

ENGINE 4 M 1.5 II

## General Description

The four cylinder engine has a bore of 75 mm and a stroke of 84 mm. The relatively low mean piston speed of appr. 10.1 m/sek. ensures a long piston life when the car is driven in the normal speed range. The three bearing crankshaft is drop forged in one operation and has hardened journals, the first main bearing, (Flywheel side), takes the end float. Main bearings, as well as bigend inserts are made of Super Micro material. All admissible clearances as well as undersizes for main- and bigend bearings (inserts) are quoted on the technical data page. Main bearing cap bolts as well as connecting rod bolts are expanding bolts. These expanding bolts (10 K material) must be fitted with a torque according to instructions and must not be re-used. No locking devices are employed in connection with expanding bolts.

Besides the standard size piston, suitable for 75 mm bore, there are 3 undersizes, 1, 2, and 3, the different sizes varying by 0.01 mm (.00039"). The various numbers 0 - 3 are marked on the engine block surface by the factory. To ensure piston clearance of 0.04 mm (.00157"), pistons must not be interchanged.

Camshaft setting is marked on both timing pinions and must not be altered. For alteration possibilities of the valve timing see group M 3 working process 30. With the standard setting, as marked on the timing pinions, valve timing is obtained as quoted on the following technical data pages. Valveplay must be adjusted on warmed up running engine. (See group M Engine M 10).

DIMENSIONS and TOLERANCES

a) Cylinder block

Cylinder bore limit: Cylinder blocks are marked by the factory  
No. 0 - 3 on surface.

	Bore Diameter	Piston Diameter
Size 0	75.00 - 75.009	74.96
Size 1	75.01 - 75.019	74.97
Size 2	75.02 - 75.029	74.98
Size 3	75.03 - 75.039	74.99

b) Crankshaft

(Drop forged in one working process, journal surface hardened).  
Three bearing crankshaft.

Main bearing bore in block in mm:  $59 \varnothing H 6 = 59 \left( \begin{matrix} + 0.019 \\ + 0.000 \end{matrix} \right) \varnothing$

Main Journal in mm:  $55 \varnothing h 6 = 55 \left( \begin{matrix} + 0.000 \\ - 0.019 \end{matrix} \right) \varnothing$

Main Bearing Material: Super Micro  
Main Journal Dimensions in mm: 1st bearing  $55 \varnothing \times 39 H 8 = 39 \left( \begin{matrix} + 0.039 \\ + 0.000 \end{matrix} \right)$   
2nd and 3rd bearing  $55 \varnothing \times 32$

For Main Bearing 1

Dimensions of Main Shells	Journal Dia.	Length of Shells	Wall Thickness
Standard	55.0 h 6	38.83 - 38.88	1.960 - 1.968
Undersize 0.25 mm(.0098")	54.75 h 6	38.93 - 38.98	2.085 - 2.093
Undersize 0.5 mm(.0197")	54.5 h 6	39.03 - 39.08	2.210 - 2.218
Undersize 0.75 mm(.0295")	54.25 h 6	39.13 - 39.18	2.335 - 2.343
Undersize 1.0 mm(.0394")	54.0 h 6	39.23 - 39.28	2.460 - 2.468

For Main Bearings 2 and 3

Standard	55.0 h 6		1.960 - 1.968
Undersize 0.25 mm(.0098")	54.75 h 6		2.085 - 2.093
Undersize 0.5 mm(.0197")	54.50 h 6	28 0.1	2.210 - 2.218
Undersize 0.75 mm(.0295")	54.25 h 6		2.335 - 2.343
Undersize 1.0 mm(.0394")	54.0 h 6		2.460 - 2.468

Crankpin dia.  $48 \varnothing h 6 = 48 \left( \begin{matrix} + 0.000 \\ - 0.016 \end{matrix} \right)$   
and length in mm Length = 29 H 8

Material of Connecting Rod Inserts (Shells): Super Micro

Dimensions of Connrod Inserts	Crankpin Diameter	Length of Inserts (Shells)	Wall Thickness
Standard	48.0 h 6		1.962 - 1.970
Undersize 0.25 mm(.0098")	47.75 h 6		2.087 - 2.095
Undersize 0.5 mm(.0197")	47.50 h 6	25 - 0.1	2.212 - 2.220
Undersize 0.75 mm(.0295")	47.25 h 6		2.337 - 2.345
Undersize 1.0 mm(.0394")	47.0 h 6		2.462 - 2.470

Admissible running clearance in center main with fixed end mains 0.04 mm (.00157")

Admissible untrue in journal and crankpin 0.006 mm (.000236")

Admissible angle of taper in bearing length 0.01 mm (.000394")

Admissible eccentricity between main-bearing and flange 0.01 mm (.000394")

Main bearing running clearance 0.04 - 0.06 mm  
(.00157 - .00236")

Main bearing end float 0.12 - 0.209 mm  
(.0472 - .114")

Torque - Maincap bolt 10,0 m/kg or 70 ft/lb

c) Connecting rod and piston

Length of connecting rod from center to center 160 mm or appr. 6.19/64  
Connrod bigend dia. (less shells)  $52 \text{ mm } H 6 = 52 \left( \begin{matrix} + 0.019 \\ + 0.000 \end{matrix} \right)$

Running clearance - Bigend inserts 0.04 - 0.06 mm  
(.00157 - .00236)

Torque Conn. rod bolt	4.5 m/kg or 35 ft/lb
Bigend end float (side clearance)	0.065 - 0.15 mm (.00255 - .00433")
Adm. weight difference of conn. rods	Maximum 5 g or 2.8 dram
Gudgeon pin (king pin) bush	25/21.6 $\phi$ x 26 mm
Gudgeon (king) pin	22/16 $\phi$ x 62 mm
Locking device	Spring ring 22 DIN 73/23
Type of piston	Solid skirt, autothermic desax. (offset) 1.5 mm or .0591"
Piston running clearance	0.04 mm or .00157"
Piston rings: Groove 1	Compression ring 75/68.4 x 2 (.078")
Groove 2	" " 75/68.4 x 2 (.078")
Groove 3	" " HN 75/68.4 x 2.5 (.0984")
Groove 4	Oil ring BS 75/68.4 x 4.5 (.177")
Up and down play of rings	0.02 mm (.000787")
Ring gap	0.1-0.3 mm (.00394 - .0118")

d) Camshaft

Camshaft bearings	3, running in engine block
Type of bearings	plain bushes WM 10 material: (lead bronze. lined steel bushes)
Drive	helical spur wheel
Bore diameter in block	45 $\phi$ H 7 = 45 (+ 0.025 ) $\phi$ (+ 0.000)
Camshaft journal dia.	41 $\phi$ f 7 = 41 (- 0.025 ) $\phi$ (- 0.05)
Bush dimensions	
Bore diameter	41 $\phi$ H 7 = 41 (+ 0.025 ) $\phi$ (+ 0.000)
Length	28 $\pm$ 0.1 mm

e) Cylinderhead (one piece L. A. casting)

Nut tightening Torque-	10.0 m / kg or 70 ft/lb
cylinderhead bolts	O. H. V.
Valve gear	Checked with valve clearance 0.38 mm or .0150"
Valve timing	
Inlet opens	18 <sup>o</sup> b. T.D.C. or 44 mm
Inlet closes	56 <sup>o</sup> a. B.D.C. or 137 mm
Exhaust opens	56 <sup>o</sup> b. B.D.C. or 137 mm
Exhaust closes	18 <sup>o</sup> a. T.D.C. or 44 mm
Flywheel diameter	280 mm or 11 1/32"
1 <sup>o</sup> measured on flywheel	2.44 mm or .0961"
Valve clearance, hot	Inlet and Exhaust valve 0.2 mm or .00787"
Valve dimensions	Inlet Exhaust, armoured
Length mm	110 (appr. 4 21/64") 111 (appr. 4 3/8")
Valve head dia. mm	35 (appr. 1 3/8") 30 (appr. 1 3/16")
Valve stem dia. mm	9 e 8 9 e 8
Valve face angle	45 <sup>o</sup> 45 <sup>o</sup>
Valve seat width	Inlet and Exhaust 1.5 - 2.0 mm (.0591" - .0787")
Valve stem - adm. untrue	0.02 mm (.000787")
Adm. untrue between stem and head	0.03 mm (.00118")
Adm. untrue - push rod	0.1 - 0.2 mm (.00394 - .00787")
Valve spring:	Poundage Length Effective Wire Diameter
Inner spring	
E 12.14-41	kg mm coils mm
Length unloaded	0 45
Valve, closed	7.3 37.7 6.5 2.6 dia.
Valve, opened	15.8 29.2
Outer spring	
E 12.14-40	
Length unloaded	0 51 4.5 3.6 dia.
Valve, closed	14.8 42.5
Valve, opened	29.7 34

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Valve guide:	
Material	Ge 26. 91 (Cast iron)
Overall length mm	Inlet and Exhaust 60 (appr. 2 3/8")
Limit size of valve guide bore:	
Inner diameter	9 $\emptyset$ H 7 = 9 ( + 0.015 ) $\emptyset$ + 0.000
Outer diameter	15 $\emptyset$ s 6 = 15 ( + 0.039 ) $\emptyset$ + 0.028
Valve seat ring	
Material:	Leadsteel or Chrome - Nickel - Molybdenum Alloy.
Bore - dia. - cylinderhead	Inlet 37 $\emptyset$ H 7 = ( + 0.025 ) - 0.000
	Exhaust 33 $\emptyset$ H 7 = ( + 0.025 ) - 0.000
Outer diameter of ring	Inlet 37 $\emptyset$ + 0.18 + 0.15
	Exhaust 33 $\emptyset$ + 0.18 + 0.15
Valve seat ring, cooled to 60° C below zero is shrunk into heated up cylinder head.	

f) Lubrication

Type	Gear pump
Drive	from crankshaft
Oilfilter	gauze intake screen, additional surface oilfilter in side flow.
Oilpressure, hot engine	at least 1.5 Atü. or appr. 22 lb./sq.in.
Engine housing breather	breather tube outside Valve chamber breathing by carburettor suction.

g) Cooling

Waterpump	Impeller pump on engine block coupled with fan.
Waterpump drive	from crankshaft by fan belt. 9.5 x 925/975 narrow fan belt.
Waterpump lubrication	greaser, roller bearing grease only. Feed water pump grease through drip bore.
Thermostat release temperature	75° C $\pm$ 2° or appr. 167° F
Fan	2 Double blades, 350 mm or appr. 13 51/64" $\emptyset$ adm. balance error 15 cm /g

h) Carburettor

Spare part No.	C 71.17 - 25 U
Type	Solex 32 P J C B
Main jet	130
Pilot jet	g 55
Pump jet	40
Air correction jet	175
Venturi	26
Starter fuel jet	1.5
Starter air jet	4
Pilot air jet	1.6
Emulsion tube	1.5
Float weight	5.7 g (appr. 2.85 dram)
Float needle valve	1.5
Split pin - dashpot pump	center hole
Airfilter	"Knecht" Air silencer with wet filter element (Cleaner) or "Knecht" Air silencer with oilfilter element (Cleaner) (Export)

i) Fuel pump

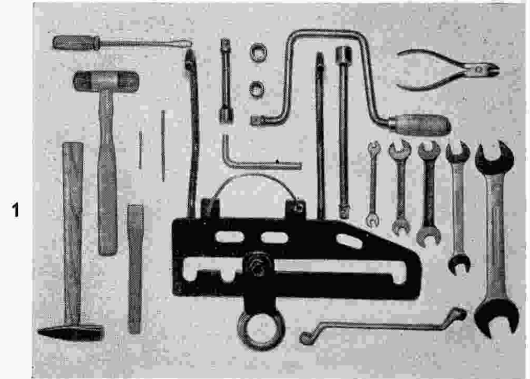
Fuel pump	Solex diaphragm pump PE 10209
Drive	Camshaft eccentric disk

M. ENGINE

M1. Engine removal and replacement

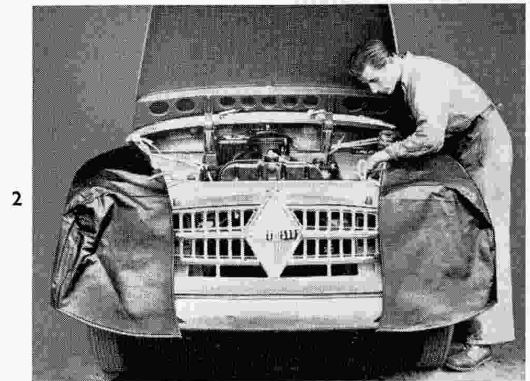
Tools: D.E. spanners 7, 8, 9, 10, 2 x 14, 2 x 17, 27 mm, box spanner 14 mm, sockets 14, 17 mm, screw driver 6 mm, punch 2 + 4, hammer, chisel, side cutting nipper (Cotter pin), mallet with plastic head, Allen 8 mm, handle with extension, engine lift apparatus WK 143.

Figure 1



1. Drain cooling system  
(Water drain cocks: engine below exhaust manifold, radiator front R. H.)
2. Cover wings

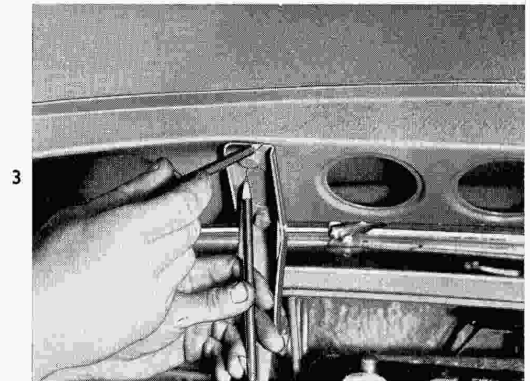
Figure 2



3. Undo negative and positive cable from battery  
(Spanner 14 mm)
4. Undo hood  
(Socket 14 mm)

Caution: Mark hood before removal on mounting points to ensure correct fit when replaced.

Figure 3

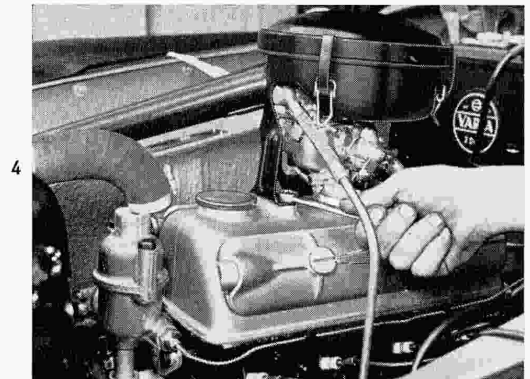


5. Remove radiator and heater hoses.  
Remove heater tube.  
(Thin punch)

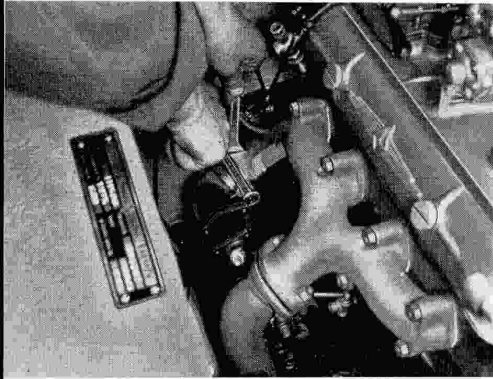
Caution: When reassembling, radiator tubing and connecting hose to drain cock must be in alignment, otherwise danger of rupture for rubber hose.

6. Undo 4 nuts to remove airfilter from cylinderhead  
(Ring spanner 14 mm)

Figure 4



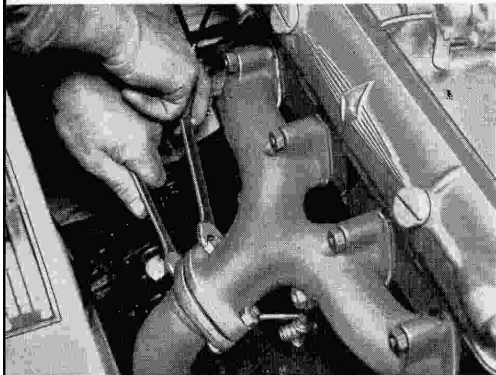
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7. Undo starter cable on starter and auxiliary switch cable (Socket 14 mm, screw driver 6 mm)
8. Undo 3 cables on dynamo (Spanner 9 mm)
9. Undo ground cable on engine (Spanner 17 mm, ring spanner 17 mm)

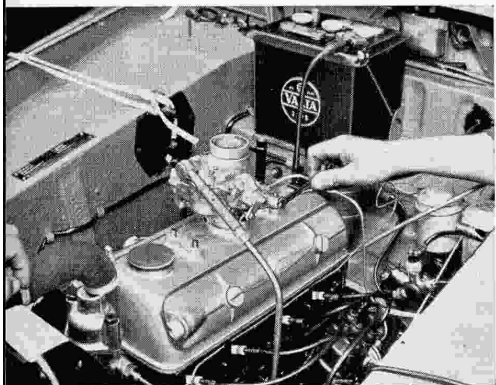
Figure 5



6

- Caution: Secure all cables on the side to avoid clinging on engine.
10. Undo exhaust pipe on exhaust manifold flange (2 spanners 14 mm)

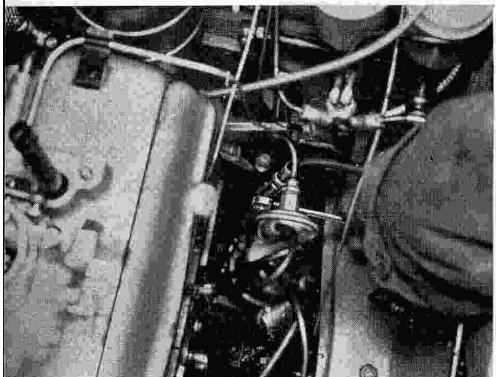
Figure 6



7

11. Undo "Faudi" ball joints on accelerator (Screwdriver)
12. Undo connection on heater cock (Spanner 7 mm)
13. Undo carburettor Bowden cable (Spanner 8 mm)
14. Pull out Bowden cable (Spanner 7 mm)

Figure 7



8

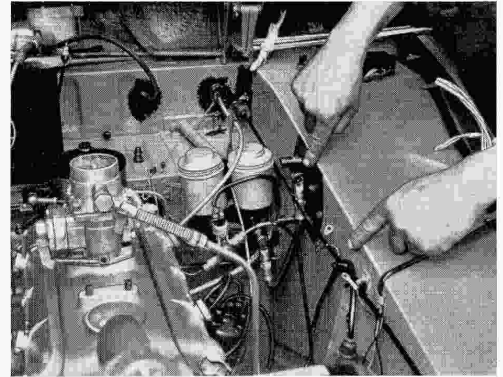
- Caution: When reassembling tighten inner control wire, press back wire allowing 1 mm play and fasten.
15. Remove low tension cable from distributor (Spanner 7 mm)
  16. Remove connection cable from oil pressure switch (Spanner 7 mm)
  17. Pull out high tension cable from distributor.
  18. Remove fuel pipe to fuel pump on pump (Ring spanner 18 mm)
  19. Undo hollow bolt for connecting hose to clutch cylinder on clutch cylinder. (Ring spanner 17 mm)

Figure 8

Caution: Tighten connecting hose high enough to avoid accidental drainage of brake fluid tank. All other cables must be securely fastened to avoid clinging.

Figure 9

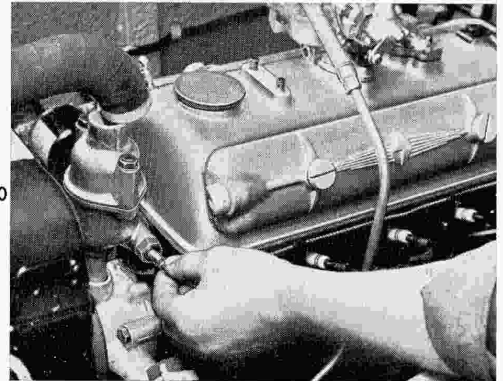
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20. Undo connection of remote thermometer by undoing knurled nut.

Figure 10

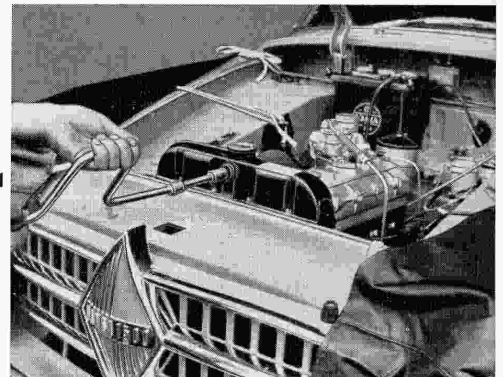
10



- 21. Remove 2 clamps on remote thermometer tubing (Screwdriver 6 mm)
- 22. To remove shift rods, undo split pin. Push out rods. (Side cutting nipper)
- 23. Undo bolts, radiator top. (Socket with handle and extension 14 mm)

Figure 11

11

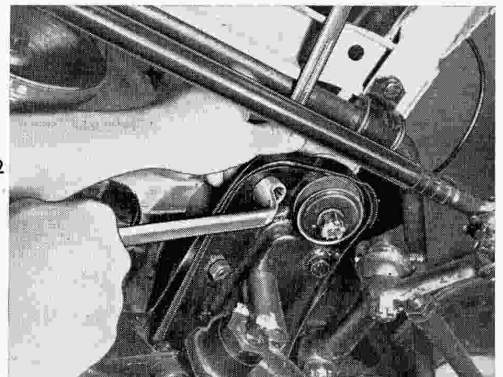


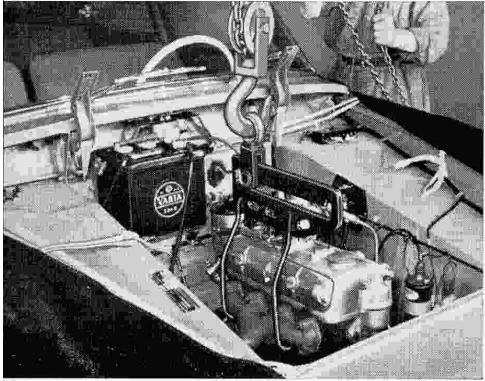
- 24. Undo bolt, radiator, bottom. (Socket spanner 14 mm, hold up bottom with ring spanner 14 mm)
- 25. Lift out radiator.
- 26. Undo engine mounting, front, bottom. (Ring spanner 17, spanner 17 mm)

Figure 12

12

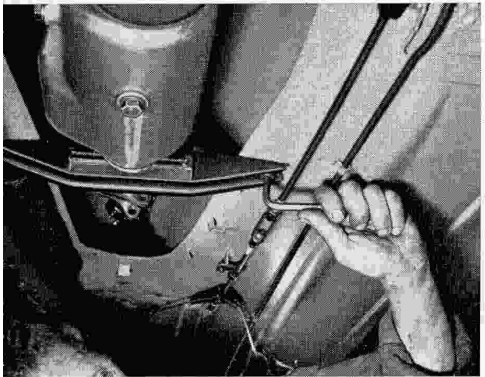
- 27. To remove rubber cover for propeller shaft tunnel opposite exhaust pipe, bend up clip. Hang cover over exhaust pipe. (Screwdriver)
- 28. Bend up locking plates on propeller shaft screwing. (Hammer, chisel)





29. Undo nuts on propellershaft flange.  
(2 spanners 17 mm)
30. Press out prop. shaft flange bolts.
31. To loosen flange, tap shortly with plastic head mallet, push flange backwards.  
(Plastic head mallet)
32. Remove engine with engine lift apparatus WK 143.

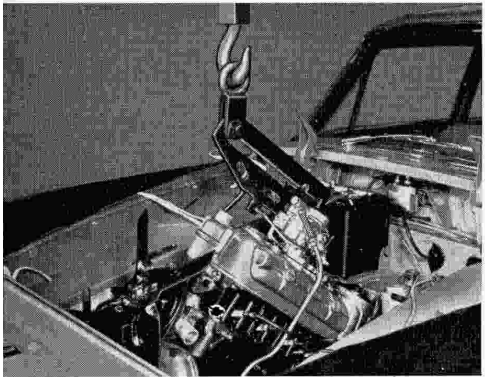
Figure 13



Caution: Hang up engine lift apparatus, so that hook hangs in center notch.

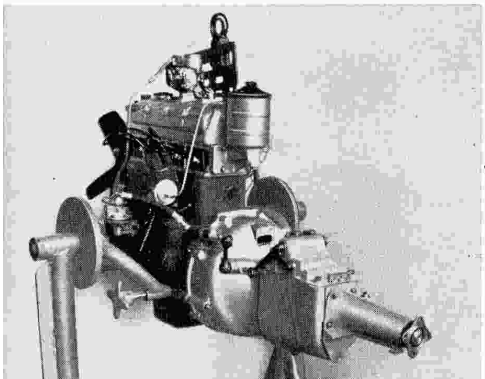
33. Undo gearbox mounting below frame.  
(Allen key 8 mm)

Figure 14



34. Lift engine slightly and pull forward, that engine moves freely underneath.
35. Undo Speedometer connection.  
(Spanner 27 mm)
36. Undo support plate for push and pull cable on intermediate housing.  
(Spanner 10 mm)
37. Lower engine and hang up engine lift apparatus so that the hook hangs now in front notch.

Figure 15



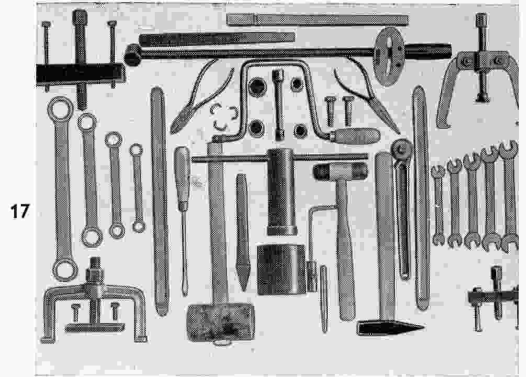
38. Lift up engine inclined and forward.
  39. Screw engine on engine stand.
- Reassembling in reversed order.



M 3. Dismantling and reassembling  
of the engine

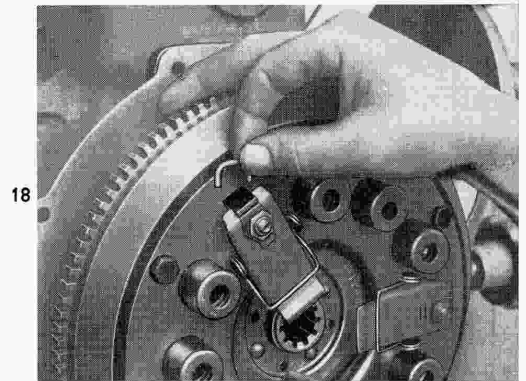
Tools: Spanner 8, 10, 12, 14, 17, 19, sockets 14, 17, 19, 24 mm, ring spanner 14, 17, 19, 22 mm, tension wrench, 3 clutch tension stirrups, plastic head mallet, rubber head mallet, hammer, chisel, punch, 2 tyre levers, side cutting nipper, screw driver 12 mm, extractors S 13, WK 59, WK 23, WK 24, special spanner WK 16a, clutch guide punch WK 35, hard wood block, round hard wood rod.

Figure 17



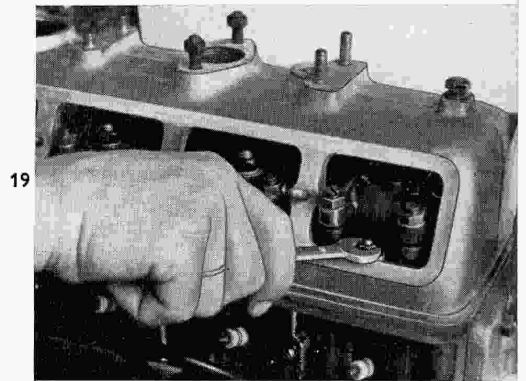
1. Undo clutch housing and gearbox.  
(Socket 14 mm, spanner 14 mm)
2. Undo clutch (Socket 14 mm, 3 clutch tension stirrups)  
(For precise instructions see K 1)

Figure 18



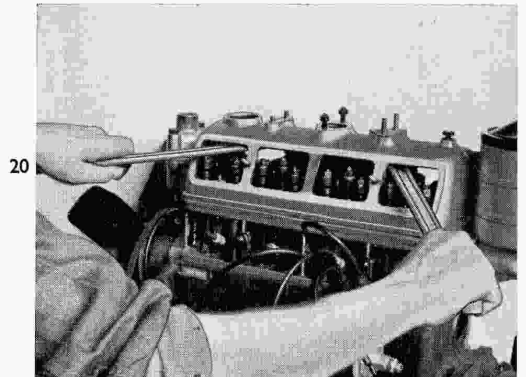
3. Remove engine sump drain plug, drain oil.  
(Ring spanner 17 mm)
4. Remove fuel pipe from carburettor to fuel pump.  
(Spanner 17 mm)  
Caution: Tighten screwing with 2 fibre washers each on carburettor and fuel pump, sludge danger!
5. Remove vacuum pipe from carburettor to distributor  
(Spanner 8 mm, mounting clip on head 14 mm spanner)
6. Remove carburettor. (Spanner 12 mm)
7. Remove both valve cover lids.
8. Undo cylinderhead valve cover  
(4 bolts, spanner 10 mm)

Figure 19

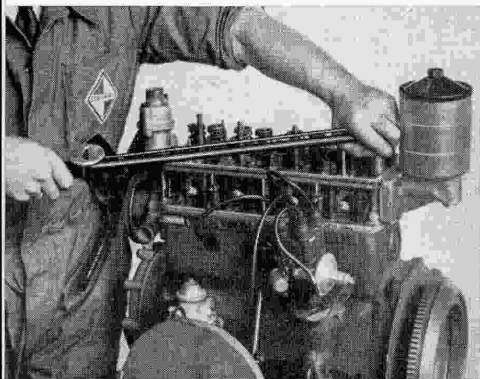


9. To remove valve cover, tap cover slightly with plastic head mallet to loosen gasket, take off with 2 tyre levers.  
(Plastic head mallet, 2 tyre levers)

Figure 20



Caution: Screw drivers or similar tools must not be used on joint surfaces. Apply tyre levers on reinforced places of cover.



21

10. Remove intake manifold (4 nuts, spanner 14 mm)

Caution: Tap intake manifold slightly with plastic head hammer, do not force screwdriver between joint surface. When reassembling replace rubber sealing rings between intake manifold and valve cover.

11. Undo screwing of rocker shaft.  
(4 nuts, socket 17 mm)

12. Loosen rocker shaft from below with plastic head hammer and remove. (Plastic head hammer)

13. Remove pushrods, check same for concentricity.

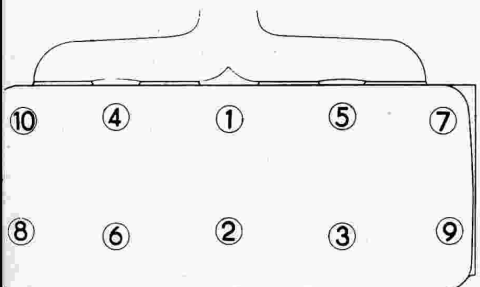
14. Undo cylinderhead stud nuts (10 nuts, socket 17 mm) slackening each half a turn at a time until they are all quite free.

Caution: Use tension wrench when tightening down cylinderhead nuts. Torque 10 m kg or 70 ft/lb.

Figure 21

Caution: Tighten nuts in correct sequence, see figure 22, starting from center studs, tighten each nut half a turn at the time.

Figure 22



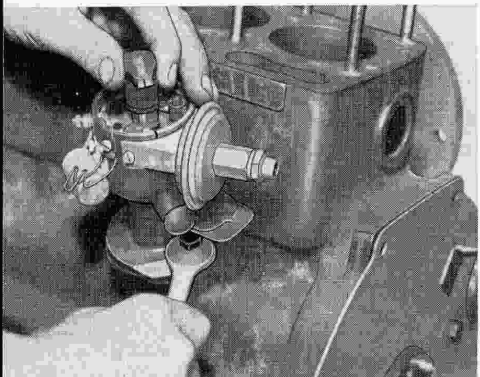
22



23

Caution: When reassembling place both washers, which are flattened at one side under nuts next to inlet ports.

Figure 23



24

15. To loosen the cylinder head, tap slightly with plastic head mallet and take off the head.  
(Plastic head mallet)

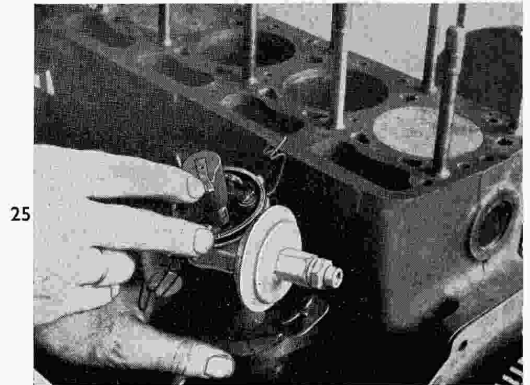
Caution: When reassembling cylinderhead, place cylinderhead gasket with lettered side on top.

16. Undo distributor from base and pull out.  
(2 nuts, spanner 14 mm)

Figure 24

Caution: When refitting distributor, turn engine until the piston of the first cylinder (on flywheel side) is at Top Dead Center, compression stroke. Mark on flywheel must coincide with crankcase pointer. Valves are closed. Rotor must point to mark on distributor casing. Replace distributor and turn rotor from left to right till engaging dog snaps in and distributor base rests on casing.

Figure 25



17. Remove fuel pump (2 nuts, spanner 14 mm)
18. Remove waterpump (4 nuts, ring spanner 14 mm, spanner 14 mm)

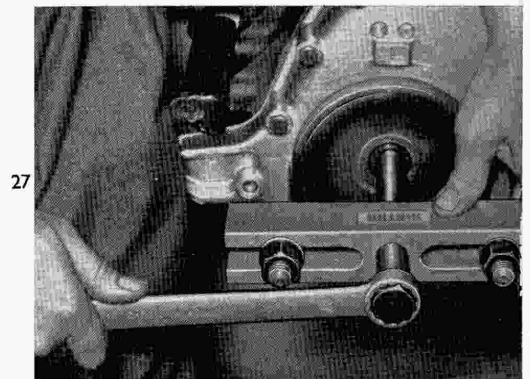
Caution: When reassembling connection between pump and thermostat, soften rubber ring for 20 minutes in oil. Insert tube with long pivot into thermostat.

Figure 26



19. Undo crankcase breather.  
(2 nuts, spanner 10 mm)
20. Turn engine 90°, remove oilsump.
21. Undo pulley bolt on crankshaft.  
(Socket 24 mm)
22. Pull off pulley from crankshaft, use extractor S 13.  
(Extractor S 13, ringspanner 22 mm, spanner 19 mm)

Figure 27



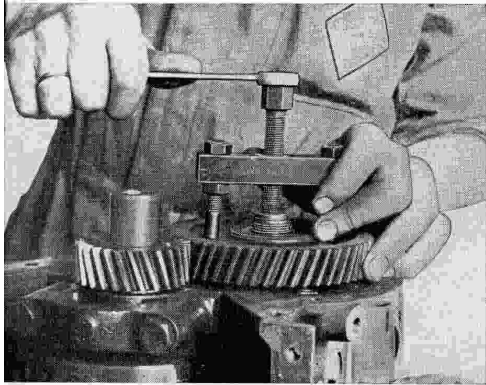
23. If an extractor is not available, drive off pulley with hardwood block and hammer.  
(Hammer, hardwood block)

Figure 28

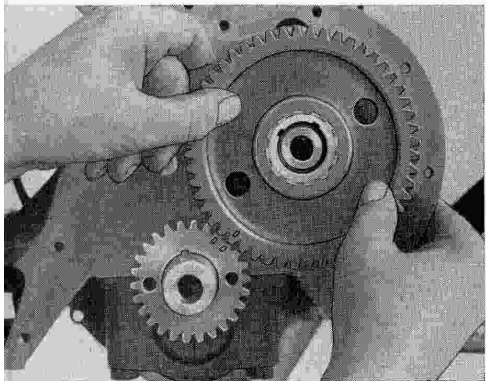
Caution: Place hardwood block close to hub, turn crankshaft several times.

24. Undo timing cover nuts. (10 nuts, socket 14 mm)

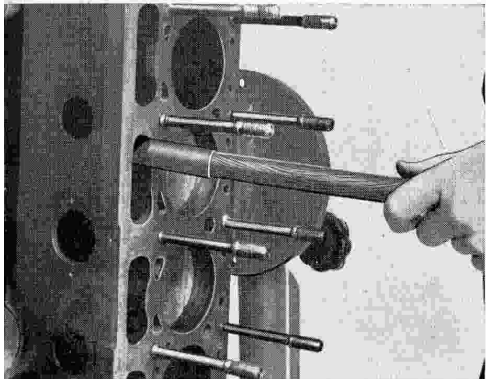




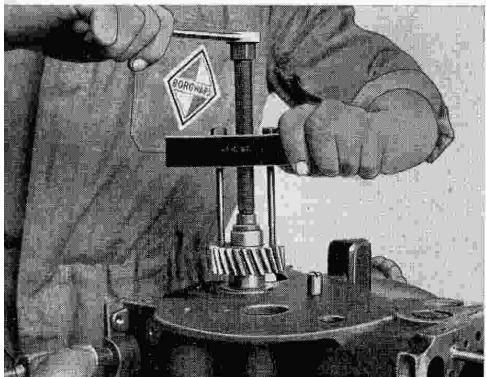
29



30



31



32

25. Remove key on crankshaft (Side cutting nipper)
26. Remove oil collector ring.
27. Remove recoil bolt and spring from camshaft.
28. Bend up locking plate for camshaft gear nut. (Hammer and chisel)
29. Tighten grooved nut to attach timing gear. (Special spanner WK 16a)
30. Pull off camshaft timing gear. (Extractor WK 59, ring spanner 17 and 19 mm)

Figure 29

**Caution:** When adjusting timing gears place camshaft gear tooth marked 0 between marks 0 - 0 on crankshaft gear and push gears home. Key on camshaft must coincide with mark 0 on camshaft gear.

Figure 30

**Caution:** The hub of the camshaft timing gear has two key ways, which are offset to each other at slightly less than  $90^{\circ}$ . This allows an engine performance correction by advancing the camshaft  $1/2$  tooth width. In such a case adjust the camshaft to standard setting as mentioned above. Pull off camshaft timing gear, without altering the position of the camshaft, place key in unmarked keyway (less mark 0) and turn camshaft in rotating direction by  $1/2$  tooth until tooth and tooth gash mesh properly. The 14th tooth of the camshaft gear, counted from zero to left side (including 0 tooth) must be placed then between 0-0 marks on crankshaft timing gear

31. Remove tappets with suitable wood rod. (Hardwood rod)

Figure 31

32. Remove oilpump drive. (Pointed pliers)
33. Remove camshaft flange, pull out camshaft. (Screwdriver 12 mm)

**Caution:** When reassembling secure bolts after tightening by punch blows. (Hammer, punch)

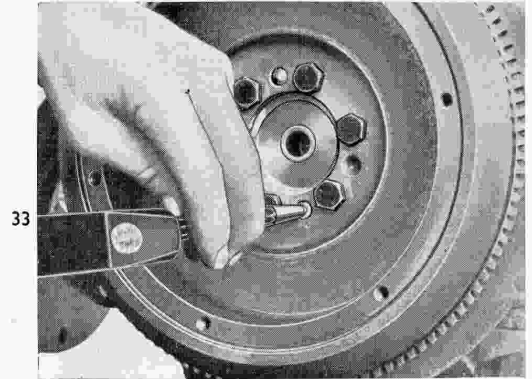
34. Pull off crankshaft gear. (Extractor WK 24, spanner 14 mm, ring spanner 22 mm)

Figure 32

**Caution:** When reassembling drive gear home with suitable piece of steel tubing.

- 35. Remove securing wire and undo oilpump nuts.  
(Side cutting nipper, socket 14 mm)
- 36. Remove securing wire from flywheel bolts.  
(Side cutting nipper)
- 37. Punchmark flywheel.  
(Hammer, punch)

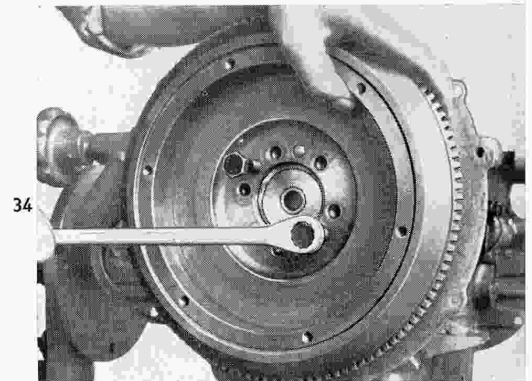
Figure 33



Caution: When reassembling, Top Dead Center mark on flywheel must coincide with keyway in crankshaft pivot (front).

- 38. Undo flywheel nuts.  
(6 bolts, socket 17 mm)  
Caution: Use tension wrench for flywheel reassembly, torque 6 m/kg or 42 ft/lb.
- 39. Force off flywheel evenly with puller screws.  
(2 bolts M12 x 1.5, ring spanner 19 mm)

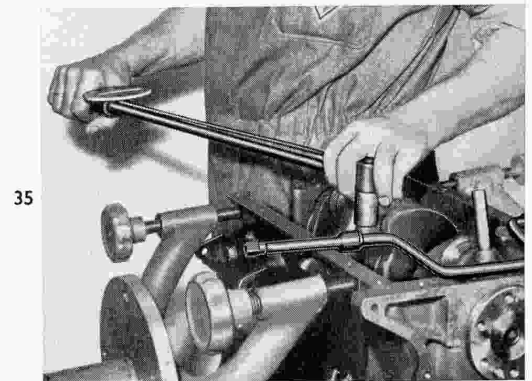
Figure 34



- 40. Remove intermediate plate between engine and gearbox.  
(Spanner 14 mm)
- 41. Undo connecting rod bolts.  
(Socket 14 mm)

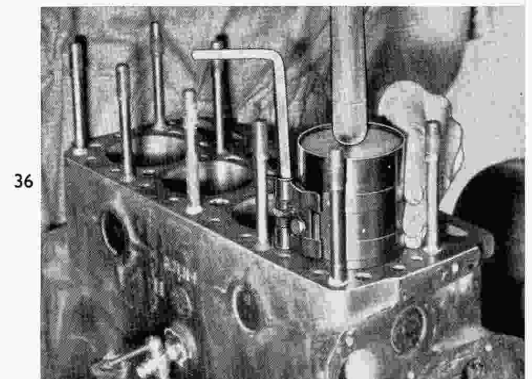
Caution: When reassembling fit new connecting rod bolts every time. Tighten with tension wrench 4.5 m/kg or 30 ft/lb, tighten bolts on tension without locking washers etc. Bolts dry fit.

Figure 35

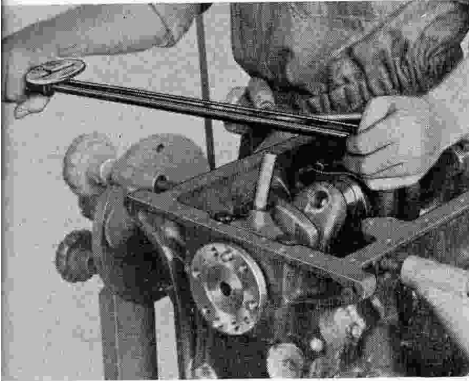


- 42. Withdraw piston and rod from top of block.  
Caution: The piston crowns are plainly marked by arrows to show their forward side, which must be strictly observed. Apply piston ring clamp.  
(Piston ring clamp)

Figure 36



*Isabella*

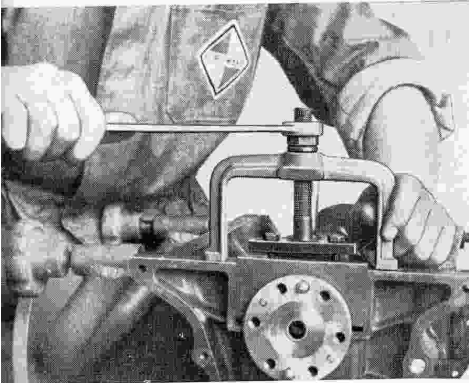


37

43. Undo hex. bearing cap bolts.  
(Socket 19 mm)

Caution: Tighten cap bolts with tension wrench only.  
Torque 9-10 m/kg or appr. 63-70 ft/lbs. Bolts are  
secured by tension, fit dry without locking washers  
etc.

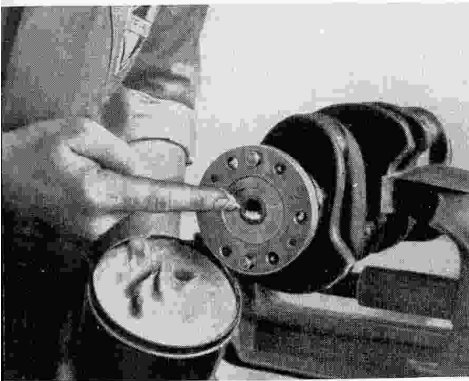
Figure 37



38

44. Pull out rear bearing cap with extractor WK 23.  
(Spanner 14 mm, ring spanner 27 mm)

Figure 38

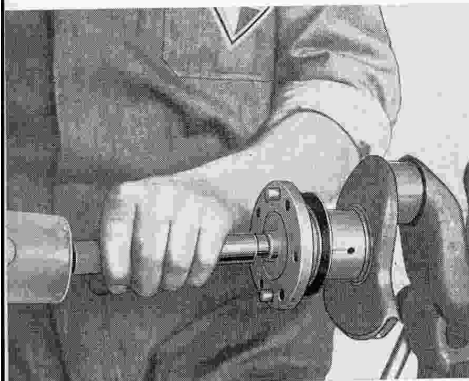


39

45. Take out crankshaft.  
46. Remove bush in crankshaft.

a) Fill up hollow behind and half of bush with stiff  
grease (Waterpump grease)

Figure 39



40

- b) Use clutch aligning mandrel (or worn gearbox  
drive wheel) and rubber mallet, drive out bush  
with hard blows by hydraulic effect.  
(Clutch aligning mandrel WK 35, rubber head  
mallet)

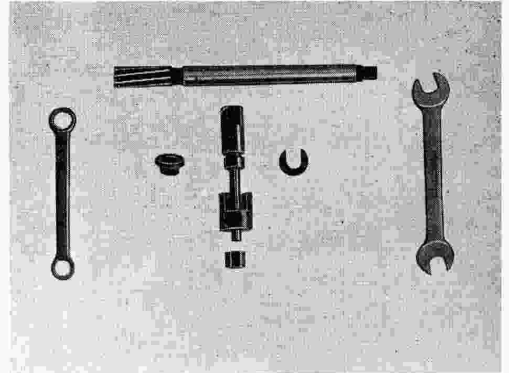
Figure 40

M 14. Replacement of small end bush  
Connecting rod inspection

Tools: Spanner 19 mm, ring spanner 19 mm, gudgeon pin fitting tool WK 94, reamer 22 mm, connrod aligner type 610.

Figure 41

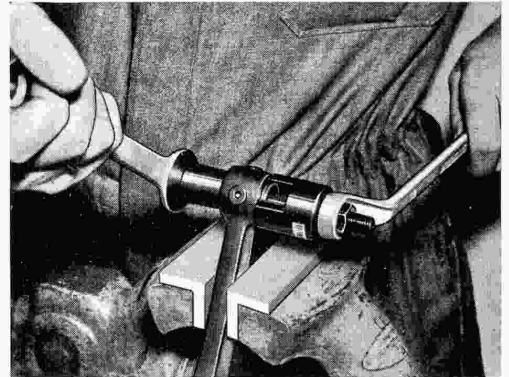
41



1. Use small end bush extractor to remove worn small end bush. (Small end bush extractor WK 94, spanner 19 mm, ring spanner 19 mm)

Figure 42

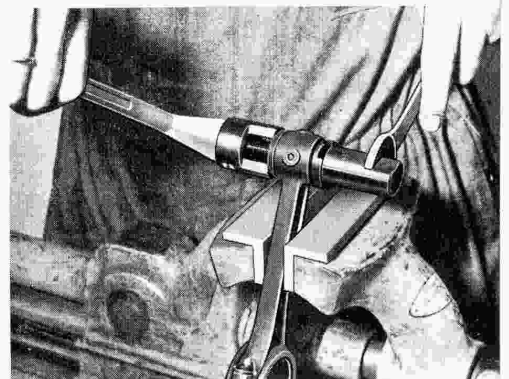
42



2. Press in new bush (Small end bush extractor WK 94, spanner 19 mm, ring spanner 19 mm)

Figure 43

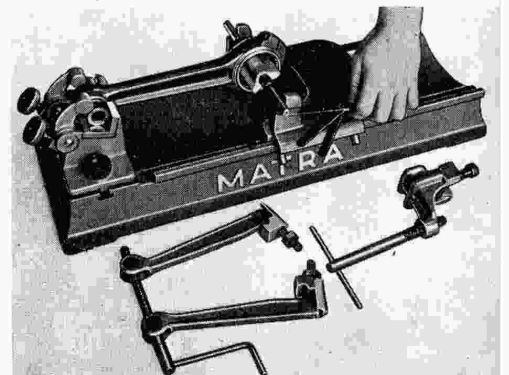
43



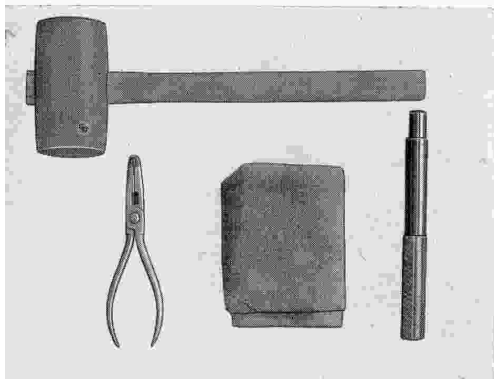
**Caution:** Observe when fitting new bush that oilbores of bush coincide with oilbores in connrod small end.

3. Redrill 3 oil bores, top and sides. (3 mm drill)
4. Re-ream small end bush with reamer 22 mm or rehone with honing tool. Gudgeon pin clearance 0.02 mm or .000787".
5. Check connecting rod on connrod aligner and re-dress if necessary.

44



*Isabella*



45

M 15. Replacement of piston  
Piston and connrod removed

Tools: Circlip pattern pliers (Seeger type circlip)  
WK 55, rubber mallet, asbestos rag.

Figure 45



46

1. Remove circlips on both sides.  
(Circlip pattern pliers)

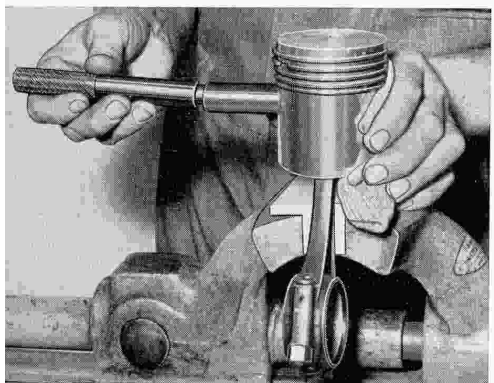
Figure 46



47

2. Gudgeon pin (Wrist pin) replacement. Heat piston crown slightly and evenly and drive out worn gudgeon pin.  
(Gudgeon pin punch WK 55, rubber head mallet)

Figure 47



48

3. Heat piston in stove or oilbath to 60-70° C (140-158° F).  
Lubricate cold gudgeon pin, push pin quickly in piston and small end.

Caution: Observe that mark on connrod-bigend faces camshaft and arrow on piston crown points forward when assembling connrod and piston.

Figure 48

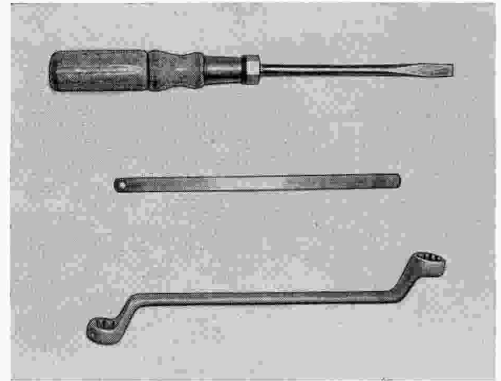


M 20. Valve adjustment

Tools: Screwdriver 10 mm, ring spanner 14 mm, feeler gauge 0.2 mm or .00787".

Figure 49

49



On principle adjust valves on running and warmed up engine only!

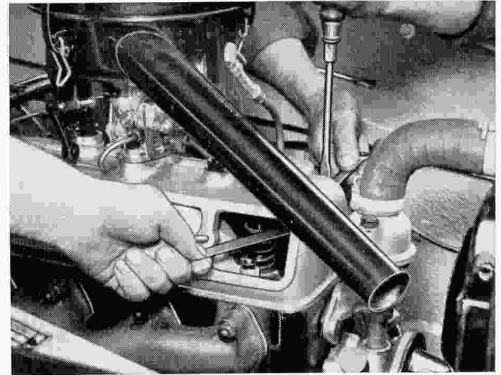
1. Remove lids of valve gear cover. (Knurled nut, use large screwdriver)

Caution: Mark lids that joints are replaced in proper places.

2. Start engine and keep idling. Engine must have normal running temperature.
3. Both outer valves are controlled with feeler gauge on opposite adjustment side.

Figure 50

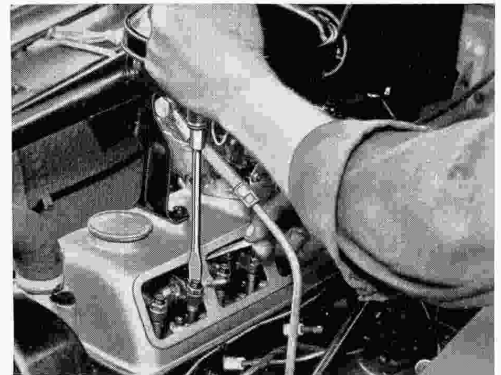
50



4. Undo check nuts and adjust adjusting screw with screwdriver. Continuous control with feeler gauge until gauge (0.2 mm or .00787) is about to jam. (Ring spanner 17 mm, screwdriver 10 mm, feeler gauge (0.2 mm, .0078")

Figure 51

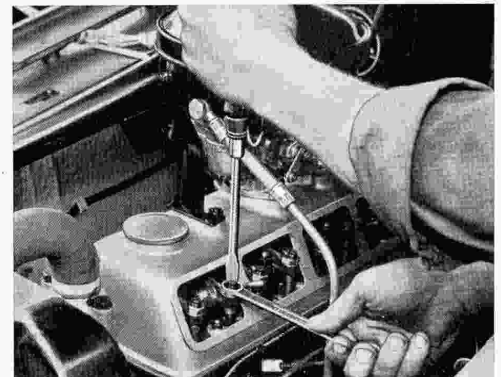
51



5. Lock correct gap with screwdriver and tighten lock nut well.

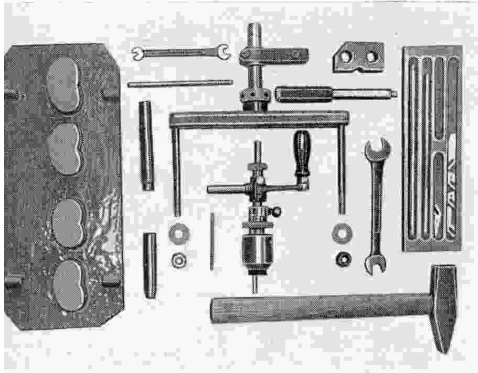
Figure 52

52



Caution: Re-check clearance with gauge after adjustment.

Isabella



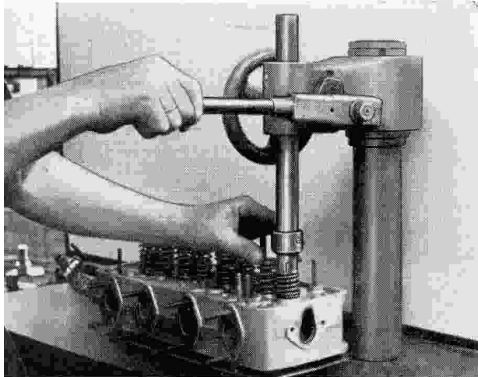
53

### M 23. Cylinderhead overhaul (including valves)

Head removed

Tools: "Hunger" valve tool, valve board BW 7, punch to press in valve seats BW 9, punch to drive in protecting tubes BW 10, valve guide punch WK 44 a, fitting block for valve guides BW 8, spanner 9, 17 mm, hammer.

Figure 53



54

1. To remove valves place cylinderhead on valve board (Valve board BW 7)
2. Remove valves.

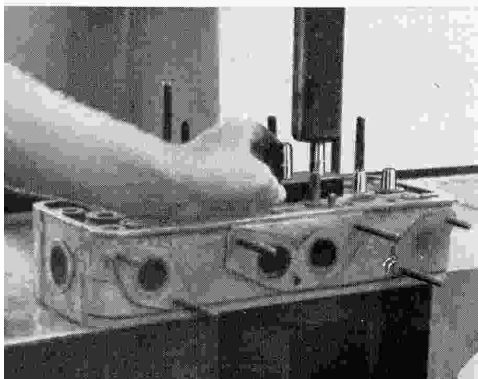
Figure 54



55

3. Check if used valvesprings can be refitted. Length of outer valve spring, unloaded 51 mm or 2.0079", length of inner spring unloaded 45 mm or 1.7716".

Figure 55



56

4. Drive out valve guides. (Valve guide punch WK 44a, hammer)
  - Caution: Drive out to combustion chamber side only!
5. Fit new guides.
  - Caution: To ensure exact guidance and depth of guide, apply guide block BW 8.

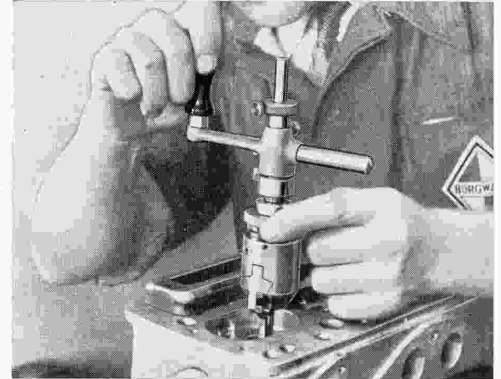
Figure 56

6. Mill away damaged valve seat rings with "Hunger" valve tool.

Caution: Mill just as large that rings can be removed, do not mill block material.

Figure 57

57

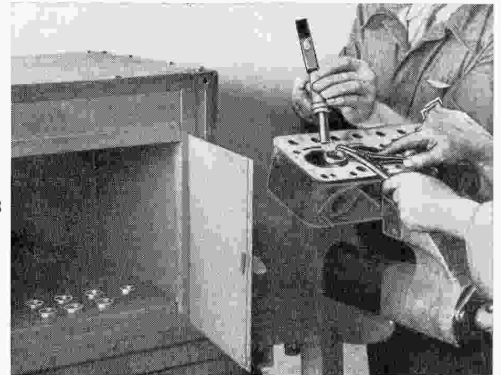


7. Fit new valve seat rings.

Caution: Heat cylinderhead to appr. 80°C or 176°F. Cool rings in solid carbon dioxide or refrigerator and handle rings with pliers, drive rings in immediately. Chamfered side of ring on seat bottom.

Figure 58

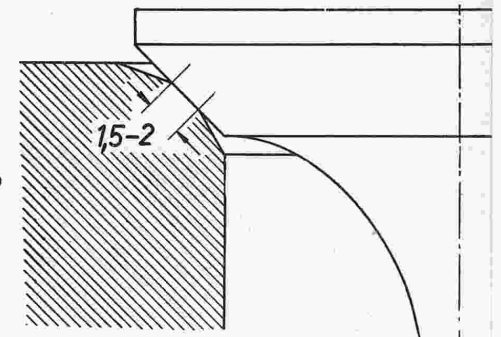
58



8. Recut valveseat rings, valve seat 45°, cut top with 15° and bottom with 75°. Width 1.5 - 2 mm (.0591" to .0787")

Figure 59

59



Caution: Tooling method for bronze alloy or lead-steel rings is the same.

9. Drive out leaky pushrod protection tubes with punch (Punch for protection tubes BW 10, hammer)

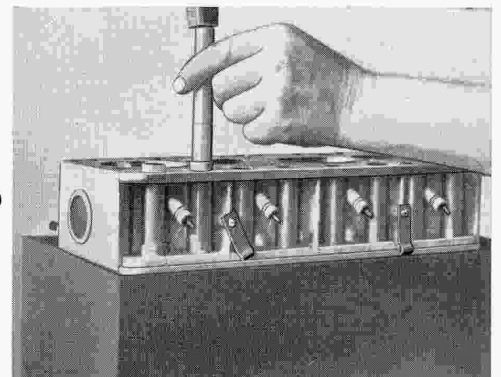
Caution: The above method should not be employed unless the tubes cannot be made tight (see next working process). Drive out tubes from joint face to valve cover side.

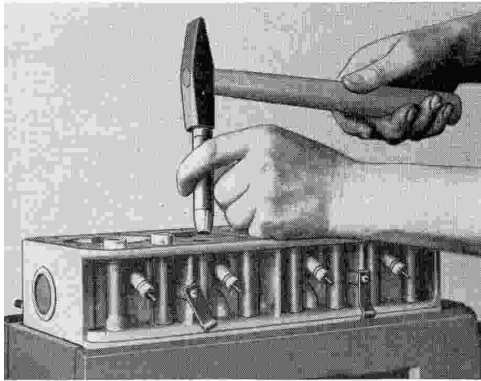
10. Drive home protection tubes anew. (Punch BW 10, hammer)

Caution: Use suitable jointing compound when fitting these protection tubes.

Figure 60

60

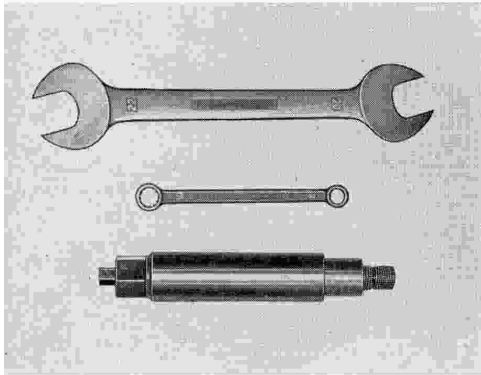




61

11. Tighten protection tubes top on valvecover side with tapered punch.  
(Tapered punch BW 10, hammer)

Figure 61

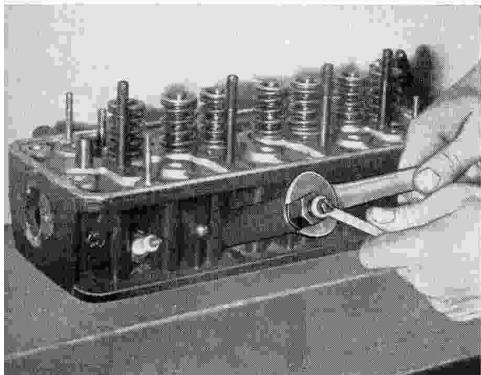


62

M 30. Renewal of threaded bush  
for sparking plug

Tools: Draw-in tool for threaded bush WK 61, spanner 22 mm, ring spanner 10 mm.

Figure 62



63

1. Bore out dowel pin (3 mm drill (.1181"))
2. Insert draw-in tool and tighten nut with ring spanner 10 mm.  
(Draw-in tool for threaded bush WK 61, ring spanner 10 mm)
3. Undo threaded bush with draw-in tool, turning counter clockwise.  
(Spanner 22 mm)

Figure 63



64

4. Turn new bush on draw-in tool and tighten nut.
5. Screw in bush in clockwise rotation, loosen draw-in tool and remove same.

Figure 64

6. Redrill (3 mm) bush and secure with driven in dowel pin.

### M 30. Replacement of crankshaft

Engine disassembled

Crankshaft removed and reground

Caution: When replacing crankshaft bearings, only "Super Micro" quality bearings must be used. Clearance 0.04 to 0.05 mm (.00157 - .00197"). Main bearing and clearance (lateral play) 0.1 - 0.189 mm (.00394 - .00742"). Grind crankshaft to clearance of bearing undersize.

Tools: Socket 19 mm, ratchet, extension, torque wrench, dial gauge with holder, rubber head mallet.

65

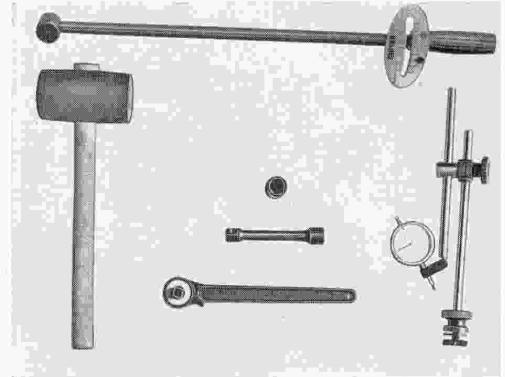
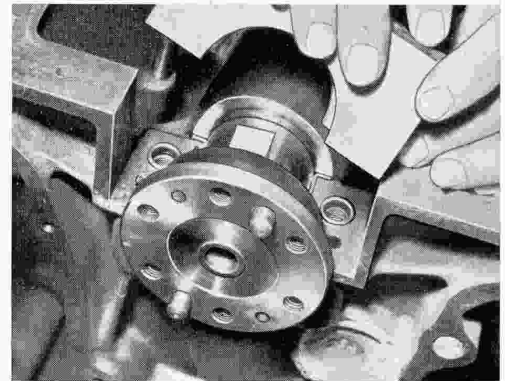


Figure 65

1. Insert main bearing halves with oil bores into housing. Located in position in the bearing housing by small tags on each half liner.
2. Check each bearing for correct clearance. Insert cigarette paper, dry, of 0.04 mm or .00157" thickness with edge length of 15 mm or 19/32". When caps are tightened, crankshaft must be tight. When bearings are tightened without paper insert, crankshaft must turn freely.

Figure 66

66



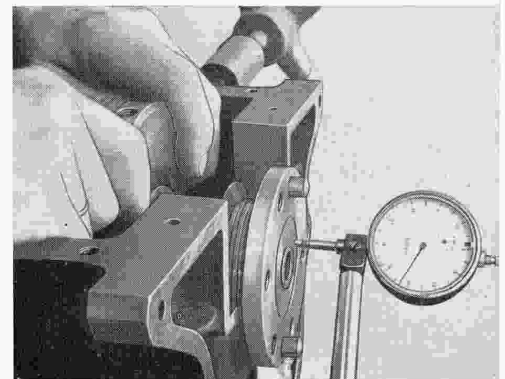
Caution: When checking bearing clearance, old bolts should be employed. Tighten with torque wrench, torque 10 m/kg or 70 ft/lbs. When finally tightening only new bolts must be fitted (See M 3/43 and figure 37)

(Socket 19 mm, ratchet and extension, torque wrench)

3. Check end float of crankshaft with dial gauge on rear main bearing side. (Dial gauge and holder)

Figure 67

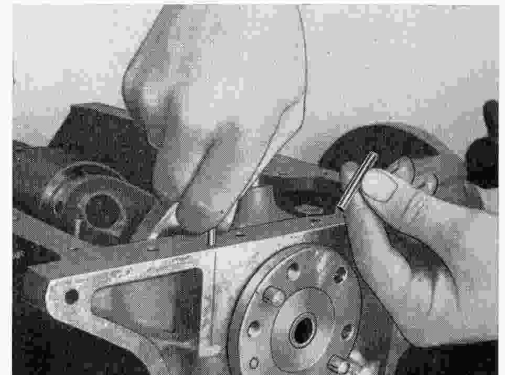
67

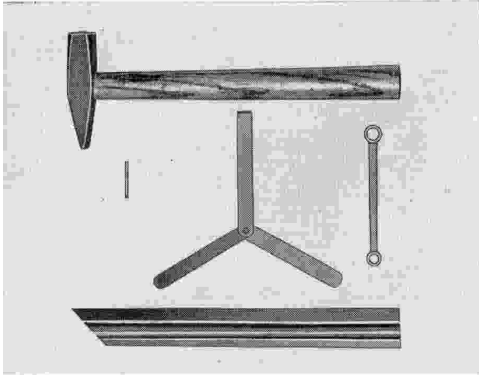


4. Insert rubber seal in rear main bearing cap when assembling. Rubber seal ends should be pressed down to be flush with joint face before fitting sump.

Figure 68

68





69

M 43. Oilpump overhaul  
Oilpump removed

Tools: Hammer, punch 3 mm, ring spanner 10 mm, straight edge, feeler gauge 0.1 - 0.01 mm (.00394 - .00039")

Figure 69



70

1. Check oil pump transport. Insert bell and pump up to gears into oil. When turning shaft clockwise oil must be transported.

Figure 70



71

2. Remove wire gauze basket from bell. (2 bolts, ring spanner 10 mm)

■ Caution: No vice should be used for disassembly of oilpump. Pump must be held by hand.

Figure 71



72

3. Remove pump bell from pump housing. (2 bolts, ring spanner 10 mm)
4. Remove oil pump housing cover plate. (4 bolts, ring spanner 10 mm)
5. Remove oil pressure relief valve dowel pin. Remove relief valve. (Thin punch, hammer, pliers)

■ Caution: Relief valve order of assembly: Piston - spring - washer valve plug. Spring is calibrated, must not be altered by compression or extension.

Figure 72

6. Check cover plate with straight edge, flatten run-in spots.  
(Straight edge)

Figure 73

73



7. Check end float of gears, permissible play 0.03 mm or .00118".  
Measure clearance with feeler gauge.

Figure 74

74

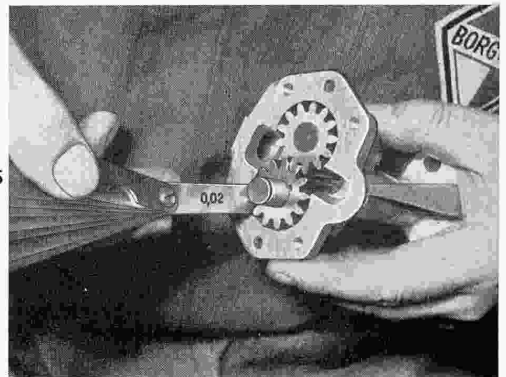


Caution: If end clearance becomes too large, housing must be flattened with gears removed in the same way the cover is flattened.

8. Check lateral clearance of gears.

Figure 75

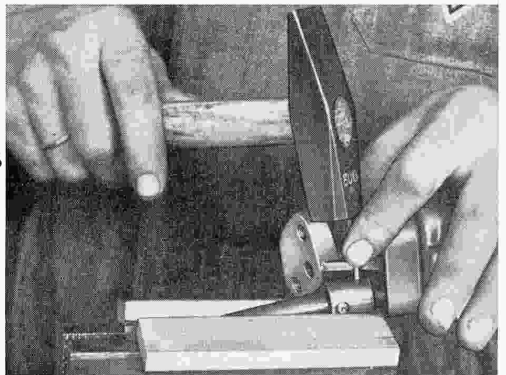
75

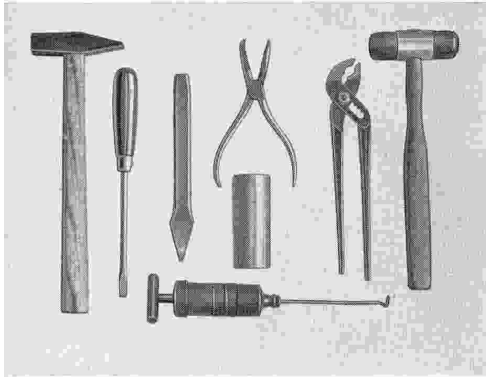


- If this clearance becomes larger than 0.02 mm or .00078", housing must be renewed.
9. Remove gear from idler shaft.
  10. Drill dowel pin in drive bush fitted to oilpump drive shaft.
  11. Drive out dowel pin with thin punch.  
(Punch 3mm, hammer)

Figure 76

76





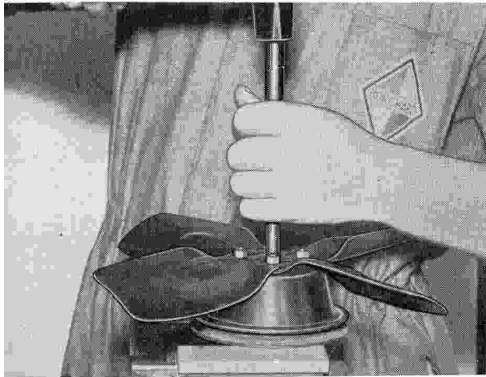
77

M 47. Waterpump overhaul

Waterpump removed

Tools: Hammer, plastic head mallet, cape chisel, circlip pattern pliers (Seeger circlips), gland nut pliers, waterpump greaser WK 92, tubing, screwdriver 8 mm.

Figure 77

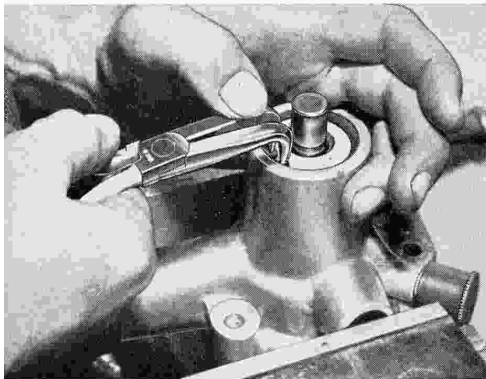


78

1. Support pulley and withdraw pulley from waterpump shaft by tapping shaft.  
(Hammer, punch)

■ Caution: When reassembling, housing bolts must be placed in position before pulley is fitted by tapping.

Figure 78



79

2. Remove "Seeger" circlip and take out "Nilos" seal ring.  
(Circlip pattern pliers)

Figure 79



80

3. Undo lid of pump.  
(3 slotted screws, screwdriver 8 mm)
4. Drive out shaft from impeller side.  
(Punch, hammer)

Figure 80

5. Draw off "Axia" rubber seal unit by force, use waterpump pliers.

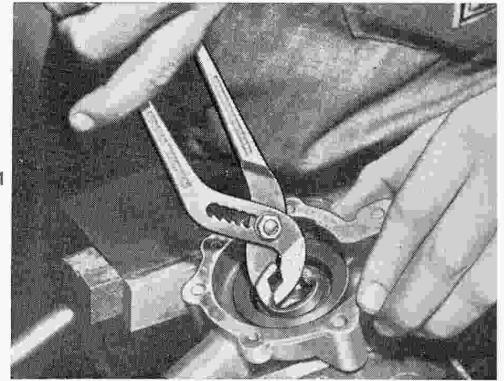
■ Caution: This seal is destroyed when removed and must be renewed every time.



6. Strike neckring of "Axia" rubber seal with small cape chisel in two places and draw out with water-pump pliers.  
(Cape chisel, hammer, waterpump pliers)

Figure 81

81



7. Draw off ballbearing from waterpump shaft.
8. Drive out housing ball bearing together with feltring support, feltring and washer and waterpump shaft.  
(Waterpump shaft, plastic head hammer)

Figure 82

82



Caution: Feltring with support and washer are destroyed when disassembling and these too must be renewed in every case. The second bearing is also driven outwards over seat of first bearing in housing. If housing is heated up with electric heater to appr. 60° C or 140° F, the ball bearings can be easily removed.

9. Observe sequence of operations when reassembling: Washers for feltring - feltwasher support with feltring - ballbearing.

Figure 83

83



Caution: Soak feltring in hot tallow or warm water-pump grease. Grease bearing well with bearing grease.

10. Drive "Axia" rubber seal evenly home with tube 32 x 40.

Figure 84

84



Caution: After reassembly of waterpump fill up space between bearings and greaser and between feltring and rubber seal with waterpump grease. Reassembly operations in reversed sequence. Before pulley is pressed home both housing bolts must be fitted.

M 50. Ignition timing

Ignition can be adjusted with the aid of a 6 V. test lamp in the following way:

1. Remove sparking plugs that the engine can be turned without resistance.
2. Remove distributor cap and check gap of contact breaker points. Gap of contact breaker points 0.4 mm or .0157" at highest valve lift.

Figure 85

3. If essential, adjust points to correct gap. Slacken screws securing the fixed contact plate. Adjust plate by turning eccentric screw and tighten screws again when gap is set.
4. Turn first piston (cylinder on flywheel side) to Top Dead Center, Compression Stroke. Both valves must be closed.
5. Open inspection hole cover on intermediate case (Flywheel mark) and rotate engine slowly in rotating direction until marks on flywheel and housing

Figure 86

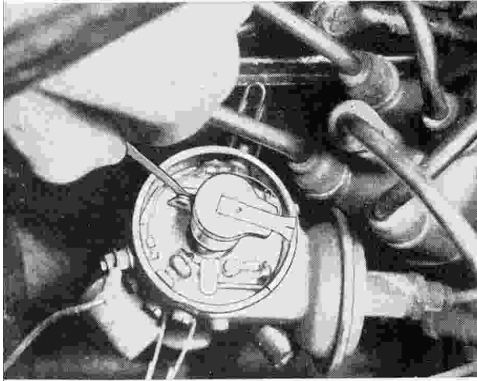
- Caution:** If marks are passed over, turn back and start rotating slowly anew until the marks coincide. In this position, the distributor rotor mark and mark on distributor body top edge must coincide.
6. Slacken distributor clamp bolt so that distributor can be rotated.

Figure 87

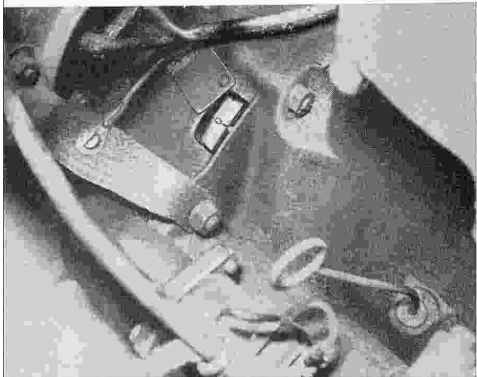
7. With the low-tension lead connected to the distributor, turn on ignition switch and connect 6 Volt testlamp with the contact breaker point (i.e. one lead from the distributor low-tension terminal and the other to earth) and turn the distributor until the lamp lights, which indicates that the points have just opened.

Figure 88

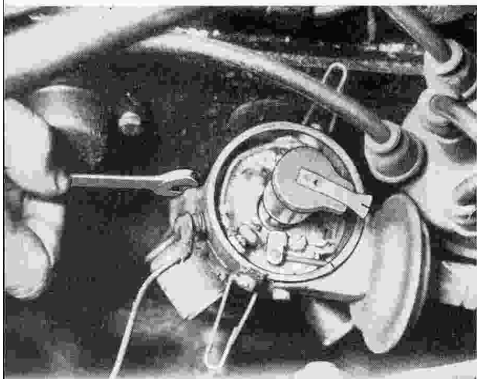
- Caution:** If the moment of lamp lightening was passed over, turn back and rotate slowly again until lamp lights.
9. Tighten distributor in this position. Refit distributor cap and close inspection cover on flywheel casing.



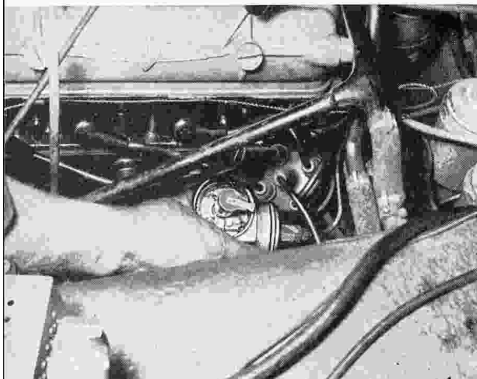
85



86



87



88

**Solex Downdraught Carburettor  
Type 32 PICB**

The carburettor 32 PICB is a down-draught type carburettor with an air intake diameter of 32 mm or appr. 1 1/4". For the first time the starting device shows an independently working starter air valve for weakening the startmixture after the engine has started. The accelerator pump actuates also the partial load control.

The starting device is designed as rotary valve system. Though this starting device shows the principle switch position of the hitherto usual step starter, the performance, however, seen as a whole, can be described as infinitely variable. The production of the starting mixture does no longer take place in the starter body but in a hollow space on the starter disk. Whereas so far the air intake from the floatchamber for the weakening of the startmixture after the engine start operated without control part, the new starting device on the carburettor type 32 PICB is controlled by vacuum in the suction pipe.

A further innovation on the starter device of this carburettor type is the omission of the starter airjet, its dosing action is now actuated by a calibrated bore in the starter disk.

By installation of a vacuum conversion channel between starter rotary valve and mixing chamber the transition from start carburation to main carburation is favourably influenced.

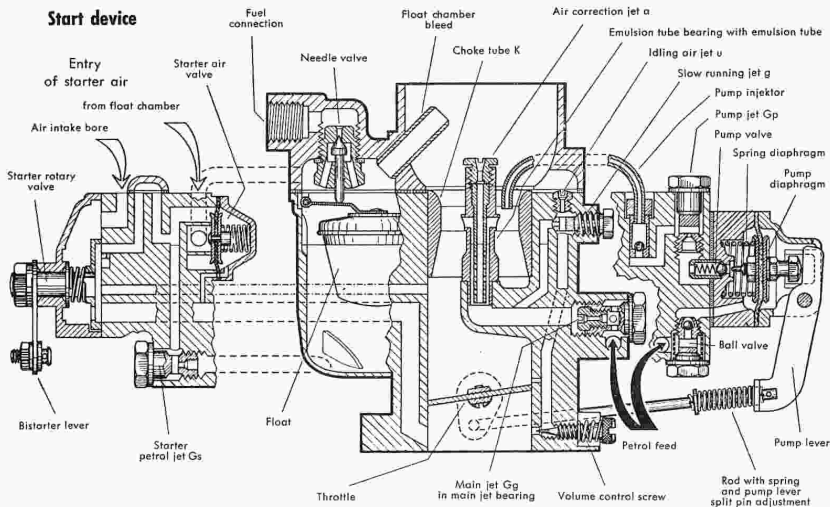
A mechanically operated diaphragm pump is employed as accelerating pump, which is connected to the throttle spindle by a linkage. With closed throttle the pump diaphragm is pressed outward by the diaphragm spring. As the pump space is connected with the floatchamber over a ball valve, this space is normally filled with fuel. When the throttle is opened, this movement is transferred to the diaphragm by means of the lever linkage and fuel is sprayed into the mixing chamber of the carburettor over pump valve, pump jet Gp and pump injector. During the pressure stroke, the ball valve, which is placed in the fuel feed of the floatchamber operates as nonreturn valve and prevents a flow back of the fuel. By repeated closing of the

throttle the "Suction stroke" of the pump is actuated by pressure of the diaphragm spring. Thereby the pump space is refilled with fuel. During this process the ball valve, which is placed in the fuel feed, operates as "Straightway valve", while a second ball valve in the base of the injector as "Nonreturn valve" prevents leaking of air from mixing chamber into the pump system.

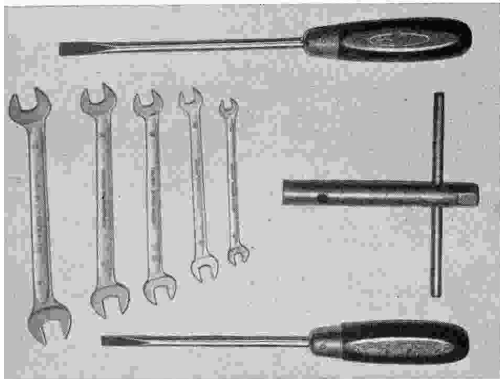
It must be observed that the additional amount of fuel is fixed only by the pump stroke. An alteration of the pump jet Gp solely alters the duration of injection as the calibration of this jet fixes the passage per unit of time.

The partial load control is a precautionary measure to tune for the most favourable performance and consumption, thus increasing economy. It is an additional task of the diaphragm pump. Its function is based on a second way for the fuel passage into the mixing chamber over pump jet Gp and injector. (The first way leads over main jet and emulsion tube bearing). The way through the pump system is governed by the pump valve, which is controlled by the pump diaphragm. The diaphragm, in connection with the diaphragm spring, represents a control mechanism, which instantly responds to all alterations of the throttle position.

The partial load control is operated by a spring-loaded ball valve, which is closed in state of rest. A tenonlike extension of the diaphragm rod can reach the ball and opens the valve as soon as the diaphragm in its end position is pressed through inwards. When the pump accelerates, the pump valve is at first opened by the pressure, which is transferred to fuel from the diaphragm. If the diaphragm pressure ceases and if the throttle is in this moment within the partial load zone, the springloaded ball closes the pump valve independently. The fuel/air mixture is then produced solely by the main jet system. If, however, the throttle is opened in the full throttle zone when the diaphragm pressure ceases, the tenon of the diaphragm rod holds the ball valve open, so that also after the diaphragm movement ceases, additional fuel is steadily sucked off according to the vacuum effect from injector tube resp. pump system, and is added to enrich the fuel air mixture in the mixing chamber.



Isabella

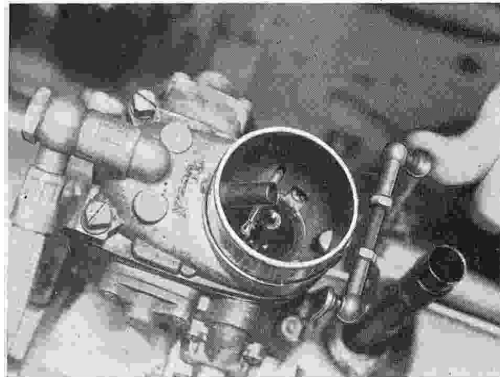


89

M 53. Testing and overhauling carburettor  
Carburettor removed

Tools: Spanner 8, 11, 12, 14 mm, screwdriver 6, 11 mm, split pin pliers, tubular box spanner 14 mm.

Figure 89



90

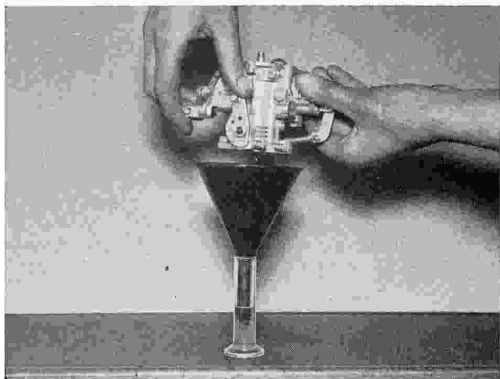
Caution: The correct carburettor setting is adjusted by the works. Alterations or replacement of jets or controls must not be carried out. Before the carburettor is removed, the injection pump of the accelerator can be tested. Undo airfilter, press guide lever of carburettor control and check if fuel ejects from injection tube, lever movement appr. 10 mm or 13/32". The auxiliary jet sets in at fixed lever movement of 30°.

Figure 90

1. Undo float chamber cover (Screwdriver)
2. Take out float lever pin with screwdriver when replacing float.

Caution: Float lever is correctly adjusted and must not be bent. The correct level of float in float chamber is 16 + 1.5 mm or appr. 5/8 + 1/16" below upper edge of float chamber body.

Figure 91



91

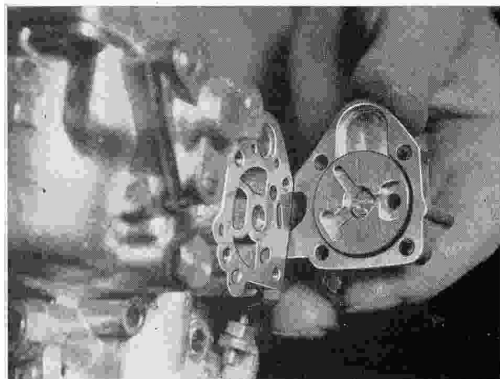
3. Test accelerator pump flow capacity. Fill float chamber with petrol. Press pump lever 10 times and collect fluid in measuring glass. Pump delivery per stroke: 0.9 to 1.2 ccs. When testing, pump must deliver 9 - 12 ccs petrol in measuring glass.
4. Remove split pin from pump rod on pump lever. (Split pin pliers)

Caution: Split pin must be positioned in center bore, alteration of split pin position will result an alteration of injection quantity but will also, in reversed sense, cause alteration of partial load so that no fuel is saved.

5. Undo 4 corner screws to remove injection pump, complete with diaphragm. (Screwdriver)
6. Undo two remaining screws to remove diaphragm. When reassembling diaphragm, this is placed into correct position by the spring. Both injection pump and diaphragm are held into position by 6 screws.
7. When fitting new diaphragm, check again pump delivery.
8. Undo starting carburettor.

Caution: When reassembling starting carburettor with drawn starting carb, the orifice must coincide with the center of the carburettor.

Figure 92



92

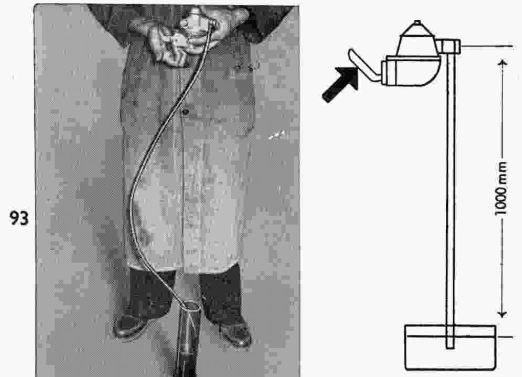
Jets are changed in the usual manner. Position of jets are shown in drawing on opposite page. Reassembly in reversed sequence.

M 63. Dismantling and overhaul of fuel pump  
Fuel pump removed

Tools: Screwdriver 6 and 8 mm.

Test delivery of fuel pump before dismantling and after reassembling. When completely emptied, pump must begin to deliver within 12 full strokes, height 1 m or 40".

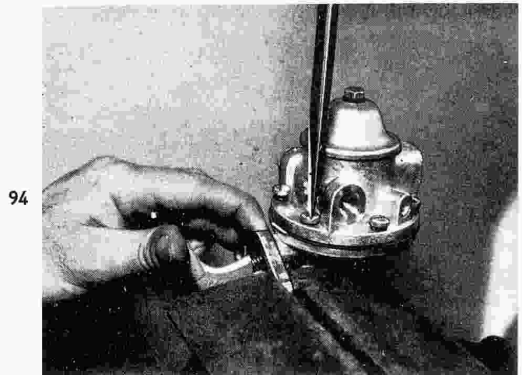
Figure 93



1. Slacken slotted screws to separate pump top - pump bottom casing.  
(Screwdriver 8 mm)

**Caution:** When reassembling top and lower part of casing tighten 6 slotted screws loosely, chuck pump in lead jaws, press lever by hand to pull through diaphragm, and tighten screws diagonally.

Figure 94



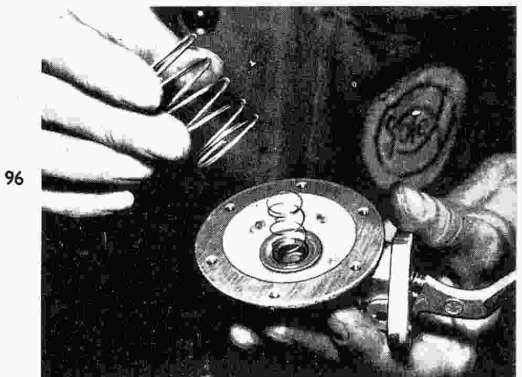
**Caution:** Place diaphragm so that long elevation on outer edge points to lever small cam on the diaphragm and mark on pump body coincide compulsory.

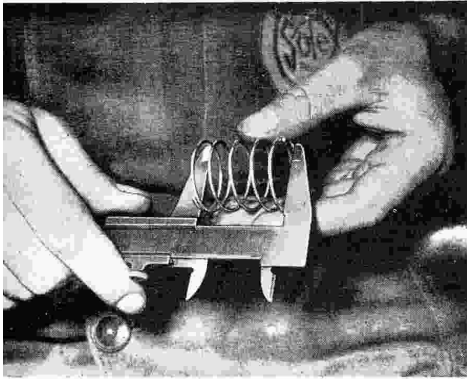
Figure 95



2. When reassembling new diaphragm fit firstly oil-guard washer, then diaphragm spring.

Figure 96

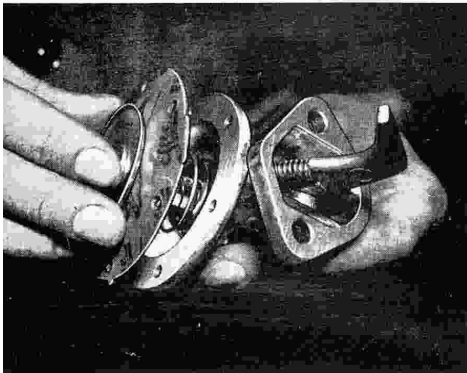




97

Caution: The diaphragm spring is calibrated and must not be altered by compression or expansion. Measure length of spring, 44 mm or 1.7323" with caliper gauge.

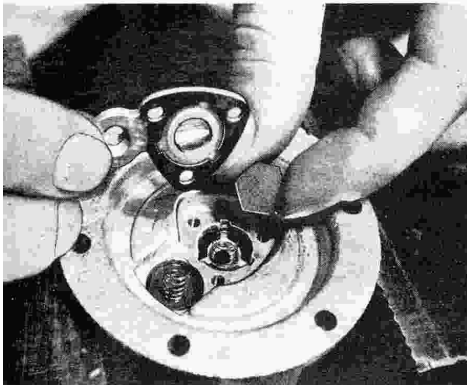
Figure 97



98

3. Turn bottom pump body with diaphragm fitted so that link falls down. Turn diaphragm slightly clockwise to bring slot of diaphragm rod on the hook of link and engage by turning anticlockwise.

Figure 98

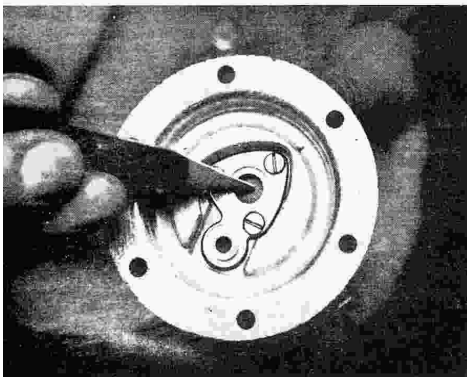


99

4. When testing valve resp. replacement remove retaining plate. (Screwdriver 6 mm)

Caution: When renewing valve, put bright side of valve on seat.

Figure 99



100

5. After reassembly of top part and retaining plate check free movement of valve with pencil or other soft pin. Do not use scriber.

Figure 100

After removal of cap the starting valve is accessible. Reassembly in reversed sequence.

M 65. Engine - Performance Control

Before this apparatus is used the following inspections must be carried out: Check valve clearance, clean breather and airfilter, lubricate carburettor control, adjust idling, check ignition and distributor - breaker points. To obtain best performance, modern devices should be used such as the electronic Auto Tester "Exakta", which is employed for the following engine performance controls.

Figure 101

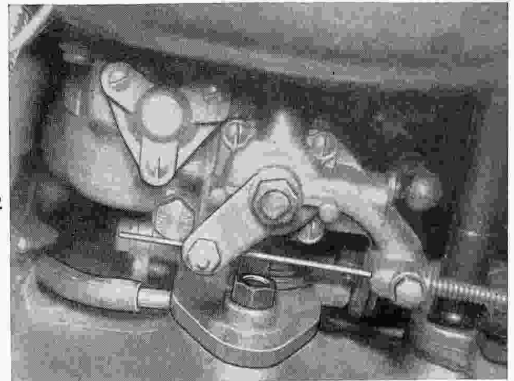
101



1. Remove sparking plugs, control gap, renew if necessary. Plugs must be replaced principally after appr. 15.000 km or 10.000 miles.
2. Install test flange between carburettor and cylinder-head for vacuum test.

Figure 102

102

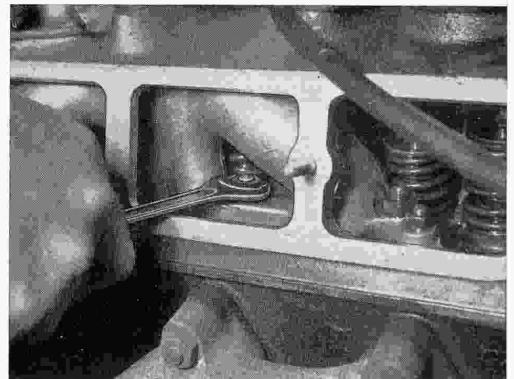


**Caution:** For further controls leave test flange installed between carburettor and cylinderhead. Compensate difference in height between airfilter and cylinderhead by fitting plastic spacer in equal height.

3. Control inlet manifold for tightness and correct fit.

Figure 103

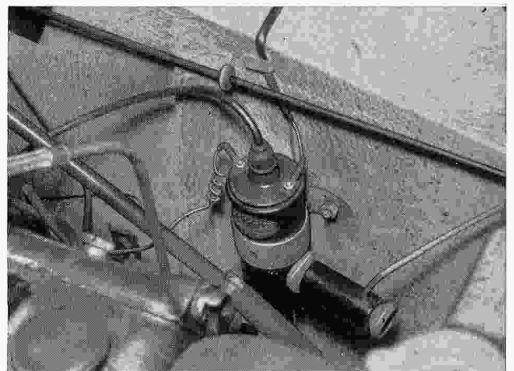
103

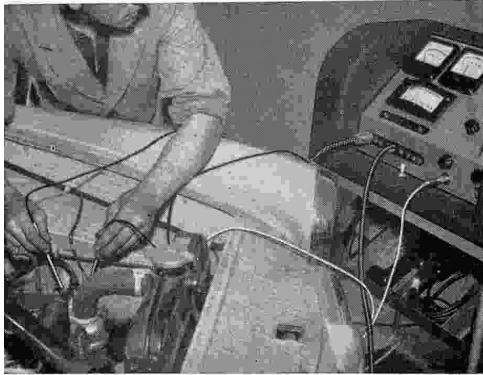


4. Connect apparatus with circuit. Place testcoil on ignition coil.  
(Adhesion by suction)

Figure 104

104

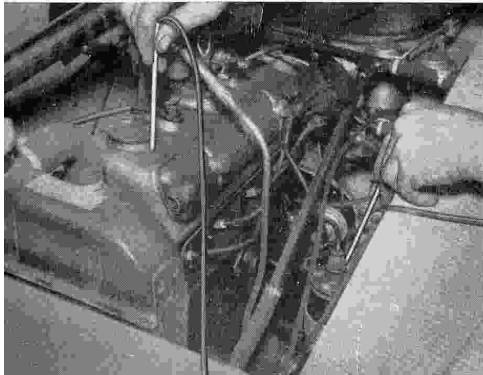




105

5. Check ignition equipment.
  - a) Check potential drop and loss with voltmeter, engine standing. Ignition switched on.

Figure 105



106

- b) Check ignition current with ampere meter.

Figure 106

- c) Check ignition timing. Switch on test lamp and oscillograph.

Caution: Ignition timing control enables the correct setting of ignition timing of idling engine as well as proper function of the centrifugal governor and vacuum adjustment. Every second tooth of the fly-wheel after T.D.C. should be marked for an exact control. Every two teeth correspond then to  $5^{\circ}$  ignition timing.

Figure 107

- d) Control of ignition timing at various revolutions
    1. With centrifugal governor only.
    2. With centrifugal governor and vacuum.Slacken distributor and turn to zero in idling for ignition timing.

6. Check ignition with oscillograph.

Figure 108

Caution: A fault finding chart is supplied for oscillograph tests.

7. Vacuum measurement and idling adjustment.

If the vacuum does not work properly, check valve clearance with gauge on running engine. With inserted gauge, drop of vacuum must be 0.2 atü or appr. 2.58 lb/sq. in. (psi)

Lesser drop = too much valve clearance, too much drop = valve clearance too narrow. If drop is too large, check valve clearance with standing engine. If valve clearance with standing engine is correct, a guide has not sufficient clearance. If vacuum drop is correct but the highest vacuum is not obtained, valves are leaking and must be reground.

8. Vacuum test for fuel measurement. Find curve for various revolutions, if necessary by counter check test run without airfilter. Airfilter is clogged when vacuum is increased with filter removed. If less vacuum is indicated, too much fuel is present and in such a case the carburettor must be checked and adjusted.

9. Measure pump pressure. Pump pressure should be 0.2 atü or appr. 2.58 lb/sq. in.

10. Piston control. Fasten pendulum, 2 opposite cylinders each working. If performance drops, look for faulty piston by employment of various measurement connections.



107



108