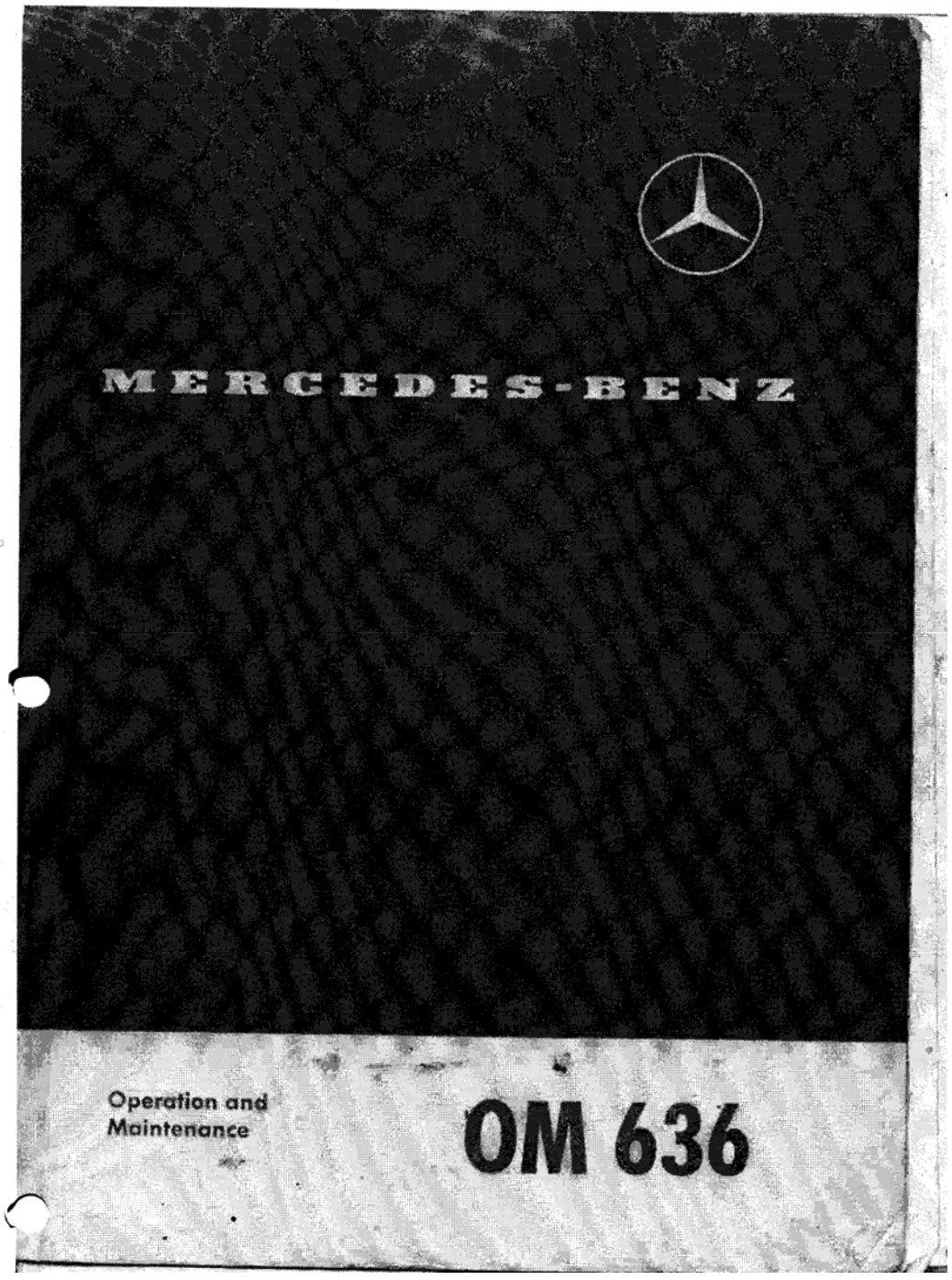


MERCEDES-BENZ

Operation and Maintenance

OM 636

Contents

General

Expert operation and maintenance will influence to a high degree the life and availability of your engine. It is therefore to your own interest to closely follow the indications of this brochure on Operation and Maintenance and to carry out in due time the prescribed maintenance work in the correct intervals. In doing so, please attend to the conditions of the engine application when there are departures from standard operating conditions. It is only in this manner that your guarantee claim is maintained. As a matter of principle, do not break lead seals at the injection pump and at the speed governor.

Should there be the desire for an information exceeding the compass of this brochure, the supplier of the unit or of the installation as well as the next Mercedes-Benz Service station are prepared to readily fulfill your demand within the frame of their possibilities. This will also hold true in case of questions concerning repair or supply of spare parts.

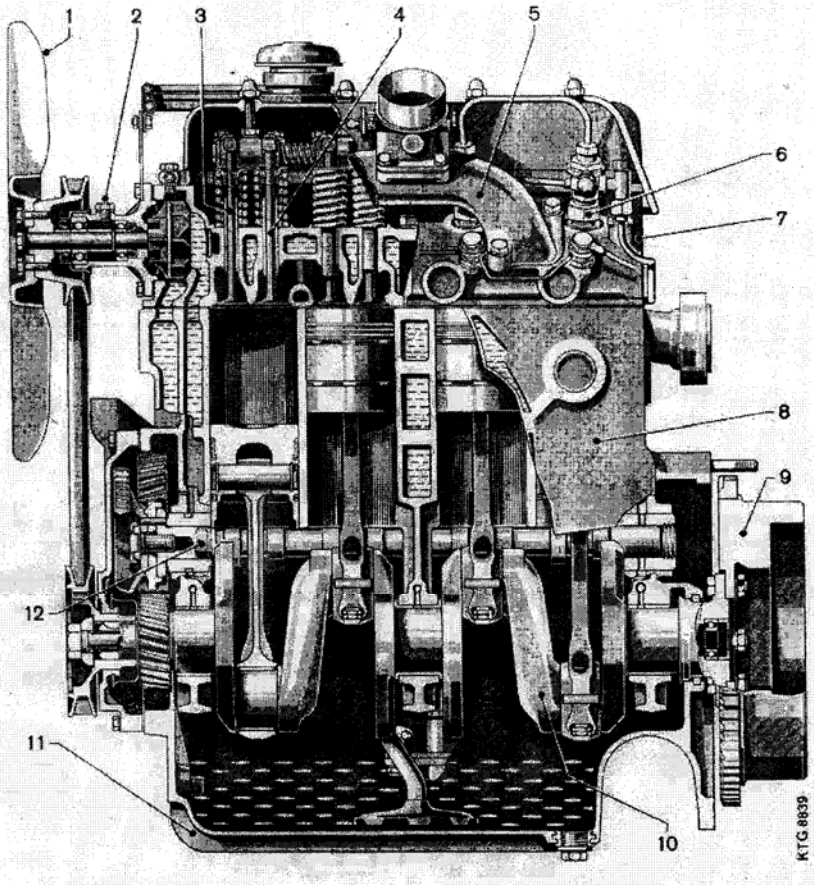
In regard to general Service problems, the supplier organization, Daimler-Benz AG, as indicated on the identification plate, will be at your disposition. Should this address not be at hands, please contact

Daimler-Benz Aktiengesellschaft
Dept. Kundendienst Motoren

7000 Stuttgart-Untertuerkheim
Postfach 202

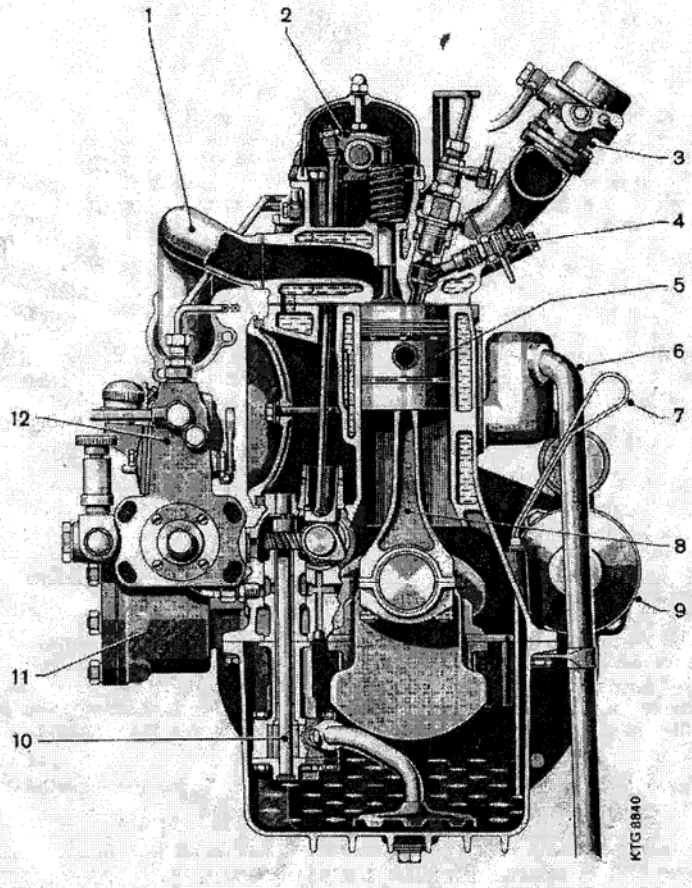
Telephone: 0711-33621
Telex: daibenz stgt 07-23901

For securing a fast reply of your inquiry or spare parts order, please always state the complete engine number. The identification plate with the engine number is on the right engine side, at the front behind the fuel filter or on the flywheel housing.



1 Fan
2 Cooling-water pump
3 Exhaust valve
4 Intake valve
5 Air-intake pipe
6 Injector
7 Cylinder head
8 Cylinder crankcase
9 Flywheel
10 Crankshaft
11 Oil pan
12 Camshaft

Figure 1 ⊙M 636 Longitudinal section



1 Exhaust-gas collector
2 Rocker arm
3 Mixture controller
4 Heater plug
5 Piston
6 Crankcase ventilation
7 Dipstick
8 Connecting rod
9 Starter motor
10 Oil pump
11 Horizontal oil filter
12 Injection pump

Figure 2 OM 636 Cross section

Structure

The MERCEDES-BENZ Diesel Engine OM 636 is a vertical, water-cooled, four-stroke, four cylinder in-line engine which employs the Daimler-Benz precombustion chamber. In the following description of the engine it should be kept in mind that the point of reference for numbering of the cylinders and of the bearings will be the side of the accessory case whereas the sense of rotation as well as the designations clockwise and counterclockwise are referred to the flywheel end.

Cylinder crankcase - The cylinder crankcase of gray iron has integral cylinders. On the right engine side there are the injection pump with the speed governor and the lube-oil filter attached. Situated on the left engine side are the generator, the starter motor, the oil dipstick and the breather pipe for equalization of the pressure in the crank chamber. At the front face there are the helical drive gears for the camshaft and for the injection pump, closed by a cover. The tappet chamber, too, which is located at the right engine side, is closed by a cover. The light-metal oil pan is bolted to the bottom of the cylinder crankcase by hexagon-head screws.

Cylinder head - The common cylinder head of alloy cast iron is fastened onto the cylinder crankcase by hexagon-head bolts. A flat-type gasket seals the combustion chambers of the cylinders and the cooling-water passages from the crankcase to the cylinder head. The intake and the exhaust valves run in guide bushes from gray iron. The cylinder head is closed by a light-metal cover which takes up the oil-filler neck.

Crankshaft - The crankshaft, which is drop forged has hardened bearing surfaces and is suspended three times in multi-element friction bearings. The central bearing serves at the same time as the thrust bearing. Counterweights at the crank cheeks compensate the rotating inertia forces and contribute thus to unloading the crankshaft main bearings in quietening the operation of the engine.

The gear for drive of the timing and a vee-belt pulley are mounted at the crankshaft end opposite to the flywheel.

Connecting rod - The forged connecting rod receives a two-piece multi-element friction bearing. The piston pin is supported by a bronze bushing which is pressed-in into the small end. The bearing cap of the connecting-rod big end is screwed to the rod by two fitting bolts and nuts.

Pistons - The light-metal piston has three compression rings and two oil-scraper rings. The floating piston pin is secured by two circlips. The piston crown is trough shaped.

Camshaft - The camshaft is supported in three light-metal bearings in the crankcase. It is drop forged and possesses hardened bearing surfaces and cams. Against axial displacement it is secured by a collar bearing at the drive side.

The collar bearing as well as the second bearing are split and are held together by circlips. The drive of the camshaft is achieved by the crankshaft via helical gears. The second gear which is bolted to the camshaft serves for driving the injection pump and the injection-timing mechanism.

Valves - Each cylinder has one overhead valve each for the intake and for the exhaust. The valves are timed by the inferior camshaft via tappets, push rods and rocker arms.

Injection units - The fuel feed pump is flanged to the injection pump together with the hand primer. It delivers the fuel from the container via a filter to the injection pump. The fuel is pressed through delivery lines of identical lengths to the injectors (pintle-type injectors). Finely atomized, it is injected into the precombustion chamber. A part of the injected fuel burns in the precombustion chamber. The discharging hot gases cause a pressure rise resulting in a superior and more uniform combustion of the mixture of diesel fuel and air in the combustion chamber proper. The leak fuel of the injectors flows back to the fuel container by a collecting line.

A pneumatic or a centrifugal speed governor which is flanged to the injection pump adapts the fuel quantity to the actual engine load. An automatic injection-timing mechanism, installed on request, advances the point of injection with increasing engine speed.

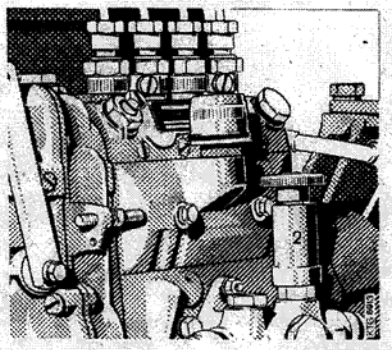
Lube-oil circuit - The lube oil in the oil pan is aspirated by a gear-type pump via a strainer. This pump is bolted onto the bottom of the crankcase and is driven by the camshaft via helical gears. It primes the lube oil to the main oil gallery via an edge-type or a screen-type filter. From there, it is delivered to the bearings of the crankshaft and of the camshaft by small bores. Bores in the crankshaft direct the oil to the connecting-rod bearings. From the first camshaft bearing, the lube oil rises to the cylinder head by means of a pressure line, situated at the engine exterior, from where it continues its way to the rocker-arm brackets. The rocker-arm bearings as well as the push rods and valves are supplied with lube oil through the hollow rocker-arm shafts. The injection pump with speed governor and the cooling-water pump are equipped with a lubrication of their own. In special cases, the injection pump is connected to the lube-oil circuit.

A by-pass valve in the lube-oil filter and a pressure-relief valve in the main oil gallery protect the oil circuit against overloading. Cylinder contact faces, piston pins, gears and timing cams are lubricated by splash oil.

An oil-pressure gauge permits continuous surveillance of the lube-oil pressure.

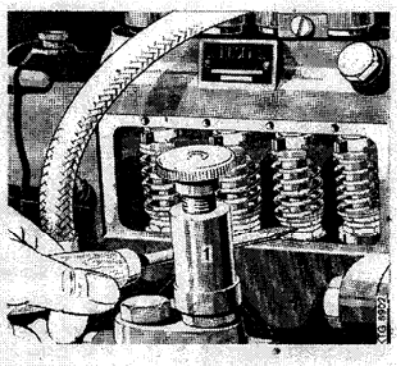
Coolant circuit - A cooling-water pump which is driven from the camshaft via a vee-belt aspirates the water which is recooled in the radiator or in the heat exchanger and primes it into the crankcase. The coolant rises at the cylinders, enters the cylinder head by means of bores and flows by an elbow to the thermostat. As long as the engine has not yet reached its operating temperature, the coolant flows back from there by a by-pass line directly to

the cooling-water pump. Not before having attained the operating temperature is the thermostat fully open and the coolant can then flow through the re-cooling system.



1 Bleeder screw
2 Manual fuel primer

Figure 4 Bleeding of injection pump



1 Manual fuel primer

Figure 5 Bleeding of delivery lines

bleeder screw is free from bubbles. Tighten the bleeder screw(s) again and secure the plunger of the hand primer again in turning the knurled nut clockwise.

Bleeding of the injection pump - Unscrew both of the bleeder screws for one or two turns. Slacken the hand primer at the fuel feed pump and prime fuel until it escapes free from bubbles at the bleeder screws. Tighten the bleeder screws again and secure the plunger of the hand primer.

Bleeding of delivery lines - This is required only when the delivery lines are completely empty and when the battery is not fully charged.

Remove the lateral cover at the injection pump. Subsequently move up and down the individual pump elements by means of a suitable tool until the pertinent injector ejects. The plungers of the injection pumps should in this instance be at their bottom dead centers and the fuel rack be in full-load position. After bleeding of all four lines, reinstall the lateral cover in paying attention to the sealing surface.

Other preparations - Examine all hose connections and all pipe branches for leakage. Check the brackets and the fixation bolts of the attached accessories for firm seat, including the bolts for engine suspension. Tighten, if required.

When connecting the battery, ensure that cables are free from oxides.

COSMETIC STANDARD FOR FINISHED FABRICATED PARTS UK PACC

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J.W.Fisher
Quality Systems Manager
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Regular operation

Examine the coolant level in the surge tank of the attached-type heat exchanger or of the radiator. If required, fill up with cooling water to which 0.5% of a cooling-water processing agent (corrosion inhibitor) has been added.

Do not fill cold water into an engine of operating temperature.

Check the lube-oil level in the oil pan by means of the dipstick and replenish the oil, if required, in adding oil up to the top mark at the oil dipstick. The oil dipstick is calibrated to the normal installation position of the engine.

Check and replenish the fuel level in the storage container. When filling-in, ensure freedom from impurities. Never empty the container completely as otherwise the fuel system has to be bled anew.

Starting

Open the stop valve at the fuel container. Introduce the key into the switch box. In doing so, the red pilot lamp will light up. Cut-in the heater plugs in turning the glow-starter switch into position "1" and keeping it there. Preheat. The duration of preheating is as well a function of the ambient temperature as it is of the engine temperature. It varies between a minimum of 30 seconds for temperatures in excess of +8 °C and a maximum of two minutes for temperatures below −8 °C (see also page 15). The heater-plug indicator resistor is allowed to glow red only. When it glows white, there is a ground contact at one or more than one heater plugs which should be eliminated soonest.

When starting an engine of operating temperature, a preheating is not required. Turn the glow-starter switch into position "2" and keep it there until the engine has fired. Do not cut-in longer than 15 seconds during every starting attempt. Release the switch as soon as the engine has fired. It should return automatically into the position "0". Bring the speed-control lever at the injection pump into the full-load position during the starting procedure. Return the speed-control lever, if possible, into the idling position when the engine has fired.

When the engine does not fire, pause for one minute after every starting attempt in order to save the battery.

Do not actuate the starter motor as long as the engine rotates.

When the engine has fired, immediately check the oil pressure at the oil-pressure gauge. With a cold engine it first will be above the standard reading. When the indication of the oil pressure is below 0.5 kg per sq cm at 650 rpm for an engine at operating temperature, the lube-oil supply is no longer secured. Shutdown the engine at once.

When the engine is started the first time or after a period of longer immobilization, prime the lube oil immediately before the start. In doing so, interrupt

When the oil pressure drops or fluctuates greatly, when speed or output decrease, when the engine breathes heavily or abruptly, when the exhaust shows excessive smoke or when the coolant temperature rises suddenly, the engine is endangered and has to be shutdown immediately.

Shutdown

First unload the engine. Decrease the engine speed gradually by means of the speed control lever to avoid heating of the coolant. Then shutdown.

The engine may be shutdown at once when the duty will require it or also in case of troubles.

Pull the key from the switch box and close the stop valve at the fuel tank.

Winter operation

At the beginning of the cold season, the following advice on the operating agents and for starting of the engine should be kept in mind.

Fuel, see under the section "Operating Agents".

Exchange the lube oil in due time against the less viscous winter oil of the grade SAE 10W, if the ambient temperature drops below freezing point for a period of various days. When the cold ceases, the oil may be mixed with summer oil SAE 30 without risk.

Protect the coolant against frost in due time by the addition of an antifreeze. The antifreeze is of no detrimental influence on the processed cooling water. See also under the section "Operating Agents".

Starting – Even under severe cold, do not pre-heat longer than two minutes and start 15 seconds. After the third starting attempt, interrupt the starting cycle for two minutes minimum in order to allow for a recovery of the battery.

During the cold season, the battery deserves particular attention. The state of full charge is to be aimed at in keeping the consumption of electricity down to the absolute minimum and in also maintaining it carefully. As the starting capacity is greatly reduced with cold, it is a good idea to keep the battery in a heated room after shutdown of the engine.

Maintenance

A regular and careful check, lubrication and cleaning are decisive factors for the availability and service life of your diesel engine. It is therefore to your interest to always carry out all of the subsequently listed maintenance work according to the Maintenance Schedule.

The maintenance of the engine can be performed after operating hours, after mileage or after fuel consumption in accordance with the application.

Maintenance after operating hours is recommended for stationary engines of little periods of idling and a fair loading for which a reliable record on the hours of operation can be maintained. For instance, engines of generator, pump, drilling, compressor and ship-propulsion sets.

Maintenance after mileage is recommended for engines which are installed as power plants into vehicles, the average speed of which is in the vicinity of 30 km per hr and in which instances the engine is not employed for larger work during standstill of the vehide. For instance, engines of trucks, busses and rail cars. However, it is not recommended for garbage trucks, fire-fighting vehicles with motor pump or for similar vehicles.

Maintenance after fuel consumption is recommended for engines of greatly fluctuating loads or of long periods of idling. For instance, engines of garbage trucks, concrete mixers without a separate drive, excavators, cranes, agricultural implements and the like. This type of maintenance, however, can be carried out also with engines which per se would have been serviced after hours of operation.

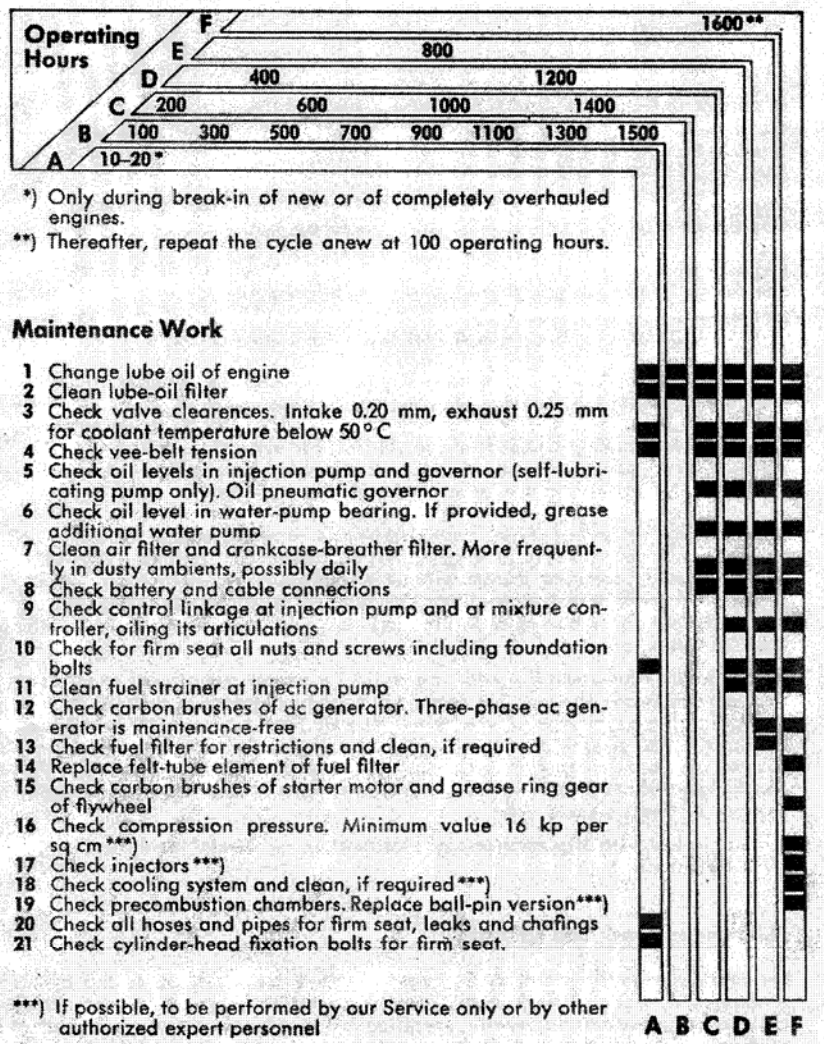
The prescribed dates and the work are valid for normal operational conditions. Unusual conditions may possibly demand different maintenance periods. In case of heavy dust precipitation, for instance, the air filter may possibly be cleaned daily. It is also possible that the exterior cleaning of the recooling system may become necessary in shorter intervals than indicated in the schedule. With standby generator sets of a very short operating period, the lube oil should be changed at least once a year.

Please, follow also the maintenance instructions of special equipment which might be attached.

Maintenance work and schedule

On the next page the necessary Maintenance Work is correlated to the cycles A through F, each of them adapted to the operating hours. Every work which is to be performed after a certain, specified number of operating hours is marked in the angle of the cycle by black fields.

The exact instruction for every maintenance work is found in the following sections under identical item numbers.



*) Only during break-in of new or of completely overhauled engines.

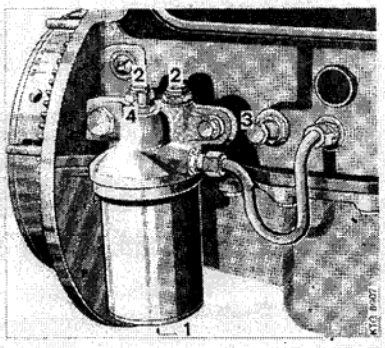
**) Thereafter, repeat the cycle anew at 100 operating hours.

Maintenance Work

1 Change lube oil of engine
2 Clean lube-oil filter
3 Check valve clearences. Intake 0.20 mm, exhaust 0.25 mm for coolant temperature below 50 °C
4 Check vee-belt tension
5 Check oil levels in injection pump and governor (self-lubricating pump only). Oil pneumatic governor
6 Check oil level in water-pump bearing. If provided, grease additional water pump
7 Clean air filter and crankcase-breather filter. More frequently in dusty ambients, possibly daily
8 Check battery and cable connections
9 Check control linkage at injection pump and at mixture controller, oiling its articulations
10 Check for firm seat all nuts and screws including foundation bolts
11 Clean fuel strainer at injection pump
12 Check carbon brushes of dc generator. Three-phase ac generator is maintenance-free
13 Check fuel filter for restrictions and clean, if required
14 Replace felt-tube element of fuel filter
15 Check carbon brushes of starter motor and grease ring gear of flywheel
16 Check compression pressure. Minimum value 16 kp per sq cm ***)
17 Check injectors ***)
18 Check cooling system and clean, if required ***)
19 Check precombustion chambers. Replace ball-pin version ***)
20 Check all hoses and pipes for firm seat, leaks and chafings
21 Check cylinder-head fixation bolts for firm seat.

***) If possible, to be performed by our Service only or by other authorized expert personnel

Conversion factor for Maintenance Cycle after mileage and fuel consumption: One operating hour equals 30 km or 6 liters of fuel.



1 Fixing screw, filter bowl
2 Bypass valves, filter
3 Pressure-relief valve, main oil gallery
4 Connection, oil-pressure gauge

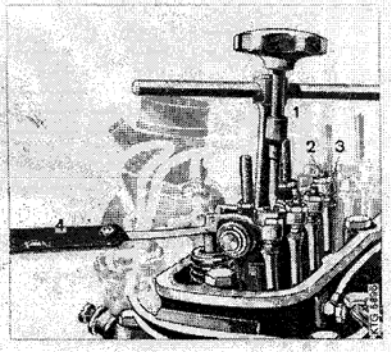
Figure 7 Cleaning of vertical oil filter

3 Check valve clearances

The valve clearance is understood as the gap between the end of the valve stem and the rocker arm. The valve clearance is checked by means of a feeler gauge. For valve clearances, see page 44. For checking purposes, first remove the cylinder-head cover and turn the flywheel in the sense of rotation until the piston of cylinder no. 1 is in the firing top dead center, that is both valves are closed. Push a valve-clearance feeler gauge of suitable thickness between the stem end and the rocker arm and check the valve clearance. When the setting is correct, the feeler gauge is extracted flush. When the clearance is too large or to small, slacken the lock nut und reset the adjusting screw until the feeler gauge may be removed flush, the lock nut tightened.

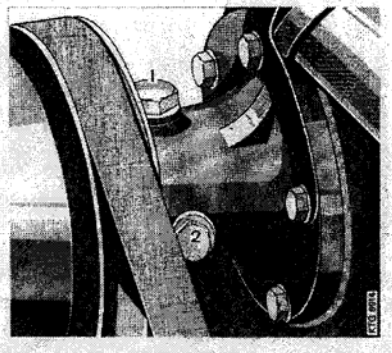
When both valves are checked or reset, turn the flywheel in the sense of rotation until the next cylinder, according to the firing sequence 1-3-4-2, is in its firing top dead center.

Reset the cylinder-head cover with a faultless rubber seal and tighten it.



1 Special wrench, part no. 000 589 64 09
2 Adjusting screw
3 Lock nut
4 Feeler gauge

Figure 8 Checking of valve clearances



1 Oil-filler plug
2 Oil-level control plug

Figure 11 Oiling of cooling-water pump

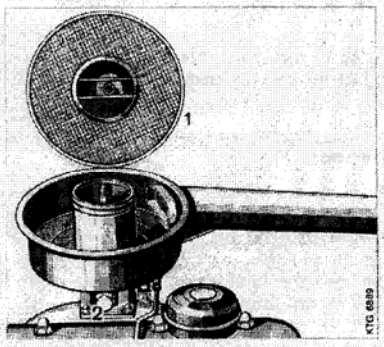
6 Check oil level in water-pump bearing. Grease additional water-pump, if provided

Check the oil level at the oil-level control plug and replenish, if need be, through the filler plug. Ensure that the bleeder bore in the filler plug is not clogged. Grease the additional water pump by the grease gun (cancelled in case of engines with radiator and fan).

7 Clean air filter and crankcase-breather filter

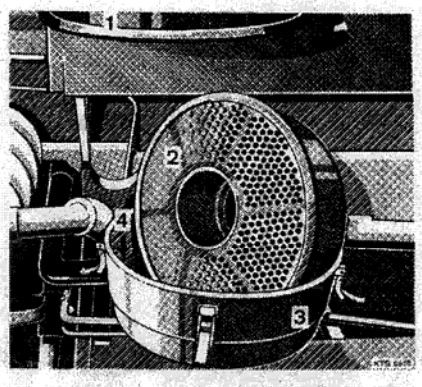
Wet-air filter - Open tensioning locks or wing nut and take off the top part of the filter together with the element from the bottom part. Wash the element in diesel fuel and blow out by compressed air, if available.

After drying, moisten the element uniformly with lube oil (by spray or immersion) and let it drip off. Clean the bottom part of the filter by a gasoline-moistened rag. Assemble top and bottom parts and fasten tensioning locks or wing nut.



1 Filter top, with element
2 Fixing screw

Figure 12 Cleaning of wet-air filter



1 Filter-housing upper part
2 Filter element
3 Filter-housing lower part
4 "Normal level" mark

Figure 13 Cleaning of oil-bath air cleaner

Oil-bath air cleaner - In case of serious dust precipitation, the oil filling in the filter has to be examined more frequently, possibly every day. This is done while the engine is cold and inoperative. To this end, open the tensioning locks and remove the filter-housing lower part together with element. When the oil has become thick by sludging or when it has reached the top mark, change the oil. Wash out the filter element in diesel fuel and spin it dry. Do not use gasoline, water or cleaning agents which contain lyes or acids. Blow out with compressed air, if available. Fill with lube oil up to the mark "Normal". Re-assemble filter-housing lower part together with element. In doing so, take care of the gasket replacing damaged ones.

8 Check battery and cable connections

Keep the battery clean and dry. The bleeder bores in the plugs of the cells should at all times be open to allow easy evacuation of the gases produced during the charge.

When the terminals or the poles are dirty, slacken the terminals, clean them and apply an acid-free and acid-resistant battery grease in order to avoid corrosion.

Do not let the battery compound come into contact with gasoline, oil or grease. Do not place tools onto the battery and keep open fire away.

Check the acid level of the individual cells. The acid level should exceed the top edge of the plates by 10 mm. Replenish with distilled water, if required. Do not use a metal funnel for replenishing. Check the acid level every two weeks during the warm season.

Measure the density of the acid in the individual cells by an acidimeter (hydrometer). The measurement data will give information on the state of charge

of the battery. See the subsequent chart. When the acid level has been replenished, a measurement of the density should be carried out not earlier than 30 minutes thereafter. During measurement, the acid temperature should be 20 to 27 °C.

Acid density		Specific weight		State of charge
normal	tropics	normal	tropics	
32 °Bé	27 °Bé	1.285	1.23	well charged
24 °Bé	16 °Bé	1.21	1.12	semi-charged
14 °Bé	13 °Bé	1.11	1.08	discharged, recharge at once

When greater differences in the acid density between the individual cells are noticed or when the battery is completely discharged, it has to be checked by a battery service and be recharged. Examine even unused batteries periodically to maintain their serviceability.

9 Check control linkage at injection pump and at mixture controller

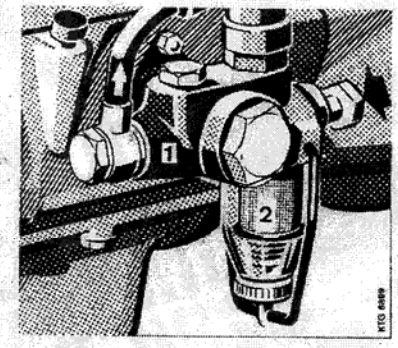
Check the control linkage at the injection pump or at the mixture controller for function and for easy movability. Lubricate its articulations by a few drops of oil. Grease Bowden cables, when provided, from time to time by regular gun grease.

10 Check all bolts and nuts for firm seat

Check all bolts and nuts of the attached assemblies and components for firm seat and retighten, when required. In doing so, adhere to torque data where prescribed. Check also the bolts and nuts of the engine bearers. In case of leaks, tighten the pertinent screws.

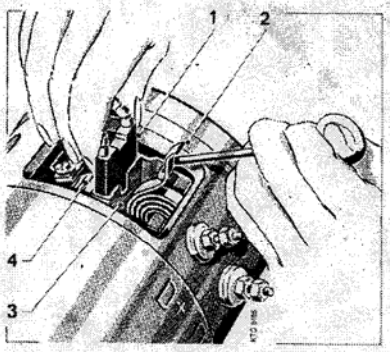
11 Clean fuel strainer

Close the stop valve at the fuel tank. Slacken the knurled nut and swivel upwards the tensioning strap. Remove the wire-mesh insert together with the bowl downwards. Clean element and bowl in clean gasoline or in diesel fuel using a soft brush. Exchange a hardened sealing ring in due time to avoid aspiration of air. When reassembling, the tensioning strap should be straight to avoid jamming of the bowl. Tighten the tensioning nut. Open the stop valve at the fuel tank again. In case of heavy contamination, clean the fuel tank as soon as there is a change.



1 Fuel feed pump
2 Fuel strainer

Figure 14 Fuel strainer



1 Carbon brush
2 Spring
3 Carbon-brush holder
4 Collector

Figure 15 Checking of carbon brushes

12 Check carbon brushes of dc generator *

Disconnect the negative cable from the battery and remove the cover strap from the generator. Lift the springs pressing the carbon brushes onto the collector and check if they will glide easily in their guides. Dirty or jamming carbon brushes are cleaned by a clean rag which is moistened by gasoline. Do not work on smooth contact faces with emery cloth, file or knife. Blow well out the carbon-brush holder. Heavily worn, unsoldered or broken carbon brushes are exchanged in pairs against new ones of identical type. The brushes should be dry during insertion. They should glide easily in their guides and the spring should not hit the brush when inserted. The surface of the collector should be uniformly smooth, without grooves and of a gray-black color. Should the surface not be free from dust, oil or grease, use a clean rag which is moistened with gasoline for cleaning. A grooved or ovalized collector should be turned down in a special shop. In no case it should be treated with emery paper or a file. Oil generator provided with lubricator.

13 Check fuel filter for restriction and clean, if required

Check for restriction - Unscrew the bleeder screw at the filter cover for some turns, slacken the knurled nut at the hand primer of the fuel feed pump and actuate the pump plunger repeatedly. In doing so, the fuel should escape as a strong jet at the bleeder screw. When the fuel flows weakly only, clean the filter as described subsequently.

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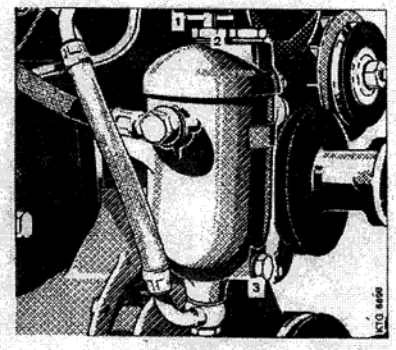
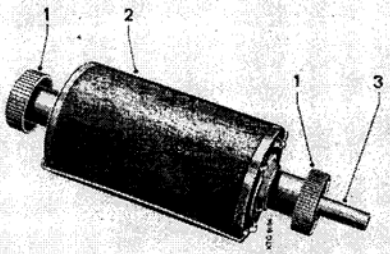
* Start or tow engines equipped with three-phase ac generator only when battery connected. Do not disconnect terminals as long as engine rotates. Check voltage by test lamp or voltmeter only.



1 Bleeder screw
2 Clamping nut
3 Drain plug

Figure 16 Cleaning of fuel filter



1 Cleaning device, type EFEP
2 Felt-tube element
3 Tube, air inlet

Figure 17 Cleaning device

Cleaning of filter

Close the stop valve at the fuel tank. Before taking out the element, drain the filter bowl. To this end open the bleeder screw and unscrew the sludge-drain plug. Slacken the tensioning nut, remove the filter cover and pull out the felt-tube element.

Provisional cleaning (to be carried out only when a device similar to BOSCH, type EFEP, is not available). (See figure 17). Close both ends of the felt-tube element by plugs to allow penetration of the cleaning agent into the interior of the element by the felt only. Brush the element in diesel fuel or in kerosene by a soft, non-metallic brush, shake it and clean it again in clean cleaning agent.

Thorough cleaning (using a device, as for instance, BOSCH type EFEP, see figure 17). Connect the device and brush the felt-tube element with a soft, non-metallic brush in diesel fuel or in kerosene shaking it then. During immersion, keep the small tube of the device closed. Get the element fully soaked and blow through by compressed air or by the mouth until foam bubbles are produced at the exterior of the felt tube. Flush the element and get it completely soaked again. Repeat this cycle four to five times.

Insert the felt-tube element again into the cleaned bowl. Place the cover with a faultless gasket and tighten by the tensioning bolt. Open the stop valve at the fuel tank and prime fuel by the hand primer until it escapes at the bleeder screw. Close the bleeder screw.

14 Replace felt-tube element of fuel filter

The indications on removal and installation of the element are described in Maintenance Work no. 13 "Check the fuel filter for restriction etc".

15 Check carbon brushes of starter motor

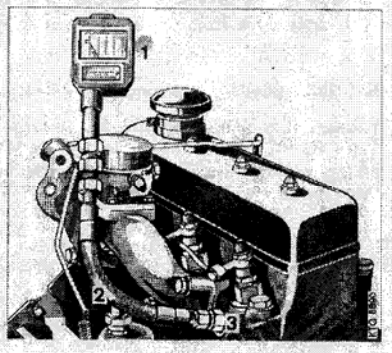
For checking, cleaning and, if need be, for replacing of the carbon brushes as well as for cleaning of the collector the same indications hold true as described in Maintenance Work no. 12 "Checking of the carbon brushes of the dc generator".

Clean the starter-motor pinion and the ring gear of the flywheel with a brush dipped into fuel. Then lubricate with graphite grease. In case of burr at pinion and flywheel, remove it by a file.

16 Check compression pressure

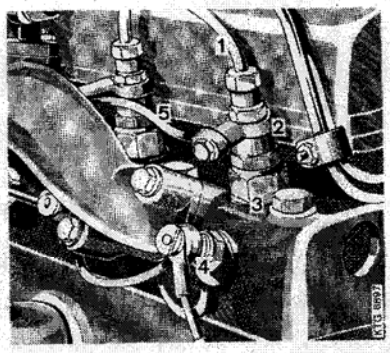
This maintenance work should be carried out, if possible, by our Service our by other authorized expert personnel.

Check the valve clearances of the engine and reset, if desirable. Run the engine up to operating temperature. Disconnect the distributing bars and unscrew all heater plugs. The supply of fuel interrupted, crank the engine various times by the starter-motor in order to remove possibly present oil-carbon deposits and soot which might clogg up the compression-pressure recorder. Screw-in the connection piece with the sealing ring into the bore of the heater plug connecting the compression-pressure recorder to it by the extension. Bring the measuring sheet in the recorder into the position corresponding to the cylinder. Crank the engine with interrupted fuel supply and fully open mixture controller a few rotations. The duration of the measurement should be identical for all cylinders. When the minimum value (see page 43) is not obtained, the cylinder head has to be removed and the gas-tight seat of the valves, the cylinder-head gasket, piston and piston rings have to be checked. Clean the heater plugs before their installation, examine and replace in case of damage.



1 Compression-pressure recorder
2 Extension
3 Connection piece

Figure 18 Checking of compression pressure



1 Delivery line
2 Banjo fitting
3 Injector holder
4 Heater plug
5 Leak-fuel line

Figure 19 Injector, mounted

17 Check injectors

Removal of the injector - Unscrew the union nut for fixation of the delivery line and of the leak-fuel line from the injector. When slackening the banjo fitting, secure the injector holder against rotation by a fork spanner. Unscrew the injector holder with socket-spanner element 312 589 00 09 from the precombustion chamber and take out the seal (injector plate).

Checking and cleaning of the injector - Clean the exterior of the injector holder in diesel fuel. Unscrew the union nut and remove the injector. The repair of an injector should, if possible, be carried out by our Service only or by other authorized expert personnel.

Installation of the injector* - Crank the engine for a few rotations in order to remove contaminations. Introduce new injector plate into the precombustion chamber. Screw-in the injector holder with a new or with an overhauled injector into the precombustion chamber. Tighten by the socket-spanner element to the prescribed torque (see page 46). Connect the delivery and leak-fuel lines free from stress and check for leaks while the engine is operating.

18 Check cooling system and clean, if required

The cooling system should be cleaned when the temperature of the coolant is 5 to 10 °C higher than the temperature during the initial operation, provided operating conditions and engine load are identical. Vee-belt tension and thermostat should be faultless.

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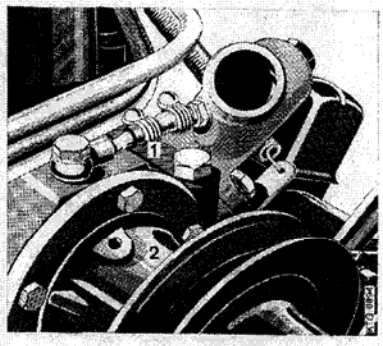
* Do not proceed to this item unless Maintenance Work 19 "Checking the precombustion chambers" has been performed.



1 Bleeder line

Figure 20 Bleeding of cylinder head

Exterior cleaning

Radiator - When a light, oil-free contamination only is present, it may suffice to spray a water jet through the radiator from the engine side or blow through then by compressed air. In case of a heavy contamination, the radiator should be removed and be cleaned thoroughly in a 3 to 5% solution of a cleaning agent (as P3 or potassium carbonate). Thereafter, flush the radiator with clean water and blow through with compressed air, if available.

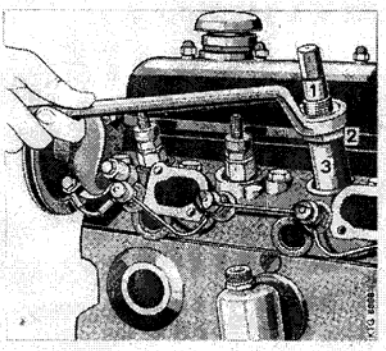
Interior cleaning

Drain the entire coolant. Fill the cooling system with clean, unprocessed water to which 3 to 5% -- (that is 300 to 500 g for 10 liters of water) -- of a commercial, alcalinic, silicone containing detergent (for instance, P3 Dimal 220, Grisiron LZ or WZ and similar brands) have been added. Run the engine with this solution for about three hours. Then drain the detergent and after it has cooled down flush the engine three times with clean water. With the third filling, run the engine up to operating temperature and subsequently drain the water.

Heat exchanger - Unscrew the lateral closing cover (raw-water inlet). A mechanical cleaning will do in the instance of a normal contamination, not necessitating the removal of the cooling element. In the event of serious contamination, the complete heat exchanger should be removed and both closing covers have to be unscrewed for extracting the cooling element. Clean the element thoroughly in a hot alcalinic solution (solution of P3 or potassium carbonate). Then flush well with clean water. Replace the rubber O-rings in the crude-water outlet cover during assembly. Follow this sequence: crude-water outlet cover; cooling element; crude-water inlet cover.

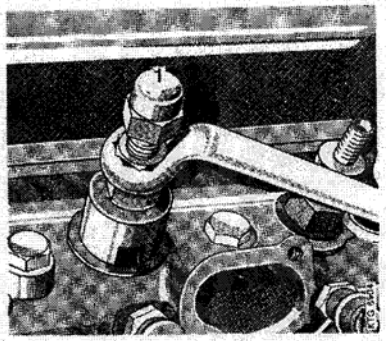
Fill the cooling system with processed water according to the prescription.

Caution: Never fill cold water into hot engine.



1 Special wrench, part no. 636 589 01 63
2 Hexagon nut
3 Pivot spanner, part no. 636 589 01 07 or 02 07

Figure 22 Unscrewing of threaded thrust ring



1 Extractor, part no. 636 589 01 33

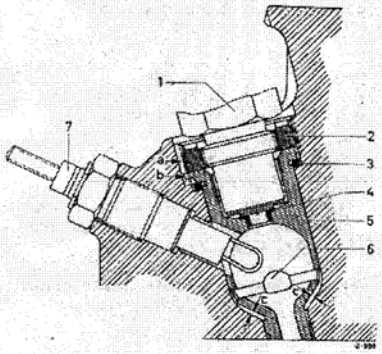
Figure 23 Extraction of precombustion chamber

Check bleeder line between cylinder head and coolant-outlet fitting for restriction. See fig. 20.

19 Check precombustion chambers, replace version with ball pin

This work, however, should only be carried out by our Service or by other competent and authorized personnel, equipped with the necessary special tools.

First, remove the injector as described under Maintenance Work 17. Take off the distributing bar from all four heater plugs. Unscrew the heater plug by a socket spanner SW 21.



1 Injector
2 Threaded thrust ring
3 Sealing ring
4 Injector shim
5 Precombustion chamber with ball pin
6 Ball pin
7 Heater plug
a Groove
b Nose

Figure 21 Section through precombustion chamber

Unscrew the threaded thrust ring for fixation of the precombustion chamber by the special tool 636 589 01 63 and the sleeves 636 589 01 07 or 636 589 02 07. Lift the precombustion chamber by means of the extractor 636 589 01 33. To this end, screw-in the thrust spindle as deep into the precombustion chamber as practicable. Turn the lifting bell until the recess is exactly over the groove in the cylinder head. The precombustion chamber is lifted in tightening the hexagon nut. During removal, the lifting bell should not be allowed to rotate as otherwise the lug of the prechamber is cut off.

Replace the sealing ring in the cylinder head before installation of a new precombustion chamber. Insert the precombustion chamber into the cylinder head and screw-in the threaded ring in tightening it to the prescribed torque (see page 46). Replace the threaded ring whenever the grooves are damaged. Screw-in again the heater plug and the injector holder. Reconnect distributing bar, delivery lines and leak-fuel lines.

20 Check all pipes and hoses for firm seat, chafings and for leaks

The delivery lines are to be connected free from stress and should be checked for leakage while the engine is running. Eliminate leaks at the fittings by re-tightening and use new seals where required. Exchange damaged lines and brittle or swollen hoses.

21 Check cylinder-head fixation screws for firm seat

Remove the cylinder-head cover and the rocker-arm shafts while the engine is still warm. When using the offset ring spanner 120 589 00 03, the rocker-arm shafts need not be removed.

Tighten the cylinder-head screws in the sequence of figure 24 to the prescribed torque (see page 46). The two screws with the thread M-10 are torqued to abt 6 mkp by a hand wrench. After having re-tightened all screws, mount again the rocker-arm shaft and check the valve clearances. See Maintenance Work 3.

Check all screws and nuts of the intake and exhaust collectors. Re-install the cylinder-head cover with a faultless rubber seal. Do not tighten too much to avoid pressing out of the seal.

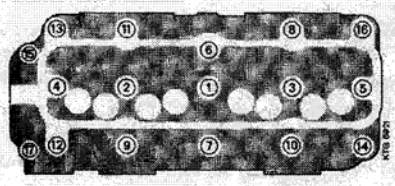


Figure 24 Torqueing sequence of cylinder-head bolts

Immobilization and storage

Before immobilizing or storing the engine more than two months under favorable storage conditions - that is balanced temperatures and dry air - the unit and its accessories should be protected against corrosion by the subsequently desdribed preserving measures.

When the storage conditions are less favorable - that is that the temperatures are greatly Fluctuating, the humidity of the air is high and when stored in the tropics or near the sea (salt contents of the air) - the engine should already be preserved on occasion of a shorter immobilization. For protective agents, see under the section "Operating Agents".

Lube-oil circuit - The lube oil which is in the oil pan and in the oil filter is drained while the engine is still at operating temperature and substituted by break-in (anti-corrosion) oil. For preservation of the lube-oil circuit, a filling of the oil pan with two thirds of the prescribed oil volume will suffice. With injection pumps with self-lubrication, drain the existing lube oil and replace it by break-in oil.

Fuel system - Drain the fuel from the tank and from the filter completely. Mix about 15 liters fuel with 1 liter break-in oil and fill the mixture into the fuel tank. Run the engine with this mixture at medium speed for about 20 minutes so that the fuel system is filled. Close again the stop valve at the fuel tank.

Coolant circuit - Drain the coolant. To this end, open the drain cocks, bleeder valves and the filler plug. The coolant may be saved and stored in a closed container for later re-use. Check the antifreezability before re-use.

Cylinders - First, remove the heater plugs. Then turn the piston of the cylinder to be treated into the bottom dead center. Squirt about 15 cu cm break-in oil by a spray can or by an atomizer into each heater-plug bore. Subsequently, turn the engine a few rotations by hand and re-install the heater plugs. This is to avoid rusting of the cylinder contact faces and sticking of the piston rings.

When the engine is immobilized for a long period, the preservation of the cylinders has to be repeated every six months. When storage conditions are unfavorable, the preservation is repeated every four months.

Close air-intake collector or air filter, the exhaust-gas collector and all other openings at the engine by suitable material as oil paper, cardboard and similar matter after preservation Seal by adhesive tape.

Clean unpainted parts of the engine carefully and spray over with break-in oil or apply anti-corrosion grease.

Protect the engine against humidity and dirt.

Battery - The battery is to be maintenanced periodically for keeping its useability. A battery which is filled with acid and charged should be recharged every four weeks as otherwise the plate sets will be corroded within short and the battery is no longer serviceable.

In the event of a longer immobilization, it is recommended to remove the battery and to hand it over to the Service indicating that it is "out of gear".

Transport

Preserve the engine as prescribed in the preceeding paragraph. Drain the protective agents from the oil pan, oil filter, fuel filter and, possibly, from the oil-bath air cleaner. Close all openings at the engine by suitable material and seal well. Protect the engine against dirt and moisture during transport. Special protective measures are required for overseas shipment. More detailed indications should be requested from the manufacturer's plant, if need be.

Trouble-Shooting

Besides a careful operation and maintenance of the engine, it is of importance to remedy in due time every possible trouble. Some indications for curing of such troubles are contained in the sections "Maintenance Items" and "Further Work". In case of major damage, it is advisable to call our Service or other authorized expert personnel.

During starting

Trouble	Cause
When cutting-in, the starter motor does not turn or too slowly. The starter-motor pinion does engage, but stalls then	Battery unsufficiently charged. See page 23 Terminals of the connecting cables are loose or oxidized Cables are damaged Starter switch is damaged Solenoid switch of starter motor is damaged Overrunning clutch of starter motor slips Starter-motor terminals or carbon brushes have ground contact Carbon brushes jam in their guides, are unsoldered or broken. See page 27
Starter motor turns, pinion does not engage	Pinion or ring gear are heavily contaminated or damaged
Starter-motor pinion continues to run after glow-starter switch has been released	Glow-starter switch or solenoid switch at starter motor defective. Disconnect the connection cable to the starter motor
Pinion does not disengage after firing of the engine	Trouble in the starter motor. Shut down the engine immediately
Engine does not fire although the starter motor is in order	Heater plugs are defective Injection pump does not deliver as feed line clogged. Fuel tank is empty, the fuel system is unsufficiently bled, the injection pump or the fuel feed pump are not in order

Trouble	Cause
Engine does not fire although the starter motor is in order	Engine compression too low. See page 27 Valves do not close since valve clearances too small. See page 20. Valve springs are broken, valve seats leaky. Piston rings are broken or cylinder-head gasket defective
During operation	
Speed and output decrease	Lack of fuel Delivery lines are leaking Delivery valve of injection pump leaky (engine is hunting in idle) Banjo fitting at the injection pump is leaking Needle of injector jams or carbonized. See page 28 Valve clearances wrong. See page 20 Air or fuel filter heavily contaminated Exhaust-gas backpressure too high as exhaust-gas collector and silencer are fouled
Engine knocks (unusual engine noise)	Injector leaks or injector needle sticks. Thus, the opening pressure of the injector drops allowing non-atomized fuel to enter the precombustion chamber. See page 28. Before removing the injector, accelerate the engine repeatedly from idle to high speed Leak-fuel line clogged Beginning of delivery is off. See page 40 Damage to the crank gear. Shut down the engine immediately
Exhaust gases are blue	Lube-oil level in engine or oil-bath air cleaner too high Lube oil enters the combustion chamber as the piston rings are stuck or because the clearances in the valve guides are excessive

Trouble	Cause
Exhaust gases are white	Cylinder head or cylinder-head gasket are leaking allowing coolant to enter the combustion chamber Injector injects improperly so that the fuel burns incompletely Beginning of Delivery is off
Exhaust gases are black	Air filter seriously fouled Injection pump delivers too early or too late Delivery volume of the injection pump is excessive Injector defective. See page 28 Cylinder compression insufficient
Coolant temperature too high	Lack of coolant Cooling system dirty. See page 28 Vee-belt of water pump loose. See page 21 Water pump defective Thermostat defective Cylinder-head gasket leaking
Lube-oil pressure too low. When decreasing rapidly, shut down the engine immediately	Lube-oil level in the oil pan is too low. Needle of the oil-pressure gauge is fluctuating Lube-oil too thin. See page 52 Oil-pressure gauge defective Pressure-relief valve in main oil gallery leaking Oil pump defective Bearing clearances excessive due to wear
Engine breathes heavily. Shut down the engine at once	When the engine breathes vaporously, coolant may have come into the lube oil Abundant oil filling Piston rings are stuck, have seized or are broken Damage to the crank gear. Bearings have seized due to lack of oil or inadequate filtering
Engine stops or speed drops suddenly	Fuel tank empty Fuel filter clogged. See page 25

Trouble	Cause
Engine stops or speed drops suddenly	Air in the injection pump, feed lines are leaking fuel feed pump aspirates air Ventilation of the fuel tank is clogged Piston seized or damage to the crank gear by lack of oil or overload. Shut down the engine

Further Work

The work subsequently described requires expert knowledge plus the availability of some special tools. It should, therefore, be carried out by our Service or other authorized expert personnel, if practicable.

Removal and installation of injection pump

Remove the injection pump only when absolutely necessary because of a trouble. In doing so, do not break the lead seals. Hand over the pump and its governor to a BOSCH Service for repair, stating the engine type, output and speed.

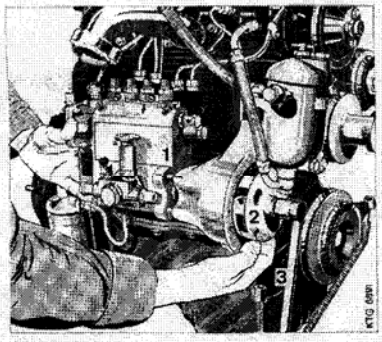
Removal of the injection pump - Close the fuel supply and disconnect the fuel-feed line and the control linkage from the injection pump. In case of a pneumatic governor, disconnect also the vacuum line at the governor. Close the openings by plugs.

Set the engine to Beginning of Fuel Delivery before removing the injection pump. See next section.

In the event of an immediate re-installation of the pump, the position of the injection pump at the clamping flange is marked by a chisel or a needle.

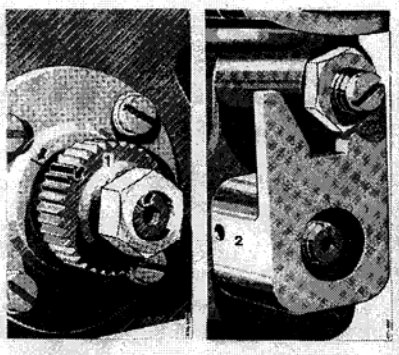
Unscrew the four clamping screws and pull the pump from the timing-case cover. Take off the coupling from the follower on the pump or drive shaft. When the pump is exchanged, pull the follower by special tool 636 589 00 03, if required, and take the Woodruff key from the groove.

Installation of the injection pump - Fasten the follower at the drive shaft of the injection pump if it has been removed. Secure the follower against rotation while tightening the hexagon nut. Then, check if the coupling sleeve is easily pushed onto the follower.



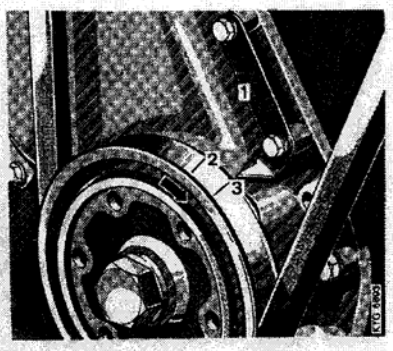
1 Mark, mounting flange
2 Injection-timing device
3 Retaining spanner with return spring

Figure 25 Bringing-in of injection pump



1 Follower pinion, drive side
2 Installation gauge, part no. 636 589 01 23, governor side

Figure 26 Marks and installation gauge at injection pump



1 Setting pointer
2 "OT" mark for top dead center
3 "FB" mark for beginning of fuel delivery

Figure 27 Marks for "OT" (TDC) and "FB" (beginning of fuel delivery) on pulley

Push the coupling sleeve onto the drive shaft in the timing case. Set the injection pump to Beginning of Delivery as described subsequently.

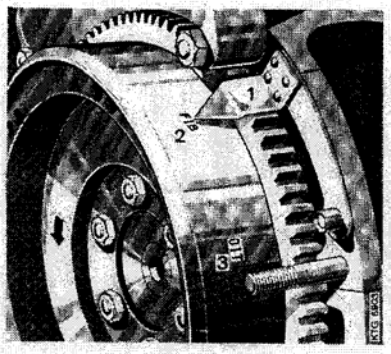
Secure the pump against rotation during insertion. To this end, push the installation gauge 636 589 01 23 onto the stub axle opposite to the follower. This is feasible only with injection pumps which are equipped with a pneumatic governor.

Before the introduction, check once again if the engine is in position of Beginning of Delivery. In case of engines equipped with injection-advance mechanism, the flyweights are to contact the inner side which means that they are in idling position.

Run-in the injection pump such into the coupling sleeve that the studs are in the center of the slotted holes. This is to facilitate the precision control of the pump. In case of re-installation of the old pump, the marks previously applied should register. Place the washers and slightly tighten the pump by two hexagon nuts. Remove the installation gauge again as otherwise the pump shaft is damaged.

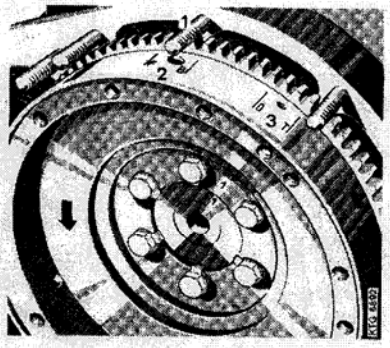
After the precision control of the Beginning of Delivery has been achieved in swivelling of the pump, tighten both hexagon nuts finally, placing the remaining two nuts also with washers and tightening them. Remove the plugs at the individual connections of the line. Reconnect the delivery lines and the control linkage.

Bleed the fuel system. See page 12. Start the engine and check all lines for leakage during operation.



1 Setting pointer
2 "FB" mark for top dead center
3 "OT" mark for beginning of fuel delivery

Figure 28 Marks for "OT" (TDC) and "FB" (beginning of fuel delivery) on flywheel part no. 636 030 01 05



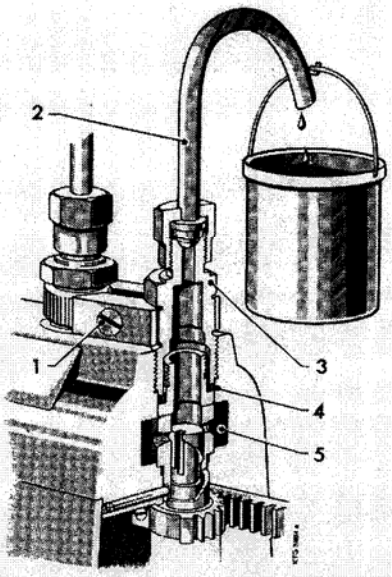
1 Stud
2 "FB" mark for beginning of fuel delivery
3 "OT" mark for top dead center

Figure 29 Marks for "OT" (TDC) and "FB" (beginning of fuel delivery) on flywheel part no. 636 030 02 05

Checking Beginning of Delivery

Unscrew the heater plugs and bring the piston of cylinder no. 1 to firing dead center. This is done when the "OT" mark for top dead center on the pulley or on the flywheel registers with the setting pointer, see figures 27 and 28, or with the stud in the crankcase, see figure 29. The valves of cylinder no. 1 (at the accessory-case side) should be closed. Turn the crankshaft backwards for abt 50 degrees. In the instance of engines equipped with injection-timing mechanism, rotate the flywheel for 1-3/4 revolutions in the sense of rotation to avoid that the flyweights leave their idling end position.

Unscrew the delivery line of the first pump barrel lifting the delivery valve and its spring. Connect the spill tube 636 589 02 23 and hook up a container. Open the stop valve at the fuel tank and bleed the fuel filter. It is also possible to use the special container 000 589 05 23 with pipe 621 589 01 90 00 which is directly connected to the injection pump. While the fuel flows, turn the crankshaft slowly in the sense of rotation until the fuel just ceases dripping. In this position, the marks at the flywheel or at the vee-belt pulley should register with the setting pointers, see figures 27 to 29. Should this not be the case, slacken the injection pump and swivel it in the slotted holes of the connection flange according to the deviation. Swivelling the pump toward the engine retards the Beginning of Delivery while swivelling away from the engine advances it. The check is repeated in continuing to rotate the crankshaft for



1 Clamping pieces
2 Overflow tube
3 Pipe-connection socket
4 Sealing ring
5 Fuel channel

Figure 30 Checking of beginning of fuel delivery by overflow method

exactly two turns in the sense of rotation and bringing it into the position for Beginning of Delivery.

After this correction, tighten the injection pump finally. Unscrew the spill tube and insert again the delivery valve together with its spring. Torque the banjo fitting to the prescribed value, slacken and tighten it then finally. Secure the banjo fitting again and connect the delivery line. Check the fuel rack for easy movability.

Technical Data

General data

Type designation		OM 636 VI-E
Version:		
Basic engine with pneumatic governor without injection-timing device		636.917.000
Basic engine with centrifugal governor and injection-timing device		636.917.001
Design		vertical, cylinders in-line
Process		DB precombustion chamber
Cycle		four-stroke
Number of cylinders		four
Cylinder bore	mm	75
Piston stroke	mm	100
Total piston displacement	cu cm	1,767
Dead space, including precombustion chamber	cu cm	24.5
Compression ratio		19:1
Compression pressure, 200 rpm and engine of operating temperature standard/minimum	kp per sq cm	22/16
Mean effective pressure, 40 hp and 3,000 rpm	kp per sq cm	6.80
Mean piston speed, 3,000 rpm	m per sec	10
Injection sequence, cylinder no. 1 at accessory-case end		1-3-4-2
Sense of rotation, facing the flywheel		counterclockwise
Waste heat, cooling water	kcal per hp-hr	abt 675
Combustion-air rate, 3,000 rpm	cu m per min	abt 2.7
Starting system, standard/optional		electric/inertia
Cooling system		water recirculation
Permissible service inclination in longitudinal and transversal directions, continuous/brief	degrees	15/20
Permissible pto torque, torsional and flexural stress of front crankshaft end	mkp	2

Setting data

Valve clearances		
intake	mm	0.20
exhaust	mm	0.25
Beginning of Delivery,		
engines with injection-timing device and of fork lifts	deg. crank BTDC	26
engines without injection-timing device	deg. crank BTDC	32
Opening pressure of injectors,		
new injectors	kp per sq cm	110 to 120
used injectors	kp per sq cm	100 minimum
Opening pressures		
By-pass valve in lube-oil filter	kp per sq cm	2
Pressure-relief valve in main oil gallery	kp per sq cm	8

Temperatures and pressures

Coolant temperature, before thermostat		
continuous	°C	85 maximum
brief	°C	90 maximum
Beginning of thermostat opening	°C	abt 77
Overpressure, cooling system	kp per sq cm	0.4 maximum
Lube-oil pressure, minimum at 650 rpm and engine of operating temperature	kp per sq cm	0.5
Exhaust-gas bulk temperature, 40 hp, 3,000 rpm and 20 °C intake-air temperature	°C	650 maximum

Rating and consumption*

Continuous Rating A	hp	16.5 to 32 18 to 36**
Continuous Rating B	hp	18.5 to 35 20 to 40**
Speed	rpm	1,500 to 3,000

* See page 45

** These data apply to engines with centrifugal governor and injection-timing device

Special Rating	hp	21 to 42**
Speed	rpm	1,500 to 3,300
Automotive Rating	hp	21 to 43
Speed	rpm	1,500 to 3,500
Fuel consumption		
Continuous Rating A	g per hp-hr	208 to 226 194 to 203**
Continuous Rating B	g per hp-hr	212 to 233 204 to 214**
Special Rating	g per hp-hr	204 to 215**
Lube-oil consumption	g per hp-hr	abt 3

Filling capacities

Lube-oil in engine circuit	l	6.5***
in oil pan, dipstick top mark	l	6.25***
bottom mark	l	3.5***
Cooling water, engine with radiator, type UkKV	l	13
engine with heat exchanger, type UkWtKr	l	10

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* The indicated Continuous Ratings A and B, according to DIN 6270 are available at the flywheel as useful output. In case of engines with radiator (UkKV), deduct the power consumed by the fan.

Reference Conditions -	Barometric pressure	mm Hg	736
	Intake-air temperature	°C	20
	Relative humidity	%	60

The indicated Special Rating and the Automotive Rating according to DIN 70 020 are available as useful output at the flywheel with +5 % tolerance.

Reference Conditions -	Barometric pressure	mm Hg	760
	Intake-air temperature	°C	20

The data on fuel consumption are valid with +5% tolerance (without a tolerance in the instance of the Special Rating and of the Automotive Rating) when using a diesel fuel of a net calorific value of 10,000 kcal per kg minimum.

** These data apply to engines with centrifugal governor and injection-timing device

*** This value varies with the actual oil pan

Dimensions and weights

Dimensions, basic engine "Uk"		
length	mm	abt 700
width	mm	abt 515
height	mm	abt 705
height, over center of crankshaft	mm	abt 490
Weight, basic engine "Uk", without generator and starter motor, dry	kp	abt 168
Starter motor and generator	kp	abt 17

Tigthtening torques

Drankshaft-bearing bolts	mkp	8
Connecting-rod bearing bolts	mkp	3.75
Cylinder-head fixation bolts	mkp	8
Heater plugs in cylinder head	mkp	5
Injector holder in cylinder head	mkp	7 to 8
Through fitting on injector holder	mkp	5
Injector in injector holder	mkp	7 to 8
Precombustion chamber in cylinder head	mkp	15
Rocker-arm fixation nuts	mkp	2
Banjo fitting at injection pump	mkp	4.5 + 0.5
Union nuts of delivery lines	mkp	2.5
Flywheel fixation bolts	mkp	5
Vee-belt pulley on crankshaft		
gray-iron pulley	mkp	18
light-metal pulley	mkp	12

All threads and the pertinent thrust faces should be clean and smooth. Use engine oil for lubrication excepting the connecting-rod and cylinder-head bolts which will employ graphite oil for lubrication. Different lubricants require substantially deviating torques.