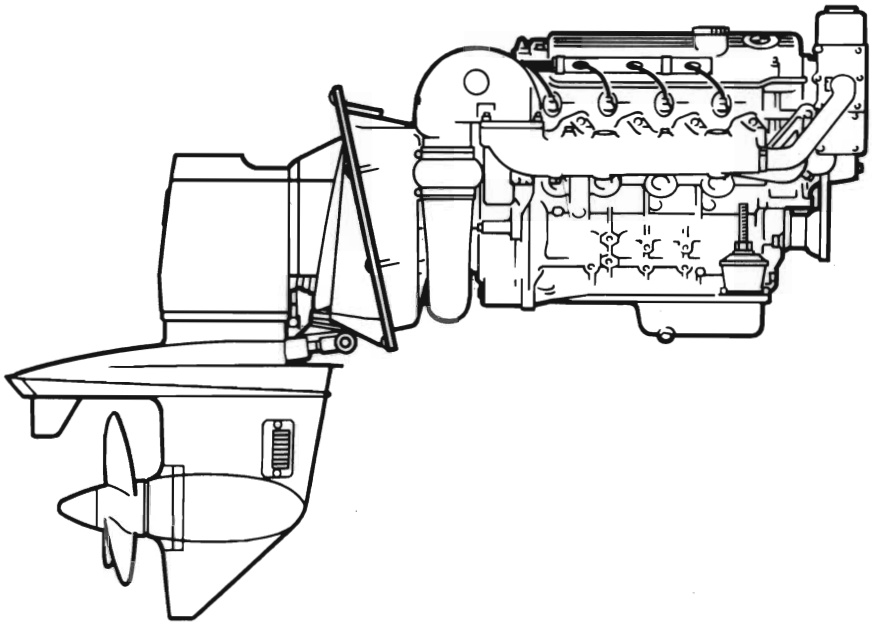
Workshop Manual
BMW B 130



BMW Marine Engines

This Workshop Manual
describes the total dismantling
and reassembling of
a BMW Marine B 130 Engine.

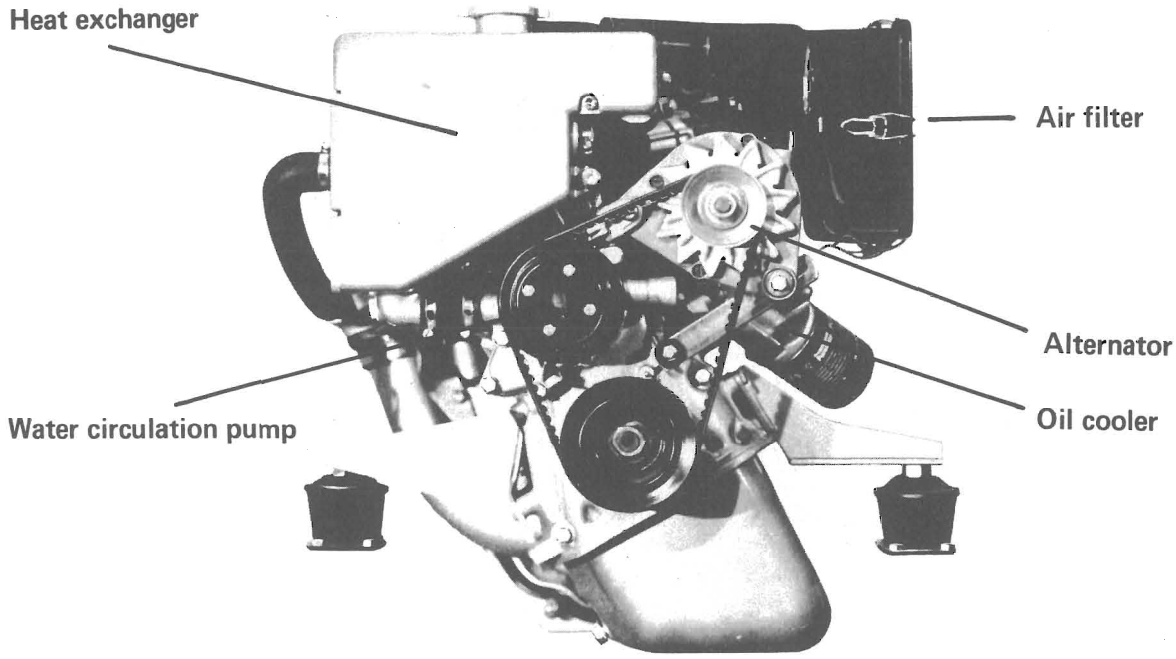
In cases where just one
or only a few assemblies
needs attending to, the headings
"Dismantling" and "Overhaul"
of the previous sections
should be ignored, and the main
instructions followed to the point
of the actual job.

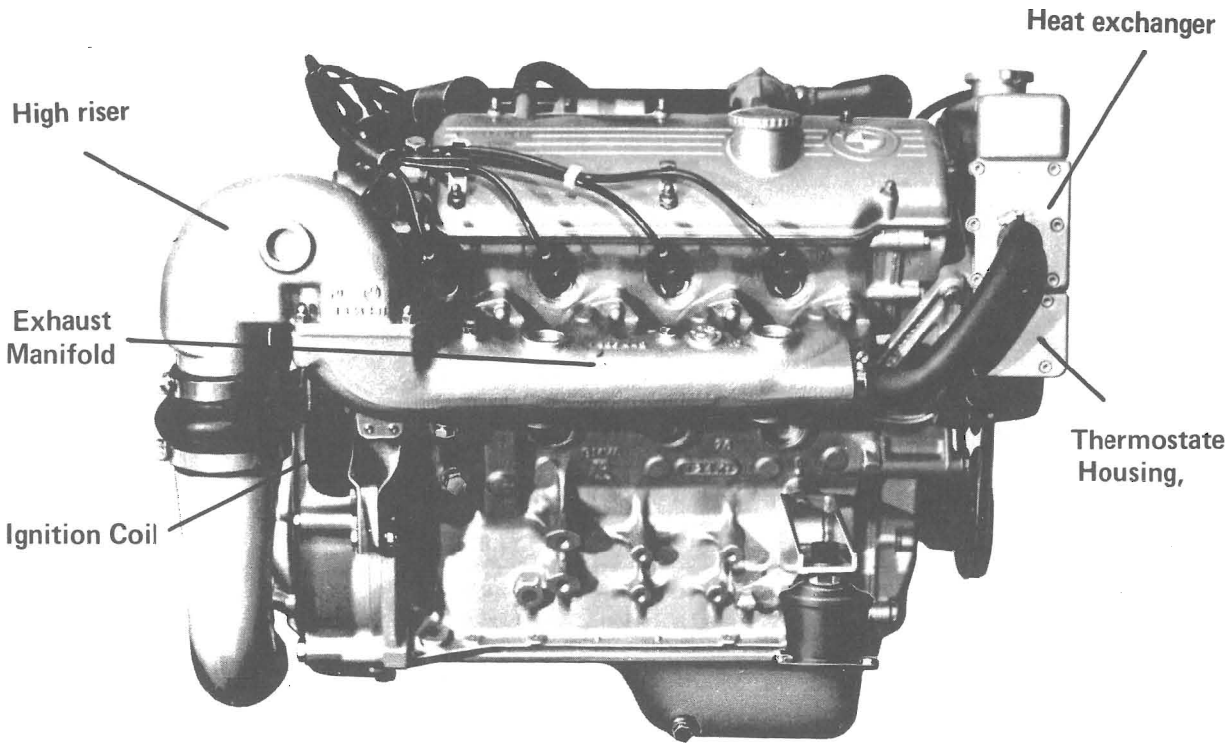
Specifications are given directly
in connection
with each working stage,
and to some extent also in the
"Technical Data" section.

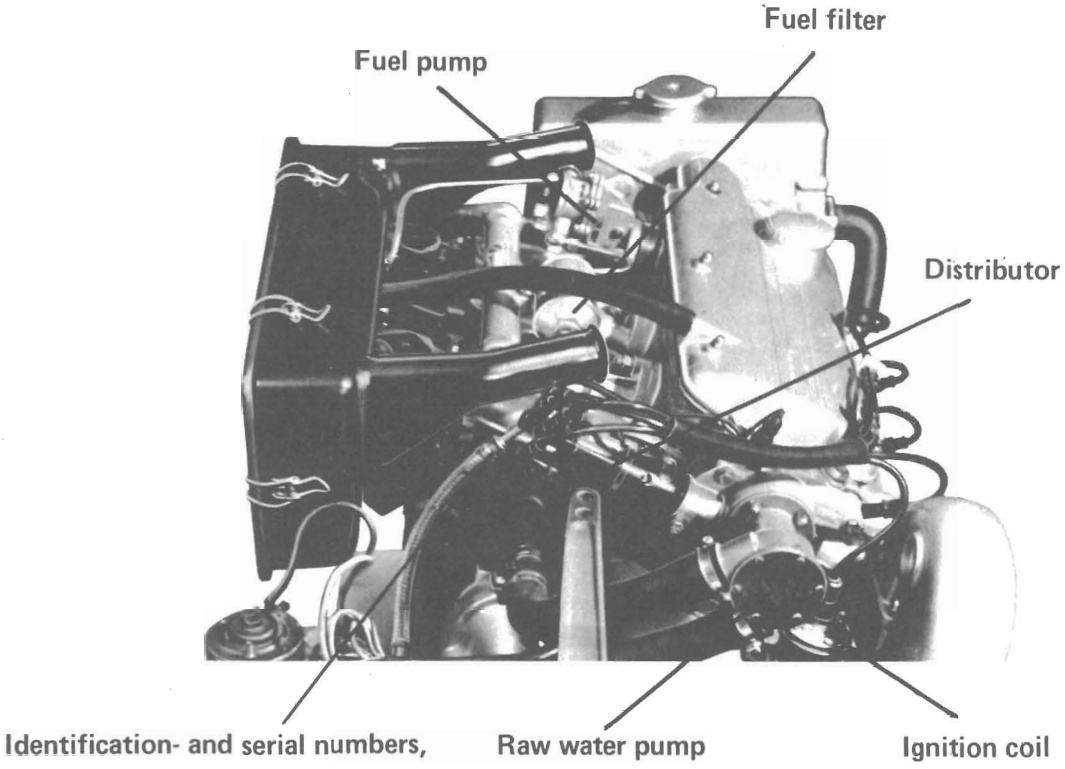
Contents

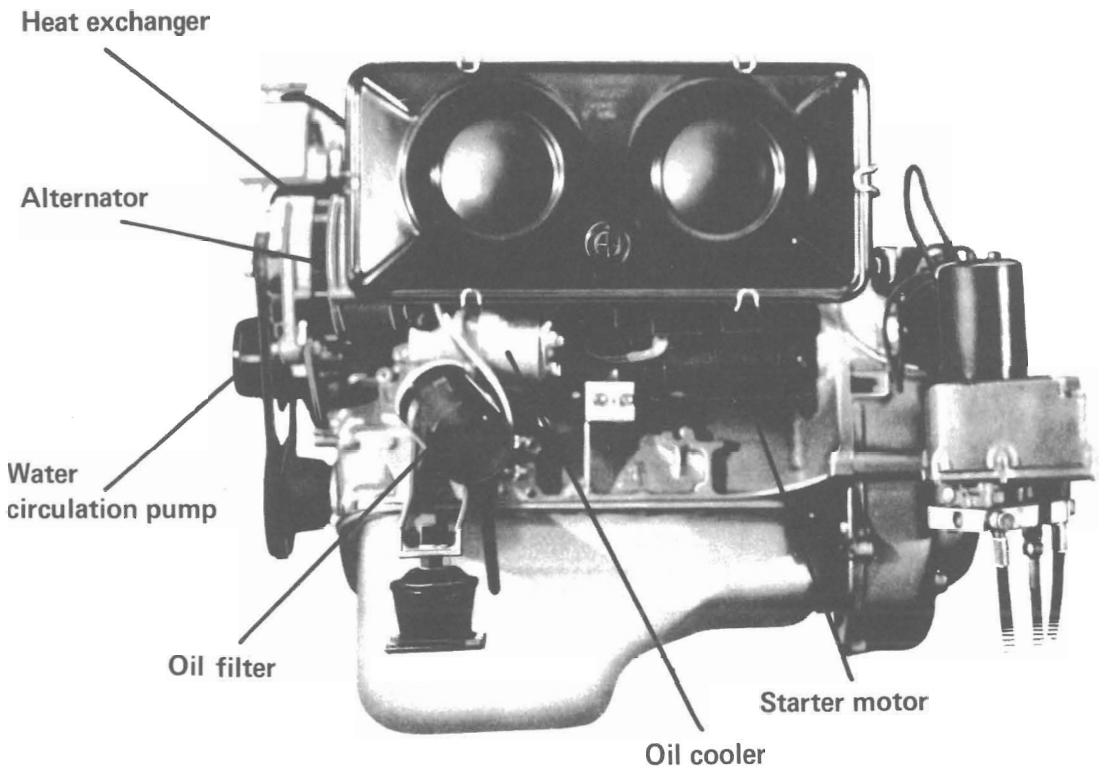
Engine presentation and introduction

11.00 In parts catalogue









Technical data

Cyl. capacity	1990 cc
Bore	89 mm
Stroke	80 mm
Comp. ratio	8.2:1
Max. output kW/RPM	85/5500
Max. Torque Nm/RPM	16 5/3500
Dry Weight, engine only	195 kg (430 lbs)

Cooling System

Type/Capacity	Dual Circuit/6,5 litre
Raw Water Pump	Johnson
Thermostat	
— opens at	71°C

Fuel System

Fuel, standard grade, min. rating	93 ROZ
Fuel Filter, type	BMW
Carburettors	2 x SOLEX 44 PHN-3

Lubricating System

Oil, grade (API)	SAE 20W—50
Capacity	4 l (+ 0.25 l a filter change)
Filter	Full flow, disposable type
Oil Pressure, max RPM	4,0 bar (appr.)
— idling	0,8 — 1.2 bar
Oil pump, type	Eaton

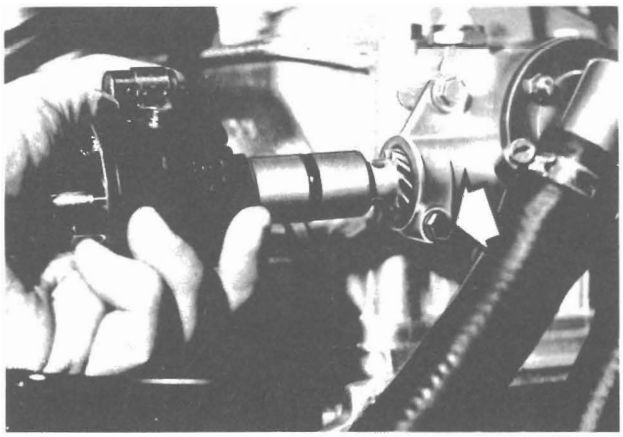
Electrical System

Voltage	12 V
Polarity	negative earth
Starter battery requirement	60 Ah

Distributor

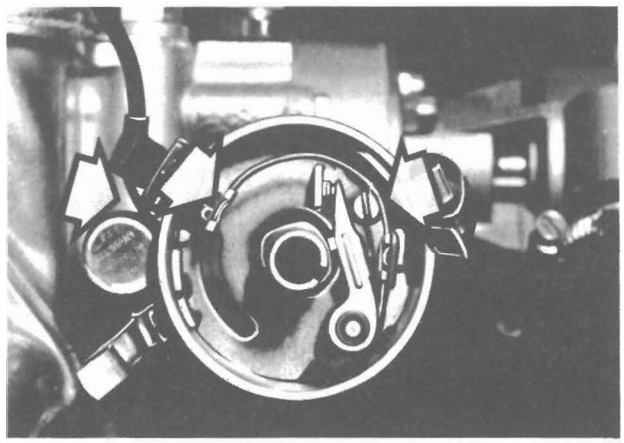
12.11 In parts catalogue

- disconnect high tension lead harness at spark plugs and clips
- disconnect the primary current lead at distributor housing terminal
- undo the clamp bolt (10 mm) and pull out the complete distributor



Dismantling

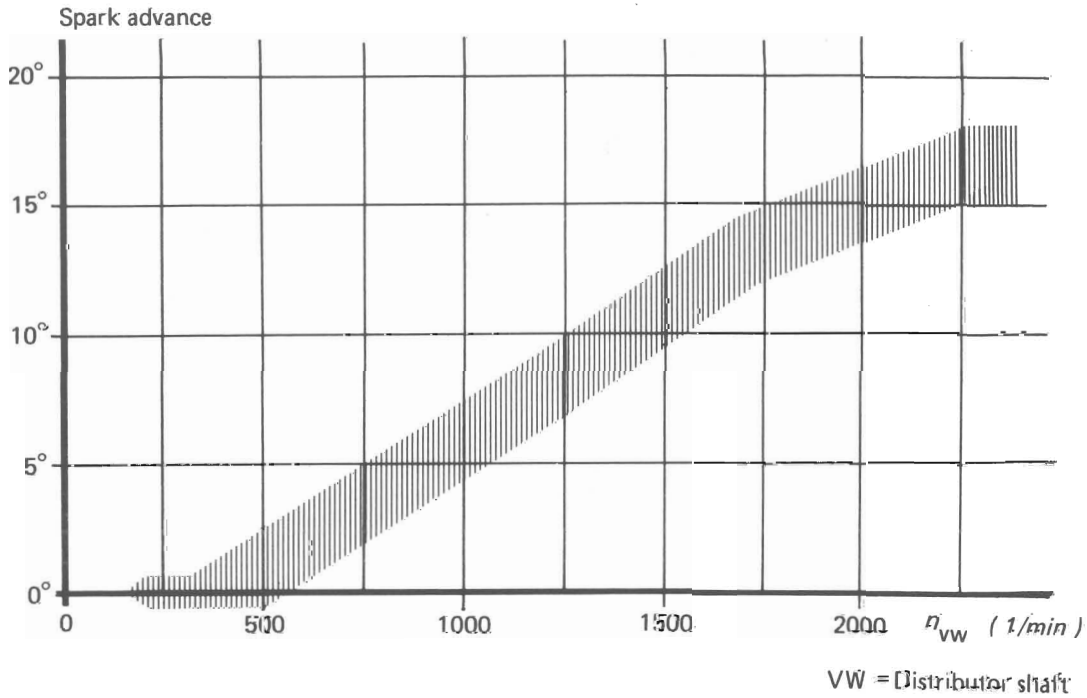
- remove the distributor cap
- pull off the distributor arm and cut-out switch
- disconnect breaker points assembly lead at condenser terminal. Remove breaker points assy.
- remove the condenser fastening screw and grommet at terminal housing. Remove condenser.



Overhaul

The distributor housing, including the timing advance mechanism shaft, bushing and gear is replaced as one unit in case of malfunctioning, wear or damage.

Test the distributor in a suitable test bench and compare the values with the specified advance curve.



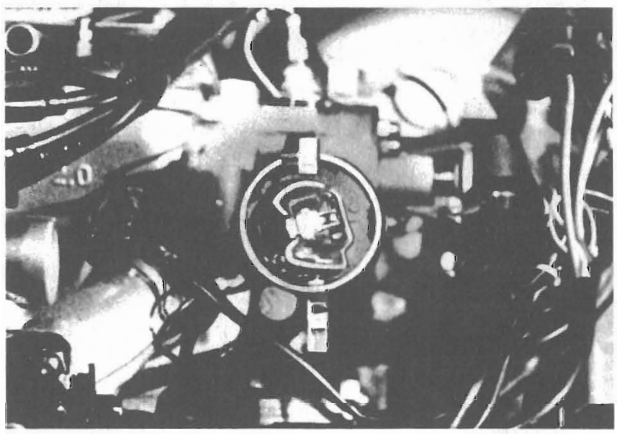
VW = Distributor shaft

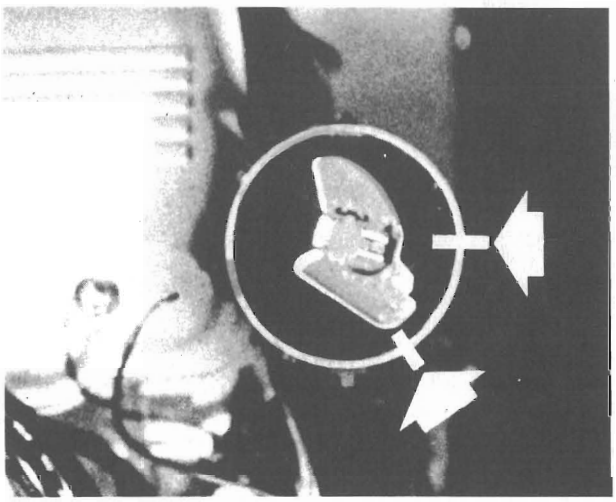
Check the breaker points for wear, burning or pitting. No attempts should be made to 're-condition' defect points.

Check the condenser condition and resistance – the latter should be at least *200 000 Ohms* and the capacity 0,18–0,22 *µF*.

Installing

- replace the distributor O-ring
- set the no 1 piston at TDC of compression stroke
- turn the rotor anticlockwise until it points approx 35 mm before the notch in the distributor housing
- push down the distributor with the clamps vertically and the flat pin connector facing towards engine front
- start the engine and adjust dwell angle
- adjust ignition timing

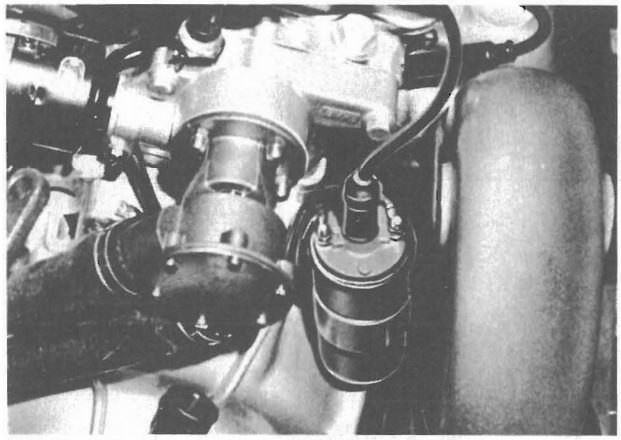




Ignition specifications

Ignition timing (dyn.)	25° B.T.D.C/2650 min^{-1}
Dwell-angle	62 ± 3°

Ignition *Cut-out switch*, operates above 5900 RPM.



Ignition coil

Ignition coil is located between the raw water pump and the high riser.

Removal
Loosen the clamp and pull out the coil

Testing
By testing the ignition coil should meet the following specifications.

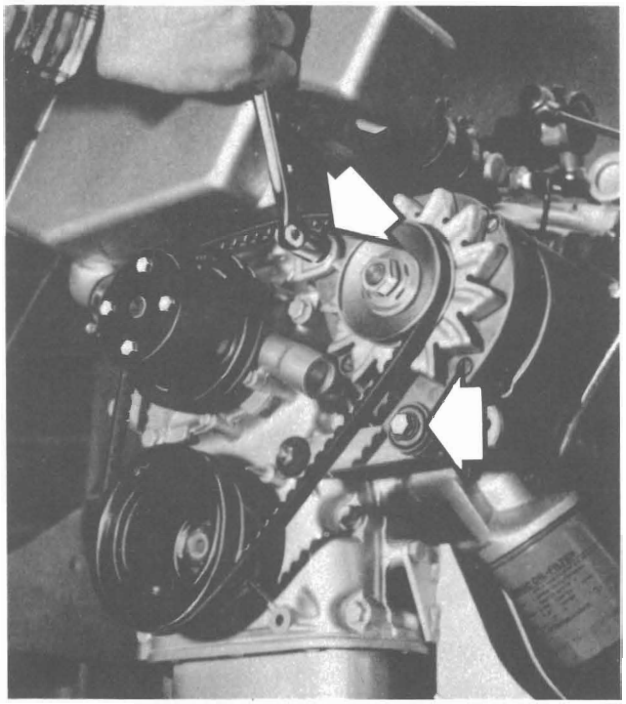
Resistance	primary coil	0.4 – 0.5 Ω

Spark plugs

12.12		
Type	Bosch	W145 T30
	Beru	145/14/3A
	Champion	N 10 Y
Spark plug gap		0,6 mm
Tightening torque		Nm 24–29

Alternator

12.31 In parts catalogue



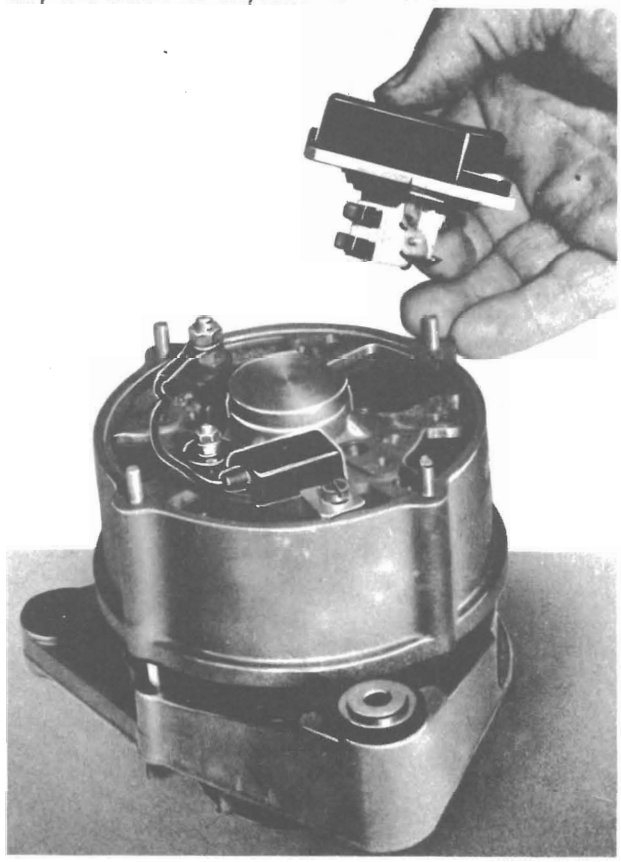
- disconnect alternator leads
- loosen the alternator fastening bolts (13 mm) and push the alternator towards the engine
- remove the drive belt. Note: In some cases, for instance when the belt is new, it may be necessary to remove the circulation pump pulley, fastened with four screws (10 mm) in order to avoid damage to the belt
- remove the bolts and lift out the alternator

The alternator is normally replaced as one service unit.

Alternator

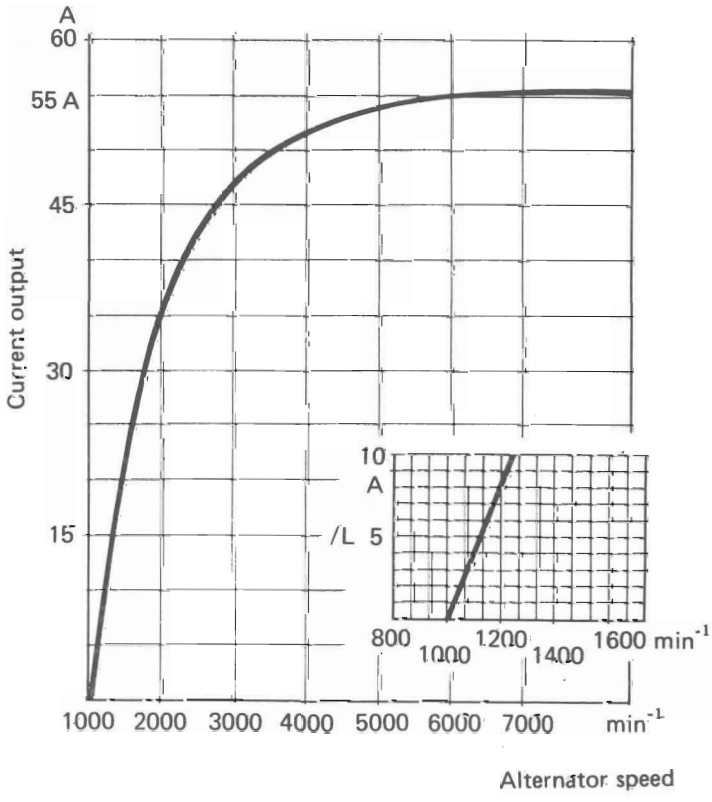
Max field current draw	4 A

The condition of slip rings and brushes can however be checked by removing the brush holder. Loosen the two screws securing the same and lift carefully out the brush assy and check for oxydation and wear.



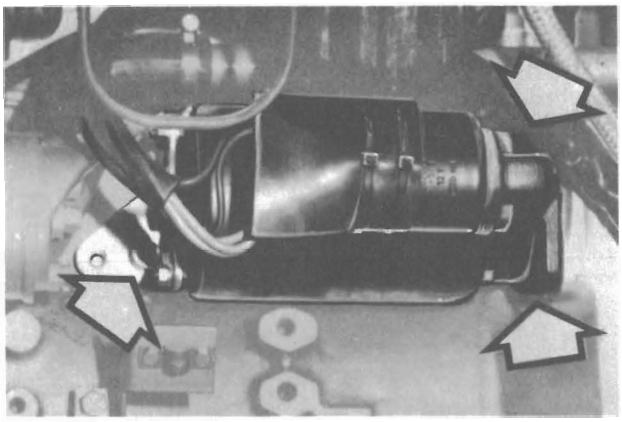
Installing alternator

- make sure that the drive belt tension is correct, i.e. when one of its longer free parts will stretch appr. 5 mm when light pressure is applied.



Starter motor

12.41 In parts catalogue



- disconnect the electric leads
- remove the two retaining bolts through starter motor flange on the flywheel cover side
- remove the single Allen bolt (8 mm) at the starter motor front bracket
- pull out the starter, lowering and twisting its front end in the same movement

  Note: The starter motor although possible to dismantle and repair, is normally replaced as a service unit.

Installing

- fit the starter motor and tighten the through bolts to 43–48 Nm and the Allen bolt to 24 Nm respectively.

Starter

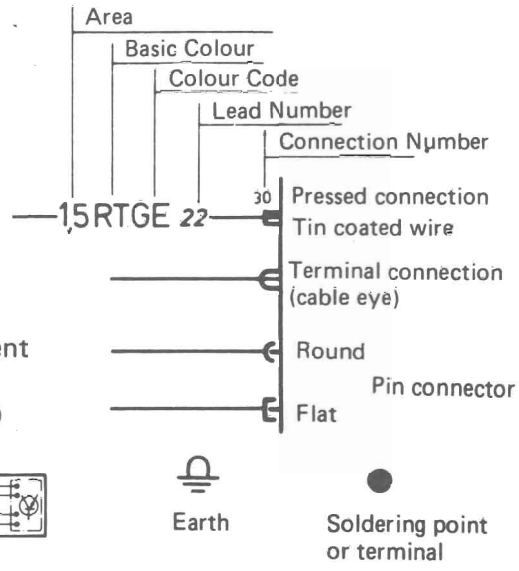
Max rpm unloaded	10 000 min^{-1}
Max current draw (blocked)	460 A
Solenoid:	
Pull & hold winding	38 A
Hold winding	9 A

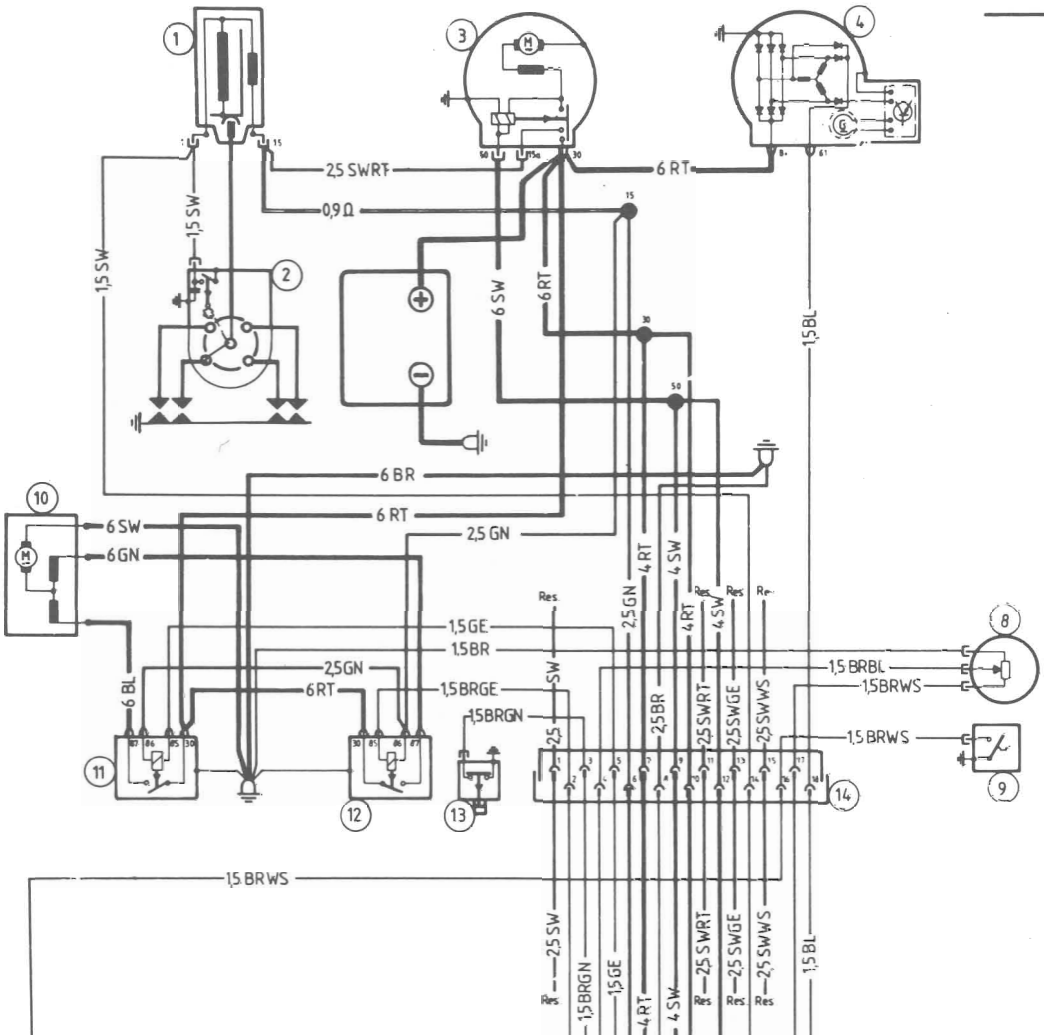
Wiring diagram

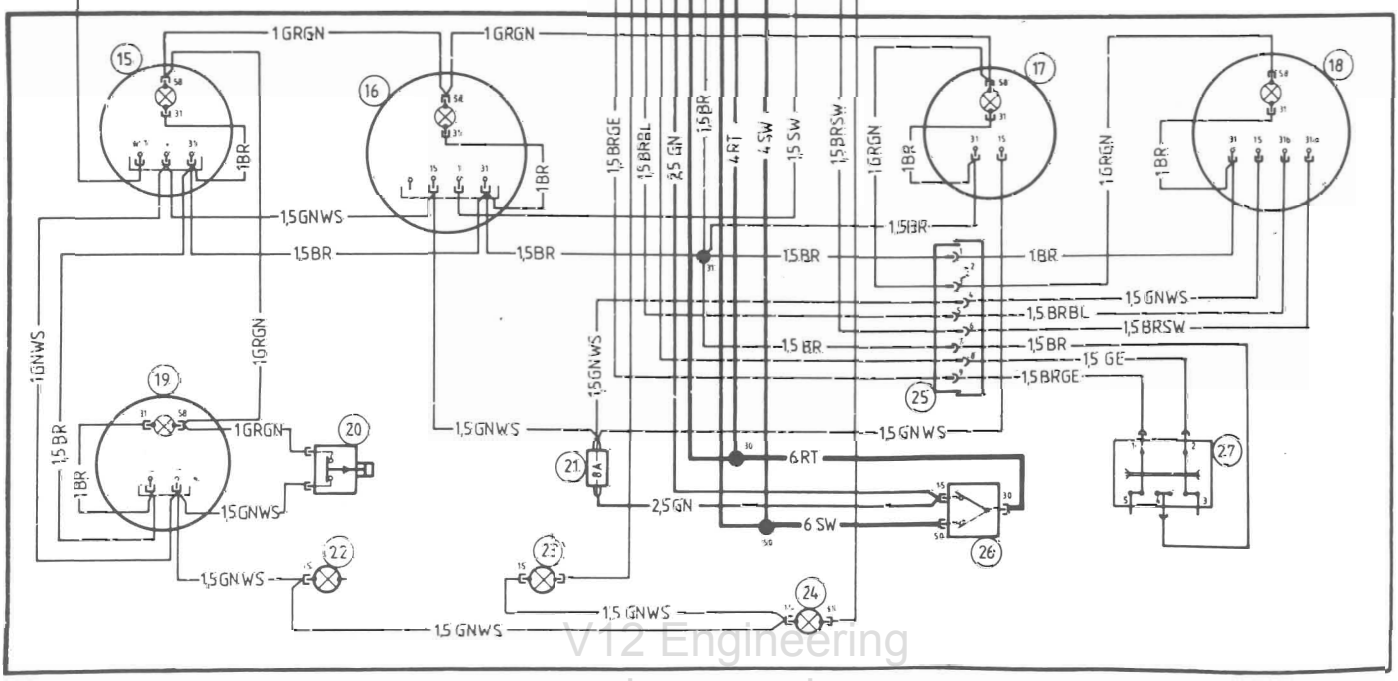
V 12 Engineering
Box 50, Ontario, Canada P0X 1C0
www.bmwmarine.com

Colour Coding

BL = Blue
BR = Brown
GE = Yellow
GN = Green
GR = Grey
RT = Red
SW = Black
VI = Violet
WS = White
TR = Transparent







1 Ignition Coil
2 Distributor
3 Starter Motor
4 Alternator

8 Trim Indicator Sender
9 Temp Control Switch
10 Power-Trim Motor
11 Relay II
12 Relay I
13 Oil Pressure Switch
14 Plug Connector 18-pin
15 Engine Temperature Gauge
16 Tachometer
17 Hour Meter
18 Power-Trim Indicator
19 Voltmeter
20 Instrument Light Switch
21 Fuse
22 Reserve
23 Warning Light – Oil Pressure
24 Warning Light – Alternator
25 Plug Connector 8-pin
26 Ignition Switch
27 Power-Trim Switch

Carburettor

13.11 In parts catalogue

Dismantling & overhaul

– see separate hand-book

– remove the air intake filter housing
– disconnect fuel lines and throttle linkage
– undo the stud nuts in the carburetter bolt flange
– remove the carburetter.

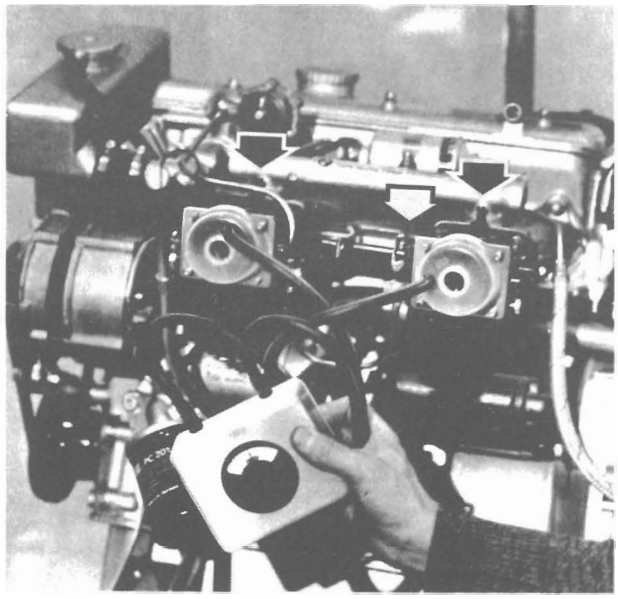
Adjustment

Fuel level
Check and adjust float height with a gauge made according to drawing below.

Idling adjustment and carb. synchronization
– remove the flame arrestor
– disconnect carburettor synchronization bar
– adjust throttle set screws until idling speed is correct and vacuum balance gauge shows zero
– adjust idling mixture screws until the engine runs evenly. Use if possible a CO-meter for this operation. Correct amount CO is 3,5–4,5 %
– readjust the idling speed and balance if necessary
– connect the synchronization bar
– install the flame arrestor

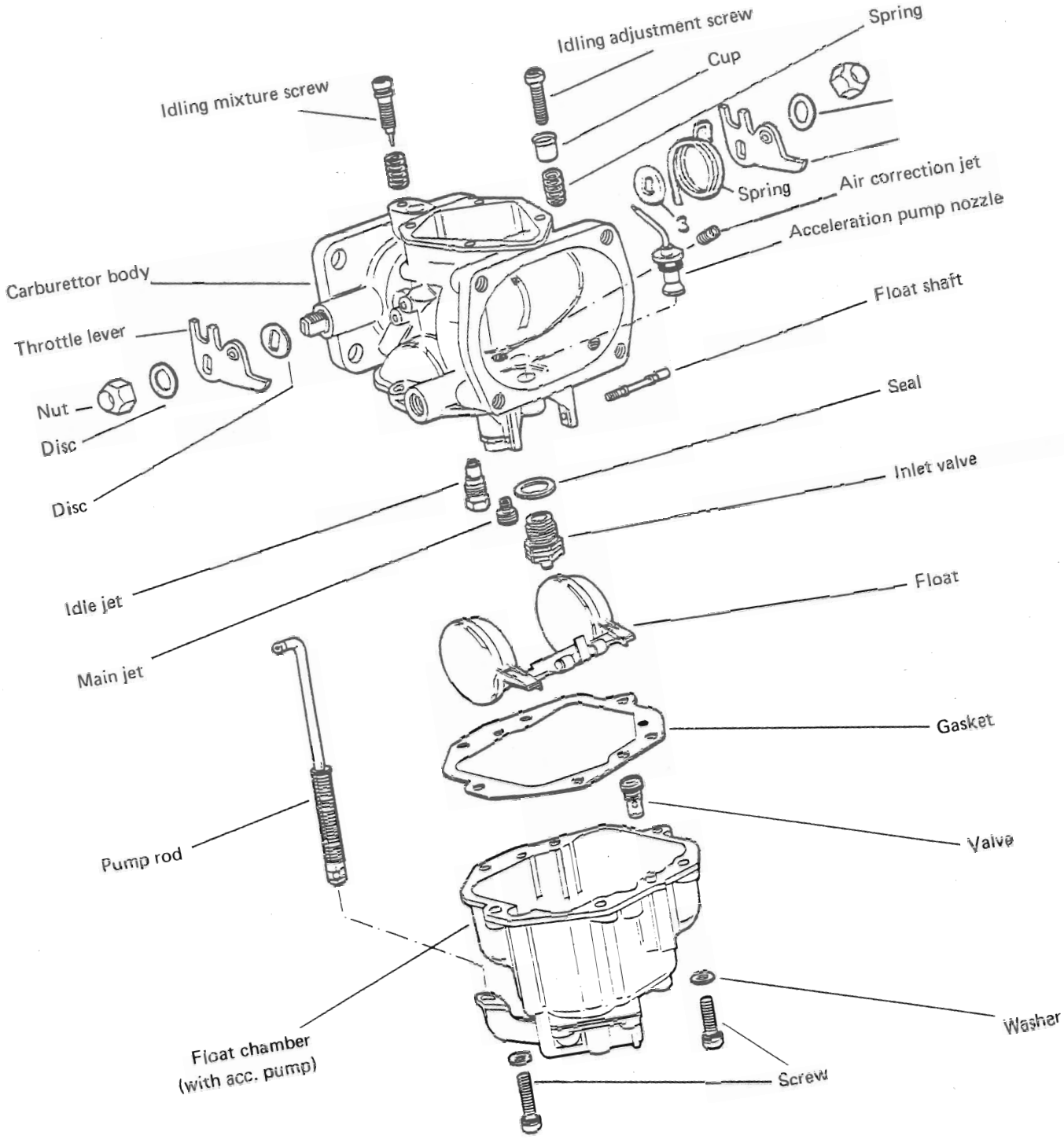
Installing

– fit the carburetters and tighten the stud nuts to 1.0 – 1.4 kpm
– connect the linkage and fuel lines
– synchronize the carburetters according to the above instructions.



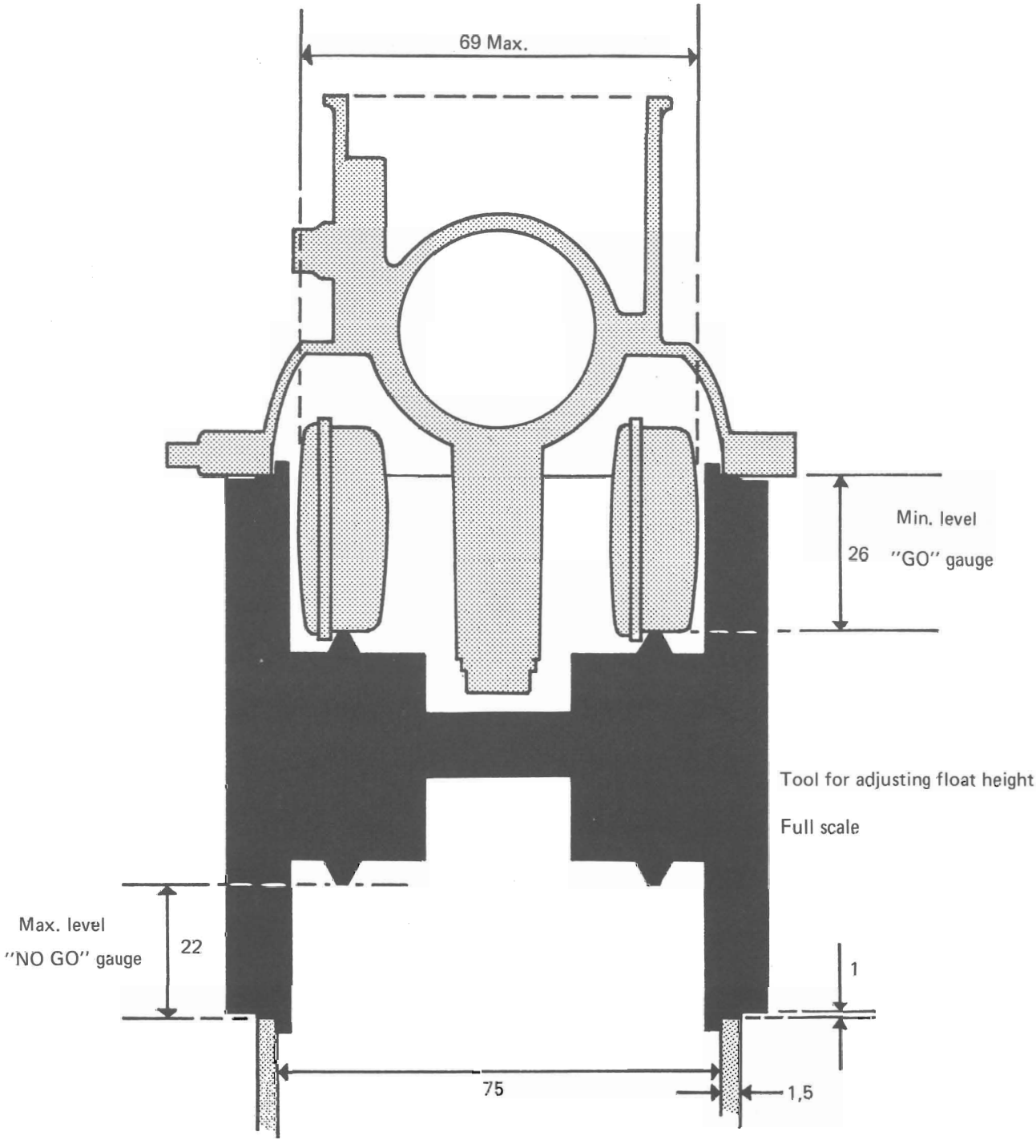
Specifications

Venturi	34
Main jet	162
Air correction jet	210
Idling jet	57
Acceleration pump nozzle	70
Inlet valve with ball	1.7 mm
Float	20627017
End of pump stroke at a throttle opening of	8.5 mm



Tool for adjusting float height

Section A–A

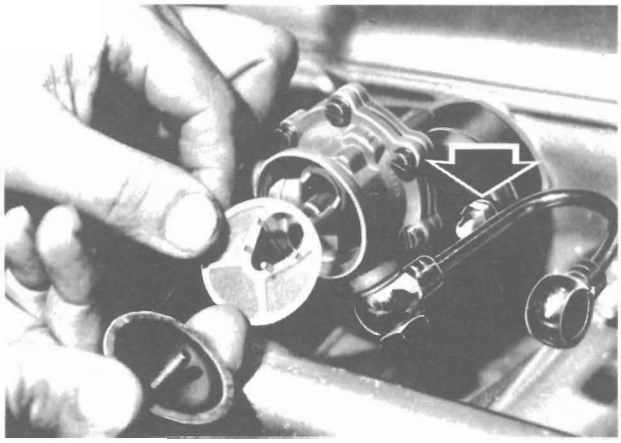


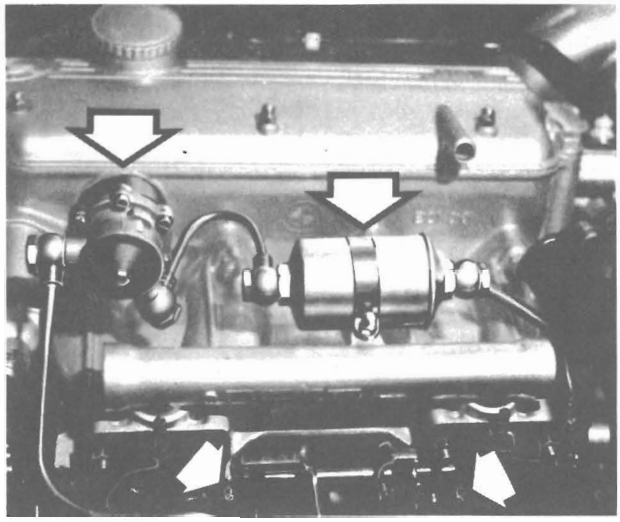
Fuel pump

13.31 In parts catalogue

Pump removal

- remove tappet cover ventilation tube
- disconnect fuel pipes at the filter (19 mm) and at the pump
- remove the fuel pump fastening bolts (13 mm)
- pull off the pump complete with push-rod and spacer. Note the bolt flange plastic inserts.





Installing

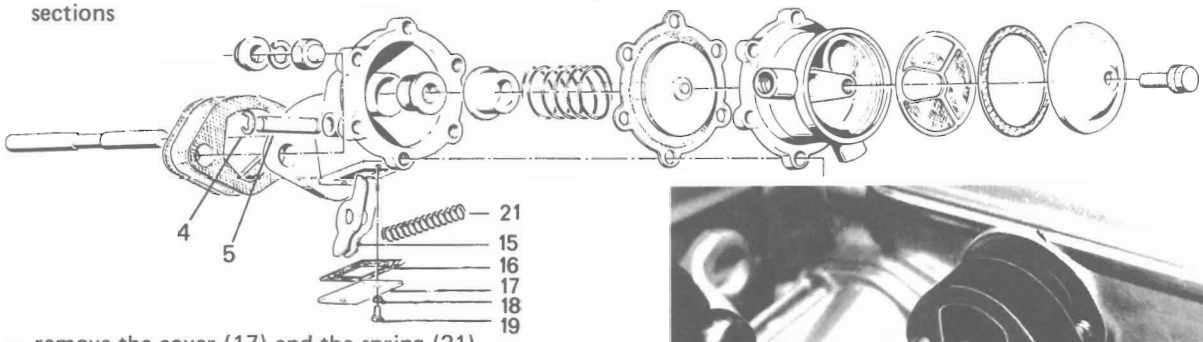
- make sure that the pump in- and outlets are pointing horizontally.

Check that spacer and gasket are assembled in correct order and that the plastic bushings are positioned in the bolt flange holes. Grease the pump push rod before installing.

- Tighten the bolts to 1.0 – 1.4 kpm.

Overhaul

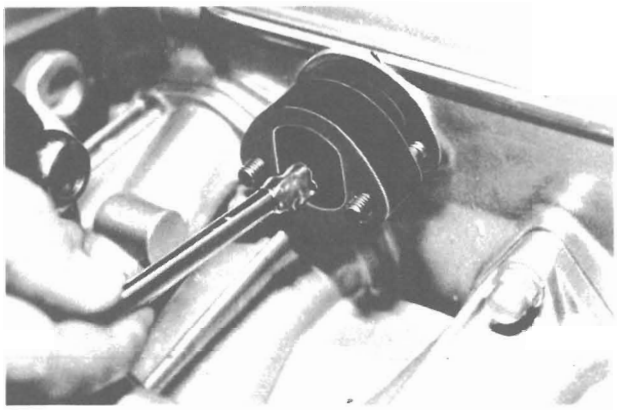
- remove the pump top cover centre screw (8 mm)
- separate cover and gasket from the pump housing
- lift out the plastic filter
- remove the six screws and separate the pump housing sections



- remove the cover (17) and the spring (21)
- remove the circlip (4) and knock out the pin (5)
- remove pump lever (15) and disassemble the rest of the pump.

Check all components for wear, distorsion etc.

Assembly is done in opposite sequence.



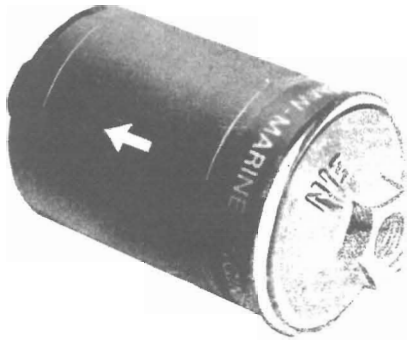
Fuel filter

13.32 In parts catalogue

The fuel filter

is of the disposable type. Check that fuel flow direction is correct, according to markings 'Ein' = IN and 'Aus' = OUT.

Always use new gaskets when fuel lines are connected to pump or filter.



Heat exchanger

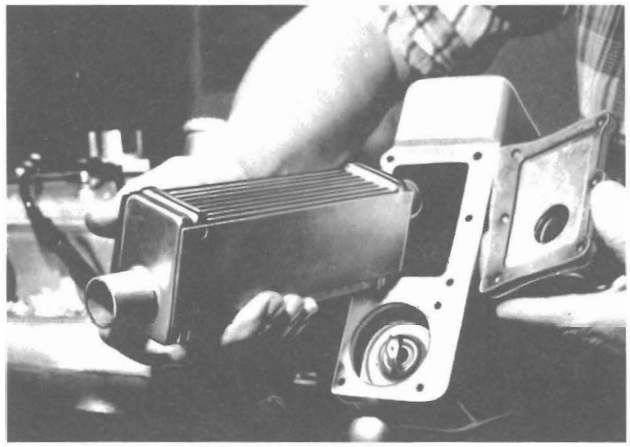
17.10 In parts catalogue

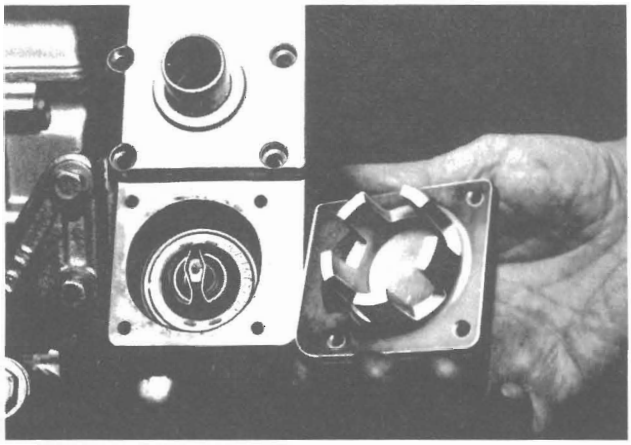
Removal

- drain both cooling water circuits
- disconnect all hoses at the heat exchanger
- remove the retaining bolts – three with hexagonal heads (13 mm) and one Allen bolt (6 mm)
- remove the heat exchanger and its brackets

Dismantling and overhaul

The thermostat is seated inside the lower inspection cover. It starts opening at 71°C.



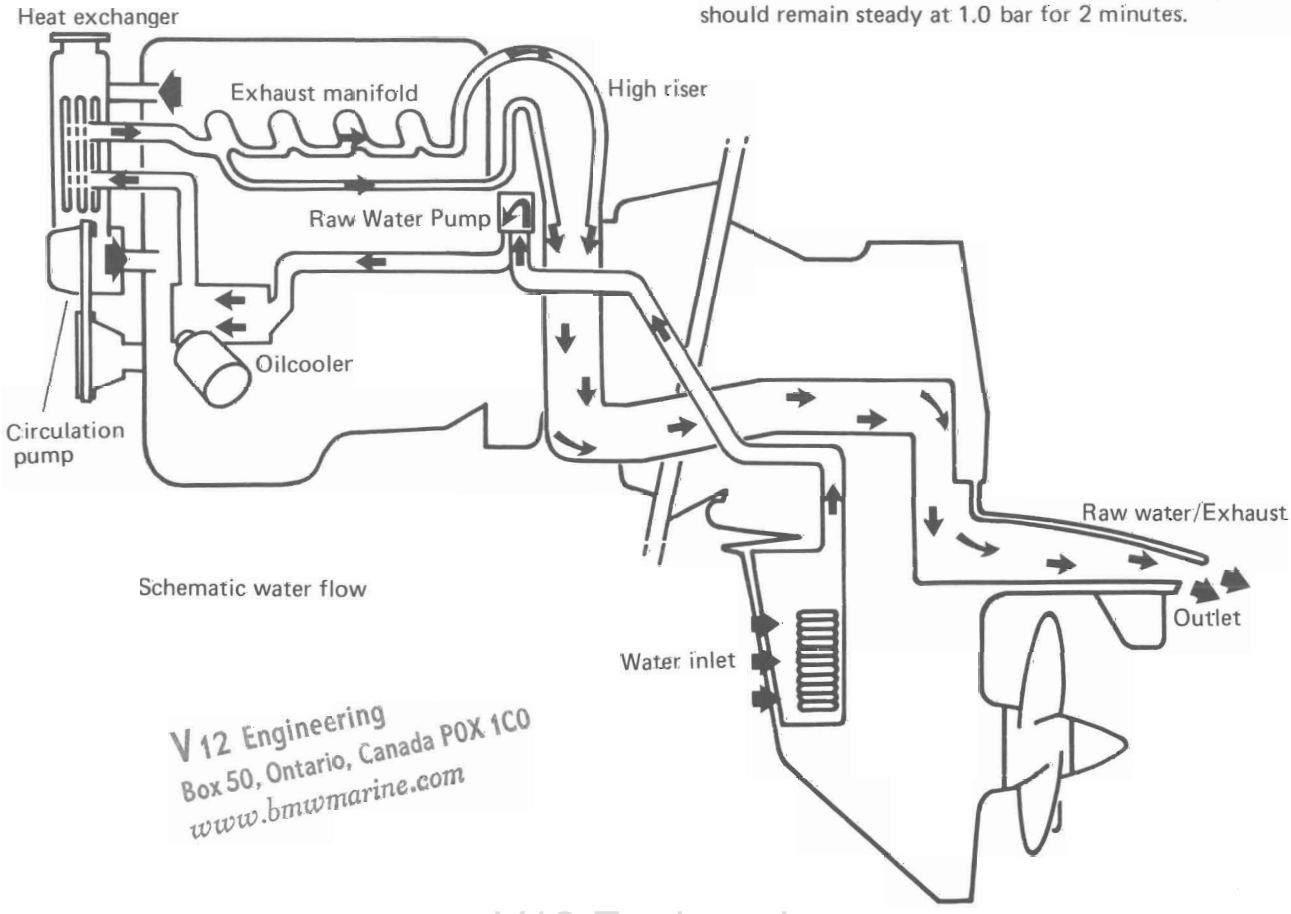


The heat exchanger raw water circuit block is accessible when the upper inspection cover is removed – six Allen bolts (5 mm).
Use new O-rings at the hose connections on the block and new gaskets under the inspection covers when the unit is re-assembled.

Installing

- attach the heat exchanger brackets to the engine.
- install the heat exchanger and tighten the retaining bolts to 10 Nm (hex.heads) and 10 Nm (Allen bolt)
- connect the hoses from oil cooler, circulation pump, engine block and exhaust manifold.

Whenever the closed cooling circuit (fresh-water circuit) has been opened, it must be pressure tested. The pressure should remain steady at 1.0 bar for 2 minutes.



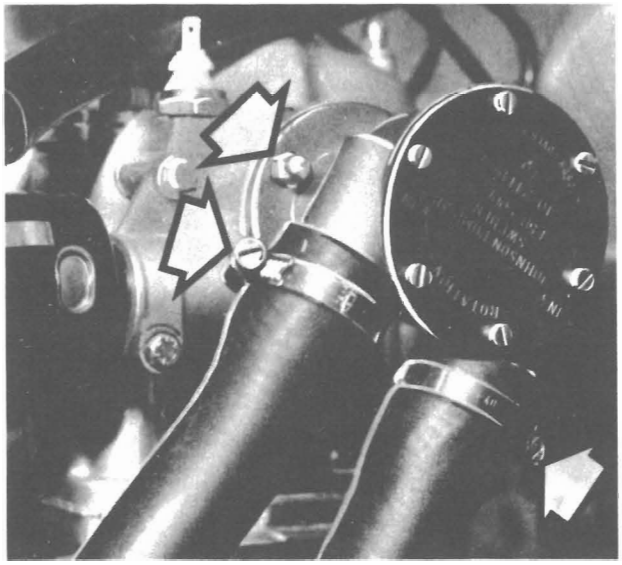
Schematic water flow

Raw water pump

17.11 In parts catalogue

Removal

- remove hoses at in- and outlets
- remove the pump housing fastening nuts
- pull out the pump housing as one unit with shaft and drive.



Dismantling

- remove the pump housing cover and gasket
- use two screwdrivers to pry the impeller off the shaft
- remove the lip seal (12) and the O-ring (13)
- press out the shaft and bearing assembly as one unit with pressure applied on the shaft impeller end
- press bearing assembly (14) off the shaft (2)
- remove the plastic inner seal (7)
- remove the pump housing lobe (6) by undoing the screw (11).

Overhaul

Check all components – lobe, impeller, and pump housing cover in particular – and replace components with visible wear or defects. Bearing assy is one unit.

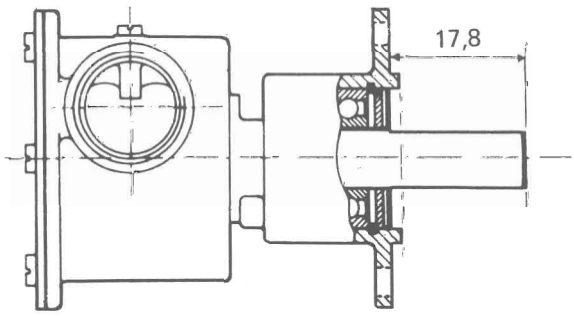
Reassembly as follows –

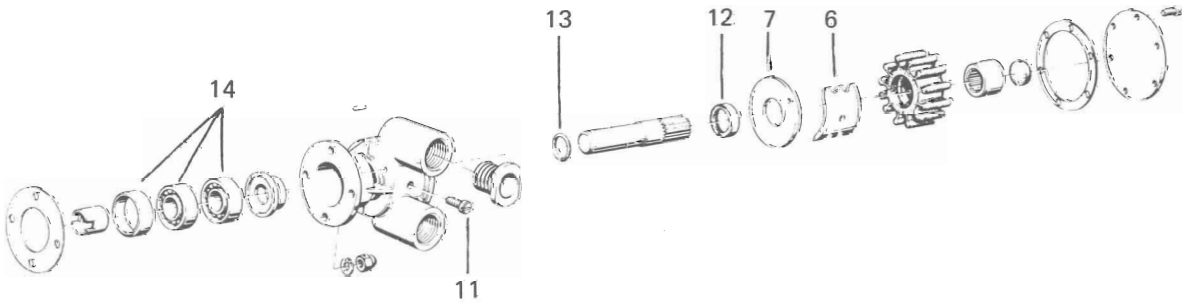
- install plastic inner seal
- press bearing assembly onto the shaft according to the measurements indicated in the diagram
- install shaft and bearings in the pump housing
- fit circlip and rear end plastic seal (8)
- install the O-ring and the lip seal (12) with the lip facing the shaft impeller end
- coat the lobe and its adjoining surface lightly with sealing compound prior to installation. Also cover the fastening screw threads with the sealant.
- install the impeller, lightly coated with vaseline
- install the front cover with a new gasket.

Installing

- use a new gasket when the raw-water pump is re-installed in the cylinder head. Tighten the nuts.

Assembly measure





F5B-802 — Impeller Neoprene

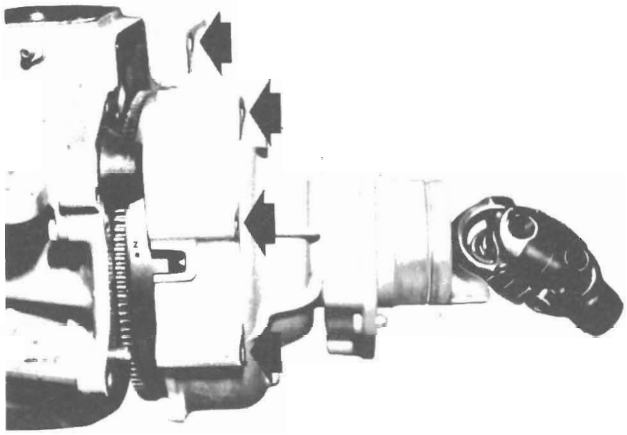
0,3	0,13	7	0,13	10	0,18	12,5	0,18	20	0,25	28
0,6	0,13	6,5	0,13	9	0,18	11,5	0,18	19	0,25	26
1,0	0,13	6	0,13	8	0,18	10	0,18	17	0,25	24,5
1,5	0,13	5	0,13	7	0,18	9	0,25	14	0,37	21
2,0	—	—	—	—	—	—	0,25	11	0,37	16

Flywheel housing

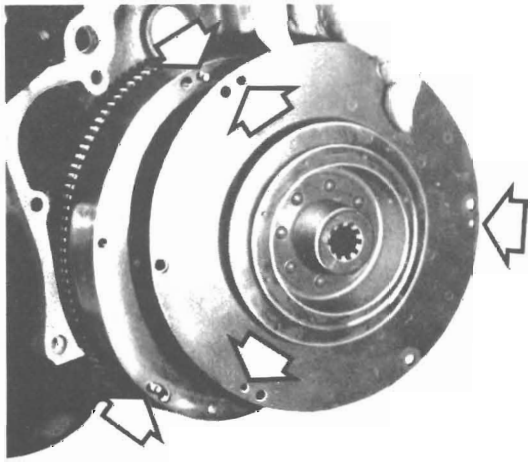
21.21 In parts catalogue

Removal

— remove the clutch housing by undoing the seven bolts (three 13 mm and four 17 mm respectively) securing the clutch housing to the engine block



– support the clutch housing while pulling it straight out – the drive shaft is splined to the flywheel clutch plate
– remove the clutch plate by loosening the 5 screws securing the clutch plate.



Flywheel housing

Disassembly

– remove the six Allen screws securing bellow support to clutch housing
– press out the complete shaft from the engine side in a press
– undo the lockwasher and remove the grooved nut from the shaft
– pull off bearings and sealing rings
– clean and inspect all parts
– always discard lock washer and sealing ring

Assembly

– pre-assemble drive shaft
Note: sealing ring must be filled with water resistant grease.
– tighten the nut to 37 Nm
– press the drive shaft fully into the clutch housing

Installing

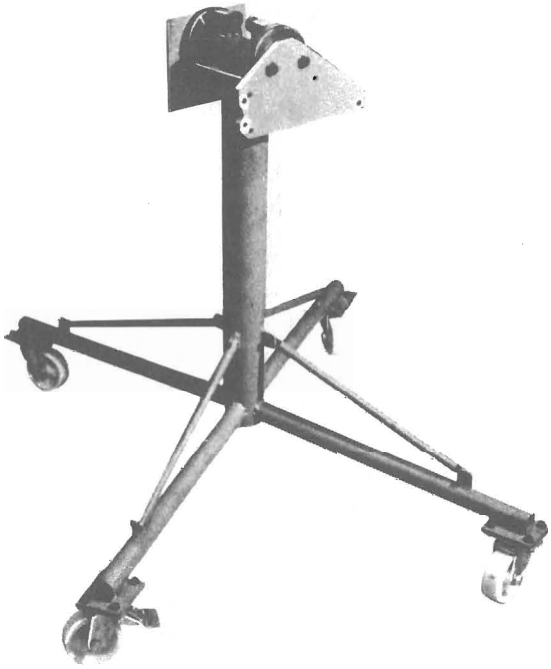
– grease the drive shaft splines liberally with water resistant grease
– make sure that the drive shaft splines do enter the driving disc correctly and that the flywheel housing is properly seated on the locating dowels
– tighten the bolts

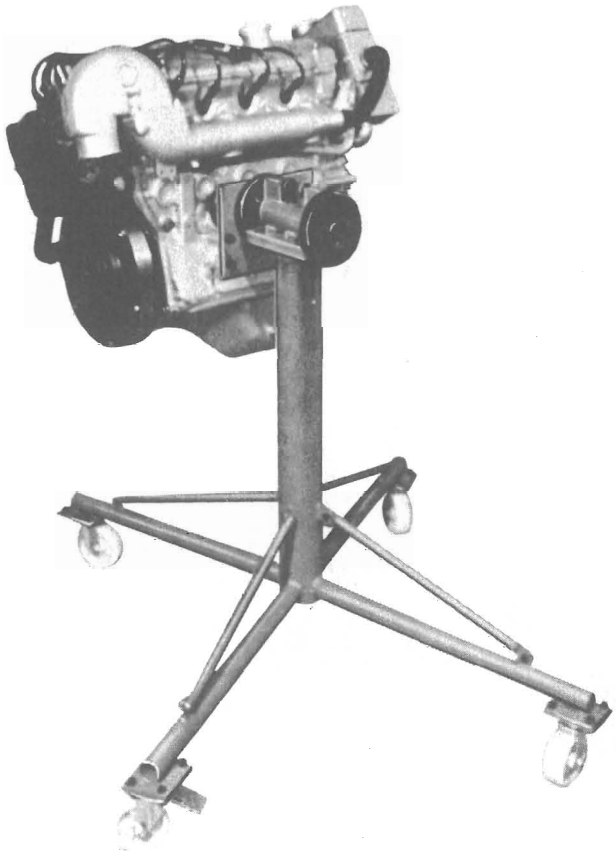
Engine disassembly preparation

11.01 In parts catalogue

Preparation

- Drain the engine oil and water:
- Remove the exhaust manifold (eight 13 mm dome-nuts)
- Attach the adaptor plate (Special Tool No. 110 100) to the Engine Stand. (Tool No. 001 500)
- Attach the engine onto the stand, supported by three bolts through the adaptor plate into threaded holes in the engine block.





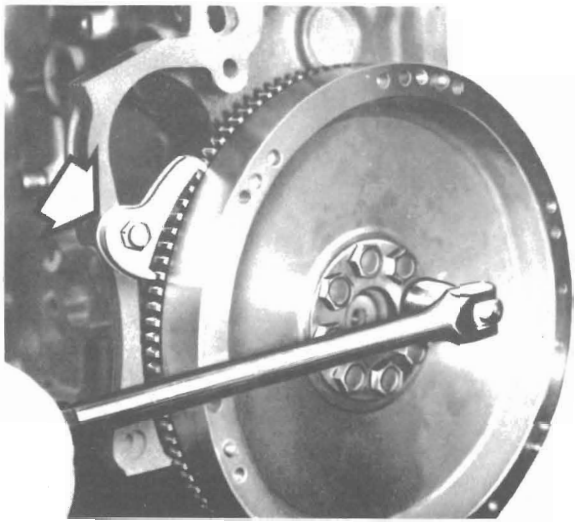
Flywheel

11.22 In parts catalogue

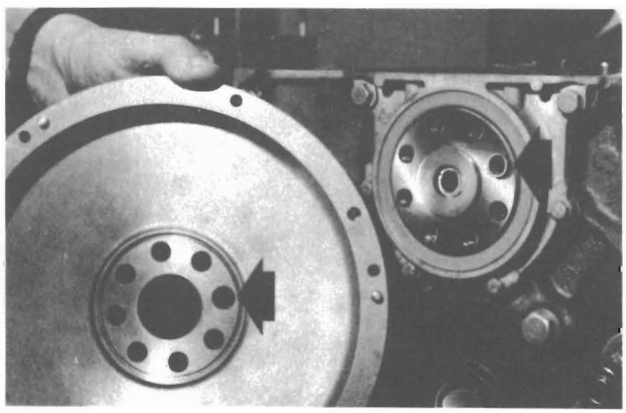
FLYWHEEL REMOVAL

Preparation

- remove clutch housing and clutch see chapter 21.21
- with special tool 112140 locking the flywheel, remove the flywheel retaining bolts (17 mm);



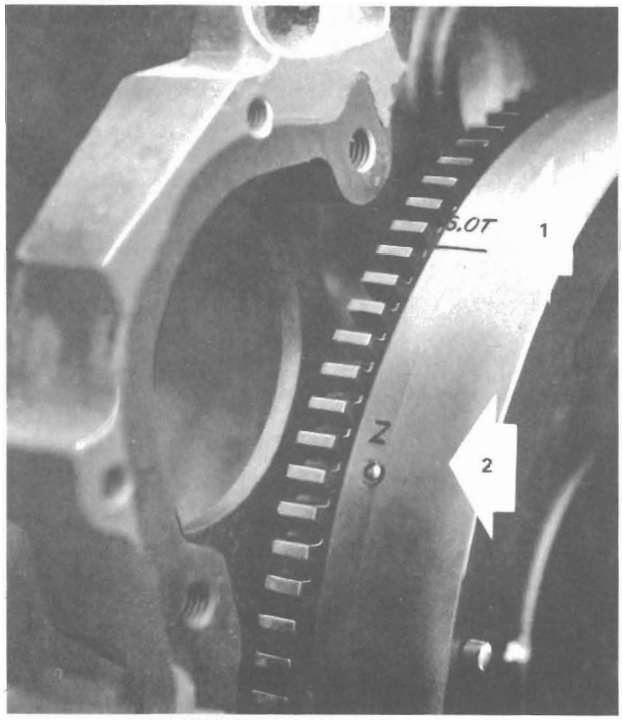
NOTE I: Observe the guide sleeve in crankshaft when installing the flywheel



NOTE II: Always use Loctite 270 when tightening the bolts

Tightening torque Nm 98–113

NOTE III: The flywheel bolts should never be used twice. Always scrap old ones.



The flywheel has two marks for ignition timing.

1 Indicates TDC

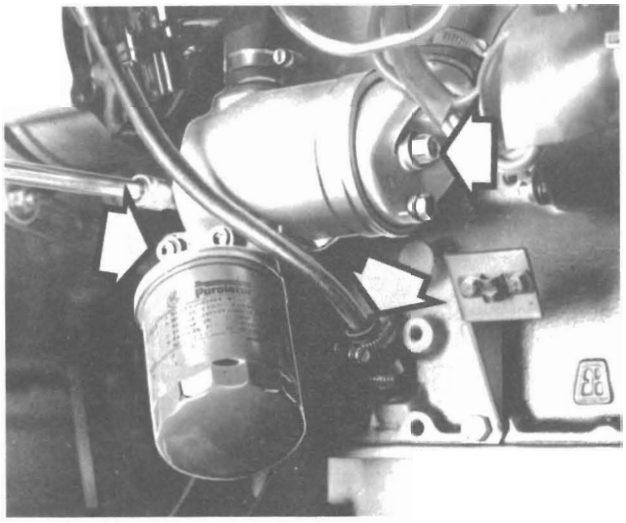
2 Ignition timing
25° BTDC for 4-cyl. engine

Oil cooler

11.42 In parts catalogue

Removal

- remove the oil dipstick and its tube (10 mm retaining screw in clamp)
- disconnect the cooling water hoses
- unscrew three Allen bolts (6 mm) and remove the oil cooler, complete with filter



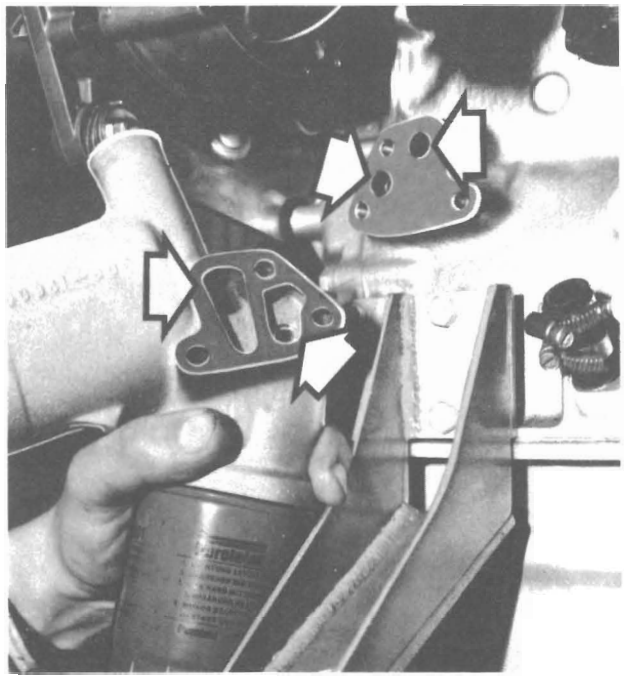
Disassembly

NOTE: The cooler insert must never be removed when cooler is installed on the engine as water trapped in the circuit will flow into the oil pan.

- undo the centre bolt and separate the block from the housing. Remove and discard all O-rings and gaskets. Clean out all deposits of salt and dirt. Check for leakages, preferably with a pressure test
- the oil filter is of the disposable, spin-on type. Remove the cartridge and fit a new one with a new gasket.

Assembly

- install the cooler insert with new O-rings, making sure the drain plug on cooler cover is facing downwards

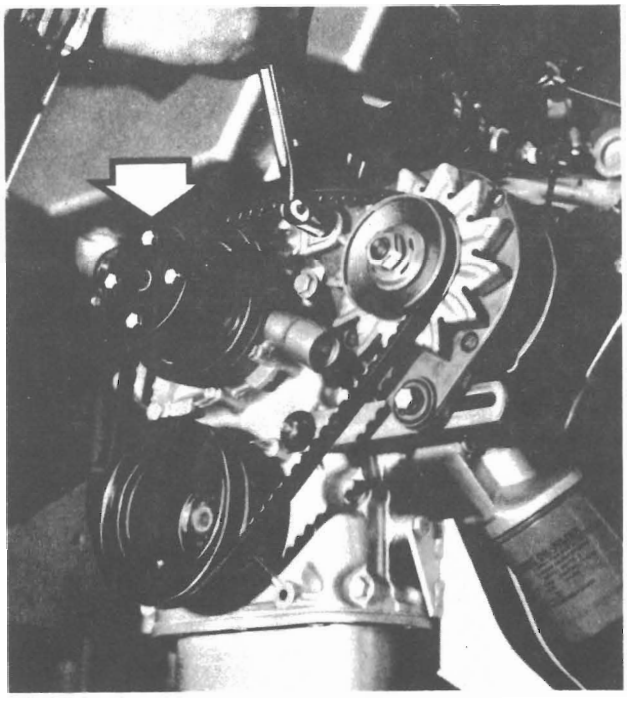


Installing

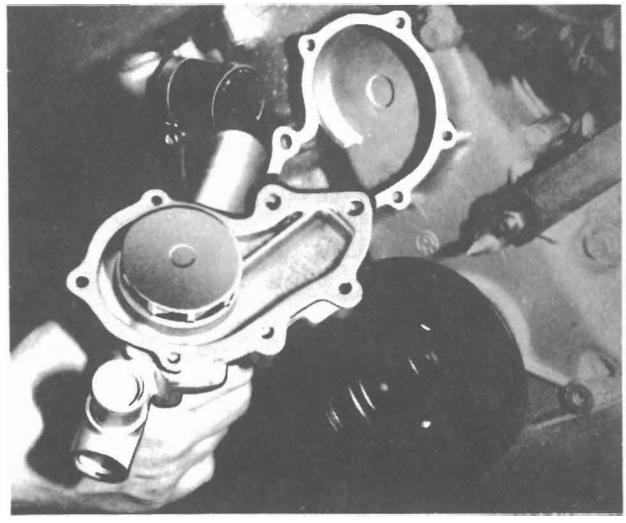
- ensure that all adjoining surfaces on cooler and engine block are clean and smooth and all passages free
- fit the cooler/filter unit with new gasket and tighten the Allen bolts.
- connect the hoses and dipstick

Water circulation pump

11.51 In parts catalogue



- remove the drive belt pulley, four screws (10 mm)
- loosen the hose clamp at the pump housing water outlet
- remove the pump housing fastening screws (3 x 13 mm and 4 x 10 mm)
- remove the pump housing cover. Light tapping with a soft mallet may ease the operation



Dismantling & overhaul

The shaft with bearing assembly and seals is a press fit in impeller and pulley flange. When disassembling, the pulley flange is removed with an extractor and the pressure then applied on the shaft impeller end. But since circulation pump troubles are rather rare, unless the whole component is worn out, the pump is more often replaced as a complete unit.

Installing

- install the pump with new gasket. Tighten the screws evenly.
- install the pulley, tighten the screws
- for correct drive belt tensioning, see "Alternator"

Specifications

Clearance between guide ring and impeller mm	1 ± 0.2
Distance between gasket surface and drive disc outer edge	91.8 ± 0.2

Cylinder head

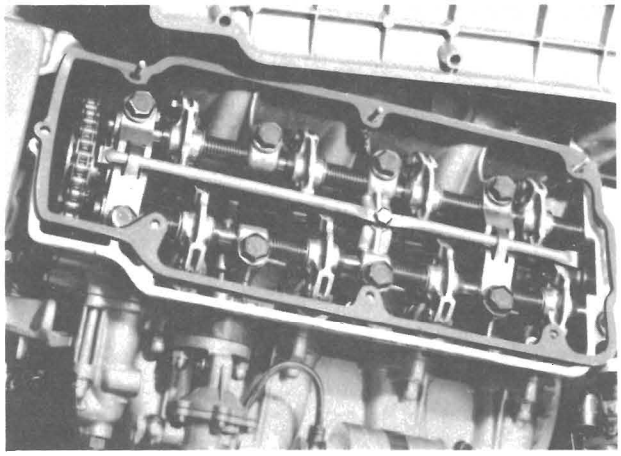
11.12 In parts catalogue

CYLINDER HEAD AND VALVE ASSEMBLY

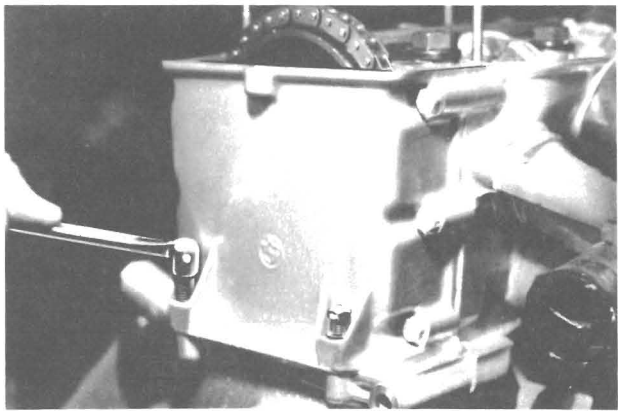
Preparation

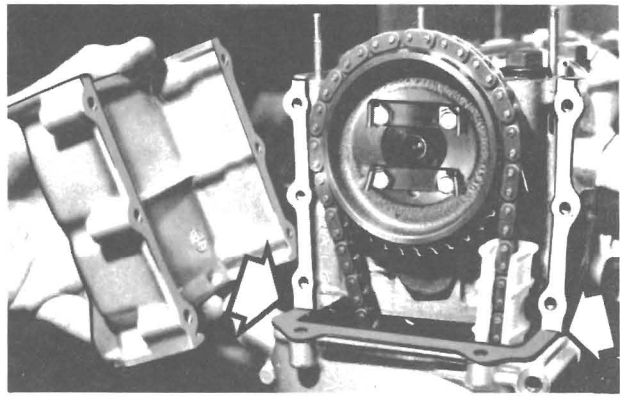
- remove complete engine fuel system, see chapter 13
- remove the header tank, se chapter 17.10
- remove raw water pump, see chapter 17.11
- remove distributor with high tension leads, see chapter 12.11
- NOTE: If work is to be done on cylinder head only, the engine should first be cranked until No 1 piston is at TDC of the compression stroke.

Cylinder head removal

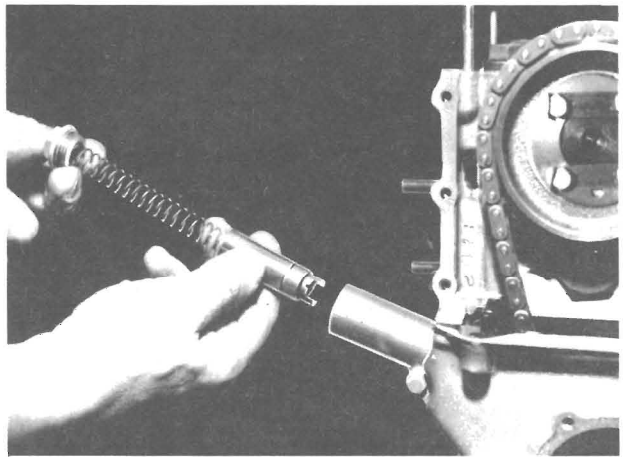


- remove valve rocker cover
- remove the timing gear cover upper section (eight 10 mm screws)

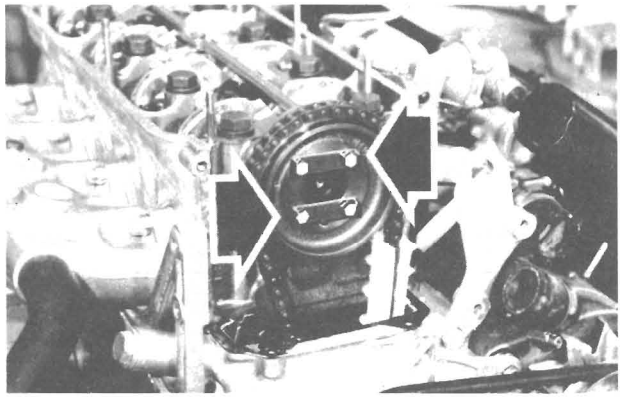




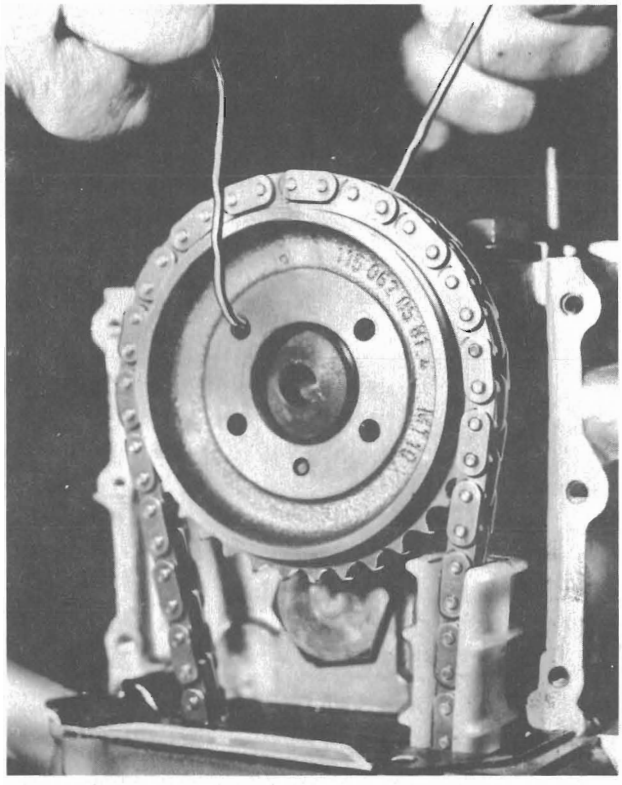
- NOTE: As a sealing compound is used during assembly, light tapping at the edges may prove necessary to separate the cover from the cylinder head.



- remove the timing gear chain tensioner plug, spring and piston



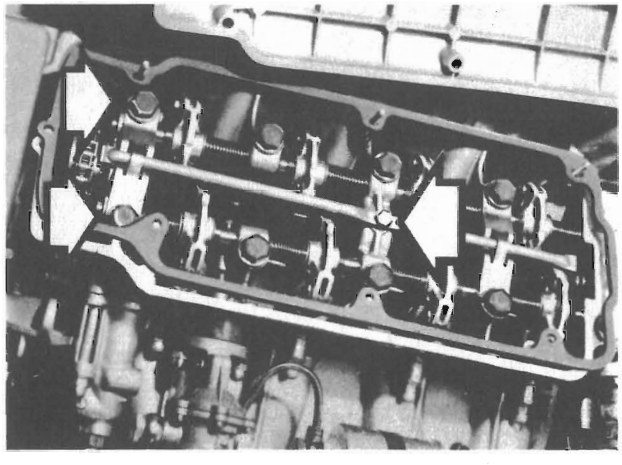
- undo the camshaft sprocket screws (10 mm) secured with locking tabs



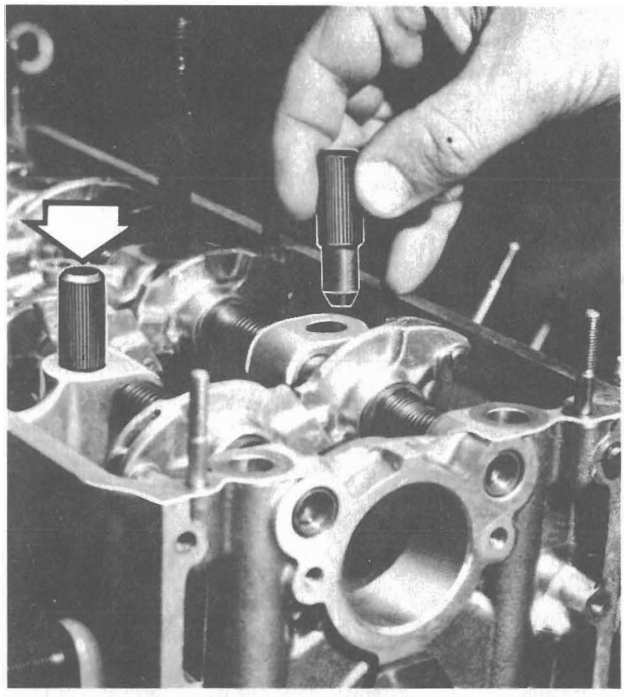
– secure the chain to the sprocket with a piece of wire, to avoid altering the timing as the sprocket is separated from the camshaft. Rest sprocket and chain temporarely on the chain guide

4	6	9	7	1
2	8	10	5	3

– loosen the cylinder head bolts (19 mm) evenly and in opposite sequence to tightening
NOTE: Do not yet remove the bolts.



– remove the two front cylinder head bolts and the oil distributor pipe .

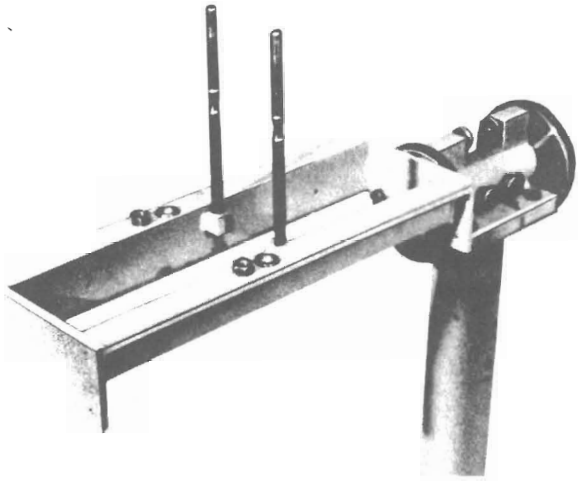


– insert the knurled pins from special tool No 111040 in place of these two bolts to prevent the rocker arm shafts going out of position
– now the remaining cylinder head bolts can be removed
– separate the cylinder head from the cylinder block
– light tapping with a soft mallet may facilitate the operation. Lift the cylinder head straight off.

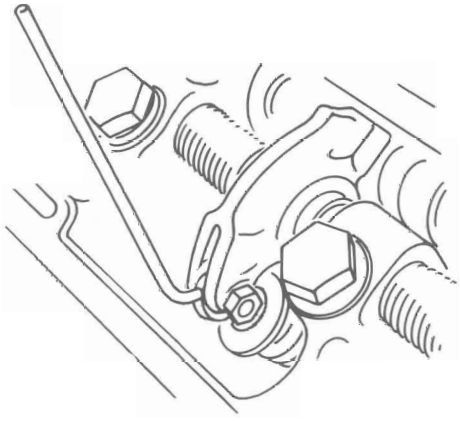
DISMANTLING CYLINDER HEAD

Preparation

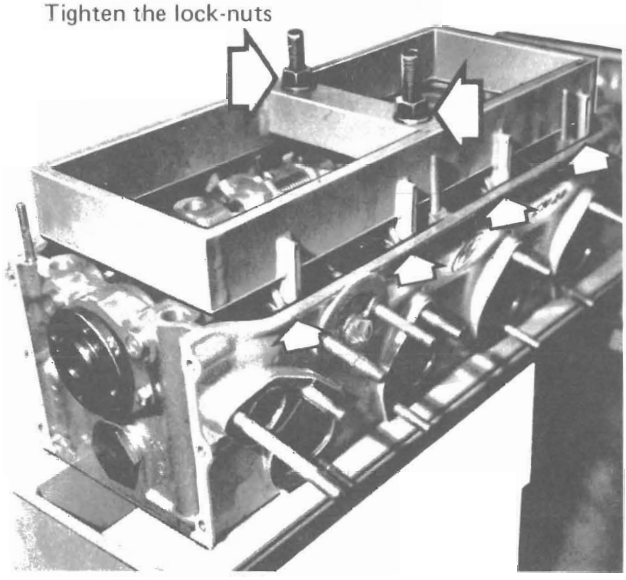
- assemble special tool no 111 040
- slide cyl. head onto the tool
- remove manifolds (if still fitted)



Camshaft removal

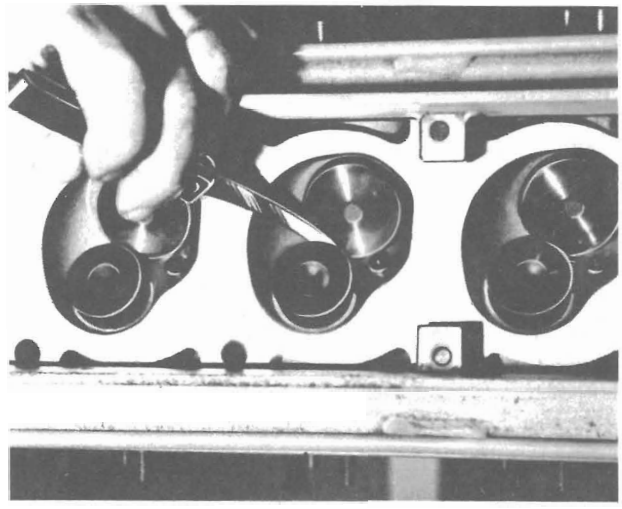


- loosen the tappet adjustment locking nut and turn the eccentric discs to get maximum tappet clearance on the inlet valves and minimum on the exhaust valves. Tighten the lock-nuts



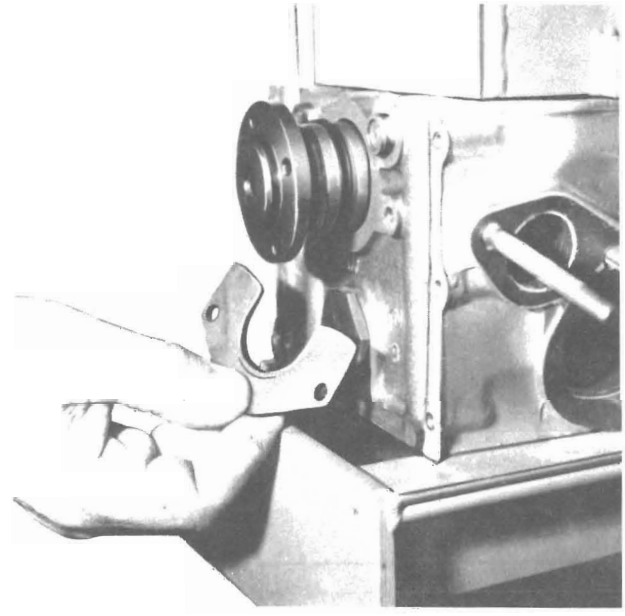
- install the valve spring compressor with each tab or boss resting exactly on one eccentric disc
- install the special nuts supplied with the tool
- turn the nuts slowly and evenly to make the tool compress the valve springs, starting on the exhaust valve side.

CAUTION. – Make absolutely certain that the valve heads do not touch each other, due to the large overlap.



Check frequently with a feeler gauge, as the margin is very minute and "hanging" valves may result in damage. If there is not enough clearance at some stage, then carefully back off the tool and start all over again, after making sure that the tool is properly installed and the eccentric discs correctly set.

- continue compressing the valve springs until the tool is fully home against the cylinder head



- remove the camshaft thrust washer retaining screws (10 mm) and thrust washer
- pull out the camshaft, carefully and well supported with both hands
- cover the camshaft bearing surfaces with tape and rest it on wooden blocks

CAUTION – The camshaft is heat tempered, hence very brittle and prone to snap or crack if malhandled

- remove the valve spring compressor.

Camshaft overhaul

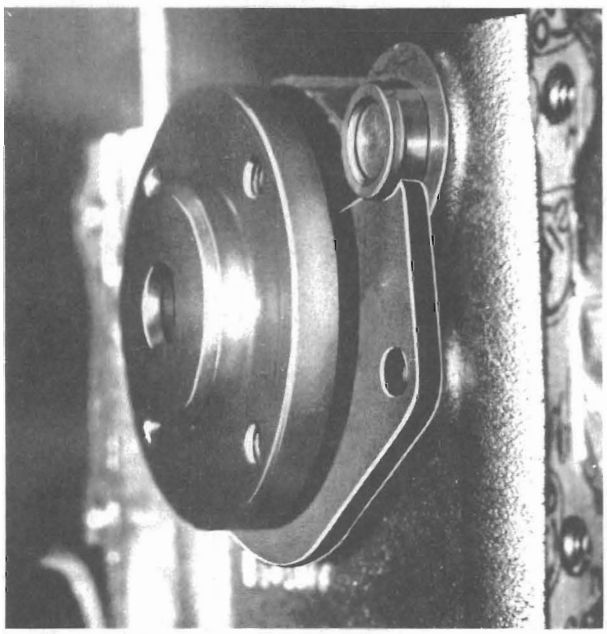
– inspect the camshaft with regard to visible defects
– check wear, out of roundness or warping according to basic dimension and tolerances stated below.

If not within the tolerances at some point, the camshaft must be replaced.

NOTE: Due to its treating qualities, the camshaft cannot be re-conditioned by grinding.

Installing

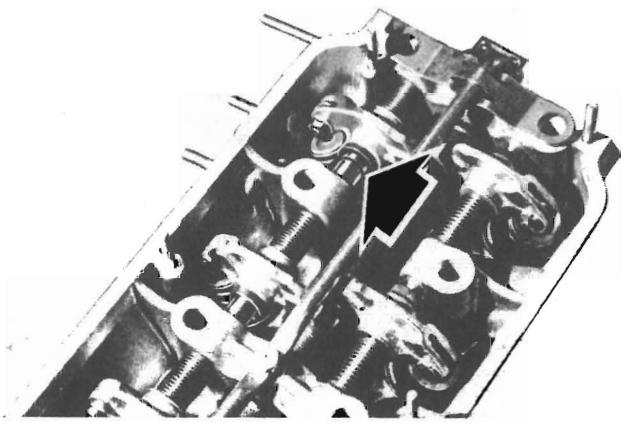
– use the special tool to compress the valve springs as described in previous section
– insert the camshaft very carefully, avoiding undue contact with rocker arms etc.



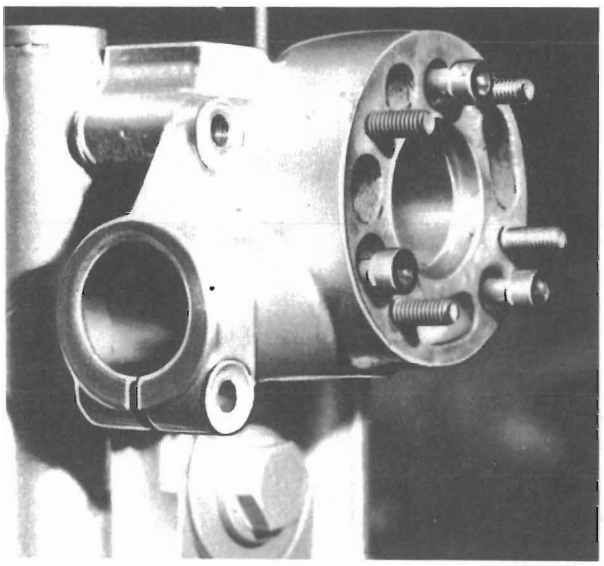
– install thrust washer and make sure it locks the camshaft as well as rocker arm shaft.

Rocker Arm Removal

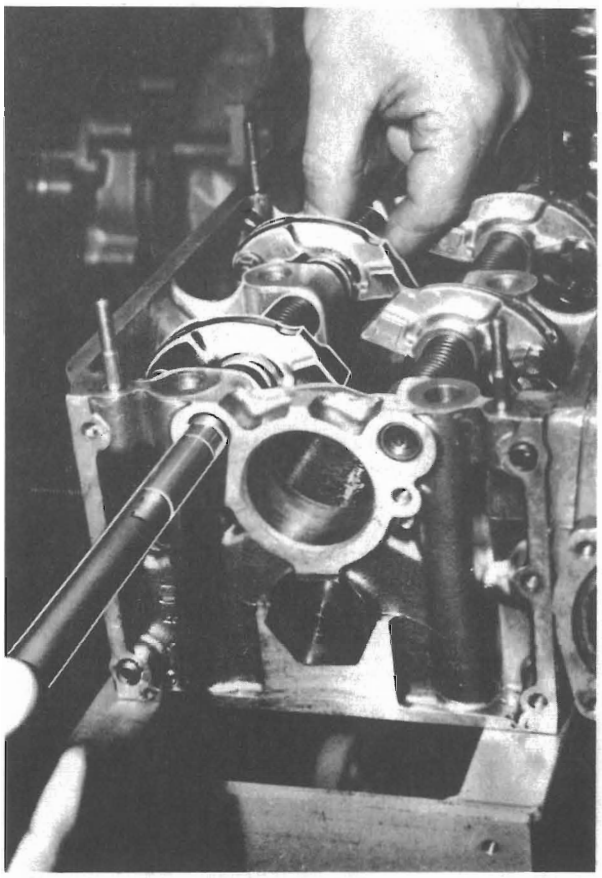
– remove the camshaft
– remove the valve actuator from cyl. head
– remove the circlips which are holding the rocker arms in position



– remove the raw-water pump and distributor drive housing (one 13 mm bolt, three Allen bolts inside the pump flange)



– pull out the rocker arm shafts



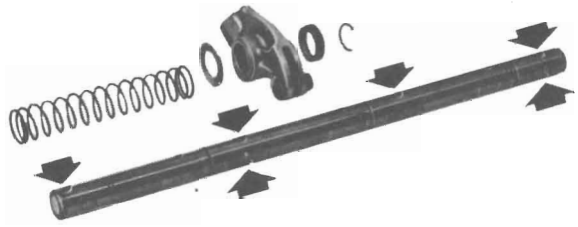
IMPORTANT – Keep each set of rocker arm, spring, washers and circlip together in a way that will prevent mixing and allow the set to be installed in its original position.

Overhaul

– check the parts in accordance with dimensions and tolerances stated below. Replace all parts showing signs of wear or defects. Pay special attention to the rocker arm heel activating the valve.

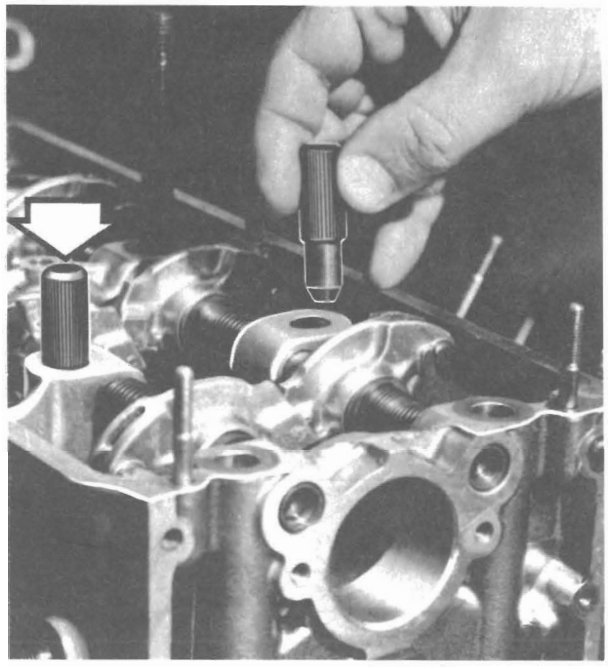
Installing

– assemble rocker arm, spring, washers and circlips, set by set in correct order, while the shaft is slowly pushed home.



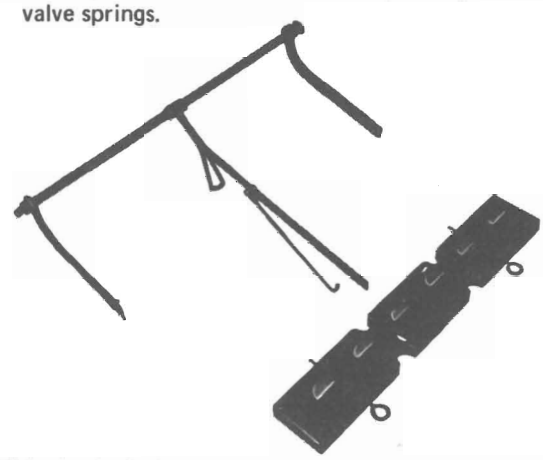
IMPORTANT – Make sure that the shafts are located correctly. Note the difference between exhaust and intake side. Check that oil channels in shaft will align with the head, while at the same time the recess for cyl. head bolts are correctly positioned.

– turn each shaft until its recesses match cylinder head bolt holes
– lock the shaft in this position with the knurled pins until remaining parts are assembled and the cylinder head ready for installation.

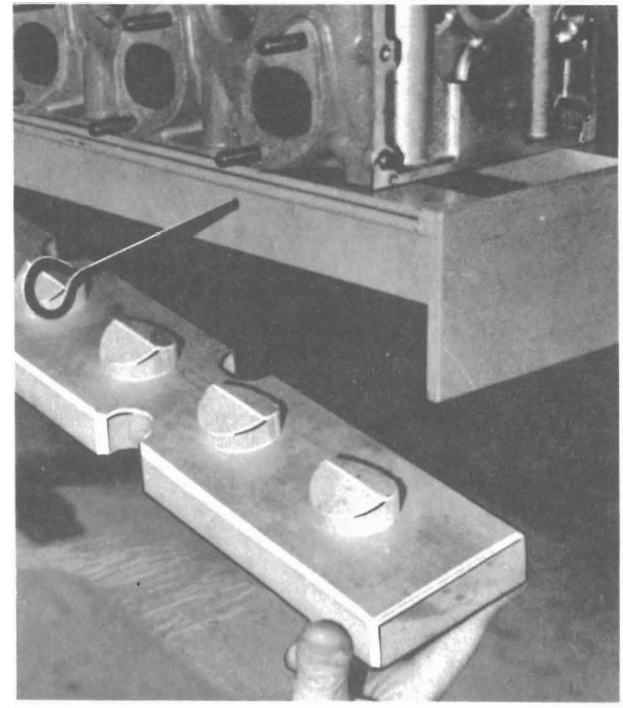


Valve removal

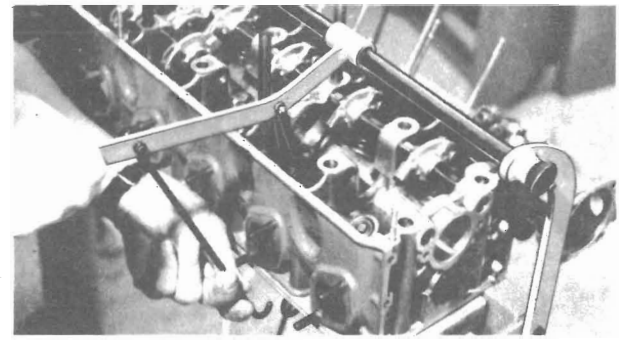
– with camshaft and rocker arms removed, install the valve special tool 111040 for compressing individual valve springs.



This also includes a wooden support positioned underneath the cylinder head, held by two rods, in order to prevent the valves from moving when the spring is compressed



– compress each valve in succession, enough to remove the valve locks, retaining cap, spring and oil seal. Ease the pressure and let the valve slide down to rest against the wooden support
– keep each valve and its components separate and in an order that allows each individual set to retain its original position.



Overhaul

- check valves, springs etc for signs of visible wear, burning and cracking. Minute defects may be corrected by grinding and/or lapping, as long as all tolerances are met
- check each valve and spring in accordance with specified dimensions and tolerances.

Valve guides and seats

A thorough check of the valves should naturally also include the cylinder head valve seats and guides. Reconditioning of minor defects as well as replacing more heavily damaged parts is possible in both cases.

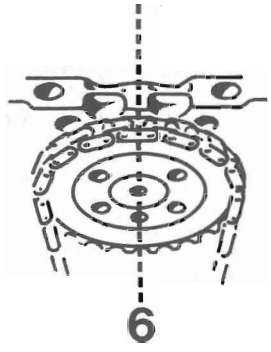
IMPORTANT – The valve seats and guides are shrink fitted into the cylinder head. This repair must only be done at specialist workshops where the cylinder head can be heated in oven.

Installing valves and springs

- insert each valve in its original position – unless the valves and/or guides have been replaced:
- install the springs with retaining rings and oil seals.
- use the special tool to compress the spring allowing the split collar valve locks to be installed. Make sure that they are properly seated in the valve stem groove, before the spring pressure is released:
- check that each rocker arm matches the valve stem.

Installing cylinder head

- Rotate the camshaft until both valves are closed; (Cyl. No 1) and the dowel shows 6 o'clock.



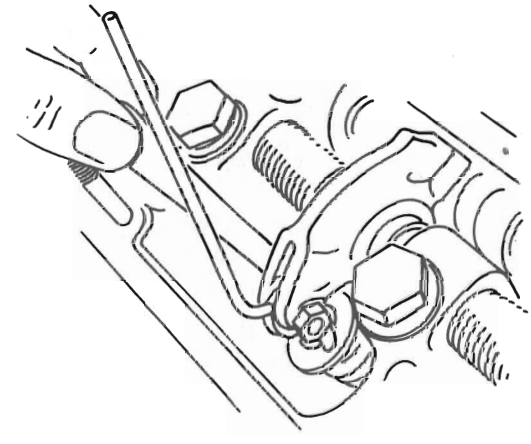
- make sure that no 1 piston is on TDC
- check that the engine block and cylinder head gasket surfaces are absolutely clean;
- check that the guiding boss on top of the engine block, does not protrude more than 5 mm over the surface; make certain that the head gasket is of the correct type;
- install the intake manifold with new gaskets (4). Tighten the nuts to 25 Nm; NOTE: Fuel pump push rod.
- coat the cylinder head gasket lightly with gasket cement (Amosit) where it meets the transmission cover;
- install the cylinder head, making certain that it is seated correctly over the guiding boss;
- install oil distributor pipe and tighten the hollow screw to 11–13 Nm. IMPORTANT: Do not overtighten
- insert the cylinder head screws with the exception of where the two rifled pins are inserted and tighten them finger-tight
- remove the knurled pins and install the remaining cyl. head bolts finger-tight
- tighten the cyl. head bolts in correct sequence to specification

8	6	2	4	10
9	3	1	5	7

- install the camshaft sprocket and chain. Use new locking tabs under the sprocket screws. Bend the tabs to secure the screws;
- install the chain tensioner. Make sure that the piston fits correctly into the chain guide and that the end of the spring with red colouring is next to the plug.
- fill the chain tensioner with oil before tightening the plug to avoid noise at first start-up.
- tighten the plug to 3,0–4,0 kpm
- install the timing gear upper cover. Coat slightly with gasket cement (Amosit), the adjoining surfaces, including the one meeting the head gasket. Tighten the screws to 0.9–1.1 kpm.

Valve clearance adjustment

- undo the eccentric disc lock nut;
- use a thin drift or similar tool to turn the eccentric disc, until the play between rocker arm and valve stem (measured with feeler gauge) is 0.15 – 0.20 mm; NOTE: Check in the same sequence as the engine firing order i.e. 1–3–4–2. The engine temperature must not exceed + 35°C.
- tighten the lock nut and make a final check that the setting has not been altered
- install the rocker cover together with a new gasket.



Specifications Cylinder Head and Related Parts

Cylinder Head

Rocker arm shaft bore	mm	15,5 $^{+0,043}_{-0}$
Rocker arm shaft radial play	mm	0,016 – 0,077
Valve guide bore OD	mm	14 $^{0}_{-0,018}$
Available over-sizes	mm	14,1/14,2/14,3
Valve guide shrink fit[1]	mm	0,018–0,044
Valve seat insert bore		
inlet std	mm	47,0 $^{+0,025}_{-0}$
1st O/S	mm	47,2 $^{+0,025}_{-0}$
2nd O/S	mm	47,4 $^{+0,025}_{-0}$
exhaust std	mm	40,0 $^{+0,025}_{-0}$
1st O/S	mm	40,2 $^{+0,025}_{-0}$
2nd O/S	mm	40,4 $^{+0,025}_{-0}$
Valve seat shrink fit[2]	mm	0,10 –0,15
Camshaft bore	mm	35 $^{+0,034}_{+0,009}$
		42 $^{+0,034}_{+0,009}$
		43 $^{+0,034}_{+0,009}$

[1] Cyl. head to be heated to 220–250°C

[2] Cyl. head to be heated to 220–250°C and valve seat insert to be cooled to –70°C in dry ice.

Valve Guide

Total length		mm	52
Outer diameter	std	mm	14,0 $^{+0,044}_{+0,033}$
	1st O/S	mm	14,1 $^{+0,044}_{+0,033}$
	2nd O/S	mm	14,2 $^{+0,044}_{+0,033}$
	3rd O/S	mm	14,3 $^{+0,044}_{+0,033}$
Inner diameter		mm	8 $^{+0,015}_{-0}$
Protrusion (rocker arm side)		mm	15 ± 0,5

Valve Seat Inserts

Outer diameter inlet STD	mm	47,15 $^{-0,009}_{-0,025}$
1st O/S	mm	47,35 $^{-0,009}_{-0,025}$
2nd O/S	mm	47,55 $^{-0,009}_{-0,025}$
exhaust STD	mm	40,15 $^{-0,009}_{-0,025}$
1st O/S	mm	40,35 $^{-0,009}_{-0,025}$
2nd O/S	mm	40,55 $^{-0,009}_{-0,025}$
Valve seat angle	°	45
Outer correction angle	°	15
Valve seat width inlet	mm	1,50 – 2,10
exhaust	mm	1,55 – 2,05

Camshaft

Camshaft bearing dia	mm	35 $^{-0,025}_{-0,041}$
		42 $^{-0,025}_{-0,041}$
		43 $^{-0,025}_{-0,041}$
Camshaft radial play	mm	0,034 – 0,075
Camshaft axial play	mm	0,02 – 0,13
Camshaft max. wharp measured at distributor gear	mm	0,025
Cam lobe basic dia	mm	26,76
Cam lobe lift	mm	7,03 ± 0,08

Valve timing (measured in crankshaft degrees, and with the valve clearance adjusted to 0,5 mm)

Intake	opens at	4° BTDC
	closes at	52° ABDC
Exhaust	opens at	52° BBDC
	closes at	4° ATDC

Rocker Arm

Rocker arm bearing ID	mm	15,5 $^{+0,018}_{-0}$
Rocker arm radial clearance	mm	0,016 – 0,052

Rocker Arm Shaft

Rocker arm shaft dia	mm	15,5 $^{-0,016}_{-0,034}$

Valves

Valve clearance cold engine (max 35°C)	inlet	mm	0,15 – 0,20
	exhaust	mm	0,15 – 0,20
Valve total length	inlet	mm	103,8 ± 0,2
	exhaust	mm	104,3 ± 0,2
Valve ste dia	inlet	mm	$8 - {}^{0,025}_{0,040}$
	exhaust	mm	$8 - {}^{0,040}_{0,055}$
Valve dia	inlet	mm	$46 - {}^{+0}_{0,16}$
	exhaust	mm	$38 - {}^{+0}_{0,16}$
Valve thickness	inlet (new valve)	mm	1,5 ± 0,15
	inlet (min. after recond)		1,0 ± 0,15
	exhaust (new valve)		2,0 ± 0,10
	exhaust (min. after rec.)		1,5 ± 0,10
Valve face angle	inlet	°	$45° 30' {}^{+20'}_{-0}$
	exhaust	°	$45° 30' {}^{+20'}_{-0}$
Max. eccentricity	valve stem/valve seat		
	inlet & exhaust	mm	0,02
Valve stem clearance	inlet	mm	0,025 – 0,055
	exhaust	mm	0,040 – 0,070
Max. allowed wear valve stem/guide		mm	0,15

Valve Springs

Colour code (cyl. head end)		green, yellow or white
Wire dia	mm	4,25
Valve spring OD	mm	31,9 ± 0,2
Valve spring length (unloaded)	mm	43,5 or 46
Valve spring loaded length (for all colour codes)	N / mm	285 N ± 12 at 37,6 mm and 687 N ± 28 at 28,5 mm

Tightening Torques

Cylinder head (to be torqued according to scheme in text and in following steps. Max engine temp. 35°C)		
	1st Nm	34–44
	2nd Nm	67–71
	3rd Nm	77–81
	4th Nm	77–81
Valve adjuster lock nut	Nm	8–11
Exhaust manifold	Nm	30–33

Timing chain and sprockets

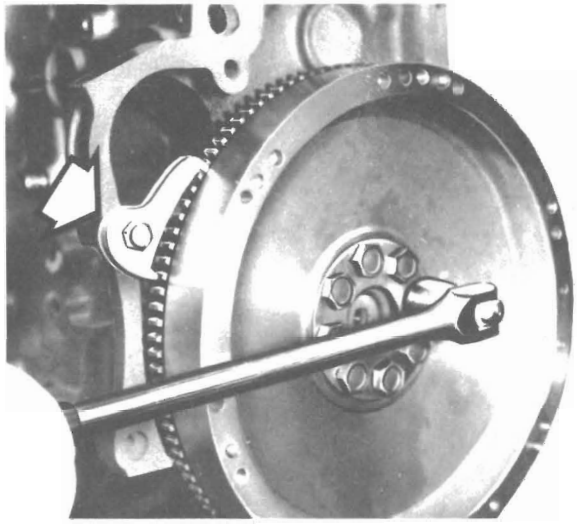
11.31 In parts catalogue

Preparation

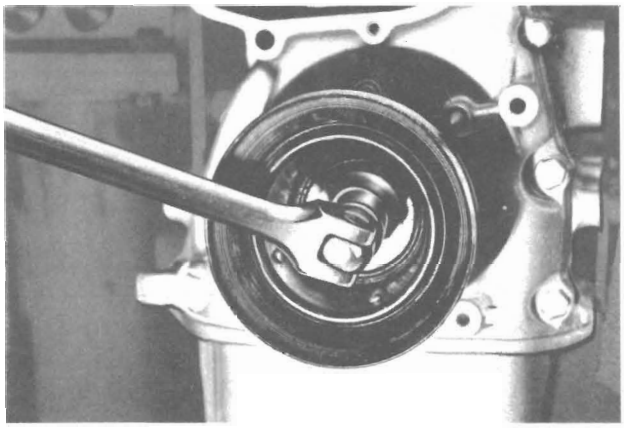
- turn the engine to set no 1 piston at TDC of comp. stroke
- remove: header tank, see chapter 17.10
  rocker cover
  altenator, see chapter 12.31
  water circulation pump, see chapter 11.51
  clutch housing, see chapter 21.21
  oil pan,

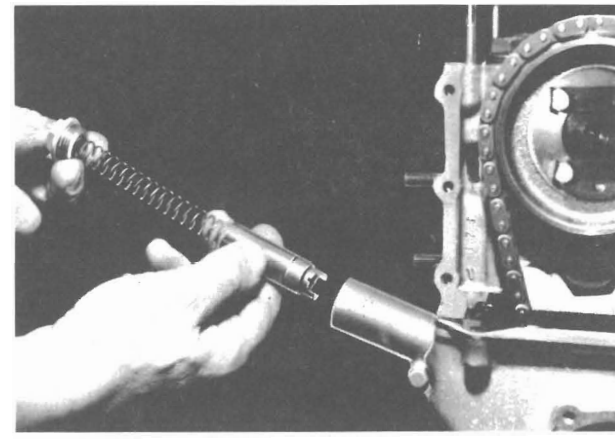
Removal

- lock the flywheel, using the special tool No. 112140 which engages the ring gear and is anchored by a through-bolt in the starter mounting flange.

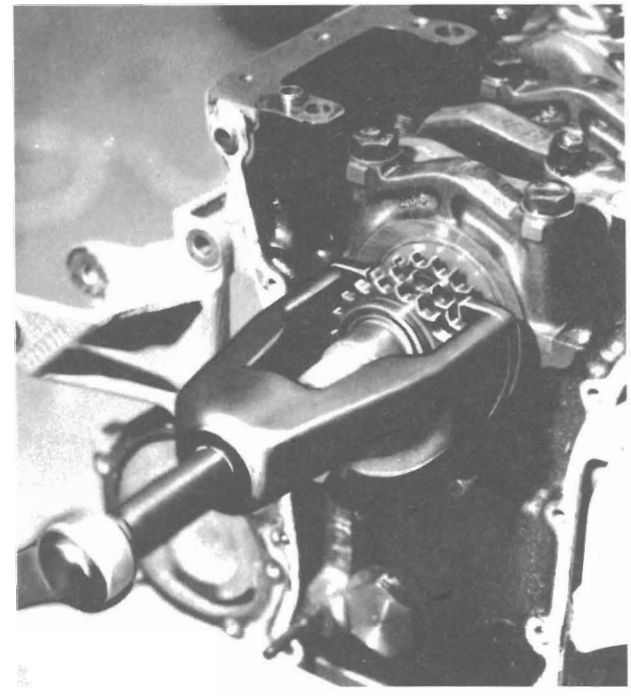


- undo the crankshaft nut on the front drive belt pulley. Extract the pulley;

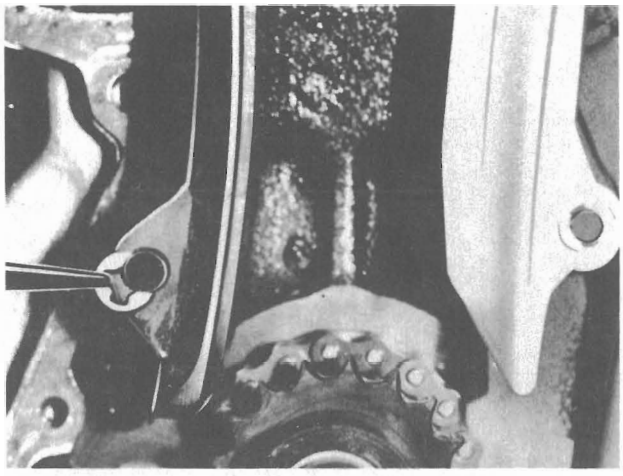




- remove chain tensioner plug, spring and piston
- remove the timing gear covers (starting with the upper one)
  NOTE: As a sealing compound has been used at the installation stage, separating the cover from the engine block may require some light tapping round the edges.
- remove the camshaft sprocket and remove the chain



- pull off crankshaft sprocket with puller, special tool no. 112000



– remove the chain tensioner after undoing its circlip.
– repeat the procedure with the chain guide (white) on the opposite side;

Timing gear overhaul

The timing gear chain is of single roller type:

Dimensions		3/8" x 7/32"
Roller diam	mm	6,35
Number of links		94

– check sprockets and chain for wear
– also check chain guide and tensioner for wear
– replace faulty parts

Assembly

– check that no 1 piston is at TDC and that the camshaft is in correct position
– install crankshaft sprocket
– install chain tensioner and guide
– fit the chain over the crankshaft sprocket in a way that allows the camshaft sprocket to be installed on the camshaft flange, without moving **neither camshaft nor crankshaft:**
– install locking tabs and screws. Tighten the screws and secure with the tabs;

Chain tensioner is of the hydraulic type and has to meet specifications as follows:

Piston lenght	mm	61.8–62.0
Spring thread, diam	mm	1.0 ± 0.015
Spring length (unloaded)	mm	155.5

NOTE: The spring end with red colour marking should face the plug.

Oil pump

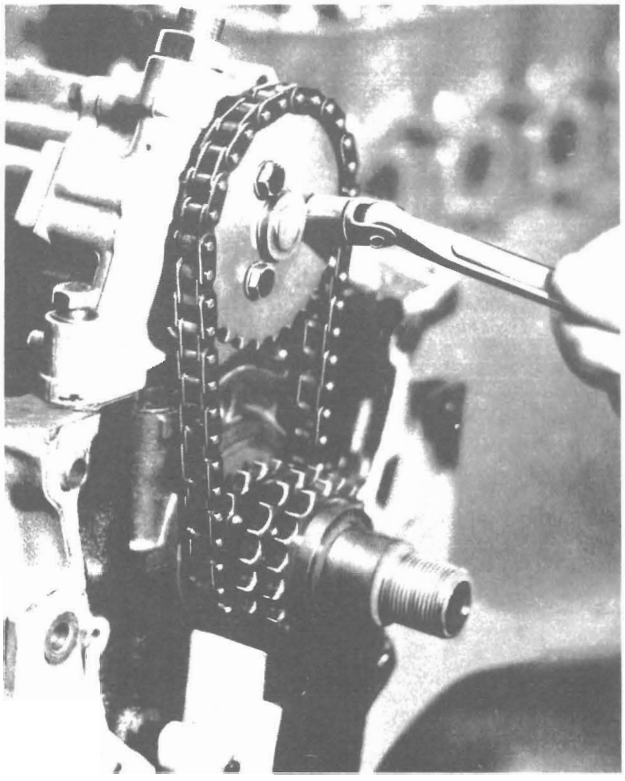
11.41 In parts catalogue

Preparation

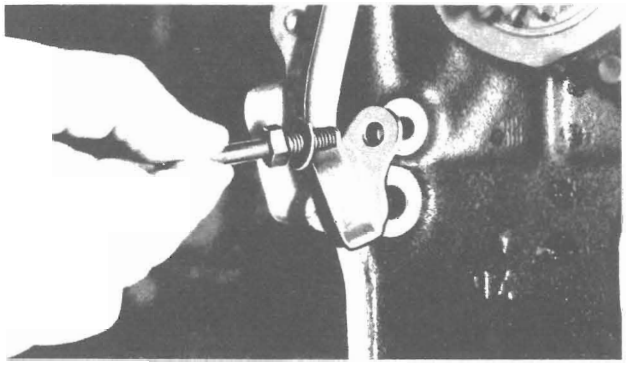
– remove timing chain, see chapter 11.31

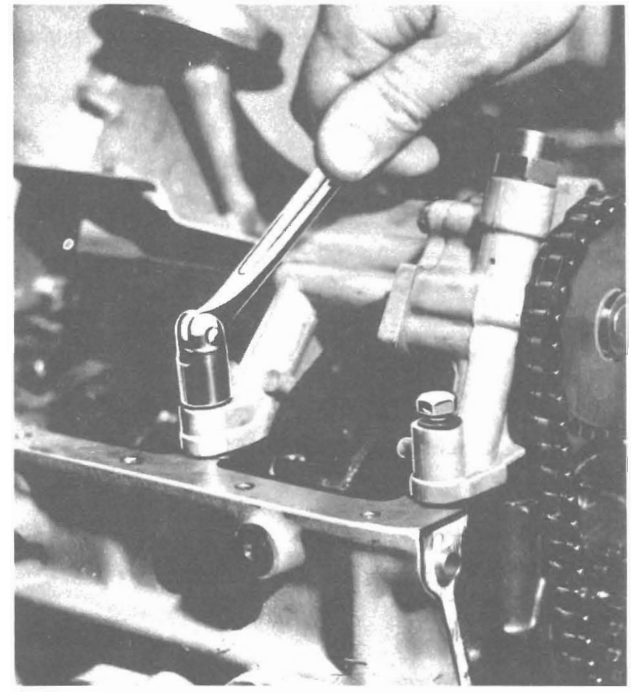
Removal

– remove the oil pump sprocket retaining bolts (10 mm) release sprocket and chain at pump and crankshaft. No marking-up is neccessary;



– undo the chain tensioner stud which also retains the pump-to-block oil pipe; Remove the pipe;

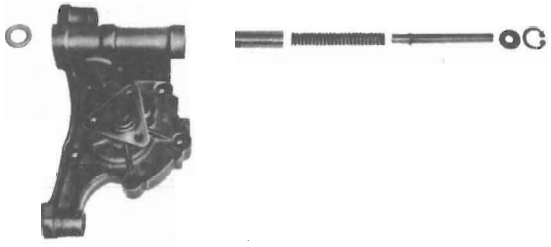




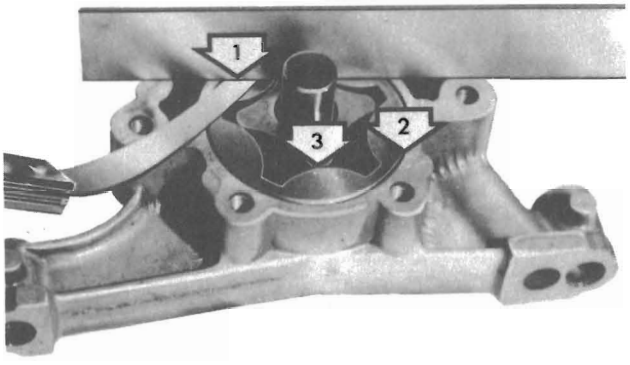
– remove the oil pump retaining bolts (13 mm); remove the oil pump;
NOTE: The pump bracket has a light press fit on two guiding bosses in the crankcase;

Oil pump dismantling & overhaul

- remove the screws (10 mm) and separate pick-up-pipe from pump housing;
- dismantle the pressure valve, including spring and piston;



- inspect the parts for visible wear or damage;
  NOTE: The oil pump can be dismantled completely by removing the sprocket flange. This is, however, rarely neccesary, as the pump usually is replaced as a complete unit.
- check wear according to specifications:



Rotor outer diam		mm	$57.1 \pm \begin{matrix}0\\0.025\end{matrix}$
Rotor width		mm	$16 \begin{matrix}-0.015\\-0.045\end{matrix}$
Rotor axial play	(1)	mm	0.035–0.095
Pump housing Ø		mm	$57.2 \begin{matrix}+0.025\\-0\end{matrix}$
Max radial play rotor/pump-housing	(2)	mm	$0.10 \begin{matrix}+0.05\\-0\end{matrix}$
Outer/inner lobe gap	(3)	mm	0.12 – 0.20
Max. perm. wear pump cover		mm	0.05
Valve spring length (unloaded)		mm	68

NOTE: In case of a removed sprocket flange, the correct installation measurement from flange sprocket surface to pump housing parting line is 42,7 ± 0.1 mm;

Oil Pump installing

- note the O–ring on the block-to-pump pipe, i.e. the pressure valve cylinder opening facing the crankcase;
- drive chain tension should allow light thumb pressure movement. Adjustment is possible with shims between pump housing bracket and crankcase. Make sure that the shims are correctly positioned with regard to oil flow opening.
- push the bracket fully home on the guiding bosses. Tighten the retaining bolts.

Connecting rods, bearings and pistons

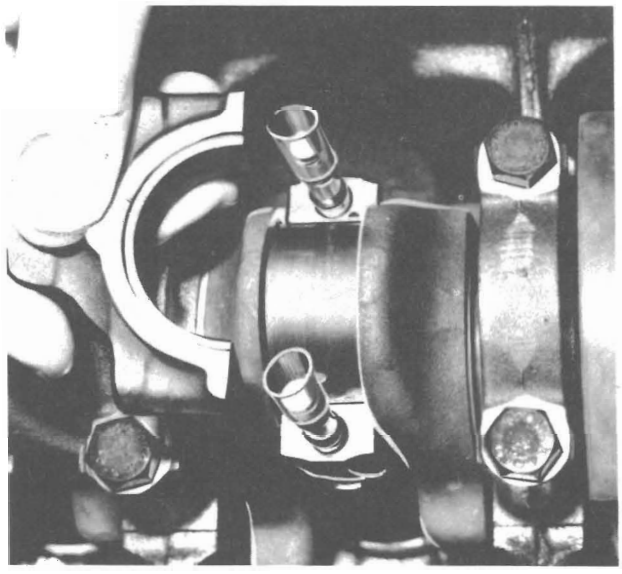
11.24 In parts catalogue

Preparation

- remove oil pan
- remove cylinder head, see chapter 11.12

Removal

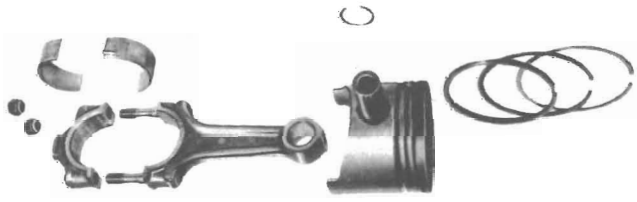
- undo the nuts on the big end bearing caps;
- remove the caps – note figure markings which correspond with identical markings on the connecting rod.
- cover the threads of the cap bolts to prevent scratching the journals;



- push connecting rods and pistons out of the cylinders.

Piston – con.rod dismantling

- remove the gudgeon pin circlip in one end and push the pin far enough to free the connecting rod;
- remove the piston rings, using a piston ring expander;
- keep piston, connecting rod, cap- and bolts together in sets.



Overhaul

- clean the piston ring grooves and check the ring play:

Exessive play means piston and/or piston ring replacement

- check ring gap (ring installed in the cylinder):

- check piston for condition, ovality play (in cylinder) and weight:

NOTE: Piston weight classes are marked '+' or ' – '. Only pistons of the same make and weight cathegory must be used.

NOTE: Piston and gudgeon pin must always be replaced together.

Connecting rod

– check connecting rod parallelism and twist:

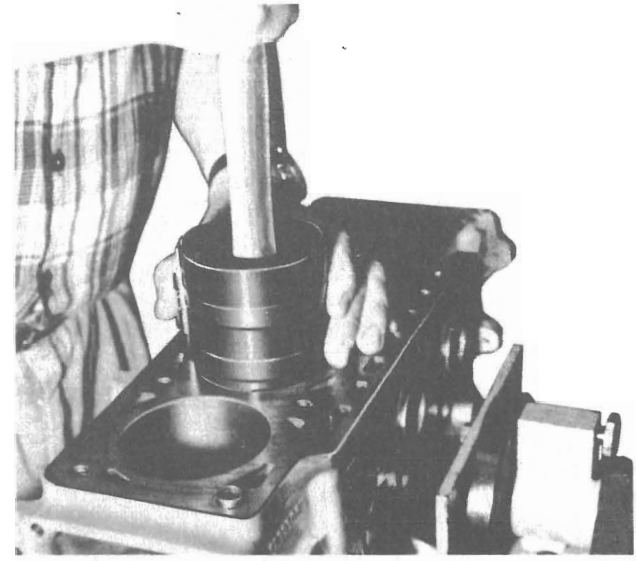
NOTE: Conrods with bushings are available as service units. If the bushing only is replaced, make sure that its gap is positioned in 90° angle to the oil bore,

– check big end bearing play (on crankshaft journal. Use Plastigage and tighten the cap bolts to full torque, 52 – 57 Nm.

CAUTION: The connecting rods are arranged in weight cathegories, identified by colour markings. (see Spare Parts Catalogue).
Under no circumstances should the total weight discrepancy of four connecting rods in one engine exceed ± 4 g bearing shells excluded.

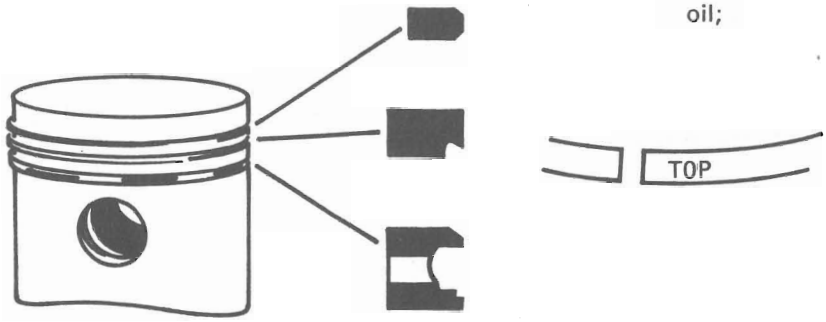
NOTE: Excessive big end bearing play may well indicate crankshaft journal wear or ovality. See the appropriate section for checking.

– big end bearing shells are available in various sizes corresponding to the degree of crankshaft journal reconditioning.
– check that there is no noticeable axial play in the big end bearing;



NOTE: The piston crown arrow marking should point towards the front (timing gear end) of the engine

– install big end bearing caps, taking notice of the markings: Tighten the nuts evenly in stages to 52 – 57 Nm kpm.
– check that the big end bearing moves freely on the crankshaft journal;
– lubricate bearings and cylinder bores with some engine oil;



Installing

– make sure that the connecting rod oil bore and the piston crown arrow marking face the same direction;
– make sure that all piston rings are installed with "TOP" facing upwards;
– install the complete piston and connecting rod in the cylinder, using a piston ring compressor. Spread the piston ring gaps 180° apart.

Specifications

Connecting Rod

Length (C/L big end to C/L small end)	mm	135 ± 0,1
Big end bore	mm	$52^{+0,015}_{-0}$
Small end bore (without bearing)	mm	$24^{+0,021}_{-0}$
Piston pin bearing OD	mm	24,060 – 24,100
Piston pin bearing ID	mm	$22^{+0,010}_{+0,005}$
Big end bearing radial play	mm	0,023 – 0,078
Max allowed parallellity discrepancy (measured with bearings at a distance of 150 mm)	mm	0,04
Max allowed twist		0° 30'
Max allowed con.rod weight difference within the engine	g	± 4
Big end	g	± 2
Small end	g	± 2

Pistons

Piston dia Std	mm	88,97
intermediate size	mm	89,05
1st O/S	mm	89,22
2nd O/S	mm	89,47
Piston clearance	mm	0,045
Max weight tolerance within the engine	g	10
Piston pin bore	mm	$22^{+0,004}_{-0}$
Piston pin offset	mm	1,0

Piston Rings

1st compression ring		
Height	mm	$1,75^{-0,010}_{-0,022}$
End gap	mm	0,3 – 0,5
Side clearance	mm	0,060 – 0,092
2nd compression ring		
Height	mm	$2^{-0,010}_{-0,022}$
End gap	mm	0,2 – 0,14
Side clearance		
Mahle pistons	mm	0,030 – 0,062
KS pistons	mm	0,040 – 0,072
Alcan/Nüral pistons	mm	0,030 – 0,062
Oil control ring		
Height	mm	$4^{-0,010}_{-0,022}$
End gap	mm	0,25 – 0,40
Side clearance		
Mahle pistons	mm	0,020 – 0,052
KS pistons	mm	0,030 – 0,062
Alcan/Nüral pistons	mm	0,020 – 0,052
Piston pin clearance		
Mahle pistons	mm	0,001 – 0,005
KS pistons	mm	0,002 – 0,006
Alcan/Nüral pistons	mm	0,001 – 0,005

Tightening Torques

Big end bearing cap	Nm	51 – 56

Crankshaft and bearings

11.21 In parts catalogue

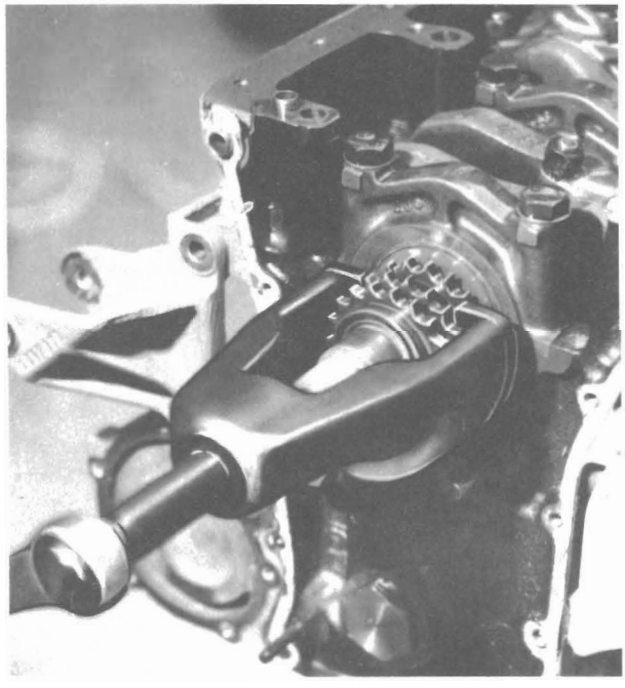
CRANKSHAFT – MAIN BEARINGS – JOURNALS

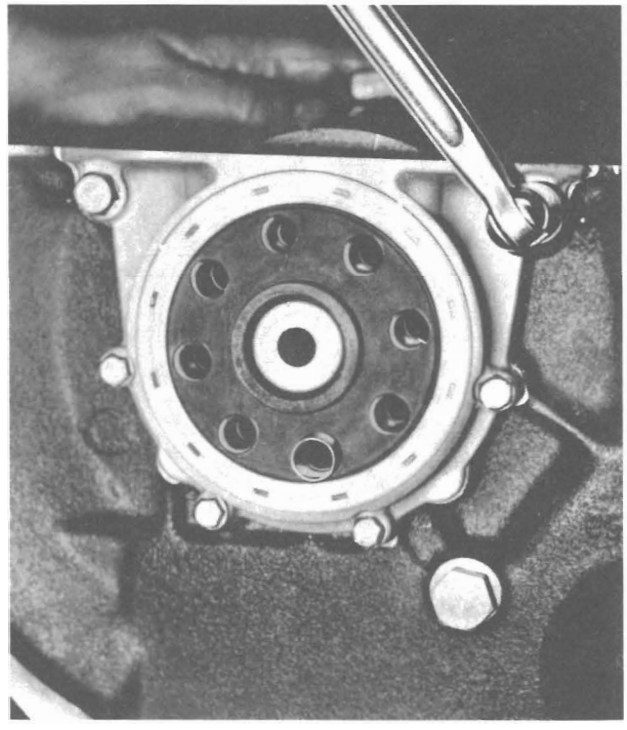
Preparation

- remove cylinder head, see chapter 11.12
- remove timing chain, see chapter 11.31
- remove oil pump, see chapter 11.41
- remove clutch housing, see chapter 21.21
- remove pistons and connecting rods, see chapter 11.24
- remove flywheel, see chapter 11.22

Removal

- pull off the crankshaft chain sprocket, using special tool No 112000. The sprocket will pass freely over the outer key.

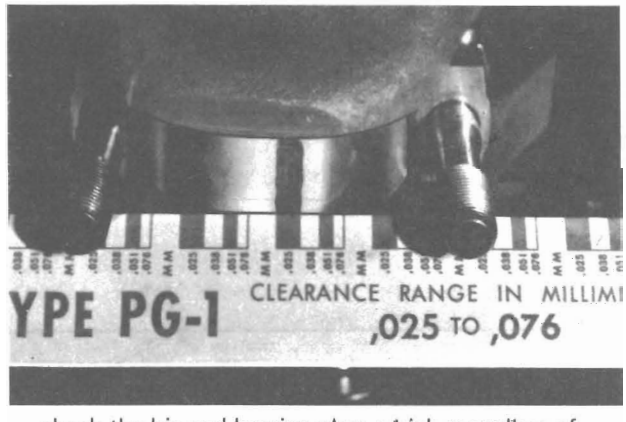




- remove the crankshaft seal assy at the flywheel end (four 10 mm and two 13 mm bolts.
- check the crankshaft **axial play: 0.085 – 0.174 mm;**
- mark-up the main bearing caps to make sure that they are installed in their original positions;
  Remove the bearing caps;
  NOTE: Bearing No. 3 also acts as the thrust bearing.
- lift out the crankshaft.

Crankshaft & bearings overhaul

- use Plastigage PG–1 to establish the radial play of the main bearings. There are two different bearing categories in respect of dimensions, carrying markings in red or blue respectively.

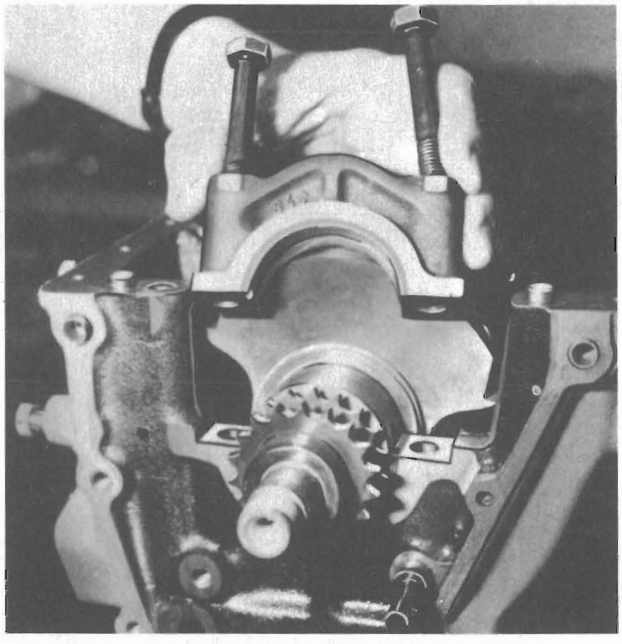


- check the big end bearing play, which regardless of crankshaft colour marking should be: 0.023–0.078
  There are oversized bearing shells available for the various stages of crankshaft re-conditioning.
- check the crankshaft main bearing journals:

IMPORTANT: In case of crankshaft regrinding the crankshaft journals must be hardened. A job for a specialist!

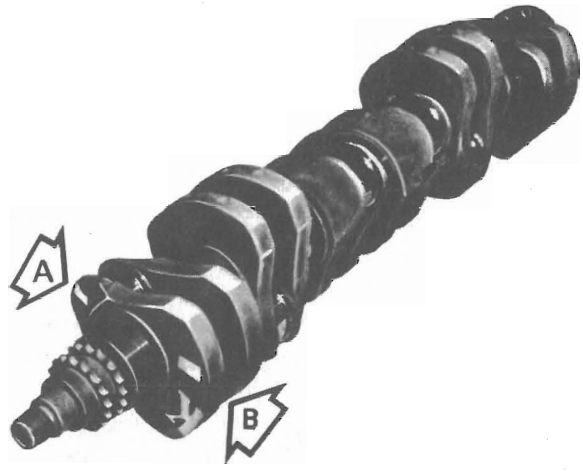
Installing

– check that the main bearing caps regain their original position and are turned the right way around, e.g. notch to notch; Note the oil pump bracket on No. 3 bearing.



– tighten the bolts evenly and in stages to 5,8 – 6,3 kpm.
– remove the lip seal in the shield from inside and out. Install the new seal the other way around, with tool 111240, lips facing the crankcase;

– use a new gasket when the shield is installed.
– check the crankshaft big end bearing journals,
– check the crankshaft out-of-true which measured on the No. 3 bearing journal should be max: 0.1 mm
– if the crankshaft does not meet these tolerance, it should be reconditioned or replaced.



Crankshaft journals are colour coded

– 1 line (A and B) is 1st U/S
– 2 lines (A and B) is 2nd U/S
– 3 lines (A and B) is 3rd U/S

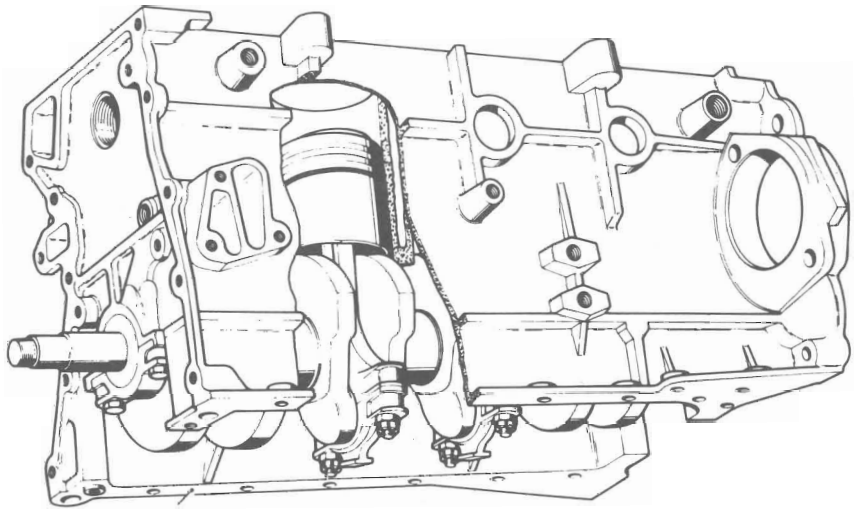
Specifications

Crankshaft axial play	mm	0,085 – 0,174
Stroke	mm	80 ± 0,1
Max allowed warp (measured on 3rd main bearing when crankshaft is resting on the outer bearings)	mm	0,1
Journal finish	R_t (μ)	2,0
Main bearing radial play	mm	0,030 – 0,070
Connecting rod radial play	mm	0,023 – 0,069
Main bearing journals dia		
std red	mm	$55\ ^{-0,010}_{-0,020}$
std blue	mm	$55\ ^{-0,020}_{-0,029}$
1st U/S red	mm	$54,75\ ^{-0,010}_{-0,020}$
1st U/S blue	mm	$54,75\ ^{-0,020}_{-0,029}$
2nd U/S red	mm	$54,50\ ^{-0,010}_{-0,020}$
2nd U/S blue	mm	$54,50\ ^{-0,020}_{-0,029}$
3rd U/S red	mm	$54,25\ ^{-0,010}_{-0,020}$
3rd U/S blue	mm	$54,25\ ^{-0,020}_{-0,029}$
Crank journals dia		
std	mm	$48\ ^{-0,009}_{-0,025}$
intermediate	mm	$48\ ^{-0,034}_{-0,050}$
1st U/S	mm	$47,75\ ^{-0,009}_{-0,025}$
2nd U/S	mm	$47,50\ ^{-0,009}_{-0,025}$
3rd U/S	mm	$47,25\ ^{-0,009}_{-0,025}$
Axial bearing width		
std	mm	$30\ ^{+0,064}_{+0,025}$
1st O/S	mm	$30,2\ ^{+0,064}_{+0,025}$
2nd O/S	mm	$30,4\ ^{+0,064}_{+0,025}$
3rd O/S	mm	$30,6\ ^{+0,064}_{+0,025}$

Cylinder block

11.11 In parts catalogue

- check the cylinders for wear, conicity and ovality in accordance with the specifications:
- if the mentioned requirements are not met, the cylinder should be reconditioned. As in a case where visible damage is established.



Specifications

Cylinder diameter		
std	mm	89,015 ± 0,005
intermediate	mm	89,095 ± 0,005
1st O/S	mm	89,265 ± 0,005
2nd O/S	mm	89,515 ± 0,005
Bore finished to	$R_t(\mu)$	3 – 4
Max. allowed out of round	mm	0,01
Max. allowed conicity	mm	0,01
Max. allowed total wear piston and cylinder	mm	0,10 – 0,15

Maintenance Schedule

	Daily prior to starting	Every 14th day	Every 50 hours or yearly	Every 100 hours or yearly	Every 2nd year
Engine oil level	●				
Fresh water coolant level	●				
Battery level		●			
Belt tension		●			
Draining optional fuel filter		●			
Engine oil change			●		
Clean or change spark plugs			●		
Engine oil filter change			●		
Valve clearance				●	
Adjust breaker points (Dwell angle)				●	
Ignition timing				●	
Lubricate distributor				●	
Tighten hose clamps				●	
Raw water pump impeller				●	
Change fuel filter				●	
Change fresh water coolant (when using Anti-Freeze)					●

Winter lay up and Recommission

Of great importance to the durability and life of the engine is the preparation for the winter storage. The following recommendations will give the engine and stern drive the necessary protection during the winter lay up.
The preservation should be done as soon as possible when the boat is taken out of the water.

1. Lower drive into a can or tank with at least enough water that it covers the anti-caviation plate. Use only clean fresh water. Run the engine at 1200–1400 rpm for 20 minutes to remove the dirt and deposits from the raw water system and to warm up the engine.
2. Change engine oil and filter. Use the normal recommended engine oil during the winter period.
3. Drain the water can and replace the water with a mixture of 90 % water and 10 % emulgating rust preventive oil. Run the engine for 20 minutes to ensure that all metal parts of the cooling system becomes a good antirust protection. Drain the raw water system completely as the water/oil solution gives no protection against freezing.
4. Remove the raw water pump impeller to
   a) drain the water pump
   b) check the condition of the impeller
   c) avoid distortion of the impeller blades if impeller is in good condition.
5. Change stern drive oil. If water is present it will either come out as clear water when the drain plug is removed, or give the oil a greyish 'milky' apperance.
6. Loosen the alternator to release the stress of the drive belt.
7. Check the fresh water coolant for sufficiant anti-freeze protection. A 50/50 mixture is recommended.
8. Protect the electric system with a drying spray CRC 5–56 or similar. NOTE! Do NOT spray the INSIDE of distributor cap as oil on the breaker points leads to burned points and starting difficulties.
9. Remove the spark plugs and injects 2 cl engine oil into each spark plug hole. Turn the engine 2–3 turns by hand and install the spark plugs by hand.
10. Clean the stern drive.
11. Remove the propeller and grease the propeller shaft with 'Anti-Seize'.
12. Check the propeller blades for bent blades, nicks and burrs.
13. Touch-up the paint if scratches are apparent.
14. Change the sacrificial anodes if necessary.
15. Drain fuel and change filter elements.
16. Leave the battery for winter storage and charging.

RECOMMISSION BEFORE LAUNCHING

1. Assemble the water pump and adjust to correct belt tension.
2. Adjust the alternator to correct belt tension.
3. Install the propeller.
4. Replace the spark plugs.
5. Check oil levels in engine and stern drive.
6. Check cooling water level (fresh water system)
7. Install a fully charged battery. Add a protective coating of grease on the battery poles.

RECOMMISSION AFTER LAUNCHING

1. Start the engine and check that the instruments and indicators are operating properly.
2. Check for water and oil leaks while engine is running.
3. Run the engine for half an hour and recheck the engine oil.

BMW Marine Engines

01 512 128 176
2.80