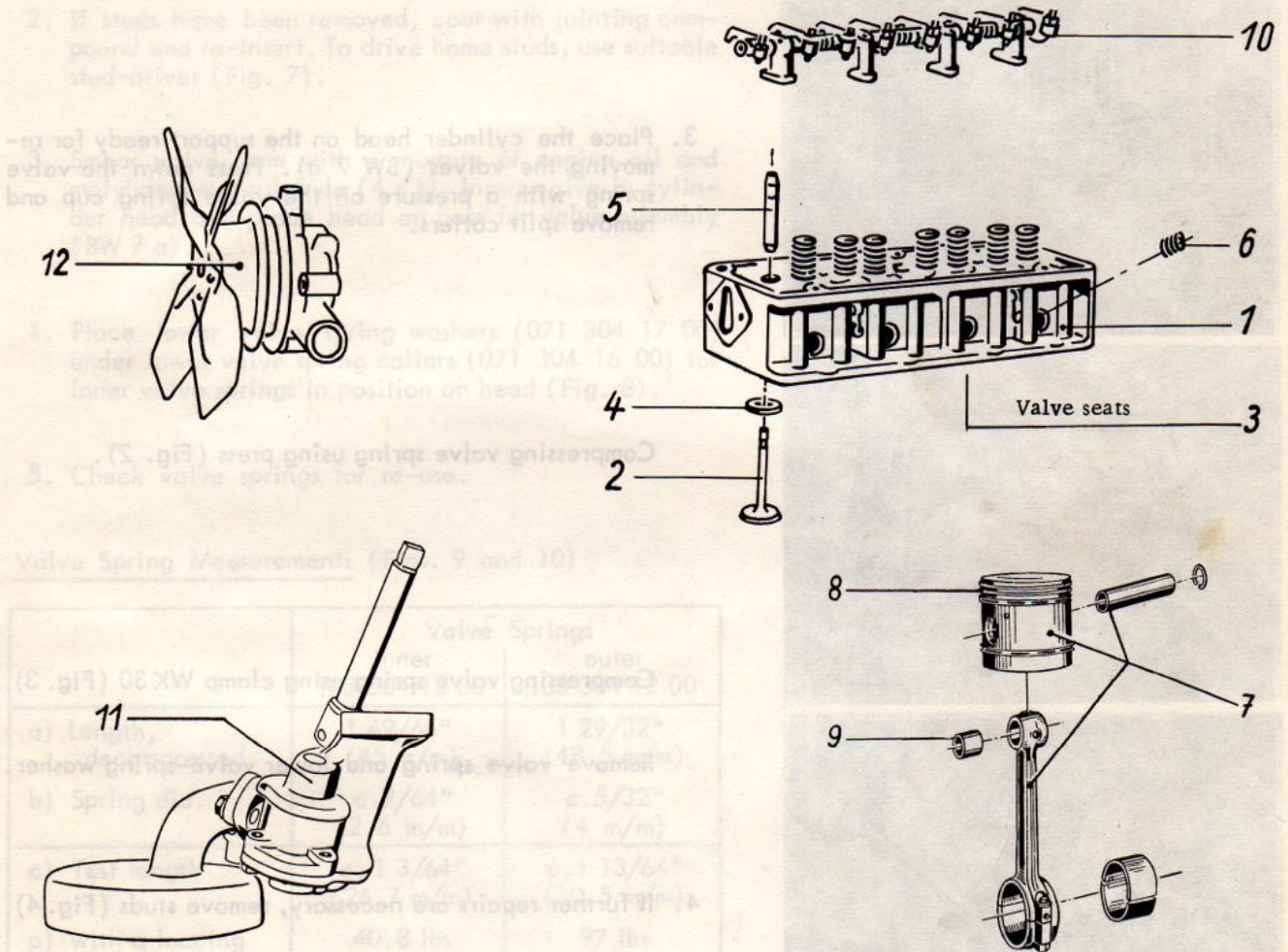




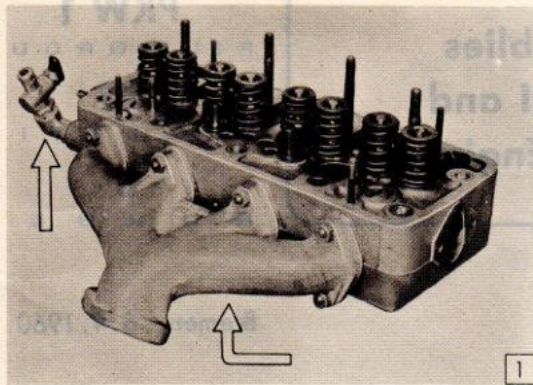
Repair of Assemblies for Type 4 M 1.5 II and Type 4 M 1.5 II TS Engines

Bremen, 6.4.1960

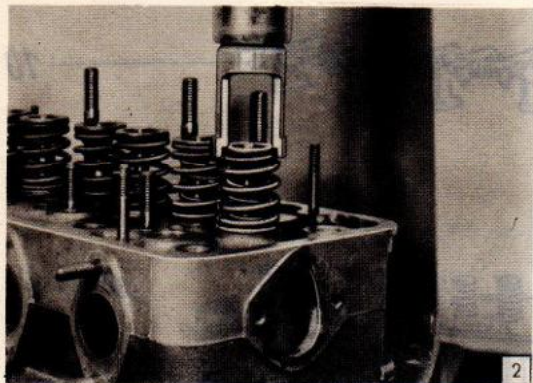


The following jobs are dealt with: -

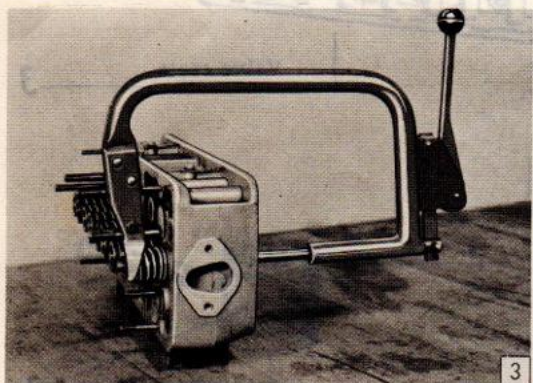
Fig.	Job	Ref: No.	Page
1.	Dismantling and assembly of cylinder head	302 40	2
2.	Turning or grinding valve face	302 83	4
3.	Machining valve seats	302 85	5
4.	Replacing valve inserts	302 81	6
5.	Replacing valve guides	302 13	6
6.	Sparking plug screw insert replacement	302 17	7
7.	Dismantling and re-assembly of piston and connecting-rod	303 12	8
8.	Removal and fitting of piston rings	303 13	8
9.	Replacement of little end bushes, fitting gudgeon pins	303 83	9
10.	Dismantling and re-assembly of rocker-shaft	304 40	11
11.	Dismantling and re-assembly of oil pump	305 40	11
12.	Dismantling and re-assembly of water pump	168 40	13



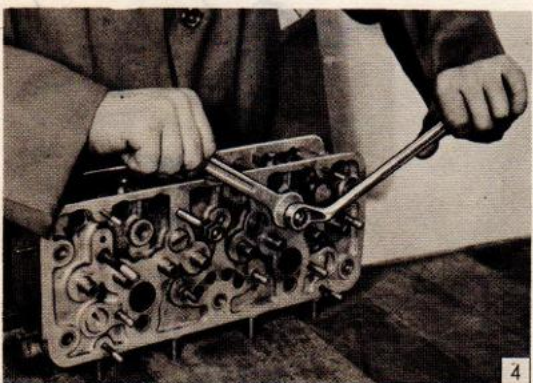
1



2



3



4

Dismantling and re-assembling Cylinder Head

(Job No. 302 40)

Dismantling

1. Remove heater stop-cock and elbow (Fig. 1).

Remove sparking plugs.

2. Remove exhaust manifold (Fig. 1).

3. Place the cylinder head on the support ready for removing the valves (BW 7 a). Press down the valve spring with a pressure on the valve spring cup and remove split cotters.

Compressing valve spring using press (Fig. 2).

Compressing valve spring using clamp WK 30 (Fig. 3).

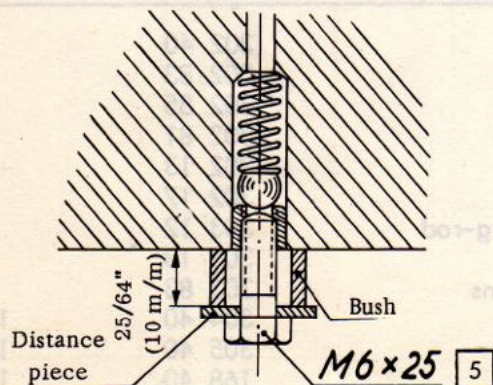
Remove valve spring and lower valve-spring washer.

4. If further repairs are necessary, remove studs (Fig. 4).

To remove studs, use two hexagonal nuts screwed one against the other.

5. If necessary for further repairs, remove non-return oil valve.

To do this, screw M6 screw into bush which is pressed into head, and draw out bush with screw using distance piece and washer (Fig. 5).



Assembly

The cylinder head is ready for assembly. i. e. Valve seats have been machined and valve guides replaced or checked for re-use. The face of the cylinder head is checked for truth and re-faced if need be.

1. Fit non-return oil valve (Fig. 6).

Important! The countersunk seat in the bore of the bush must face the ball-valve.

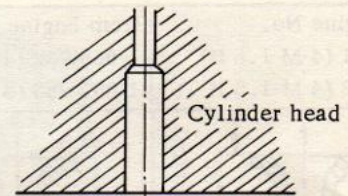
2. If studs have been removed, coat with jointing compound and re-insert. To drive home studs, use suitable stud-driver (Fig. 7).
3. Smear valve stem with a mixture of engine oil and molybdenum disulphide (4 : 1). Insert valve in cylinder head and place head on base for valve assembly (BW 7 a).
4. Place lower valve spring washers (071 304 17 00) under lower valve spring collars (071 304 16 00) for inner valve springs in position on head (Fig. 8).
5. Check valve springs for re-use.

Valve Spring Measurements (Figs. 9 and 10)

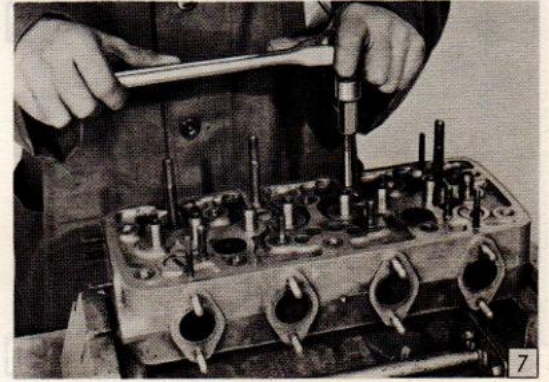
	Valve Springs	
	inner 103 304 13 00	outer 103 304 12 00
a) Length, decompressed	1 49/64" (45 m/m)	1 29/32" (48.5 m/m)
b) Spring dia.	c. 7/64" (2.6 m/m)	c. 5/32" (4 m/m)
c) Test length	c. 1 3/64" (26.7 m/m)	c. 1 13/64" (30.5 m/m)
p) with a loading of	40.8 lbs (18,5 kg)	97 lbs (44 kg)
permissible variation	± 2.43 lbs (1.1 kg)	5.73 lbs (2.6 kg)

Test valve springs with suitable valve spring testing gear (e. g. Matra No. 012 C 075).

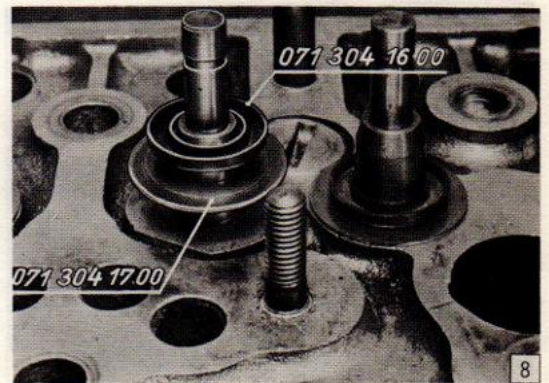
6. Place valve springs in position and fit upper valve spring cups.



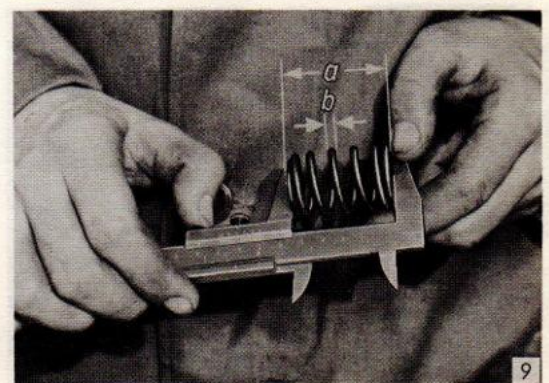
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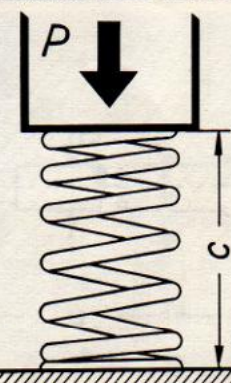
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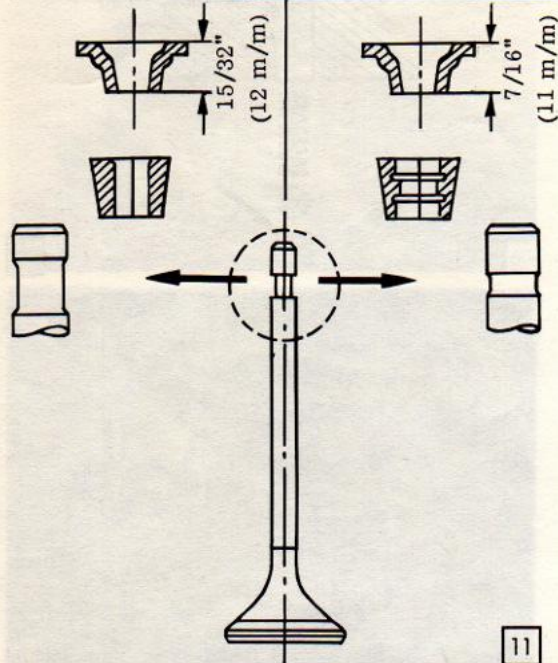


9



10

up to Engine No. 1 065 731 (4 M 1.5 II) 1 331 962 (4 M 1.5 II TS)	from Engine No. 1 065 732 (4 M 1.5 II) 1 331 963 (4 M 1.5 II TS)
---	--



7. Compress valve springs and insert split cotters.

Important! When replacing parts, the type of valve, valve spring cup and cotter should be carefully noted (Fig. 11).

(see also KD Circular No. PKW 1/30/5)

Check the length of outer valve spring when assembled:-

4 M 1.5 II	1 19/32" (40.5 m/m)
4 M 1.5 II TS	1 9/16" (39.5 m/m)

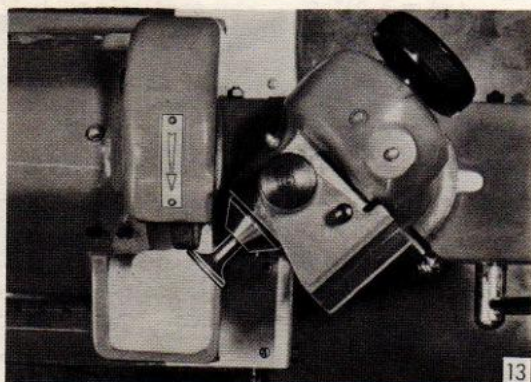
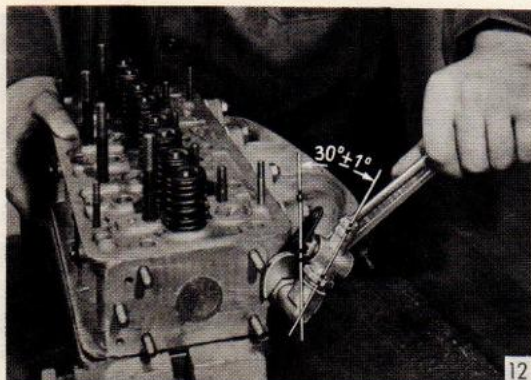
Should the above measurement be too great owing to machining of the valve seat, extra washers (Part No. 071 304 17 00) should be inserted under the valve springs.

8. Fit heater stop-cock and elbow using jointing compound. Ensure that elbow is assembled at the correct angle (Fig. 12).

9. Screw sparking plugs into cylinder head.

The following plugs are officially approved for use:-

Maker	4 M 1.5 II	4 M 1.5 II TS
Bosch	W 175 T 1	W 225 T 1 or W 175 T 1 (cementless type)
Beru	175/14	225/14
Champion	L-85	L-85



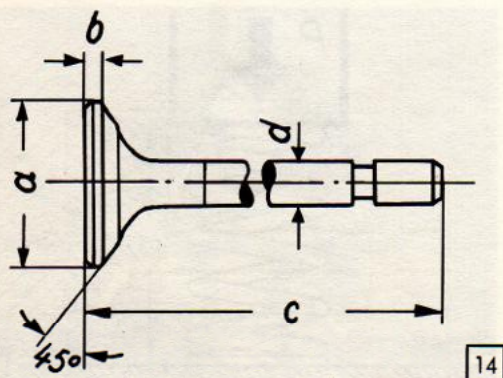
10. Fit exhaust manifold to cylinder head.

Re-facing valves (302 83)

If the valve face shows signs of burning or traces of deposits, it should be reground before re-use. This can be done either by grinding or by careful turning (Fig. 13).

Valve face measurements: (Fig. 14)

	4 M 1.5 II		4 M 1.5 II TS	
	Inlet	Exhaust	Inlet	Exhaust
a) Head dia.	1.38" ± .008 (35 ± 0.2)	1.18" ± .008 (30 ± 0.2)	1.42" ± .008 (36 ± 0.2)	1.22" ± .008 (31 ± 0.2)
b) Head thickness (to chamfer)	.039" ± .004 (1 ± 0.1)	.079" ± .006 (2 ± 0.15)	.039" ± .004 (1 ± 0.1)	.079" ± .006 (2 ± 0.15)
d) Length o.a.	4.331" ± .004 (110 ± 0.1)	4.37" ± .004 (111 ± 0.1)	4.37" ± .004 (111 ± 0.1)	4.409" ± .004 (112 ± 0.1)
d) Stem dia.	for every 9 e 7 = .3527" - .3533" (8.960 - 8.975)			



Machining Valve Seats (302 85)

The valve seats may be re-cut by either milling or turning with a valve-seating tool.

A) Re-cutting valve seat with turning tool (Fig. 15).

B) Re-cutting valve seat with milling tool (Fig. 16).

It is advisable to clean the seats with emery cloth before re-cutting them in order to protect the milling cutter!

Important! Should it be necessary to replace the valve guides, this should be done before the valve seats are re-cut (see Job No. 302 13, page 6).

Work Sequence:-

1. First machine the 45° valve seat (Fig. 17). In this connection enough metal only should be removed so that the seat is just re-cut all the way round and no irregularities remain unmachined.
2. Re-cut the 15° angle of the valve seat to give measurement "b". If by re-cutting the 15° angle, too much metal is removed from the head, the valve seat insert must be replaced (Fig. 18).

b) Seat dia. outer	Inlet	Exhaust
4 M 1.5 II	1 23/64" (34.5 m/m)	1 5/32" (29.5 m/m)
4 M 1.5 II TS	1 25/64" (35.5 m/m)	1 13/64" (30.5 m/m)

3. By machining the 75° chamfer, cut the width of the valve seat to the correct dimensions.

Valve Seat Width (Fig. 19)

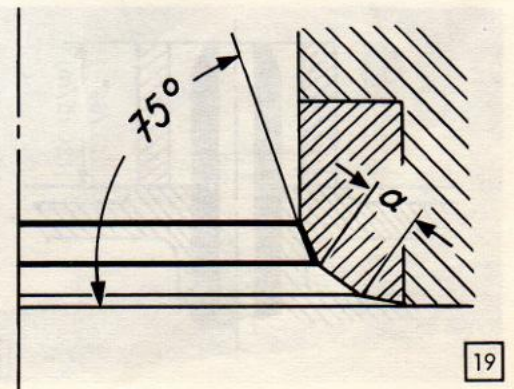
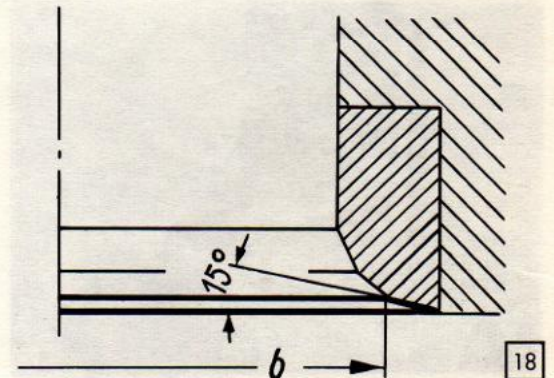
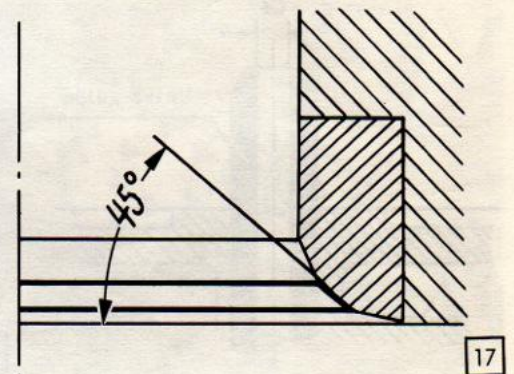
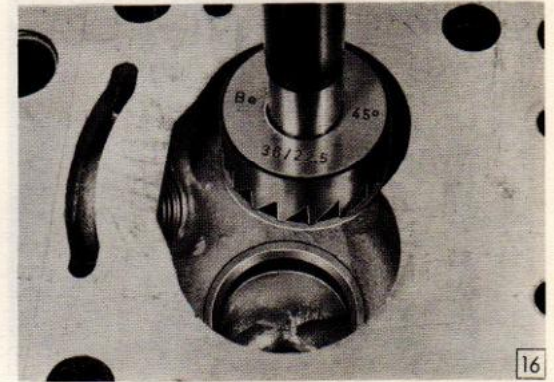
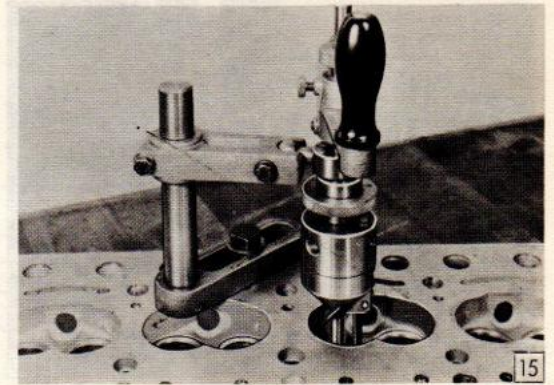
$a = .047'' - .055''$ (1.2 - 1.4 m/m) Inlet

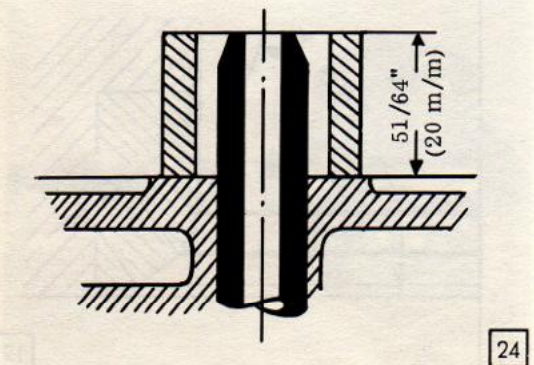
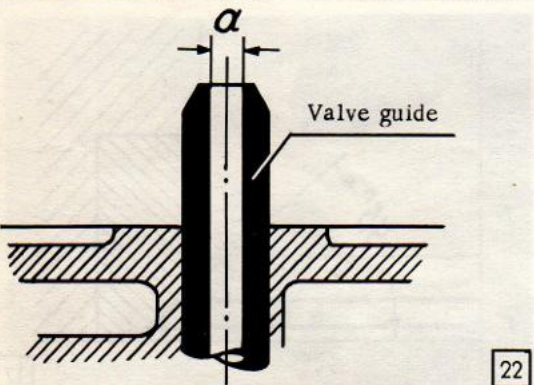
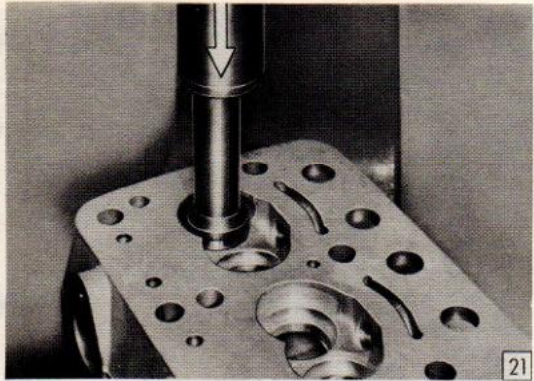
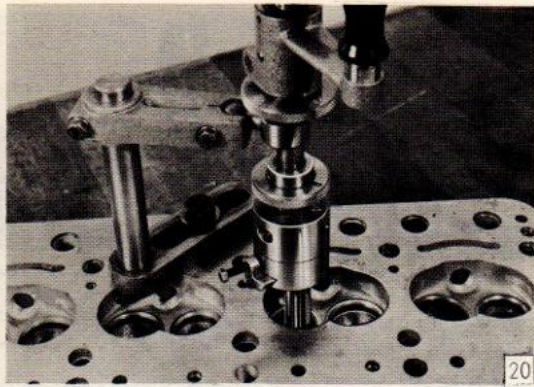
$a = .079'' - .087''$ (2.0 - 2.2 m/m) Exhaust

Grinding-in the valve to the valve seat using grinding paste is not always necessary. With re-machined seats and new or re-ground valves, proper seating may be obtained by testing the seating impression. To do this, smear the valve face lightly with marking blue and turn in valve seat under slight pressure.

If a 360° impression is not obtained, grinding-in is essential.

After grinding-in, the valve and valve seat must be carefully cleaned of all trace of grinding-in paste.





Replacing Valve Inserts (303 81)

The renewal of valve inserts demands a certain set of conditions which are necessary to ensure a satisfactory grip on the insert by the head. If the following measures are not practical, then the old part should be discarded and the cylinder head replaced.

1. Turn old valve insert out using special insert turning tool. Take great care that the insert seat in the cylinder head is untouched (Fig. 20).
2. Heat cylinder head up to 176-194° F (80-90° C) in hot water bath.
3. Cool valve insert down to -76° F (-60° C) in solidified carbon dioxide for about 5-10 minutes. For use of carbonic acid dry ice: c. -108° F (-78° C).

Caution for use of carbonic acid dry ice: Never handle container or the insert with the naked hand. Always use pliers when handling the insert!

4. Remove insert quickly with pliers and with mandrel insert into the warmed head (Fig. 21).

Important! Ensure that the chamfer of insert faces upwards.

The insert must fit true in the depression in the cylinder head to ensure proper heat dissipation.

Further re-cut the valve insert seat as in Job No. 302 85 (see page 5).

Replacing Valve Guides (302 13)

First check internal diameter of valve guide for re-use (Fig. 22).

a) Internal dia. (new)	.354"-.355" (9.000-9.022 m/m)
Wear tolerance	.358" (9.10 m/m)

If the maximum permitted tolerance has been reached or exceeded, the valve guide must be replaced.

1. Press out valve guide in the direction of combustion chamber using drift WK 44 A (Fig. 23).
2. To insert new valve guide, heat up cylinder head to 176 - 194° F (80 - 90° C) and cool valve guide in solidified carbon dioxide (see preparations for insertion of valve seat inserts above).

Check measurements, using distance piece if necessary (Fig. 24).

- After insertion, the valve guides are finished to their final dimensions using a swaging tool or a special valve guide reamer (Matra 000 107) (Fig. 25).

Important!

Do not remove burrs from top of the valve guide bore (oil scraper effect).

Replacement of Sparking Plug Screwed Inserts (302 17)

- On engines up to No. 1 003 647 (4 M 1.5 II) and No. 100 669 (4 M 1.5 II TS), the cylinder head is fitted with screwed bushes which can be inserted and withdrawn with tool No. WK 61 (Fig. 26).

Procedure:-

- When the cylinder is fitted in position, remove sparking plug and stop up plug hole with stopper.
- Drill out locating peg between cylinder head and bush (1/8" or 3 m/m drill). Remove drill chippings and extract stopper.
- Screw mandrel of WK 61 tightly into the bush and tighten sleeve to the left until the bush is screwed out.

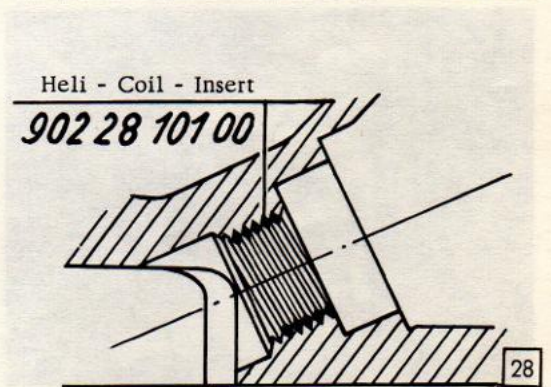
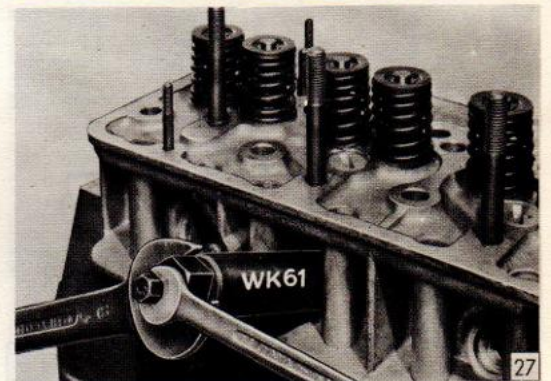
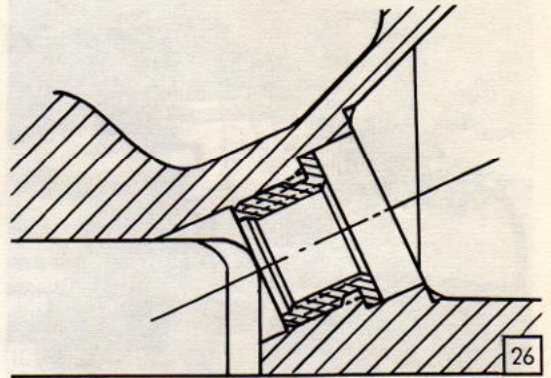
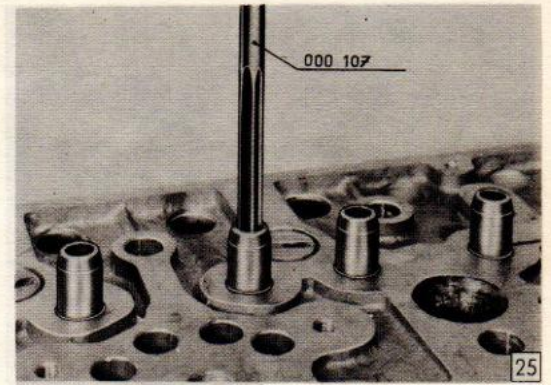
Insertion of a new bush follows the reverse sequence.

When inserting new bush, smear outer screw thread with "water glass".

After inserting new bush, re-drill and drive in 3 m 6 x 6 DIN 7 securing pin.

- On engines from No. 1 003 648 (4 M 1.5 II) and No. 100 670 (4 M 1.5 II TS) onwards, the so-called "Heli-Coil" screwed insert is fitted to receive the sparking plug (Fig. 28).

It will be found that it is not always necessary to replace this insert with a new part. Only if an insert has been loosened when unscrewing a sparking plug must a new Heli-Coil screwed insert be provided. For this, a special insertion tool is necessary (Fig. 29). This is included in the recommended screw repair outfit as set out in KD Circular No. KD-Org. 1/1.



Dismantling and Re-assembly of Piston and Connecting Rod (303 12)

Dismantling:-

1. Remove circlips retaining the gudgeon pin (Fig. 30).
2. Heat up piston with electrical warming device or in a hot chamber and drive out gudgeon pin with drift (Fig. 31).

Assembly:-

Before assembly, the gudgeon pin should be fitted to the little end bush (see Job No. 303 83, page 9). The piston should be selected according to the diameter of the cylinder bore.

1. First check that the colour markings of the gudgeon pin and the piston (inside the piston) correspond (Fig. 32).

Colour	Gudgeon Pin dia. a	Gudgeon Pin Bore in Piston dia. b
yellow/ black	.8659" - .8660" (21.994-21.997)	.8658" - .8659" (21.992-21.995)
green/ white	.8660" - .8661" (21.997-22.000)	.8659" - .8660" (21.995-21.998)

2. Heat piston up to about 176° F (80° C) with an electrical warming device or in a hot chamber, but not under any circumstances over a naked flame, as this may destroy the running-in film and lead to an eventual seizing of the piston.

3. Tighten the connecting rod in the vice using protective clamps in such a way that the piston is still movable when correctly aligned. Smear the gudgeon pin with oil.

4. Place the warmed piston correctly aligned over the connecting rod and insert gudgeon pin quickly using the guide mandrel.

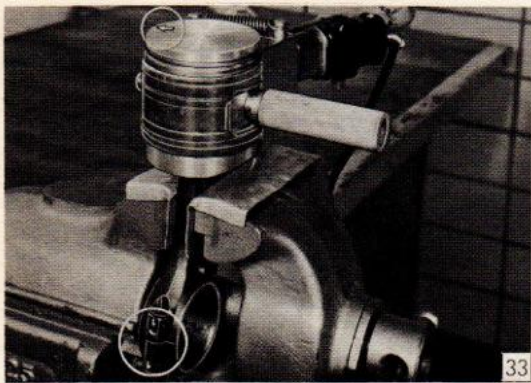
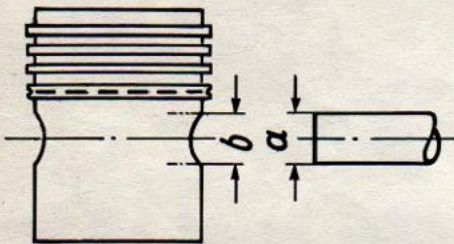
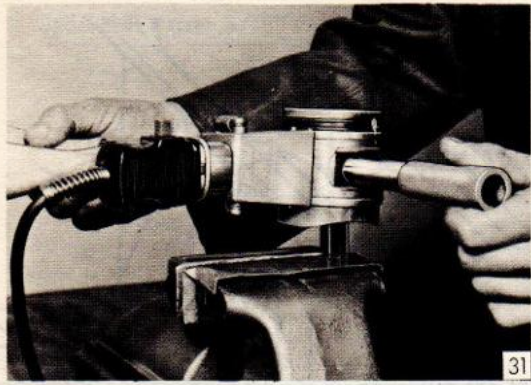
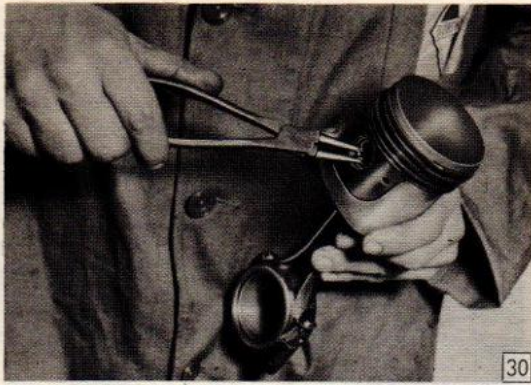
Relative position:- Connecting rod numbers to the front and arrow on the piston crown on the left (Fig. 33).

5. Centre the gudgeon pin and secure with circlips.

Removal and Fitting of Piston Rings to Piston (303 13)

Use a special pair of pliers to remove and fit piston rings (Fig. 34).

(e. g. Schwenk-Ideal. Formerly WK 29).



Unless the removal of the piston rings is absolutely essential, they should be left in position on the piston.

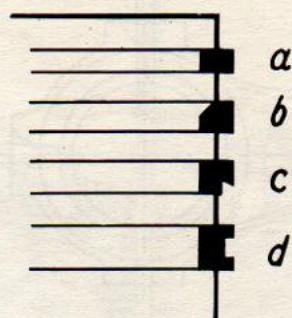
When assembling, care must be taken to ensure that the rings are fitted in the appropriate grooves of the piston (Fig. 35).

(Designation of Rings for normal dia.)

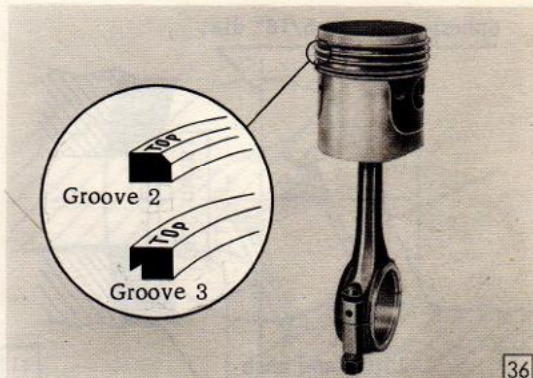
- a) Groove No. 1 Compression ring 10 f 75/68.4 x 2
- b) Groove No. 2 Internally chamfered ring 12 f 75/68.4 x 2c
- c) Groove No. 3 Stepped compression ring 30 f 75/68.4 x 2.5
- d) Groove No. 4 Slotted oil control ring 41 f 75/68.4 x 4.5

When fitting rings in grooves Nos. 2 and 3, observe the markings "top" or "oben" (Fig. 36).

The fitted rings should be turned so that the ring gaps are at an angle of 90° to each other.



35



36

Checking the Clearance of the Piston Rings

Measure the clearance by means of a feeler gauge inserted in the groove (Fig. 37).

Permissible clearance	.0014" - .0024" (0.035 - 0.062 m/m)
Wear limit	.004" (0.1 m/m)



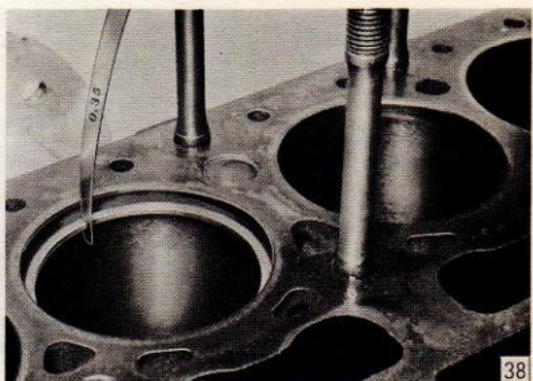
37

Checking the Piston Ring Gap

Insert the ring in the appropriate cylinder bore.

The ring must be parallel to the top of the block and some 3/8 - 3/4" (10 - 20 m/m) down the bore. Check the gap by means of a feeler gauge (Fig. 38).

Measurement of Gap	.012" - .018" (0.3 - 0.45 m/m)
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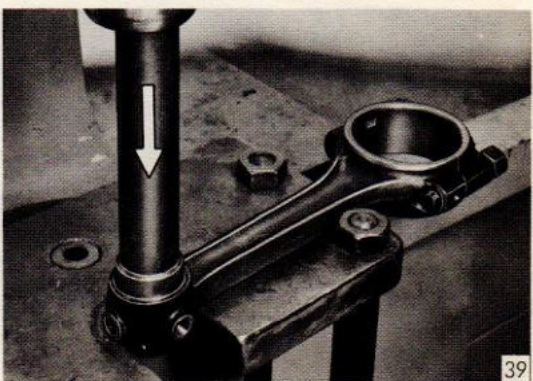


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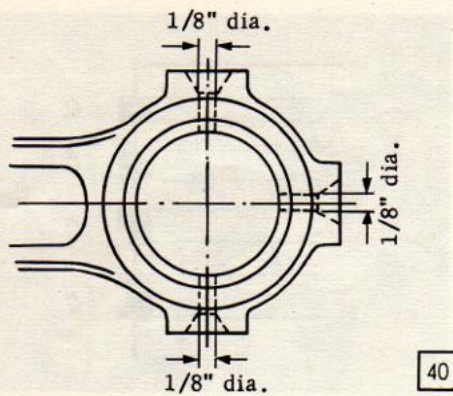
Replacement of Little End Bushes and Fitting Gudgeon Pins (303 83)

Little end bushes showing signs of undue wear should be replaced as set out hereunder.

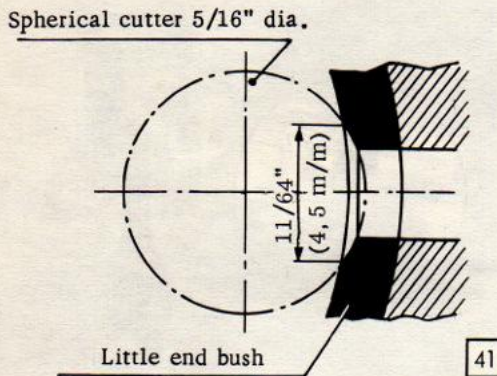
1. Press out old little end bush (Fig. 39). Use suitable mandrel. Clean out little end bore in connecting rod.



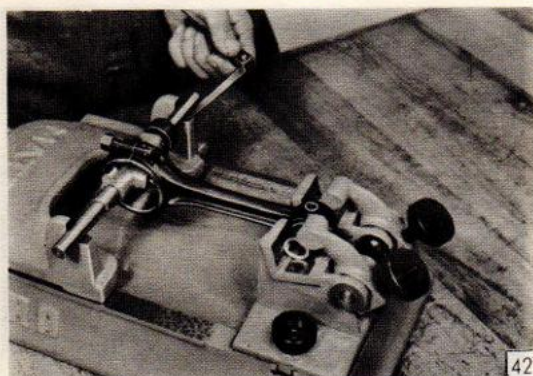
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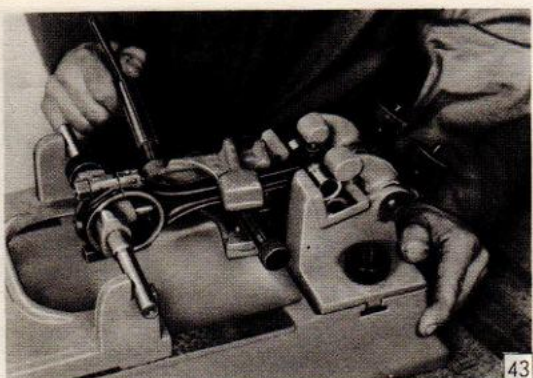
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41



42



43



44

2. Press new little end bush into connecting rod using mandrel.
3. Drill oil holes in little end bush using c. 1/8" (3 m/m) drill (3 off) (Fig. 40).
4. Countersink oil holes inside little end bush with 5/16" (8 m/m) spherical cutter. The depression should be 11/64" (4.5 m/m) across (Fig. 41).
5. Ream out little end bush to finish size and fit gudgeon pin. Use piloted reamer.

Little End Bush (fitting dia.)	Gudgeon Pin dia.	Identification Colour
.8665 - .8667 (22.011-22.014)	.8660 - .8666 (21.997-22.000)	white/green
.8663 - .8665 (22.008-22.011)	.8659 - .8660 (21.994-21.997)	black/yellow
.8664 - .8666 (22.009-22.012)	*	colourless

*) Gudgeon pins of both sizes (black or white) may be fitted.

6. Weigh the connecting rod.

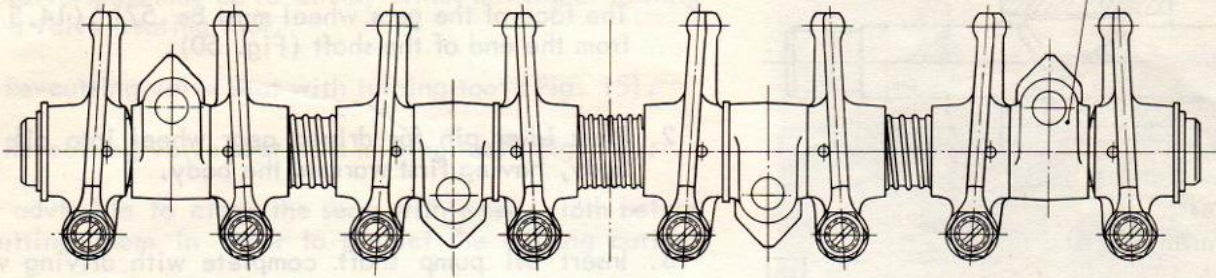
The difference in weight between the connecting rods of an engine may not exceed .176 oz (5 grams).

7. Check that the big and little ends are absolutely parallel.

To do this, insert gudgeon pin in little end and mount the connecting rod in testing rig (Fig. 42).

Should the two bearings deviate from true, the connecting rod must be bent sufficiently in a special jig (Figs. 43 and 44).

Bearing block with oil hole



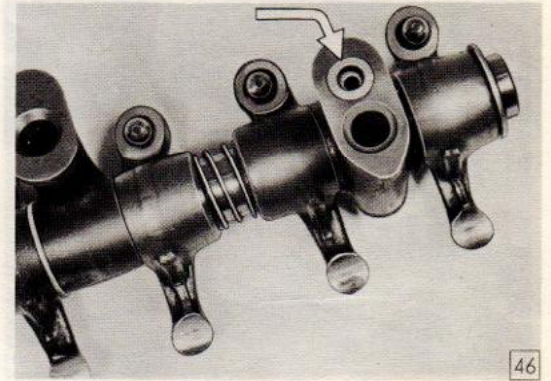
45

Dismantling and Re-assembly of Rocker Shaft (304 40)

When parts of the rocker shaft are to be exchanged, the sequence and direction of the rockers and their associated parts must be carefully observed (see Fig. 45).

Important!

The rear bearing block is provided with an oil hole. A sealing ring (000 982 03 00) is fitted in the counter-sunk oil hole (Fig. 46).



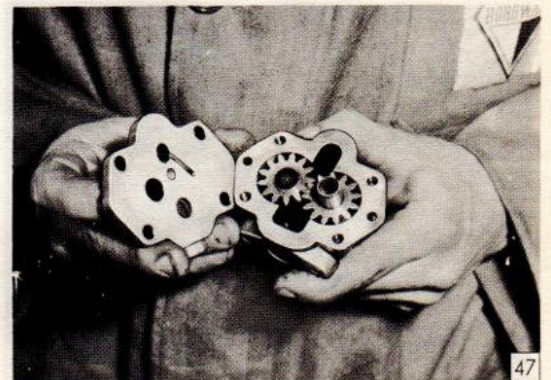
46

Dismantling and Re-assembly of Oil Pump (305 40)

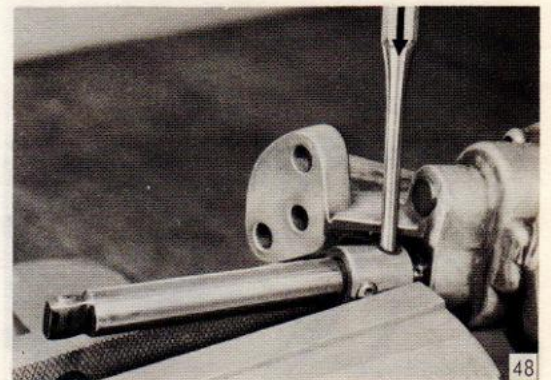
Dismantling:-

1. Remove strainer from oil pump inlet; by loosening hexagonal screw.
2. Remove inlet body.
3. Remove oil pump cover with built-in pressure relief valve (Fig. 47).
4. Drive out cylindrical pin from driving bush and detach oil pump drive shaft (Fig. 48).
5. Take the driven gear wheel complete with shaft out of oil pump body. Remove gear wheel from idler pin.
6. Drive taper pin out from oil pump cover and remove individual pieces of pressure relief valve.
7. If necessary, press idler pin out of oil pump housing.

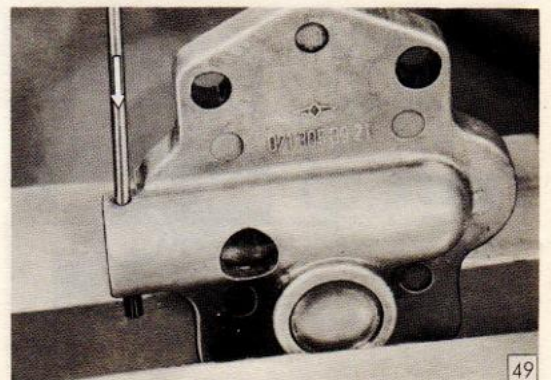
Before commencing re-assembly, the driving shaft bush in the oil pump body should be checked. If it shows signs of wear, the body should be replaced.



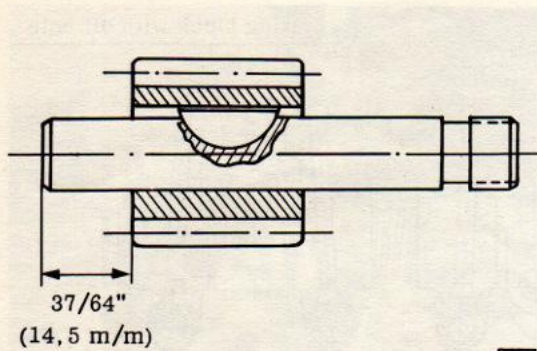
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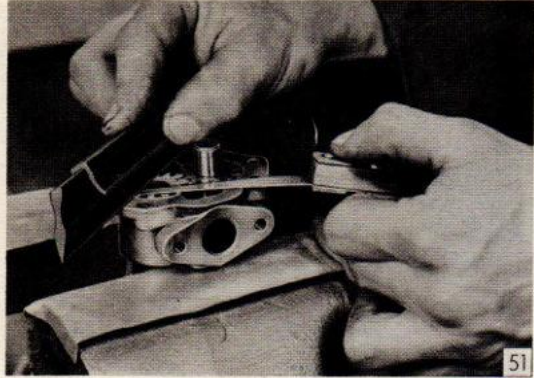
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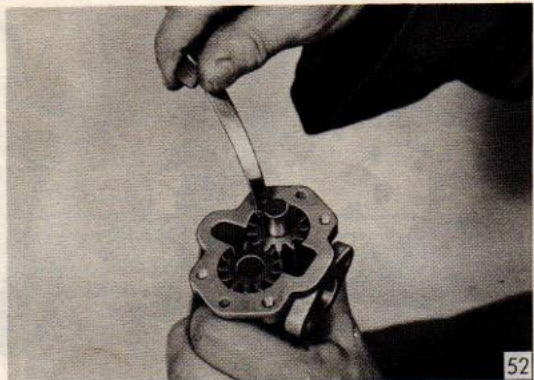
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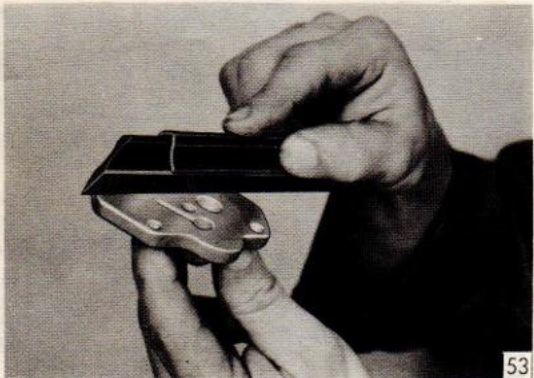
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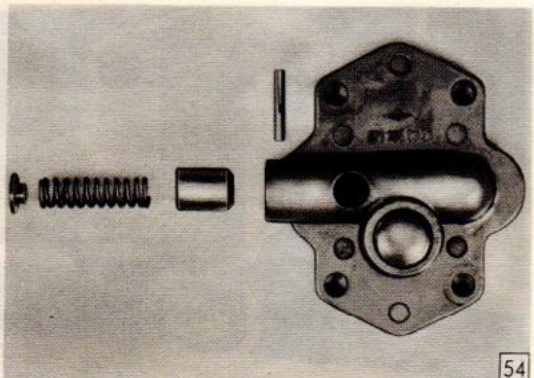
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52



53



54

Assembly:-

1. Insert key in oil pump shaft and press on gear wheel. The face of the gear wheel must be .571" (14.5 m/m) from the end of the shaft (Fig. 50).
2. Press idler pin for driven gear wheel into oil pump body, having first warmed the body.
3. Insert oil pump shaft complete with driving wheel into oil pump body, together with driven wheel.
4. Check the clearance of the gear wheels in the oil pump body. Place a knife edge over the face of the pump body and determine the clearance with a feeler gauge (Fig. 51).

Permissible Play .0012" (0.03 m/m)

If the clearance exceeds the above figure, the gear wheels and shaft must be dismantled and the face of the oil pump body machined down to suit.

5. The sideways play of the gear wheels in relation to the walls of the pump body should also be checked using a feeler gauge (Fig. 52).

Permissible Side Play .0008" (0.02 m/m)

If the sideways play is greater than that permitted, the oil pump body must be replaced and if necessary, the gear wheels also.

6. Check the oil pump cover with a knife edge (Fig. 53). If it has been worn, or is uneven, it should be machined flat or replaced with a new part.
7. Insert oil pressure relief valve, observing the correct sequence of the parts (Fig. 54). Check that the relief valve piston moves freely.
8. Fit oil pump cover and secure with hexagonal headed screws.
9. Fit drive shaft with driving bush to oil pump shaft. Insert cylindrical pin and secure with centre punch.
10. Insert strainer in pump inlet body and fit inlet body to oil pump with gasket joint.

Dismantling and Re-assembly of Water Pump (168 40)

Dismantling:-

1. Remove fan blade.
2. Press off fanbelt pulley using mandrel (Fig. 55).
3. Remove circlip (Fig. 56).

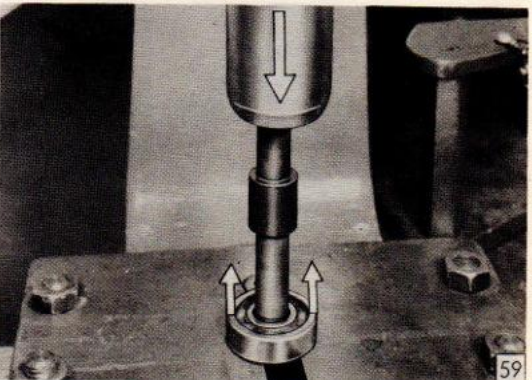
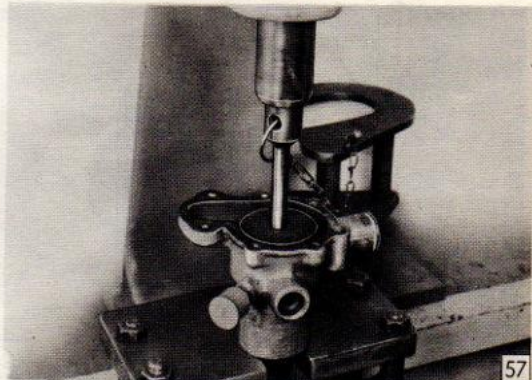
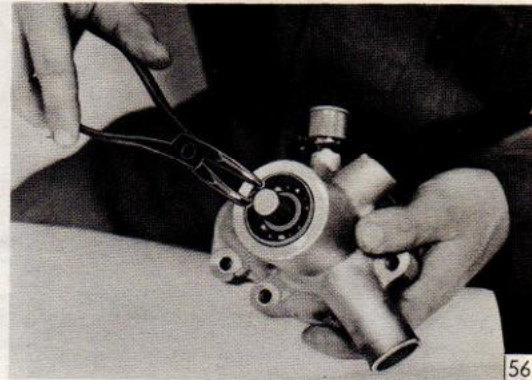
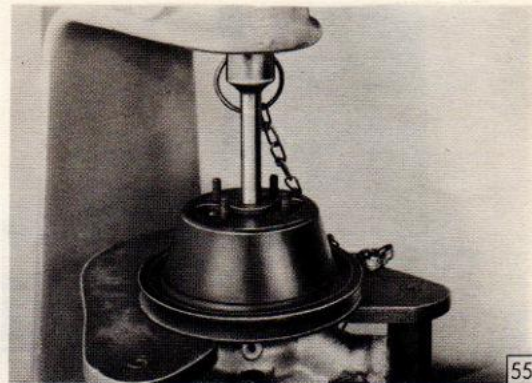
Take out "Nilos" ring and tension washer.

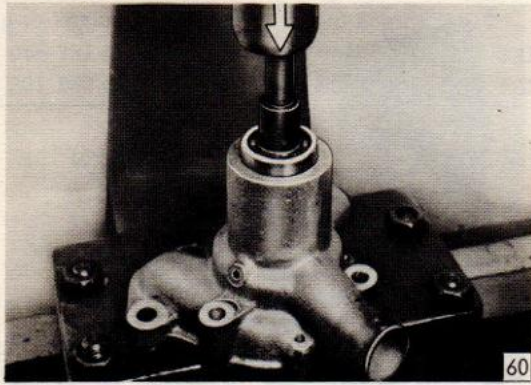
4. Remove cover from water pump.
5. Press water pump shaft out about 25/32" (20 m/m) from the impeller side (Fig. 57). Take out impeller.
6. Cut the seating ring of the sealing gland at two points with a cross-cut chisel and extract the gland seal from the pump body with a pair of pliers (Fig. 58).
7. Press out water pump shaft and ball race and remove washer, felt ring holder and felt ring.
8. Press ball-race off water pump shaft.

Assembly:-

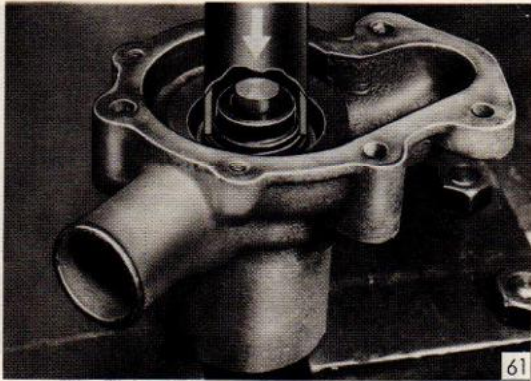
Check that all parts as suitable for re-use and where necessary, replace with new parts.

1. Insert washer, felt ring and felt ring retainer in water pump body. Use suitable piece of metal for pressing in.
2. Press ball-race on long side of water pump shaft up to the shoulder (Fig. 59).

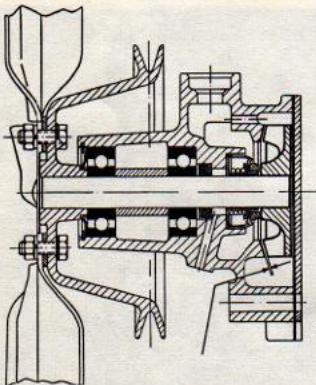




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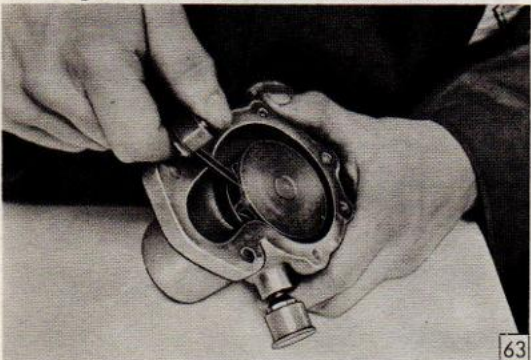


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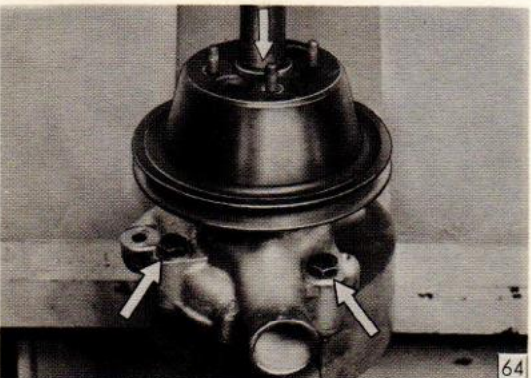


62

Working clearance max. .020" (0.5 m/m)



63



64

3. Press water pump shaft complete with No. 1 ball-race into pump body (Fig. 60).
4. Fill bearing side of water pump body about 1/3 full with ball-race or general-purpose grease.
5. Fit No. 2 ball-race onto shaft and press into pump body.
6. Press "Nilos" ring, tension washer and circlip into pump body.
7. Insert sealing gland into water pump body using suitable piece of tube to press it in (Fig. 61).
8. Press impeller on the water pump shaft. At the same time, hold a thin strip of metal .012 - .020" (0.3 - 0.5 m/m) thick between the impeller and the inner face of the water pump body.

Working Clearance max. .020" (0.5 m/m)
(Fig. 62)

Check working clearance between inner face of water pump body and impeller with a feeler gauge (Fig. 63).

9. Screw fan blade holding bolts through fanbelt pulley from the pump side with tab washers. Lock bolt heads against turning.
10. Insert the holding bolts shown in Fig. 64 with soft iron washers into water pump body. Warm up pulley and press on shaft up to the shoulder (Fig. 64).
11. Fit water pump cover and gasket to pump body.
12. Attach fan blades.

1. BORGWARD Special Tools-

WK 44 A Drift for Valve Guide .354 x .587" (9 x 14.9 m/m) dia.
WK 61 Plug Insert Extraction and Insertion Tool

2. Useful Tools and Measuring Instruments and Gauges (Commercial)

Valve Spring Compressor
Sparking Plug Spanner
.354" (9 m/m) Piloted Valve Guide Reamer (Matra 000 107)
Piston Ring Pliers (e.g. Schwenk-Ideal)
.866" (22 m/m) Adjustable Reamer (Fa. Hunger)
Connecting Rod Test Jig with Bending Attachment
.315" (8 m/m) Cylindrical Cutter
.118" (3 m/m) Drill
Valve Grinder or Lathe
Set of Milling Tools for Machining Valve Seats (15°, 45°, 75°)
Attachment for above or Valve Seat Turning Tool
"Heli-Coil" Insert Repair Kit (see Org.1/1)
.00 - .984" (0 - 25 m/m) Micrometer
Vernier Calipers
Feeler Gauges .0007, .0012, .0016, .0019" (0.02, 0.03, 0.04, 0.05 m/m)
Valve Spring Testing Gear
Knife Edge

3. Homemade Tools and Jigs

BW 7 a Base-plate for Valve Assembly

