous gas if exposed to a naked flame (including a cigarette). It can also cause skin burns on contact.

Asbestos

• Asbestos dust can cause cancer if inhaled or swallowed. Asbestos may be found in gaskets and in brake and clutch linings. When dealing with such components it is safest to assume that they contain asbestos.

Special hazards

Hydrofluoric acid

• This extremely corrosive acid is formed when certain types of synthetic rubber, found in some O-rings, oil seals, fuel hoses etc, are exposed to temperatures above 400°C. The rubber changes into a charred or sticky substance containing the acid. *Once formed, the acid remains dangerous for years. If it gets onto the skin, it may be necessary to amputate the limb concerned.*
• When dealing with a vehicle which has suffered a fire, or with components salvaged from such a vehicle, wear protective gloves and discard them after use.

The battery

• Batteries contain sulphuric acid, which attacks clothing, eyes and skin. Take care when topping-up or carrying the battery.
• The hydrogen gas given off by the battery is highly explosive. Never cause a spark or allow a naked light nearby. Be careful when connecting and disconnecting battery chargers or jump leads.

Air bags

• Air bags can cause injury if they go off accidentally. Take care when removing the steering wheel and/or facia. Special storage instructions may apply.

Diesel injection equipment

• Diesel injection pumps supply fuel at very high pressure. Take care when working on the fuel injectors and fuel pipes.

Warning: Never expose the hands, face or any other part of the body to injector spray; the fuel can penetrate the skin with potentially fatal results.

Remember...

DO

• Do use eye protection when using power tools, and when working under the vehicle.

• Do wear gloves or use barrier cream to protect your hands when necessary.

• Do get someone to check periodically that all is well when working alone on the vehicle.

• Do keep loose clothing and long hair well out of the way of moving mechanical parts.

• Do remove rings, wristwatch etc, before working on the vehicle – especially the electrical system.

• Do ensure that any lifting or jacking equipment has a safe working load rating adequate for the job.

DON'T

• Don't attempt to lift a heavy component which may be beyond your capability – get assistance.

• Don't rush to finish a job, or take unverified short cuts.

• Don't use ill-fitting tools which may slip and cause injury.

• Don't leave tools or parts lying around where someone can trip over them. Mop up oil and fuel spills at once.

• Don't allow children or pets to play in or near a vehicle being worked on.

History of the diesel engine

Rudolf Diesel invented the first commercially successful compression ignition engine at the end of the 19th century. Compared with the spark ignition engine, the diesel had the advantages of lower fuel consumption, the ability to use cheaper fuel, and the potential for much higher power outputs. Over the following two or three decades such engines were widely adopted for stationary and marine applications, but the fuel injection systems used were not capable of high-speed operation. This speed limitation, and the considerable weight of the air compressor needed to operate the injection equipment, made the first diesel engines unsuitable for use in road-going vehicles.

In the 1920s the German engineer Robert Bosch developed the in-line injection pump, a device which is still in extensive use today. The use of hydraulic systems to pressurise and inject the fuel did away with the need for a separate air compressor and made possible much higher operating speeds. The so-called high-speed diesel engine became increasingly popular as a power source for goods and public transport vehicles, but for a number of reasons (including specific power output, flexibility and cheapness of manufacture) the spark ignition engine continued to dominate the passenger car and light commercial market.

In the 1950s and 60s, diesel engines became increasingly popular for use in taxis and vans, but it was not until the sharp rises in oil prices in the 1970s that serious attention was paid to the small passenger car market.

Subsequent years have seen the growing popularity of the small diesel engine in cars and light commercial vehicles, not only for reasons of fuel economy and longevity but also for environmental reasons. Every major European car manufacturer now offers at least one diesel-engined model. The diesel's penetration of the UK market has been relatively slow, due in part to the lack of the considerable fuel price differential in favour of diesel which exists in other parts of Europe, but it has now gained widespread acceptance and this trend looks set to continue.

Principles of operation

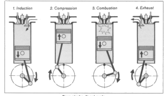
All the diesel engines covered in this book operate on the familiar four-stroke cycle of induction, compression, power and exhaust. Two-stroke diesels do exist, and may in future become important, but they are not used in light vehicles at present. Most have four cylinders, some larger engines have six, and five- and three-cylinder engines also exist.

Induction and ignition

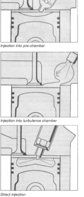
The main difference between diesel and petrol engines is in the means by which the fuel/air mixture is introduced into the cylinder and then ignited. In the petrol engine the fuel is mixed with the incoming air before it enters the cylinder, and the mixture is then ignited at the appropriate moment by a spark plug. At all conditions except full throttle, the throttle butterfly restricts the airflow and cylinder filling is incomplete.

In the diesel engine, air alone is drawn into the cylinder and then compressed. Because of the diesel's high compression ratio (typically 20 : 1) the air gets very hot when compressed - up to 750°C. As the piston approaches the end of the compression stroke, fuel is injected into the combustion chamber under very high pressure in the form of a finely atomised spray. The temperature of the air is high enough to ignite the injected fuel as it mixes with the air. The mixture then burns and provides the energy which drives the piston downwards on the power stroke.

When starting the engine from cold, the temperature of the compressed air in the cylinders may not be high enough to ignite the fuel. The preheating system overcomes this problem. The engines in this book have automatically-controlled preheating systems, using electric heater plugs (glow plugs) which heat the air in the combustion chamber just



Four-stroke diesel cycle
© Robert Bosch Limited



Direct and indirect injection
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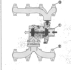


Principle of turbocharging

1 Turbocharger
2 Exhaust manifold
3 Inlet manifold

before and during start-up.

On most diesel engines there is no throttle valve in the inlet tract. Exceptions to this are those few engines which use a pneumatic governor, which depends on a manifold depression being created. Even more rarely a throttle valve may be used to create manifold depression for the operation of a brake servo, though it is more usual for a separate vacuum pump to be fitted for this purpose.

Direct and indirect injection

In practice, it is difficult to achieve smooth combustion in a small-displacement engine by injecting the fuel directly into the combustion chamber. To get around this problem the technique of indirect injection is widely used. With indirect injection, the fuel is injected into a pre-combustion or swirl chamber in the cylinder head, alongside the main combustion chamber.

Indirect injection engines are less efficient than direct injection ones and also require more preheating when starting from cold, but these disadvantages are offset by smoother and quieter operation.

Mechanical construction

The pistons, crankshaft and bearings of a diesel engine are generally of more robust construction than in a petrol engine of comparable size, because of the greater loads imposed by the higher compression ratio and the nature of the combustion process. This is one reason for the diesel engine's longer life. Other reasons include the lubricating qualities of diesel fuel on the cylinder bores, and the fact that the diesel engine is generally lower-revving than its petrol counterpart, having much better low-speed torque characteristics and a lower maximum speed.

Turbocharging

Turbochargers have long been used on large diesel engines and are becoming common on small ones. The turbocharger uses the energy of the escaping exhaust gas to drive a turbine which pressurises the air in the inlet manifold. The air is forced into the cylinders instead of being simply sucked in. If more air is present, more fuel can be burnt and more power developed from the same size engine.

Greater benefit can be gained from turbocharging if the pressurised air is cooled before it enters the engine. This is done using an air-to-air heat exchanger called an intercooler. The cooled air is denser and contains more oxygen in a given volume than warm air straight from the turbocharger.

Exhaust emissions

Because combustion in the correctly functioning diesel engine nearly always occurs in conditions of excess oxygen, there is little or no carbon monoxide (CO) in the exhaust gas. A further environmental benefit is that there is no added lead in diesel fuel.

At the time of writing there is no need for complicated emission control systems on the diesel engine, though simple catalytic converters are beginning to appear on production vehicles. Increasingly stringent emission regulations may result in the adoption of exhaust gas recirculation (EGR) systems and carbon particle traps.

Knock and smoke

The image of the diesel engine for many years was of a noisy, smoky machine, and to some extent this was justified. It is worth examining the causes of knock and smoke, both to see how they have been reduced in modern engines and to understand what causes them to get worse.

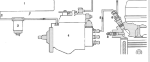
There is inevitably a small delay (typically 0.001 to 0.002 sec) between the start of fuel injection and the beginning of proper combustion. This delay, known as ignition lag, is greatest when the engine is cold and idling. The characteristic diesel knock is caused by the sudden increase in cylinder pressure which occurs when the injected fuel has mixed with the hot air and starts burning. It is therefore an unavoidable part of the combustion process, though it has been greatly reduced by improvements in combustion chamber and injection system design. A defective injector (which is not atomising the fuel as it should for optimum combustion) will also cause the engine to knock.

Smoke is caused by incorrect combustion, but unlike knock it is more or less preventable. During start-up and warm-up a certain amount of white or blue smoke may be seen, but under normal running conditions the exhaust should be clean. The thick black smoke which is all too familiar from old or badly-maintained vehicles is caused by a lack of air for combustion, either because the air inlet is restricted (clogged air cleaner) or because too much fuel is being injected (defective injectors or pump). Causes of smoke are examined in more detail in the Reference Chapter.

Fuel supply and injection systems

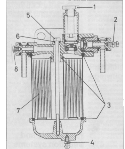
Fuel supply

The fuel supply system is concerned with delivering clean fuel, free of air, water or other contaminants, to the injection pump. It always includes a fuel tank, a water trap and a fuel filter (which may be combined in one unit),



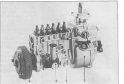
Fuel circulation - typical passenger car system
© Robert Bosch Limited

1 Fuel tank
2 Fuel feed line
3 Fuel filter/water trap
4 Injection pump with integral supply pump
5 Injector pipe
6 Injector
7 Fuel return (leak off) line
8 Glow plug (heater plug)



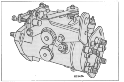
Sectional view of a typical fuel filter

1 Hand priming plunger
2 Fuel bleed screw (on outlet union)
3 Seals
4 Water drain tap
5 Through bolt
6 Through bolt seal
7 Filter element
8 Air bleed screw (on inlet union)



Bosch PE in-line injection pump and associated components
© Robert Bosch Limited

1 Pump
2 Governor housing
3 Lift pump
4 Drivegear and advance mechanism



Lucas/CAV distributor injection pump type DPC

and the associated pipework. Some arrangement must also be made for returning fuel leaked from the injection pump and injectors to the tank.

A fuel lift pump is fitted between the tank and the filter on vehicles which use an in-line injection pump, or where the fuel tank outlet is significantly lower than the injection pump. When a distributor injection pump is fitted and the tank outlet is at about the same level as the injection pump (as is the case with many passenger cars), a separate fuel lift pump is not fitted. In this case a hand priming pump is often provided for use when bleeding the fuel system.

Additional refinements may be encountered. These include a fuel heater, which may be integral with the filter or on the tank side of it, to prevent the formation of wax crystals in the fuel in cold weather. A "water in fuel" warning light on the instrument panel may be illuminated by a device in the water trap when the water reaches a certain level.

The water trap and fuel filter are vital for satisfactory operation of the fuel injection system. The water trap may have a glass bowl, in which case water build-up can be seen, or it may as already mentioned have some electrical device for alerting the driver to the presence of water. Whether or not these features are present, the trap must be drained at the specified intervals, or more frequently if experience shows this to be necessary. If water enters the injection pump it can cause rapid corrosion, especially if the vehicle is left standing for any length of time.

The fuel filter may be of the disposable cartridge type, or it may consist of a renewable element inside a metal bowl. Sometimes a coarser pre-filter is fitted upstream of the main filter. Whatever the type, it must be renewed at the specified intervals. Considering the damage which can be caused to the injection equipment by the entry of even small particles of dirt, it is not worth using cheap replacement filters, which may not be of the same quality as those of reputable manufacture.

Fuel injection pump

The pump is a mechanical device attached to the engine. Its function is to supply fuel to the injectors at the correct pressure, at the correct moment in the combustion cycle and for the length of time necessary to ensure efficient combustion. The pump responds to depression of the accelerator pedal by increasing fuel delivery, within the limits allowed by the governor. It is also provided with some means of cutting off fuel delivery when it is wished to stop the engine.

Some kind of governor is associated with the injection pump, either integral with it or attached to it. All vehicle engine governors regulate fuel delivery to control idle speed and maximum speed; the variable-speed governor also regulates intermediate speeds. Operation of the governor may be mechanical or hydraulic, or it may be controlled by manifold depression.

Other devices in or attached to the pump include cold start injection advance or fast idle units, turbo boost pressure sensors and anti-stall mechanisms.

Fuel injection pumps are normally very reliable. If they are not damaged by dirt, water or unskilled adjustment they may well outlast the engine to which they are fitted.

Fuel injectors

One fuel injector is fitted to each cylinder. The function of the injector is to spray an evenly atomised quantity of fuel into the combustion or pre-combustion chamber when the fuel pressure exceeds a certain value, and to stop the flow of fuel cleanly when the pressure drops. Atomisation is achieved by a spring-loaded needle which vibrates rapidly against its seat when fuel under pressure passes it. The needle and seat assembly together are known as the injector nozzle.

Injectors in direct injection engines are usually of the multi-hole type, while those in indirect engines are of the pintle type. The "throttled pintle" injector gives a progressive build-up of injection, which is valuable in achieving smooth combustion.

The injector tips are exposed to the temperatures and pressures of combustion, so not surprisingly they will in time suffer from carbon deposits and ultimately from erosion and burning. Service life will vary according to factors such as fuel quality and operating conditions, but typically one could expect to clean and recalibrate a set of injectors after about 80 000 km (50 000 miles), and perhaps to renew them or have them reconditioned after 160 000 km (100 000 miles).

Injector pipes

The injector pipes are an important part of the system and must not be overlooked. The dimensions of the pipes are important and it should not be assumed that just because the end fittings are the same, a pipe from a different engine can be used as a replacement. Securing clips must be kept tight and the engine should not be run without them, as damage from vibration or fuel cavitation may result.

Introduction to the Citroën diesel engine

The Citroën diesel engines covered in this manual were first fitted to BX models in early 1984, Visa models in early 1985 and C15 Vans, that were renamed Champ Vans in 1993.

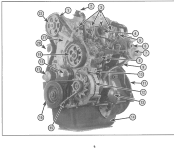
They are built at the highly automated Citroën factory at Tremery in France and are given the code names of XUD 7 for the 1.7, XUD 9 for the 1.9 and XUD 7TE for the turbo engine.

Compared with petrol engines of similar capacity the diesel version is extremely quiet, whilst being driven. Only a certain amount of engine clatter is heard at idle and when first started. Routine maintenance tasks are few, but essential, and are easily carried out. Work on the fuel injection pump will require the use of one or two dial test indicators.

Outside the engine bay the vehicles, to which these engines are fitted, are much the same as petrol-engined versions. For complete coverage of a particular vehicle, the appropriate main manual will be needed as well.

Front three-quarter view of Citroën XUD engine. Timing belt cover has been removed

1 Timing belt
2 Oil filler cap and ventilation hose
3 Injectors
4 Diagnostic socket
5 Temperature sensors
6 Fast idle thermo unit
7 Thermostat cover
8 Injection pump (Roto-diesel)
9 Coolant hose to oil cooler
10 Drivebelt tension adjusting bolt
11 Flywheel
12 Alternator
13 Oil filter
14 Sump
15 Alternator drivebelt
16 Crankshaft pulley
17 Water pump
18 Timing belt intermediate roller
19 Injection pump sprocket
20 Timing belt tensioner
21 Right-hand engine mounting bracket
22 Camshaft sprocket



Lubricants and fluids

1 Engine	Multigrade engine oil, viscosity SAE 15W/40
2 Manual transmission	Gear oil, viscosity SAE 75W/80W
3 Automatic transmission	Dexron II type ATF
4 Hydraulic system (BX models)	Green LHM fluid
5 Brake hydraulic system (Visa models)	Hydraulic fluid to SAE J1703 C
Vacuum pump (Visa models)	SAE 10W 30