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DESCRIPTION

GENERAL
Engines with type designation B 18 A are four-cylinder, water-cooled overhead-valve units. They are provided with a single down-draught carburettor. The cylinder head has separate inlet and exhaust ports, one for each valve. The crankshaft is carried in five bearings.

The output of the engine is 75 h.p. (SAE), 68 h.p. (DIN) at 4500 r.p.m. and the torque is 14.0 kgm (101 lb. ft.) at 2800 r.p.m. (SAE), and 13.5 kgm (96 lb. ft.) at 2600 r.p.m. (DIN). The compression ratio is 8.5:1, the displacement 1.26 litre, bore 84.14 mm and stroke 80 mm.

CYLINDER BLOCK
The cylinder block (29, Illustration 1) is made of special alloy cast iron and is cast in a single unit. The cylinder bores which are surrounded by cooling jackets are machined directly in the block. The valves in the block are arranged so that the oil filter, which is of the full-flow type, is directly attached to the right-hand side of the block.

CYLINDER HEAD AND VALVES
The cylinder head (22) is attached to the block by means of bolts. All the combustion chambers are machined throughout and have separate inlet and exhaust ports, one for each valve. The valves (4 and 6, Illustration 1), which are fitted in the cylinder head, are made of special steel and mounted in replaceable guides. The valve stems are chromed.

The cooling jackets are designed so that the area around the sparking plugs is also cooled. The water is also distributed by means of a pipe and directed towards the warmest parts of the engine.

Fig. 1. Engine viewed from left
1. Water outlet pipe
2. Oil filter cap
3. Carburettor
4. Air cleaner
5. Rocker casing
6. Engine number
7. Oil dipstick
8. Vacuum hose
9. Distributor
10. Starter motor
11. Attachment for distributor
12. Breather pipe
13. Fuel pump
14. Fuel hose
15. Timing gear casing
16. Water pump
17. Ignition setting mark
18. Fan
CRANKSHAFT AND BEARINGS
The crankshaft (44) is made of drop-forged steel and has ground and case-hardened bearing journals. It is carried in five main bearings, of which the rear one also functions as a pilot bearing. There are drilled oilways in the crankshaft for the lubricating oil. The big-end bearing shells, which are replaceable, consist of a steel backing with indium-plate lead-bronze bearing metal and Babbit's metal for the main bearings.

CAMSHAFT AND VALVE TAPPETS
The camshaft (45) is made of special-alloy cast iron and has case-hardened cams. It is driven from the crankshaft through a gear train which has a reduction ratio of 2:1. The camshaft is guided axially by means of an axial washer at the front end. The end float is determined by a spacing ring behind the camshaft gear. The valve tappets (26) are actuated directly by the camshaft. They are located in holes in the block above the camshaft and transfer the movement to the valves by means of push rods and rocker arms. There are no inspection covers for the valve tappets since they are accessible from above after the cylinder head has been removed.

CONNECTING RODS, PISTONS AND PISTON RINGS
The connecting rods (48) are made of drop-forged steel and are provided with a precision-machined bush which acts as bearing for the gudgeon pin. The big-end bearing shells are precision-manufactured and are replaceable. The pistons (46) are made of light-alloy and have two compression rings and one oil scraper ring. The upper compression ring is chromed in order to reduce cylinder wear. The gudgeon pin (50) has a floating fit in both the piston and connecting rod. The axial movement of the gudgeon pin is limited by circlips in the gudgeon pin hole.

Fig. 2. Engine viewed from right
1. Vacuum hose
2. Air cleaner
3. Fuel hose
4. Water outlet pipe
5. Tensioning device
6. Water inlet pipe
7. Dynamo
8. Exhaust manifold
9. Oil filter
10. Drain cock
Fig. 3. Lubricating system
1. Oil pump
2. Sump
3. Nozzle
4. Oil cooler
5. Oil filter
(B 18 B only)

LUBRICATING SYSTEM
The engine has a force-feed lubricating system, see Fig. 3. The pressure is provided by a gear pump which is driven from the camshaft and fitted under the crankshaft in the sump. The gear pump forces the oil past the relief valve, which is also fitted on the pump, through the oil filter and then through oilways out to the various lubricating points. All the oil supplied to the lubricating points therefore first passes through the oil filter.

Oil pump, relief valve
The oil pump, see Fig. 5, is of the gear type and is driven through a gear train from the camshaft. The delivery pipe from the pump to the cylinder block does not have a screwed union and is automatically tightened in position when the attaching bolts for the pump are tightened. At each end of the pipe there are sealing rings made of special rubber. The relief valve is fitted directly on the pump and consists of a spring-loaded ball. The ball has a cylindrical guide with a stop at the end position and therefore operates flexibly. Even at idling speed there is a certain amount of overflow, so that the oil pressure is then relatively low.

Fig. 4. Output and torque curves
Oil filter

The oil filter, see Fig. 6, which is manufactured as a single unit complete with element, is of the full-flow type and is screwed directly into the cylinder block. The oil which is fed out to the various lubricating points in the engine first passes through the oil filter element which is made of special paper. In the oil filter there is a by-pass valve which allows the oil to by-pass the element if resistance to flow should become excessive. When replacing the filter the old one is discarded complete and a new one fitted.

IGNITION SYSTEM

The distributor (25, Illustration 1), which is driven by a bevel gear from the camshaft, has both a centrifugal and vacuum regulator. The direction of rotation is anti-clockwise and the firing order is 1–3–4–2. For further particulars, see Part 3.

FUEL SYSTEM

The fuel is drawn by a diaphragm pump from the tank through a fuel filter and then fed to the carburettor float chamber.

Carburettor

The engine has a Zenith down-draught carburettor, type designation 36 VN. The carburettor is illustrated in Figs. 7 and 8.

Fuel feed is controlled by fuel jets fitted in an emulsion block with a nozzle which opens out into the carburettor venturi. The emulsion block also has air channels so that a certain amount of air can be mixed with the fuel at an early stage. The carburettor has a hand-regulated choke, rapid idling device, acceleration pump and economizer valve. The function of the carburettor is described under the following headings.

1. Float system.
2. Choke device with rapid idling.
3. Idling system.
5. Acceleration pump.
1. FLOAT SYSTEM

The float keeps the fuel at the correct level. When the fuel has increased to this level the float (4, Fig. 9) is lifted upwards and pushes the needle in the valve (2) against its seat through the medium of the float arm so that the flow of fuel is cut off. When the chamber level goes down the same procedure is repeated but in the reverse direction. The float bowl is ventilated through a hole (1) which is connected at the top with the upper part of the carburettor. The float is made of nylon and is fitted with a fixed arm.

2. CHOKE DEVICE WITH RAPID IDLING

In order to enrich the fuel/air mixture when a cold engine is started, the choke system is used and this is operated from the knob on the dashboard. When the choke control is pulled out when starting, the cam-shaped lever (4, Fig. 10) is actuated. This influences the choke flap (6) through the spring (7) on the flap spindle so that it closes, thereby resulting in a higher degree of vacuum and consequently a higher rate of fuel flow. When the engine has started and the degree of vacuum increases, the throttle can open itself to a certain extent.
extent, since the closing force is obtained from the spring on the choke spindle. This eliminates the risk of excessively rich fuel/air mixture when the choke is completely or almost closed. When the choke knob is pushed in again, the choke flap is forced to open fully since the flap lever pin (6) runs in a groove on the cam-shaped lever.

One of the cams on the choke lever (3) also actuates the throttle flap through the rapid idling screw (5) and the link (2). This means that the throttle flap opens at the same time as the choke flap closes. The degree to which the throttle flap opens relative to the closing of the choke flap is determined by various settings of the screw (5). This rapid idling device enables the driver to give the engine higher idling speed during the warming-up period and thus avoid the risk of the engine stalling.

3. IDLING SYSTEM

While the engine is idling, the throttle flap is almost completely closed (regulated by means of a stop screw (7, Fig. 11) whereby the degree of vacuum around and under the flap is very large. Suction through the idling channel (4) will then be considerable and fuel will be sucked up from the channel above the main jet (5) through a hole and the idling jet (6) to the idling channel which opens out into the carburettor venturi with one large and two small holes. Air is supplied both through a hole (1) under the choke flap and an air jet (2) above the idling jet.

The fuel/air mixture is controlled by means of an idle fuel adjusting screw (3) by means of which the flow area for the fuel/air mixture can be varied. Since a certain amount of air passes through the throttle flap, the fuel/air mixture being fed to the engine during idling will be richer if the screw is screwed out and leaner if it is screwed in.

The two small holes (9) just above the throttle flap supply a mixture of air and fuel when the throttle flap opening is rather larger and thus co-operate with the variable hole. In this way a smooth transition is obtained.

4. MAIN JET AND COMPENSATION JET.

ECONOMIZER VALVE

A large part of the fuel being fed to the engine when it is under loading and running at high speed passes through the main jet (4, Fig. 12). The main jet alone cannot supply a sufficiently well-balanced amount of fuel under all conditions of operation and is therefore combined with a compensation jet (3) which works in co-operation with the main jet.

Both these jets are fitted in an emission block (2) and open out with a nozzle into the carburettor.

![Diagram of carburettor and emission block](image-url)
venturi. When it passes through the emulsion block, the fuel is mixed with a certain amount of air, whereby it can mix more easily with the large quantity of air entering the engine through the carburettor venturi. The amount of air supplied to the emulsion block passes through a hole above the main jet space as well as through channels (1), and the air jet (8). The amount of air added is varied with the help of the economizer valve.

The space above the compensation jet forms a reservoir for fuel. High speed means a large rate of flow. The fuel then passes at a higher velocity through the hole in the wall to the main jet channel, whereby the level sinks down to the hole and an increased airflow results.

From the air channels (1) air is supplied to the three channels (6) in the wall towards the space above the main jet. When the fuel level in this space sinks, more air is supplied and this air is mixed with the fuel.

With the help of the economizer valve, the fuel/air mixture is supplied with an extra amount of air when the degree of vacuum in the carburettor venturi is large.

The economizer valve disc (12) is attached to a diaphragm (11) and forced against the seat by a spring (13). In this position air supply is obtained from the upper channel only through the small hole (10) at the diaphragm.

On the back of the diaphragm, however, there is a connection with the lower part of the venturi through a channel (7). When the degree of vacuum in this increases, for example when driving quietly without any great degree of loading, the valve lifts from its seat and also flows into the emulsion block through the centre hole in the valve disc.

If the degree of loading should increase, for example during acceleration, the degree of vacuum is decreased and the spring forces the disc back against its seat, whereby the supply of air decreases and the fuel/air mixture again becomes richer.

5. ACCELERATION PUMP

When the throttle is opened quickly, there is a tendency for the fuel/air mixture to be too lean, a contributory reason being that air moves more quickly than fuel and thus reaches the engine more rapidly.

In order to compensate for this sudden weakening of the mixture, a certain amount of fuel is sprayed with the help of the acceleration pump directly into the carburettor venturi.
The pump plunger (Fig. 13), located in a cylinder integral with the side of the float chamber, is actuated when pressed down by a lever with a spring-loaded joint. The pump plunger stroke can thus easily be varied by turning a washer with a cam (5), whereby the front part of the lever is stopped by a check, higher or lower depending upon the position of the washer. The last part of the rear lever section has its movement taken up by the spring (6) and the joint.

At the inlet into the bottom of the pump barrel, there is an inlet valve (8) and at the outlet, behind the acceleration jet, there is an outlet valve (9). This outlet valve is fitted with a ball which lifts and closes the air hole above during the pump stroke, whereby fuel is sprayed in through the acceleration jet (10). During normal running, the ball closes the connection from the float chamber and instead allows air to pass from the air hole to the acceleration jet. In this way fuel is prevented from passing through this jet when the pump is not operating.

Air cleaner
The air cleaner (Figs. 14, 15 and 16) is placed above the engine and functions both as a cleaner for the induction air and as an induction silencer. Three different types have been fitted, one with a replaceable paper element, one with a non-replaceable element and one of the oil-bath type. The paper element may not be washed or moistened, the only servicing permitted in this connection being to replace either the complete element or the complete air cleaner as the case may be. Where an oil-bath type air cleaner is fitted, this should be dismantled for servicing and cleaned, after which new oil is filled in up to the correct level.

Fuel pump
The fuel pump is of the diaphragm type and is driven by a cam on the camshaft. When the rocker arm in the pump is pressed upwards by the cam,
the diaphragm is pulled downwards and fuel drawn up to the pump. When the rocker arm returns, the diaphragm is pressed upwards by a spring (15, Fig. 17) and fuel is fed to the float chamber in the carburettor. When the level in the float chamber is sufficiently high, the float valve closes and the pressure in the delivery line rises until the pressure on the upper side of the diaphragm exceeds the spring pressure and pumping action ceases. The red arrows on Fig. 17 show the path followed by the fuel.

**COOLING SYSTEM**

The cooling system, Fig. 18, is of the pressure type with a circulation pump (Fig. 19). When the engine is cold, the cooling water only circulates through a by-pass pipe (4, Fig. 20). When the engine warms up, the thermostat begins to open the outlet to the radiator. When the thermostat is fully opened, the by-pass is closed by the spring-loaded valve disc on the underside of the thermostat so that all the cooling water has to pass through the radiator (Fig. 21).

While the engine is running, circulation is controlled by the thermostat so that the engine temperature is maintained within the correct limits. The
distributing pipe in the cylinder head (3) ensures uniform cooling of the warmest parts in the cylinder head. The parts around the sparking plugs are also cooled and thereby maintained at a constant temperature. The cooling water which surrounds the cylinder walls is circulated through thermo-siphon action.

**Fig. 19. Water pump**

1. Housing
2. Impeller bearings (integral unit)
3. Sealing ring
4. Locking spring
5. Shaft with ball
6. Hub

**Fig. 20. Coolant flow, thermostat closed**

1. Cylinder head
2. Thermostat
3. Distributing pipe
4. By-pass pipe
5. Water pump

**Fig. 21. Coolant flow, thermostat fully open**

1. Cylinder head
2. Thermostat
3. Distributing pipe
4. By-pass pipe
5. Water pump
REPAIR INSTRUCTIONS

WORK WHICH CAN BE CARRIED OUT WITHOUT REMOVING THE ENGINE FROM THE CAR

Measuring the compression pressure
1. Run the engine until it attains normal operating temperature. Check that the air cleaner is not blocked. Replace the element or complete air cleaner, or clean the oil-bath type air cleaner, whichever the case may be.
2. Unscrew all the sparking plugs. Depress the accelerator pedal fully and place a weight on it.
3. Hold a compression gauge in the sparking plug hole for the first cylinder. Turn the engine round with the starter motor until the gauge gives a maximum reading and repeat this procedure on the other cylinders. The battery must be in good condition in order to turn the engine sufficiently fast. The most important point to watch during this test is that the pressure between the cylinders is as uniform as possible. The maximum permissible pressure difference between the best and worst cylinders is 10 %.
4. Record the pressure obtained for each cylinder unless the gauge used is of the self-registering type.
5. If the values obtained are low or uneven, measuring should be repeated after a small amount of thick oil has been introduced into each cylinder. If the pressure is low in one of the cylinders, both with and without oil, this is a sign of leaking valves. If the pressure is higher after the oil has been introduced, it is probable that the piston rings are worn. If the pressure is low in two adjacent cylinders, this probably means that the cylinder head gasket is damaged.

Engine tuning
The engine should be tuned up at regular intervals in order to obtain the best running results. The purpose of tuning up is to reset all adjustments to the correct values, as well as to obviate any troubles due to dirt in the sludge trap, deposits on sparking plugs etc.

1. Run the engine warm and check the dwell angle (contact breaker gap), adjusting if necessary. Replace burnt contact breaker points. Check the ignition timing with a stroboscope at the specified setting speed and with the vacuum regulator disconnected. See "Specifications" for details.
2. Check the distributor cap and clean it. Clean and check the ignition cable.
3. Check the state of charge of the battery and examine terminals.
4. Clean the fuel pump sludge trap (strainer). Remove the float chamber and blow it clean. Fill the parts.
5. Check and if necessary replace the complete air cleaner or air cleaner elements as the case may be. If an oil-bath air cleaner is fitted, clean it. See under "Air cleaner" on page 31.
6. Check-tighten the intake and exhaust manifolds. Check that there are no air leaks at the carburettor.
7. Adjust the valve clearances. Check that there is no oil leakage. If the rocker casing gasket is so compressed that the casing itself contacts the cylinder head, fit a new gasket.
8. Measure the compression on all the cylinders.
9. Remove and adjust the sparking plugs or replace them with new ones.
10. Check and adjust the carburettor settings as necessary. Adjust the idling speed. Check the throttle control setting and the fan belt tension.

Replacing the water pump
1. Drain off the coolant. (One cock at the rear on the right-hand side of the engine and one on the rear of the radiator.)
2. Slacken the fan belt and disconnect the water pipes.
3. Fit in the opposite order but make sure that the sealing rings on the top of the pump come into their correct position. Also press the pump upwards against the cylinder head extension while bolting in position so that there is a good seal between the pump and the cylinder head.
4. Make sure that the sealing rings on the water pipe are in good condition and push in the pipe thoroughly when attaching.
5. Fill with coolant. Test run the engine and check for leakage.

Replacing the oil filter
When changing the oil filter, which should normally be done every 10,000 km (6,000 miles), follow the instructions on page 26.

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Fig. 24. Removing hub on crankshaft

Replacing oil seal in timing gear casing
1. Release the fan belt.
2. Screw out the bolt in the crankshaft. Remove the belt pulley.
3. Remove the circlip for the washer which retains the felt ring. Remove the washer and felt ring. Check that the casing is correctly fitted by inserting a 0.10 mm (0.004") feeler gauge in the gap between the casing and hub on the crankshaft and moving it all round. If the feeler gauge jams at any point the casing should be centred, see under "Replacing the timing gear casing".

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Fig. 23. Timing gear casing
1. Sealing ring
2. Drain holes

Fig. 25. Removing the camshaft gear
4. Fit a new felt ring. Place the washer in position and fit the circlip. Check that the circlip comes properly in position.
5. Fit the remaining parts and tension the fan belt.

Replacing the timing gear casing
1. Loosen the fan belt. Remove the fan and pulley on the water pump.
2. Remove the bolt for the crankshaft belt pulley and remove the pulley.
3. Remove the timing gear casing. Slacken a couple of extra bolts for the pump and be careful not to damage the gasket. Remove the circlip, washer and felt ring from the casing.
4. Make sure that the gaskets are in good condition and that the drain hole is open and clean inside the timing gear casing which is to be fitted.
5. Place the casing in position and fit the bolts without tightening them.
6. Centre the casing with sleeve SVO 2436, see Fig. 31. Turn the sleeve while tightening and adjust the position of the casing so that the sleeve is not jammed. Check after final tightening the casing that the sleeve can be easily rotated without jamming.
7. Fit a new felt ring, washer and circlip. Push them into their final position with the centering sleeve SVO 2408. Check that the circlip has engaged in its groove.
8. Fit the other parts and tension the fan belt. See the specifications for the tightening torque.

Replacing the timing gears
1. Drain off the coolant and remove the radiator grille (not P 120) and the radiator.
2. Carry out operations 1-3 in the previous section.
3. Remove the hub from the crankshaft with puller SVO 2440, see Fig. 24.
Valve grinding and decarbonizing

1. Drain off the coolant from the radiator and cylinder block. (Two rocks.)
2. Dismantle the throttle control. Disconnect the choke control.
3. Remove the air cleaner and carburettor.
4. Disconnect the exhaust pipe at the exhaust manifold and disconnect the hoses to the radiator as well as other connections to the cylinder head.
5. Remove the rocker casing, rocker arm shaft and push rods.
6. Remove the cylinder head bolts and disconnect the water pipe as well as the attachment on the rear exhaust manifold. Loosen the dynamo tensioner arm. Lift off the cylinder head.
7. Clean the piston crowns, combustion chambers, inlet ports and exhaust ports very thoroughly. Do not use emery cloth since small grinding particles can get in between the piston and cylinder walls and cause scoring.
8. Recondition the valve system as described under the heading "Cylinder head and valve".
9. Fit the valves. Screw the guide pins SVO 2435 into the block, one in the front right-hand hole and the other in the left rear hole. Lay components as described in points 4–8 in the previous section.
Fig. 31. Centering the timing gear casing

on a new cylinder head gasket and new
sealing rings for the water pump and fit the
new cylinder head. Screw out the guide pins
and fit the bolts in these holes as well. For
tightening sequence and tightening torque,
see Fig. 40 and at the end of the specifica-
tions. Fill the outer parts. Fill up with water.

10. Adjust the valve clearances. Run the engine
for a short while. Check the running of the
engine and re-adjust the valve clearances. It
is not necessary to re-tighten the cylinder
head bolts.

Replacing the thermostat

1. Drain off part of the cooling water.
2. Remove the bolts for the outlet pipe over the
thermostat and turn up the pipe.
3. Replace the thermostat. (1, Fig. 32). Use a new
gasket. Check the valve on the underside of
the thermostat by pressing in and releasing the
spring-loaded valve disc.
4. Screw the pipe in position. Fill with water and
check for leakage.

Removing the sump

Since it has been found to save work on some
types of engine repairs to be able to remove the
sump without lifting out the engine, the following
method has been worked out:

Fig. 32. Replacing the thermostat

1. Thermostat
2. Gasket
PV 544—210

REMOVING
1. Lift up the vehicle about 30 cm (12") above the floor and place blocks under it near the jacking points.
2. Apply a lifting device under the engine mountings. N. B. Do not lift on the water pump. Unscrew the nuts for the front engine mounting pads from below. Lift the engine as high as possible without pinching anything on the scuttle and allow it to hang on pulley blocks, a workshop hoist, an engine lifter or similar.
3. Place a jack under the front member.
4. Clean off around the brake pipes connections on the master cylinder. Disconnect the brake pipes to the front end on the master cylinder. Plug the lines in order to prevent impurities from entering the brake system.
5. Remove the four front bolts for the front member. Screw in two bolts about 75 mm (3 3/4") long in place of these, one on each side. Remove the four rear bolts for the member.
6. Lower the front and so that it is supported in the two long bolts.
7. Remove the sump in the usual way.

FITTING
1. Fit the sump.
2. Thoroughly clean the front member and lift it up. Tighten the rear bolts. Remove the long bolts at the front and fit the ordinary ones.
3. Clean off around the master cylinder and brake pipes. Fit the brake pipes.
4. Bleed the brakes.

REMOVING THE ENGINE
1. Lift up the vehicle about 30 cm (12") above the floor and block it up. Drain off the coolant (drain cocks at rear right-hand side of engine and at bottom right-hand side of radiator) and the engine oil. Remove the air cleaner and disconnect the fuel pipe on the pump. Remove the pipe clamp. Disconnect the positive terminal on the battery or remove the battery. Remove the radiator.
3. Disconnect the throttle and choke controls and all other connections round the engine.
4. Disconnect the exhaust pipe at the exhaust manifold as well as the attachment on the flywheel housing. Remove the nuts for the engine mounting pads.
5. Remove the gear lever. Remove the control for the clutch, speedometer cable and cables for the overdrive if fitted.
6. Disconnect the front joint on the propeller shaft. Place a jack under the gearbox and lift it slightly. Remove the support member.
7. Fit lifting tool SVC 4/25 on the engine. The bolt on the tool is tightened in the hole on the front end of the cylinder head (the bolt for the fuel pipe clamp is removed), the hooks being fitted under the front and rear ends of the manifold, see Fig. 33.
8. Lift the front end of the engine slightly to clear the mounting pads. Lower the gearbox but not more than necessary, and pull the engine forward at the same time as the front end is lifted. Lift out the engine by gradually raising the front end and lowering the rear end.

DISMANTLING THE ENGINE
After the engine has been lifted out of the vehicle, dismantling is carried out as follows. (Instructions for the individual parts are given under the separate headings concerned.)
1. Place the engine on a suitable stand (SVC 2/22). Check that the oil has been drained off.
2. Remove the starter motor and splash plates on the lower front edge of the flywheel housing.
Remove the flywheel housing together with the gearbox and then remove the clutch and flywheel.

3. Remove the rear flange, taking care not to damage the contact surfaces, the dynamo, water pump and distributor, rocker casing, rocker arms, cylinder head and oil filter. Remove the valve tappets with tool SVO 2424, see Fig. 35.

4. Remove the timing gear casing and timing gears. For tools, see under the heading "Replacing the timing gears". Remove the camshaft.

5. Stand up the engine on its rear end on a bench. Place three wooden blocks under it so that the crankshaft can rotate freely. Remove the carbon ridge from the cylinder bores. Remove the sump, oil pump and connecting rods with pistons. Replace the caps correctly on their respective connecting rods.

6. Turn the engine upside down and remove the crankshaft. Replace the caps correctly in their respective pistons.

CLEANING

After dismantling, all the parts should be thoroughly cleaned. Parts made of steel or cast iron can be washed in a degreasing tank with a caustic soda solution. Light-alloy parts can, however, be destroyed by caustic soda so that they should preferably be cleaned with white spirit. Pistons and bearing shells must never be washed in caustic soda. Rinse the parts with warm water and blow them dry with compressed air after washing. Clean the oilways particularly thoroughly. Pull them through with a special brush and then blow them out with compressed air. All sealing plugs at the oilway openings in the cylinder block must be removed while cleaning is carried out.

CYLINDER HEAD AND VALVES

Dismantling

1. Remove the rubber seals. Remove the valve springs by first compressing them with valve pliers and removing the valve collets, after which the pliers are released. Place the valves in order in a stand.

2. Measure the clearance between the stem and guides as shown in Fig. 34. With a new valve the clearance should not exceed 0.15 mm (0.006""). Also check that the valves are not excessively worn. See the specifications under the headings "Valve system" and "Wear tolerances".

Cleaning

Remove carbon and combustion deposits from the valves, combustion chambers and ports by using rotating brushes.

Grinding the valves and valve seats

1. Grind the valves in a machine after they have been cleaned. Fit new valves if they are excessively worn.
2. Grind the valve seats. Use an electrically driven grinder or a hand milling cutter. A pilot spindle must be carefully fitted before work is started and any worn guides must be replaced with new ones.

The seat should be ground until a good sealing surface is obtained. The angle is 45° and the width of the sealing surface should be 1.4 mm (0.055"), see "A", Fig. 37. If the sealing surface is too wide after grinding, it can be reduced by using a 70° grinding stone from the inside and a 20° grinding stone from the outside.

3. Coat the valve sealing surfaces with a thin layer of fine grinding paste and lap in the valves against their seats. Then clean the valves and seats and check that good sealing is obtained.

Replacing the valve guides

1. Press out the old guides with tool SVO 1459.
2. Press in the new guides using drift SVO 2289 which gives the correct depth; see Fig. 38.
3. Check that the guides are free from burr and that the valves move easily in them.

Assembling

1. Check that the parts are in good condition and clean. Test the springs to ensure that they maintain the values given in the specifications. See also Fig. 36.
2. Place the valves in position. Fit the lower rubber washer, steel washer (early production), valve spring, upper washer and collet and finally the rubber ring.

Replacing the rocker arm bushes and grinding the rocker arms

1. If wear amounts to 0.1 mm (0.004"), replace the rocker arm bush. Use tool SVO 1987 for pressing the bush both out and in. Then ream the bush with a suitable reamer until an accu-

Fig. 37. Valve seat width

A = 1.4 mm (0.055")

Fig. 38. Replacing the valve guides

A = 2.1 mm (0.082")
rate fit on the shaft is obtained. The hole in the bush should index with the hole in the rocker arm.

2. If necessary, grind the pressure pad of the rocker arm in a special machine.

**Fitting the cylinder head**

1. Check that the cylinder head, the cylinder block, the pistons and cylinder bores are clean.

2. Check that the oilway to the rocker arm mechanism on the valve tappet side in the middle of the block is clean. In the cylinder head, oil goes up through the bolt hole, between the bolt and hollow partition, through a diagonal oilway to the attaching bolt for the rocker arm shaft and then up into the shaft.

3. Screw down the guide pins SVO 2435, one in the front right and one in the rear left bolt hole. Fit a new cylinder head gasket and then fit the cylinder head. Screw in the cylinder head bolts tightly. Remove the last guide pins and also fit the bolts in these holes as well.
Tighten the bolts in the correct order and to the correct torque. See Fig. 42 and the specifications.

4. Fit the rocker arm mechanism. Adjust the valve clearances. Fit the other parts.

5. Run the car for a short distance. Check that the engine is running well and adjust the valve clearances.

It is not necessary to re-tighten the cylinder head.

Adjusting the valve clearance

The valve clearance can be adjusted satisfactorily with the engine stationary, no matter whether it is cold or warm. The clearance is the same for both the inlet and exhaust valves. When adjusting, use two feeler gauges, one "go" 0.40 mm (0.016") thick and the other "no go" 0.45 mm (0.018") thick. The clearance is adjusted so that the thinner gauge can be inserted easily while the thicker one must not enter.

When the piston in No. 1 cylinder is at top dead centre (the compression stroke), valves Nos. 1, 2, 3 and 5 (counted from the front) are adjusted, and with the piston in No. 4 cylinder at top dead centre, valves Nos. 4, 6, 7 and 8.

Cylinder Block

Measuring the cylinder bores

The cylinder bores are measured with a special dial indicator as shown in Fig. 45. A letter is stamped on each cylinder bore indicating the classification of the bore and piston (only on standard models).

Measuring should be carried out at different depths and in both the longitudinal and transverse directions.

Fig. 43. Tightening sequence for cylinder head

Fig. 44. Adjusting the valve clearance

Fig. 45. Measuring the cylinder bore
directions. See the Specifications for the dimensions concerned.

**Re-boring the cylinders**
The cylinders are re-bored in a special machine, after which they are honed in order to obtain a good surface finish. The complete cylinder block should be washed in a degreasing tank before being assembled in order to remove all grinding residue and impurities.

See the Specifications for the dimensions concerned. See also the text under the heading "Fit of pistons in cylinders".

**PISTONS, PISTON RINGS AND GUDGEON PINS**

**Measuring the pistons**
The pistons are measured with a micrometer at right-angles to the gudgeon pin hole 12.5 mm (0.49") from the lower edge (early production) and 2.5 mm (0.098") from the lower edge (late production), see Fig. 46.

**Fit of pistons in cylinders**
The fit of the pistons in their respective cylinders is tested without the piston rings fitted. The clearance at right-angles to the gudgeon pin hole is measured with a feeler gauge 3/16" wide and 0.03 mm (0.0012") thick attached to a spring-balance. The force applied should be 1 kg (2.2 lbs.). This gives the average value for piston clearance. When the above-mentioned force is applied, the piston clearance obtained is equal to the thickness of the feeler gauge used. Feeler gauges which are 0.02 mm (0.0008") or 0.04 mm (0.0016") thick can therefore also be used. The test is carried out at several different depths, see Fig. 47. Standard bore cylinders have a letter stamped on showing the dimensions, and the piston concerned should be marked with the same letter.

**Piston ring fit**

**IN A NEW OR RE-BORED CYLINDER**

1. Push down the piston rings one after another in the cylinder bore. Use a reversed piston to ensure that the rings come into the correct position.

2. Measure the ring gap with a feeler gauge as shown in Fig. 46. The gap should be 0.25–0.30 mm (0.01–0.02"). If necessary the gap can be widened by using a special file.

3. Check the piston rings in their respective grooves by rolling them in the groove as shown in Fig. 50. Also measure the clearance at a few points as shown in Fig. 49. See the Specifications for measurements.
IN A WORN CYLINDER BORE

When checking the fit in a worn cylinder bore the rings must be checked at the bottom dead centre position where the diameter of the bore is smallest.

Gudgeon pins

The gudgeon pins are available in three oversizes 0.08 mm, 0.10 mm and 0.20 mm larger than the standard diameter of 22.00 mm. If the gudgeon pin hole in the piston is worn so much that an oversize is necessary, the hole should first be reamed out to the correct measurement. Use a reamer fitted with a pilot guide and only take small cuts at a time.

The fit is correct when the gudgeon pin can be pushed through the hole by hand with light resistance.

CONNECTING RODS

Replacing the bushes

If the old bush in a connecting rod is worn, press it out by using tool SVO 1887 and press in a new bush with the same tool. Make sure that the lubricating holes index with the holes in the connecting rod. Then ream the bush to the correct fit. The gudgeon pin should slide through the hole under light thumb pressure but without any noticeable looseness.

Straightening

Before being fitted, the connecting rods should be checked for straightness, twist and any S-distortion. Straighten them if necessary, see Fig. 53.
New nuts and bolts should be fitted when reconditioning is carried out.

Assembling and fitting the piston and connecting rod

When assembling, make sure that the piston is turned correctly so that the arrow (early production) and slot (late production) on top of the piston faces forward as shown in Fig. 54. If the piston is turned the wrong way this will cause a loud noise. The number marking on the connecting rod should be turned to face away from the camshaft side. The gudgeon pin is then fitted, the circlips placed in position and the piston rings fitted.

Use piston ring gaps when fitting the rings. The compression rings are marked "TOP" and the
the piston in the cylinder bore. Tighten the connecting rod bolts with a torque wrench, see the Specifications for the correct value.

CRANKSHAFT
After the crankshaft has been cleaned, its journals must be measured with a micrometer. Measuring should be carried out at several points round the circumference and along the longitudinal axis of each journal. Out-of-roundness on the main bearing journals should not exceed 0.05 mm (0.002") and 0.07 mm (0.003") on the big-end bearing journals. Taper should not exceed 0.05 mm (0.002") on any of the journals.

If the values obtained are close to or exceed the wear limits mentioned above, the crankshaft should be ground to undersize. Suitable bearing shells are available in five undersizes. The measurements concerned are included in the Specifications.

Check that the crankshaft is straight to within 0.05 mm (0.002") by using a dial gauge. The crankshaft is placed on two V-blocks and a dial gauge placed against the centre bearing journal, after which the crankshaft is rotated. If necessary, straighten the crankshaft in a press.

Grinding the crankshaft
Before the crankshaft is ground, a check should be made to ensure that it is straight; this being
done as previously described. Grinding is carried out in a special machine whereby the main bearing journals and big-end bearing journals are ground to identical measurements. These measurements, which are given in the Specifications, must be carefully followed in order to ensure correct bearing clearance with the ready-machined bearing shells.

On no account must the bearing shells be scraped or the bearing caps filed.

The fillets at the ends of the journals should have a radius of 2.5–2.55 mm (0.090–0.100") on all journals, see Fig. 97. The width measurement (A) for the pilot bearing depends on the size of the journal and should be ground in order to obtain the correct measurement.

After grinding has been completed, all burr should be carefully removed from the oilway openings and all the journals lapped with fine grinding paste to the finest possible surface finish. The crankshaft should then be washed. All the oilways should be cleaned particularly thoroughly in order to remove all metal chippings and grinding residue.

Main and big-end bearings

In addition to standard sizes, bearing shells are available in undersizes of 0.010", 0.020", 0.030", 0.040" and 0.050". The rear main bearing shells are provided with flanges and have a larger width measurement relative to their size. If the crankshaft has been ground to the correct measurement, the correct bearing clearance is automatically obtained when the bearing shell concerned is fitted. The bearing shells must not be scraped and the caps must never be filed in order to obtain closer bearing fit.

The bolts should be tightened with a torque wrench; see the Specifications for information concerning tightening torques.

FITTING THE REAR SEALING FLANGE

1. Make sure that the seal is in good condition and that the flange is clean. The drain hole must not be blocked by incorrect fitting of the pump gasket. The sealing ring must not be fitted in the flange.
2. Fit on the sealing flange but do not tighten the bolts.
3. Centre the flange with sleeve SVO 2493. Turn the sleeve round while tightening the bolts and adjust the position of the flange if the sleeve jams. Check that the flange comes flush against the cylinder block on the underside.
4. After final tightening, check that the sleeve can rotate easily.

4. Fit a new felt ring and place on the washer and circlip. Press the circlip into position with the centring sleeve. Check that the circlip engages in its groove.

PILOT BEARING FOR CLUTCH SHAFT

The pilot bearing circlip and protecting washer are removed, the bearing pulled out with SVO 4280 and checked after having been washed in white spirit. If the bearing is worn it should be replaced with a new one. Before fitting, pack the bearing with heat-resistant ball bearing grease. The bearing is fitted with drift SVO 1436, after which the protecting washer and circlip are fitted.
GRINDING THE FLYWHEEL
If the wear surface of the flywheel is uneven or burnt, the surface can be ground in a saddle-mounted grinding machine, see Fig. 59, not more than 0.75 mm (0.03") of the original thickness must be ground off.

LUBRICATING SYSTEM
Replacing the oil filter
The oil filter (Fig. 61) is, together with the element and relief valve, screwed as a complete unit on to a nipple fitted in the cylinder block. The filter should be replaced every 10 000 km (6 000 miles), when the oil filter is deacarded. With a new or reconditioned engine the filter should also be changed for the first time after 5 000 km (3 000 miles).

1. Remove the old filter with the help of chain tongs as shown in Fig. 60.

2. Coat the rubber gasket (1, Fig. 61) of the new filter with oil and make sure that the contact surface for the oil filter is free from dirt. By coating it with oil, the gasket slides into better contact with the sealing surface. Screw on the filter by hand until it just touches the cylinder block.

3. Screw on the oil filter a further half turn by hand. Chain tongs must not be used when fitting. Start the engine and check that there is no leakage at the joint. Top up with oil if necessary.

Oil pump and relief valve
After the pump has been dismantled and cleaned, check that all the parts are in good condition. Test the relief valve spring (2, Fig. 62), see the Specifications for the values concerned.

Check that the tooth flank clearance is 0.15–0.35 mm (0.006–0.014"), see Fig. 65. Measure the end float, 0.02–0.10 mm (0.0008–0.0040") as shown in Fig. 63. Use a new cover to
check that the old one is not noticeably worn. If the bushes or shaft are worn, replace them with new ones. Note that the driving shaft with gear is replaced as a single unit.

The new bushes should be reamed after pressing in with a reamer provided with a pilot guide.

The sealing rings at the ends of the delivery pipe are made of special rubber and are manufactured to very close tolerances. Use only genuine Volvo spare parts. The delivery pipe must be clamped in its correct position first in the oil pump and then the oil pump and pipe together clamped against the block. The pump connecting flange should lie flush against the block before being tightened. Before being fitted, the rubber rings on the pipe can be coated with soap solution since this enables the pipe to take up its position more easily. Tap lightly on the pipe with a soft mallet if necessary.

Oilways
All oilways must be cleaned particularly carefully before the parts are fitted on the engine in order to avoid damage to the bearings, bearing journals and other components.

To clean the cylinder block water channels, remove the core plugs and after cleaning the channels and blowing them dry, fit new plugs.

IGNITION SYSTEM
Fitting the distributor drive pinion
When the piston in No. 1 cylinder is at top dead centre and in the firing position, the drive pinion for the oil pump and distributor is fitted. The