ENGINE

SECTION B

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4-CYLINDER PETROL ENGINE

(KAH MODELS)

DATA

ENGINE

Type	4 cylinder, vertical, overhead valve unit, having an R.A.C. rating of 16·2 h.p.
Bore (grade "B"—nominal)	3·1869/3·1873 in. (80·947/80·957 mm.)
Stroke (nominal)	4·33 in. (110 mm.)
Maximum B.H.P. at 3,400 r.p.m.	
—Gross	56
—Nett	52·5
Maximum torque at 1,600 r.p.m.	104 lb. ft. (14·38 kg.m.)
Piston speed per 1,000 r.p.m.	721·8 ft./min. (220·01 m./min.)
Compression ratio	6·25 : 1
Compression pressure	114 lb./sq. in. (8·01 kg./sq. cm.) (see also test conditions, detailed on page B.17)
Displacement	138·34 cu. in. (2,267 c.c.)
Firing order	1 : 3 : 4 : 2
Engine mounting	Three point rubber; two at the rear on the clutch housing, via brackets, and one at the front on a support bracket bolted to the timing cover

LUBRICATION SYSTEM

Type of system	Pressure
Type of pump	Submerged spur gear
Type of pump intake	Floating gauze filter
Pump drive	Helical skew gear on camshaft
Normal running pressure (hot)	45 to 50 lb./sq. in. (3·16 to 3·52 kg./sq. cm.)
Oil filter	
—Make	AC-Delco
—Type	By-pass, with renewable element
—Model	AC.1531196
—Maker's element number	AC.M14
Position of oil filter	Upper left hand side of cylinder block
Dipstick location	Front left hand side of cylinder block, adjacent to the ignition coil
Pressure relief valve —Type and position	Spring loaded plunger, non-adjustable. Located in the cylinder block on the right hand side. Operates to limit the oil pressure in the system to approximately 50 lb./sq. in. (3·52 kg./sq. cm.).
Position of oil filler	Mounted on upper face of the rocker cover, towards the front left hand side
Oil capacity of system	9·5 pint (5·40 litre)

MANUFACTURING DATA

ENGINE

Cylinder Block.

Type	Monobloc, integral with crankcase
Material	Grey cast iron
Water jackets	Full length of bore
Cylinders	Plain bore
Cylinder wall lubrication	Spurt hole in connecting rod big end
Bore size	Grade "B" is nominal size, but is subject to the grading as indicated at the top of page B.6. Individual bores in any cylinder block may conform to any of these five grades, i.e., the bores in any one block may not conform to one grade.

Cylinder Block—*Data continued*

	inches	*millimetres*
Grade A	3·1861/3·1865	80·927/80·937
Grade A1	3·1865/3·1869	80·937/80·947
Grade B	3·1869/3·1873	80·947/80·957
Grade B1	3·1873/3·1877	80·957/80·967
Grade C	3·1877/3·1881	80·967/80·978

Note: When the letter "T" is stamped as an additional letter to the cylinder bore grading letter, it indicates a production grading system and should be ignored.

Therefore, for service purposes a cylinder bore stamped with the letters "AT" is a grade "A" bore, and a bore stamped "B1T" is a grade "B1" bore, etc.

The grade letters of each bore are stamped on the left hand wall of the cylinder block, in line with the bore and just below the head gasket seating.

	inches	*millimetres*
Maximum oversize recommended for reboring (with or without liners)	+·030	+·762
Bore diameter in cylinder block to accommodate liner (std.)	3·3045/3·3055	83·934/83·960
Outer diameter of liner (std.)	3·3065/3·3075	83·985/84·011
Recess depth in cylinder block for liner flange	·118/·120	2·997/3·048
Recess diameter in cylinder block for liner flange	3·457/3·460	87·808/87·884
Fit of liner in cylinder block	·001 in. to ·003 in. (·025 mm. to ·076 mm.) interference	
Bore diameter of housing for main bearings	2·3948/2·3955	60·828/60·846
Main bearing cap stud size	with main bearing cap nuts tightened to the recommended torque wrench reading	
—Front and centre	$\frac{7}{16}$ in. B.S.F.	
—Rear	$\frac{1}{2}$ in. B.S.F.	

Bore diameter of housings for camshaft bearings	*inches*	*millimetres*
—Front	1·9998/2·0008	50·795/50·820
—Centre	1·9975/1·9990	50·737/50·775
—Rear	1·9005/1·9015	48·273/48·298

Cylinder Head.

Material	Grey cast iron	
Cylinder head stud size	$\frac{7}{16}$ in. B.S.F.	
Gasket		
—Type	Steel, asbestos and copper composition	
—Thickness (compressed)	·045	1·143
Valve guide housing diameter	·625/·626	15·875/15·900
Valve seat angle (inlet and exhaust)	45°	

Note: The valve seating must be concentric to the valve guide bore to within ·002 in. (·051 mm.) total indicator reading.

Valve throat diameter		
—Inlet	1·515/1·520	38·481/38·608
—Exhaust	1·247/1·253	31·674/31·826
Sparking plug thread size	14 mm. diameter × 1·25 mm. pitch	

Valve Guides.

Type	Detachable	
Material	Malleable cast iron	
Outer diameter (std.)	·6262/·6267	15·905/15·918
Fit in cylinder head	·0002 in. to ·0017 in. (·005 mm. to ·043 mm.) interference	

Valve Guides—*Data continued*

	inches	*millimetres*
Inner diameter	·3437/·3447	8·730/8·755
Overall length		
—Inlet	2·20	55·88
—Exhaust	2·60	66·04
Oversize valve guides available	+·001 in. (+·025 mm.) and +·003 in. (+·076 mm.)	
Location in cylinder head	When fitted the upper end face of the valve guides must project, ·71 in. (18·034 mm.) in the case of the inlet valve guides, and ·86 in. (21·844 mm.) in the case of the exhaust valve guides, above the bottom of the valve spring seating. The upper end of the valve guide in each case is marked "TOP" and this end must be located adjacent to the spring seating.	

Valves.

Material		
—Inlet	Steel drop forging	
—Exhaust	Steel extruded forging	
Position and operation	Overhead and operated by push rod and rocker	
	inches	*millimetres*
Valve clearances (engine hot)		
—Inlet	·007	·178
—Exhaust	·009	·229
Valve head diameter		
—Inlet	1·630/1·634	41·402/41·504
—Exhaust	1·382/1·386	35·103/35·204
Valve face angle		
—Inlet and exhaust	45°	

Note: The valve face must be concentric to the valve stem to within ·001 in. (·025 mm.) total indicator reading.

Depth of parallel section above valve face angle		
—Inlet	·05	1·27
—Exhaust	·06	1·52
Valve stem diameter		
—Inlet	·3417/·3422	8·679/8·692
—Exhaust	·3407/·3412	8·654/8·666
Valve stem clearance in guide		
—Inlet	·0015/·0030	·038/·076
—Exhaust	·0025/·0040	·064/·102
Overall length		
—Inlet	4·92	124·97
—Exhaust	4·92 in. (124·97 mm.) plus ·06 in. (1·52 mm.) for the coned head of the valve	
Valve timing		
—Inlet opens	15° B.T.D.C.	For checking these angular positions, set valve clearances to ·015 in. (·381 mm.) (see "Valve Timing" on pages B.32 to B.34)
—Inlet closes	49° A.B.D.C.	
—Exhaust opens	53° B.B.D.C.	
—Exhaust closes	11° A.T.D.C.	

Valve Springs.

Type	Dual coil	
Spring retention	Cup and split cotters	
	inches	*millimetres*
Free length		
—Inner spring	1·93	48·02
—Outer spring	2·23	56·64
Load at fitted length (with valve closed)		
—Inner spring	25 lb. (11·34 kg.) at 1·58 in. (40·13 mm.)	
—Outer spring	56 lb. (25·40 kg.) at 1·70 in. (43·18 mm.)	

Valve Spring—*Data continued*

Load at compressed length (with valve fully open)	
—Inner spring	49 lb. to 52 lb. (22·23 kg. to 23·59 kg.) at 1·23 in. (31.24 mm.)
—Outer spring	91 lb. to 97 lb. (41·27 kg. to 43·99 kg.) at 1·35 in. (34·29 mm.)

Rocker Gear.	*inches*	*millimetres*
Rocker shaft		
Overall length	7·50	190·50

Note: Shaft to be straight to within ·002 in. (·051 mm.) total indicator reading over its full length.

Outer diameter	·7490/·7495	19·025/19·037
Width of locating key slot	·093/·097	2·362/2·464
Depth of locating key slot	·100/·106	2·540/2·692
Rocker bore diameter	·750/·751	19·050/19·075
Locating key width	·090/·093	2·286/2·362
Rocker shaft standard		
Bore diameter	·750/·751	19·050/19·075
Width across boss side faces	·98	24·89
Slot width for locating key	·095/·100	2·413/2·540
Rocker retaining springs		
Free length		
—Inner	2·50	63·50
Load at fitted length		
—Inner	8 lb. (3·63 kg.) at 1·375 in. (34·925 mm.)	
—Outer	7 lb.±1 lb. (3·18 kg.±·45 kg.) at ·100 in. (2·540 mm.)	
Tappets		
Outer diameter	1·0224/1·0229	25·969/25·982
Diameter of tappet bore in cylinder block	1·0234/1·0244	25·994/26·020

Camshaft.

Location	Left hand side of the cylinder block, and operating in three steel shell, white metal lined type bearings, pressed into the cylinder block
End thrust	Taken on the location plate mounted on the front face of the cylinder block

	inches	*millimetres*
Thickness of camshaft location plate	·2047/·2057	5·199/5·225
End float	·003 in. to ·005 in. (·076 mm. to ·127 mm.)	
Journal diameter		
—Front	1·8720/1·8728	47·549/47·569
—Centre	1·8070/1·8080	45·898/45·923
—Rear	1·7668/1·7680	44·877/44·907
*Cam base diameter (nominal)	1·1138	28·291
*Cam lift (nominal)	·314	7·976
*Diameter of eccentric for fuel lift pump operation	1·373/1·377	34·874/34·976

*The lands of the cams and the fuel lift pump eccentric are taper ground, therefore, when checking these dimensions always measure over the rearmost edge of the lands, i.e., the larger dimension.

Width of timing wheel key slot on front spigot of camshaft	·187/·188	4·750/4·775
Depth of timing wheel key slot on front spigot of camshaft	·219/·223	5·563/5·664
**Bearing inner diameter (fitted)		
Front		
—Production	1·8740/1·8750	47·600/47·625
—Service replacements	1·8760/1·8770	47·650/47·676

Camshaft—*Data continued*

	inches	*millimetres*
Centre		
—Production	1·8095/1·8105	45·961/45·987
—Service replacements	1·8115/1·8125	46·012/46·038
Rear		
—Production	1·7693/1·7703	44·940/44·966
—Service replacements	1·7713/1·7723	44·991/45·016
**Maximum clearance between camshaft journal and bearing		
Front		
—Production	·0030	·076
—Service replacements	·0050	·127
Centre and rear		
—Production	·0035	·089
—Service replacements	·0055	·140

**When checking camshaft bearing diameters and bearing clearances the following remarks should be observed.

Service replacement camshaft bearings are supplied pre-finished with increased inner bearing diameters, to allow for any slight variation in the alignment through the three parent bearing bores in the cylinder block.

Camshaft bearings fitted on production, including service replacement cylinder blocks, however, are finish line bored in position, allowing closer limits on the bearing inner diameters to be maintained.

Drive	Duplex chain and timing wheels, tensioned by means of a spring blade
Lubrication of drive	Oil jet

Timing Wheels and Chain.

Timing chain		
Type	Renold Duplex Endless	
	inches	*millimetres*
Pitch	·375	9·525
Number of pitches	62	
Outer diameter of roller	·25	6·35
Internal width (measured to outer end faces of opposing rollers)	·628	15·951
Camshaft timing wheel		
Number of teeth	44	
Pitch of teeth	·375	9·525
Diameter of gear, as taken over ·25 in. (6·35 mm.) diameter pins	5·504/5·507	139·802/139·878
Width of locating key slot	·1875/·1885	4·763/4·788
Crankshaft timing wheel		
Number of teeth	22	
Pitch of teeth	·375	9·525
Diameter of gear as taken over ·25 in. (6·35 mm.) diameter pins	2·882/2·885	73·203/73·279
Width of locating key slot	·236/·237	5·994/6·020

Crankshaft.

Material	Steel drop forging
Balance	Integrally forged counter-weights
Lubrication of crankshaft main and crankpin journals	Pressure
Number and type of main bearings	Three, steel shell, white metal lined bearings, supported in the crankcase and bearings caps
End thrust	Taken on steel backed, white metal lined thrust washers, located on either side of the rear main bearing housing

Crankshaft—*Data continued*

	inches	*millimetres*
Thickness of thrust washer (std.)	·091/·093	2·311/2·362
Oversize thrust washers available	+·005	+·127
End float	·002 in. to ·004 in. (·051 mm. to ·102 mm.)	
Outer diameter of main journal (std.)	2·2490/2·2495	57·125/57·137
Maximum undersize for re-grinding main journals	—·040	—1·016
Inner diameter of main bearing fitted (std.)	2·2498/2·2510	57·145/57·175
Undersize main bearings available	—·020 in. (—·508 mm.) and —·040 in. (—1·016 mm.)	
Running clearance of main journal in bearing	·0003 in. to ·0020 in. (·008 mm. to ·051 mm.)	
Width of main journal		
—Front	1·9450/1·9530	49·403/49·606
—Centre	1·9665/1·9705	49·949/50·051
—Rear	2·4405/2·4415	61·989/62·014
Outer diameter of crankpin journal (std.)	1·93725/1·93775	49·206/49·219
Maximum undersize for re-grinding crankpin journal	—·040	—1·016
Width of crankpin journal	1·3125/1·3145	33·084/33·388
Width of locating key slot for timing wheel	·2357/·2367	5·987/6·012
Crankpin throw	2·164/2·166	54·966/55·016

Connecting Rod.

Material	Steel, "H" section, drop forging	
Distance between centres	8·699/8·701	220·955/221·005
Small end bearing type	Split bush (Vandervell Clevite 10)	
Big end bearing type	Steel shell, white metal lined	
Big end		
Bore (less bearings)	2·0425/2·0430 with connecting rod cap nuts tightened to the recommended torque wrench reading	51·880/51·892
Width	1·302/1·304	33·071/33·122
Side float	·0085 in. to ·0125 in. (·216 mm. to ·318 mm.)	
Inner diameter of crankpin (big end) bearing fitted (std.)	1·9380/1·9390	49·225/49·251
Undersize crankpin (big end) bearings available	—·020 in. (—·508 mm.) and —·040 in. (—1·016 mm.)	
Running clearance of crankshaft crankpin journal in bearing	·00025 in. to ·00175 in. (·006 mm. to ·044 mm.)	
Bearing cap bolt size	$\frac{3}{8}$ in. B.S.F.	
Small end		
Bore (less bush)	1·0685/1·0700	27·140/27·178
Width	1·10	27·94
Inner diameter of bush fitted (finished to size when in position)	·9447/·9451	23·995/24·006
Big and small end bores to be parallel in all planes to within	·0005 in. (·0127 mm.) per 1 in. (25·40 mm.) of mandrel length	

Gudgeon Pin.

Type and location	Tubular, fully floating and retained in the piston bosses by circlips	
Finish	Heat treated, ground and lapped	
Overall length	2·718/2·721	69·037/69·113
Outer diameter		
—High grade (colour coded green)	·9449/·9450	24·000/24·003
—Medium grade (natural)	·9448/·9449	23·998/24·000
—Low grade (colour coded yellow)	·9447/·9448	23·995/23·998

	inches	millimetres
Gudgeon Pin—*Data continued*		
Diameter of +·003 in. (+·076 mm.) oversize gudgeon pins available	·9478/·9480	24·074/24·079
Piston and Piston Ring.		
Type	"T" slot with flat top crown	
Material	Lo–Ex aluminium alloy, tin plated ·0002 in. (·005 mm.) thick on the outer diameter	
Form	Taper and oval ground	
Number of rings		
—Compression	2 (top ring chromium plated—2nd ring taper faced)	
—Scraper	1 (slotted)	
Additional oil control	Provision is made for an additional slotted scraper ring in the skirt. This additional ring is for service use only, see page B.39	
Compression height	2·008/2·012	51·003/51·105
Overall length (nominal)	3·660	92·964
Skirt diameter (after tin plating)	Grade "B" is nominal size, but is subject to the following grading:	
	inches	*millimetres*
Grade A	3·1844/3·1848	80·884/80·894
Grade A1	3·1848/3·1852	80·894/80·904
Grade B	3·1852/3·1856	80·904/80·914
Grade B1	3·1856/3·1860	80·914/80·924
Grade C	3·1860/3·1864	80·924/80·935

Note: When the letter "T" is stamped as an additional letter to the piston grading letter, it indicates a production grading system and should be ignored.

Therefore, for service purposes a piston stamped "AT" is a grade "A", and a piston stamped "B1T" is a grade "B1", etc.

The letter denoting piston skirt diameter grading is stamped on the piston crown.

Clearance in cylinder bore with tin plated piston fitted	·0013 in. to ·0021 in. (·033 mm. to ·053 mm.)	
Oversize pistons available	+·030 in. (+·762 mm.)	
Maximum permissible weight variation per set of pistons	2 drams (3·55 grm.)	
	inches	*millimetres*
Gudgeon pin bore diameter	·9447/·9451	23·995/24·006
Ring groove width in piston		
—Compression	·0958/·0968	2·433/2·459
—Scraper	·1895/·1905	4·813/4·839
Piston ring width		
—Compression	·0928/·0938	2·357/2·383
—Scraper	·1865/·1875	4·737/4·763
Vertical clearance between piston ring and groove	·002 in. to ·004 in. (·051 mm. to ·102 mm.)	
Piston ring radial thickness	·122/·130	3·099/3·302
Piston ring free gap (nominal)	·37	9·398
Piston ring fitted gap	·010 in. to ·014 in. (·254 mm. to ·356 mm.)	

LUBRICATION SYSTEM

Oil Pump.		
Body		
Diameter of idler pin and driving shaft housing bores	·5123/·5128	13·012/13·025
Gear wheel housing diameter	1·2847/1·2857	12·631/12·657
Gear wheel housing depth (from cover plate mounting face)	1·2495/1·2510	31·737/31·775

	inches	millimetres
Oil Pump—*Data continued*		
Driving shaft		
Outer diameter	·5111/·5116	12·982/12·995
Shouldered diameter for gear wheel location	·4333/·4338	11·006/11·019
Pinion sleeve upper diameter (operating in bush pressed into crankcase)	·7252/·7259	18·420/18·438
Pinion lower journal diameter	1·0970/1·0978	27·864/27·884
Clearance of pinion lower journal in crankcase bore	·0042/·0064	·107/·163
Idler pin		
Outer diameter	·5130/·5134	13·030/13·040
Length	1·82	46·228
Driving gear wheel		
Length	1·2475/1·2485	31·687/31·712
Outer diameter	1·2815/1·2823	32·550/32·570
Pitch circle diameter	1·085	27·559
Bore diameter	·4328/·4333	10·993/11·006
Number of teeth	10	
Idler gear wheel		
Length	1·2475/1·2485	31·687/31·712
Outer diameter	1·2815/1·2823	32·550/32·570
Pitch circle diameter	1·085	27·559
Bore diameter	·5146/·5154	13·071/13·091
Number of teeth	10	
Clearance between end of gear wheels and pump body cover plate mounting face	·0015/·0035	·038/·089
Side clearance between gear wheels and pump body internal profile	·0019/·0049	·048/·124
Pressure Relief Valve.		
Valve		
Outer diameter	·521/·524	13·233/13·310
Length	1·07	27·178
Angle of seating face	106° (included)	
Spring		
Free length	1·988	50·50
Outer diameter	·354	9
Fitted load and length	6·00 lb. to 5·25 lb. (2·72 kg. to 2·38 kg.) at 1·338 in. (34 mm.)	
Minimum working length	·984	25
Thickness of valve body seating fibre washer	$\frac{1}{16}$ in. (1·59 mm.) uncompressed	

TORQUE WRENCH DATA

Cylinder head nuts	56/60 lb. ft. (7·74/8·30 kg. m.)
Main bearing cap nuts	
—Front and centre	45/65 lb. ft. (6·22/8·99 kg. m.)
—Rear	30/40 lb. ft. (4·15/5·53 kg. m.)
Big end cap nuts	27/30 lb. ft. (3·73/4·15 kg. m.)
Flywheel setbolts	37/43 lb. ft. (5·12/5·95 kg. m.)

4-CYLINDER PETROL ENGINE
(KAH MODELS)

DESCRIPTION

The engine is a four cylinder overhead valve unit with push rod operated valves that are carried in a detachable cylinder head. The head is secured by nuts and studs to the cylinder block, which is cast integral with the crankcase. A gasket of steel, asbestos and copper composition is interposed between the cylinder head and the block to seal this joint. Plain cylinder bores are used in this engine and maximum life is ensured by employing a chromium plated top compression ring on the pistons. The engine is rubber mounted in the chassis frame at three points, one at the front centre by a support bracket bolted to the timing cover and one on either side at the rear, by means of support brackets attached to the clutch housing.

The crankshaft is a steel drop forging formed with integral balance weights and is carried in three main bearings of the detachable steel shell, white metal lined type, which are readily renewable. The main bearing upper halves seat in the crankcase, whilst the lower halves seat in the bearing caps, and lips formed on the bearing halves seat in corresponding recesses machined in both the crankcase and bearing cap bores, thus providing complete location for the bearing shells when assembled. Crankshaft main bearings are obtainable in undersizes of —·020 in. (—·508 mm.) and —·040 in. (—1·016 mm.).

The main bearing caps are located by means of their side faces, which mate with machined registers in the crankcase, and are secured by studs and friction type locknuts. The registers in the crankcase for the main bearing caps are offset from the crankshaft axis, thus the main bearing caps can only be fitted correctly one way round. Crankshaft end float is controlled by thrust washers fitted to the inner and outer end faces of the rear main bearing housing, and to prevent radial movement of the upper and lower thrust washer halves, the lower halves are dowel located to the end faces of the bearing cap. Thrust washers are available in an oversize of +·005 in. (+·127 mm.). The primary shaft spigot bearing is located in a recess machined in the rear of the crankshaft flange.

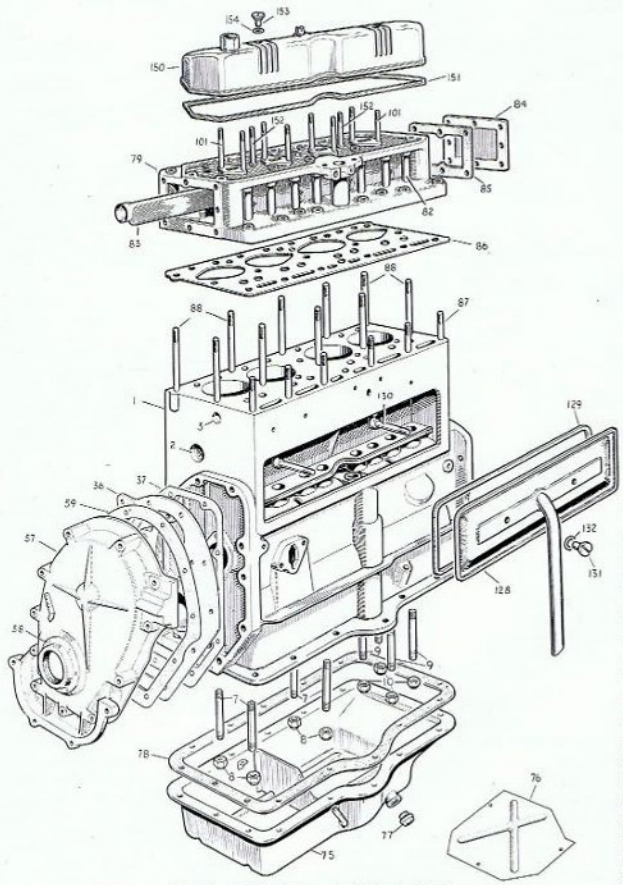
The connecting rods are steel "H" section drop forgings, formed with a closed hub at the upper (small) end, into which is pressed the small end bush. The lower (big) end is split at right angles to the rod axis and carries detachable steel shell, white metal lined type bearings, which are readily renewable. Locating lips are formed on the bearing halves and register in the recesses machined in both the connecting rod and the big end cap bores. These locating lips provide positive location for the complete bearing shells when assembled. Connecting rod big end bearings are obtainable in undersizes of —·020 in. (—·508 mm.) and —·040 in. (—1·016 mm.). The big end cap is secured to the connecting rod, by two bolts, nuts and locking plates.

Pistons of Lo-Ex aluminium alloy, with a "T" slot on the opposite side to the thrust, are attached to the connecting rod small ends by a fully floating gudgeon pin, which is retained in the piston by steel circlips. Gudgeon pins are available in an oversize of +·003 in. (+·076 mm.). Each piston is oval and taper ground and carries three piston rings located above the gudgeon pin. The top ring is a chromium plated compression ring, the second one a taper faced compression ring, and the third ring is a slotted oil control scraper ring. Provision is made at the bottom of the piston skirt for a second oil control scraper ring to be fitted in service after the vehicle has completed a considerable mileage. Pistons and rings are available in an oversize of +·030 in. (+·762 mm.). The pistons are tin plated on their outer diameters to assist "running-in".

The camshaft runs in three bearings of the steel shell, white metal lined type, which are readily renewable. The camshaft bearings are pressed into housings on the left hand side of the cylinder block. The aperture to the rear of the rear camshaft bearing is closed by means of a pressed disc. Camshaft end float is controlled by a thrust plate bolted to the front face of the cylinder block. The drive to the camshaft is transmitted from the crankshaft by means of an endless duplex chain and two timing wheels, the camshaft running at half crankshaft speed. Both chain driven timing wheels are suitably marked to facilitate valve timing. The timing chain is tensioned by means of a pivoting spring blade, which contacts the chain and bears against the inside of the timing cover. The timing chain and wheels are enclosed by an aluminium alloy cover. An oil seal riveted to the timing cover, seats around the boss on the crankshaft pulley and provides an oil tight seal at this point. A pointer is provided on the rear edge of the crankshaft pulley, and one on the timing cover front face, to facilitate setting the engine to T.D.C. (number 1 and 4 cylinders). A skew gear wheel machined in the camshaft centre journal mates with the skew gear pinion and sleeve assembly pinned to the long shaft of the spur gear type oil pump. This shaft provides the means of driving the oil pump, also the ignition distributor, via a separate driving shaft having an offset coupling at each end. The tongue at the lower end of this driving shaft mates in the sleeve of the skew gear pinion, whilst the slotted sleeve at the upper end mates with the driving dog on the distributor. An eccentric at the forward end of the camshaft drives the fuel lift pump, which is located on the left hand side of the cylinder block.

The detachable cylinder head carries the valve gear and twin rocker shaft assemblies.

Each rocker shaft assembly consists of a hollow shaft, sealed at either end by plugs and mounted at two points in rocker shaft standards, one of which locates the shaft radially by means of a key. The rocker arms are



1 CYLINDER BLOCK
2 LARGE SEALING CUP
3 SMALL SEALING CUP
4 FRONT CAMSHAFT BEARING
4A CENTRE CAMSHAFT BEARING
5 REAR CAMSHAFT BEARING
6 DISTRIBUTOR DRIVING PINION BUSH
7 to 10 MAIN BEARING CAP STUDS AND NUTS
11 CRANKSHAFT FRONT AND INTERMEDIATE MAIN BEARING
12 CRANKSHAFT REAR MAIN BEARING
13 CRANKSHAFT THRUST WASHER
14 THRUST WASHER DOWEL PIN
15 PISTON BODY
16 GUDGEON PIN
17 GUDGEON PIN CIRCLIPS
18 TOP COMPRESSION RING
19 SECOND COMPRESSION RING
20 UPPER OIL SCRAPER RING
21 LOWER SERVICE OIL SCRAPER RING
22 CONNECTING ROD
23 and 24 CONNECTING ROD BIG END BOLT AND NUT
25 NUT LOCKWASHER
26 CONNECTING ROD SMALL END BUSH
27 CONNECTING ROD BIG END BEARING
28 CRANKSHAFT
29 CRANKSHAFT TIMING WHEEL
30 TIMING WHEEL KEY
31 CRANKSHAFT PULLEY
32 OIL GUARD
33 and 34 STARTING HANDLE DOG NUT AND WASHER
35 PRIMARY SHAFT PILOT BEARING
36 FRONT ENGINE PLATE
37 FRONT PLATE JOINT
40 FLYWHEEL
41 STARTER RING
42 FLYWHEEL DOWEL
43 FLYWHEEL SECURING BOLT LOCKWASHER
44 CAMSHAFT
45 CAMSHAFT THRUST PLATE
46 CAMSHAFT TIMING WHEEL
47 TIMING WHEEL KEY
48 TIMING WHEEL SECURING SETSCREW
49 SECURING SETSCREW TAB WASHER
50 SECURING SETSCREW WASHER
51 TIMING CHAIN
52 TIMING CHAIN OIL JET
53 OIL JET LOCKNUT
54 TIMING CHAIN TENSIONER BLADE
55 CHAIN TENSIONER PIVOT PIN
56 PIVOT PIN WASHER
57 TIMING COVER
58 COVER OIL SEAL
59 TIMING COVER JOINT
60 OIL PUMP BODY
61 PUMP IDLER GEAR WHEEL SPINDLE

Fig. B.1. Cylinder block and cylinder head details

62 PUMP IDLER GEAR WHEEL AND BUSH ASSEMBLY
63 PUMP DRIVING SHAFT ASSEMBLY
64 PUMP DRIVING GEAR WHEEL
65 WOODRUFF KEY
66 PUMP COVER PLATE
67 and 68 COVER PLATE SECURING SET-SCREW AND WASHER
69 OIL PUMP FLOATING FILTER
70 FILTER RETAINING PIN
75 SUMP
76 SUMP BAFFLE
77 SUMP DRAIN PLUG
78 SUMP JOINT
79 CYLINDER HEAD
80 INLET VALVE GUIDE
81 EXHAUST VALVE GUIDE
82 PUSH ROD COVER TUBE
83 WATER DISTRIBUTION TUBE
84 CYLINDER HEAD REAR END COVER
85 END COVER JOINT
86 CYLINDER HEAD GASKET
87 and 88 CYLINDER HEAD STUDS
91 INLET VALVE
92 INLET VALVE SPRING CUP
93 CUP SEALING RING
94 EXHAUST VALVE
95 EXHAUST VALVE SPRING CUP
96 DUAL VALVE SPRINGS
97 VALVE SPRING CUP COTTERS
98 TAPPET
99 PUSH ROD
100 ROCKER STANDARD
101 ROCKER STANDARD SECURING STUD
102 ROCKER SHAFT
103 ROCKER SHAFT END SEALING PLUG
104 ROCKER INNER RETAINING SPRING
105 ROCKER OUTER RETAINING SPRING
106 ROCKER FACING WASHER
107 ROCKER SHAFT LOCATING KEY
108 OUTER RETAINING SPRING CLIP
109 ROCKER
110 VALVE CLEARANCE ADJUSTING SCREW
111 ADJUSTING SCREW LOCKNUT
128 TAPPET COVER AND BREATHER PIPE ASSEMBLY
129 TAPPET COVER JOINT
130 TAPPET COVER SECURING STUD
131 SECURING STUD CAP NUT
132 CAP NUT WASHER
150 ROCKER COVER
151 ROCKER COVER JOINT
152 ROCKER COVER SECURING STUD
153 SECURING STUD CAP NUT
154 CAP NUT WASHER
182 DISTRIBUTOR DRIVING SHAFT
183 DRIVING SHAFT COUPLING
184 COUPLING SECURING PIN

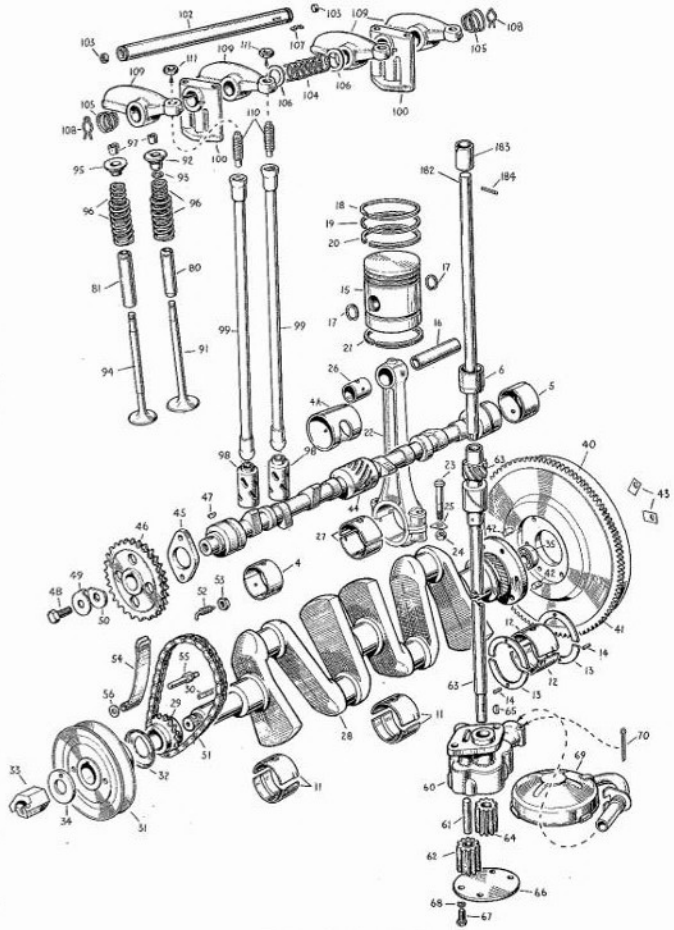


Fig. B.2. Engine internal details

arranged one each side of the rocker shaft standards so as the centre pair are held in contact by a single coil spring having a facing washer at either end, whilst the outer pair are positioned by short conical springs retained by spring clips, which locate in grooves in the rocker shaft.

One end of each rocker arm is radiused to contact the end of the valve stem and the opposite end is forged to form a boss, which is threaded and carries the adjusting screw and its locknut. The spherical end of the adjusting screw seats in the upper socket of the push rod, similarly the lower ball end of the push rod seats in the socket formed in the tappet, thus the movement originating from the barrel type tappets contacting the camshaft, is transferred, via the push rods, rocker arms and hence to the valves, which are actuated. The adjusting screws provided at the push rod end of each rocker arm are for valve clearance adjustment. The tappet chest in the side of the cylinder block is closed by means of a pressed steel cover, which is retained by two cap nuts, fibre washers sealing the nuts, and a gasket, the tappet cover. The tappet cover carries the external breather pipe.

The valves operate in renewable valve guides pressed into the cylinder head, and are fitted with dual valve springs, retained by a cup and split cotters. Valve guides are available in +·001 in. (+·025 mm.) and +·003 in. (+·076 mm.) oversizes on the outer diameter. On the spring cups fitted to the inlet valves an internal groove is formed, which locates the "O", or sealing ring. The whole valve mechanism is enclosed in a pressed steel cover, which is sealed by a gasket and retained by two cap nuts and fibre washers.

The cast iron flywheel is spigoted, dowelled and bolted to the rear of the crankshaft, with a steel starter ring shrunk on its outer periphery. The flywheel securing bolts are locked by means of tab washers. The clutch is dowelled and bolted to the flywheel rear face and the whole assembly is enclosed by the clutch housing, which as mentioned previously also provides the means of mounting the rear of the engine, via brackets.

The inlet and exhaust manifolds are secured together at the centre by studs and nuts, and a specially formed copper gasket is interposed between the mating faces of the inlet and the exhaust manifolds. Collars are fitted to the inner inlet ports in the cylinder head, which locate in recesses formed around the corresponding ports in the inlet manifold, thus registering the complete manifold assembly to the cylinder head. A gasket is fitted between the manifolds and the cylinder head. The exhaust pipe is secured to the exhaust manifold by studs and nuts, and a gasket is interposed between the exhaust manifold face and the pipe flange to seal this joint.

Information in respect of the fuel system, the cooling system, the ignition and electrical equipment, and the clutch will be found in the appropriate sections.

ADJUSTMENTS TO THE ENGINE WHILST IN POSITION

To Adjust the Valve Clearances.

Check and if necessary adjust the valve clearances every 12,000 mile (18,000 km.) adopting the following procedure:

1. Lift the bonnet (hood) and secure in the open position, also release the internal engine cowl from its anchorage.

2. Start the engine and run at a fast idling speed until hot and then switch off the engine.

3. Disconnect the breather pipe from the rocker cover and from the moulded branch on the air cleaner to carburettor hose, then lift the pipe clear (see "Fuel System" section).

4. Unscrew the two rocker cover cap nuts and lift off the cover, taking care not to damage the gasket, or lose the fibre washers fitted beneath the cap nuts.

5. To check and if necessary adjust the clearance of an individual valve, proceed as follows:

(*a*) Rotate the engine crankshaft until a similar valve on the corresponding cylinder is at full lift. Corresponding cylinders are 1 and 4, 2 and 3. Therefore, if it is desired to check number 1 cylinder inlet valve clearance, rotate the engine until number 4 cylinder inlet valve is on full lift.

(*b*) To check the valve clearance, insert a feeler gauge between the valve stem and rocker foot (see Fig. B.3). Correct clearances with the **engine hot** are:
Inlet valves
·007 in. (·178 mm.)
Exhaust valves
·009 in. (·229 mm.)

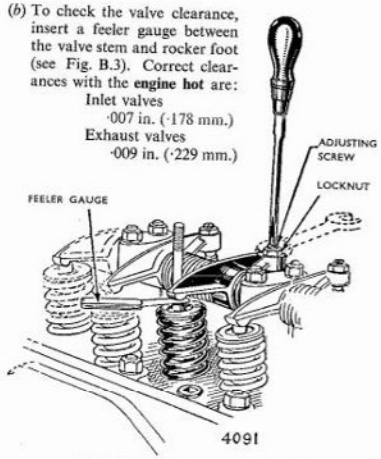


Fig. B.3. Valve clearance adjustment

(*c*) To adjust the clearance, slacken the locknut below the head of the adjusting screw, and turn the screw with a screwdriver until the correct clearance is obtained. Tighten the locknut, holding the adjusting screw in position with the screwdriver, then re-check the clearance with the feeler gauge.

(*d*) Continue the above described procedure until all the valves have been checked. To distinguish which valve clearances have been checked, identify the corresponding rocker with a chalk mark.

6. Complete the operation by refitting the rocker cover, ensuring that the gasket is in good condition and correctly positioned and that the breather pipe is connected securely.

Tightening the Cylinder Head Nuts.

Reference to Fig. B.4 will show that the majority of the cylinder head nuts are obscured by the rocker cover and therefore to effect the operation of tightening the nuts successfully the rocker cover must be removed as described under "To Adjust the Valve Clearances", paras. 1 to 4 inclusive. Proceed then as follows:

1. With the engine hot, tighten the nuts in the correct sequence as shown in Fig. B.4 to a torque wrench reading of 56/60 lb. ft. (7·74/8·30 kg. m.).

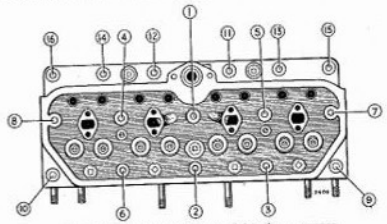


Fig. B.4. Cylinder head nut tightening sequence

2. Check the valve clearances as detailed on page B.16.

3. Refit the rocker cover, ensuring that an oil tight joint results between the cover and cylinder head, also refit the breather pipe to its connection on the rocker cover, and to the moulded branch on the air cleaner to carburettor hose. Tighten the pipe clips.

COMPRESSION PRESSURES

It is important to ensure that the valve rocker clearances are correctly set before commencing to take compression pressure readings (see page B.16). Proceed then in the following manner:

1. The correct compression pressure for the engine is 114 lb./sq. in. (8·01 kg./sq. cm.) and an engine in good condition should record this pressure at each cylinder tested, with the engine hot, sparking plugs removed, the throttle held fully open and the engine revolving at starter cranking speed.

2. If the readings obtained are substantially below the given figure, the engine is in need of attention to one, or all of the following:

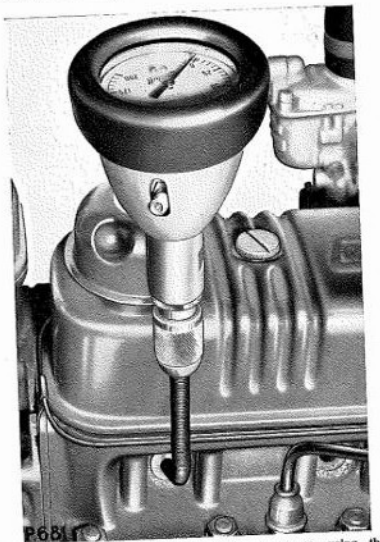


Fig. B.5. Checking engine compression pressures, using the Churchill Tool 430

(*a*) Valves and/or seatings.

(*b*) Pistons, piston rings and/or cylinder bores.

(*c*) Cylinder head gasket.

3. In addition to the above, incorrect valve timing will result in a deviation from the correct compression pressure. If the valve timing is early, the compression pressure obtained will be higher, and if late, lower than specified. Such readings will only be obtained after incorrect assembly of the timing wheels and chain. Check as detailed under "Valve Timing" on page B.32.

4. It is recommended that the Churchill 430 Cylinder Compression Tester, which is supplied as standard with a curved connecting tube and 14 mm. expanding adaptor, be used for taking pressure readings on this engine.

CYLINDER HEAD MAINTENANCE

Cylinder head maintenance includes removal of the cylinder head, decarbonising, valve refacing, valve seat re-grinding and the "grinding-in" of the valves. Opportunity should be taken to thoroughly service the carburettor, fuel lift pump filter chamber, and the distributor, as detailed under the "Fuel System" section, and the "Electrical Equipment" section respectively.

To Remove.

In the removal operations detailed below, the water pump is withdrawn together with the cylinder head as an assembly, however, if required the water pump may be suitably supported and left in position, together with the top and bottom water hoses, providing that the tension is relieved from the fan belt, and the bolts securing the water pump body to the cylinder head and the cover plate are released prior to cylinder head removal. The two removal procedures then follow the same operational sequence.

1. Lift the bonnet (hood) and secure in the open position, also release the internal engine cowl from its mounting points.

2. Disconnect the lead from one of the battery terminals.

3. Drain the water from the radiator and the cylinder block at the taps provided (see "Cooling System" section). Disconnect the top and bottom water hoses. If an anti-freeze mixture is in use, drain into a clean container for re-use in filling the cooling system upon re-assembly.

4. Slacken the dynamo adjusting setscrew and bolt, also the support nuts and bolts, pivoting the dynamo inwards towards the cylinder block. Retain in this position by re-tightening the adjusting setscrew. Withdraw the four setscrews that secure the fan assembly and fan pulley to the water pump mounting flange. Remove the fan assembly, fan pulley and fan belt.

Release the two bolts from the steady bracket, which supports the cylinder block drain tap remote handle. This operation also frees the dynamo adjusting strap from the lower securing bolt.

5. Disconnect the air cleaner hose from its location at either end, similarly the breather pipe from the connection on the rocker cover, and then lift the two components clear. Remove the rocker cover from the cylinder head, after releasing the cap nuts.

6. Disconnect the lead from the thermometer bulb, located in the water pump body thermostat chamber.

7. Remove the heater pipes (when fitted) from their adaptors situated in the water pump inlet pipe and on the rear left hand side of the cylinder head.

8. Remove the nuts that secure the rocker shaft standards to the studs on the cylinder head, and lift off the twin rocker shaft assemblies.

9. Withdraw the push rods making sure that the tappets are not extracted from their bores. To ensure the tappets are not displaced as the push rods are withdrawn, proceed as follows:

(*a*) Raise the push rod approximately ¼ in. (12 mm.) and if by this time the tappet has not separated from the rod, lightly tap the side of the push rod with a suitable implement until the tappet is released.

(*b*) Alternatively, raise the push rod approximately ¼ in. (12 mm.) and if by this time the tappet has not separated from the rod, vigorously shake the upper end of the push rod from side to side until the break is effected.

10. Remove the exhaust and inlet manifold assembly (see page B.50).

11. Disconnect the rocker oil feed pipe at the cylinder head elbow.

12. Remove the distributor complete with its mounting bracket (see "Electrical Equipment" section).

13. Remove the cylinder head nuts and withdraw the cylinder head assembly from the studs, noting that as the cylinder head is raised the distributor driving shaft must also be raised in step with the cylinder head, until it is possible as the head clears the studs and is moved rearwards slightly, to lift the driving shaft to the full height of the scuttle aperture and then tilt the shaft rearwards, so that it clears the cab scuttle, when removal of the driving shaft from the cylinder head is possible.

A composite gasket is fitted between the cylinder block and head, and a slight rocking movement may be necessary to break the joint.

Note: If any water drops into the cylinder bores when the head is lifted away it should be wiped out immediately to prevent corrosion.

To Dismantle.

Dismantling will be facilitated if the cylinder head is placed with the valve springs uppermost, on a pair of wooden blocks, one placed at either end.

1. Remove the bolts that secure the water pump to the cover plate and the front face of the cylinder head, and withdraw the pump complete.

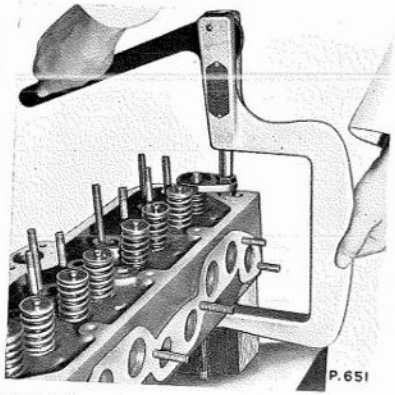


Fig. B.6. Compressing the valve springs and cup, using the Churchill Tool R.G.6513 and the compressor foot R.G.6513-1

2. Using a valve spring compressor (Churchill Main Tool R.G.6513, which includes the Compressor Foot R.G.6513–1, as shown in Fig. B.6), compress the valve springs and cups, thus freeing the split coned cotters enabling them to be removed. When carrying out this operation ensure that the hardened steel cotters and the spring cups do not damage the valve stems. Ensure that the inlet valve spring cups are not over compressed, so as to cause damage to the sealing, or "O" rings.

3. Release the valve spring compressor, and lift off the spring cups and dual valve springs.

4. Remove the valves. The valves are numbered 1–8 starting from the front of the engine and on refitting ensure they are returned to their original seats. Should a new valve be fitted, chalk it with the number corresponding to that on the original valve.

5. If it is desired to remove the water distribution tube, remove the covers at the front and rear of the cylinder head and tap it out from the rear, using a suitable wooden drift. Alternatively a suitable tool may be constructed as detailed under the "Cooling System" section, and the tube withdrawn from the front of the cylinder head, after first releasing the front cover plate.

Inspection and Overhaul.

Before inspecting any of the components, remove any carbon deposit from the combustion chambers, valve ports, inside the valve guides and the valves. Suitable wire brushes fitted into a hand drill are recommended for these operations. After cleaning the valve heads give the stems a polished finish using very fine emery cloth with oil, taking care not to reduce the valve stem diameter over the length which operates in the valve guide (see also "Decarbonising", on page B.24).

Valve Guides.

1. To Inspect. These may be checked for wear by using a new valve as a gauge. The valve stem should be a free sliding fit in the guide without excessive side play. The maximum designed clearance of the valve stem in the guide is as follows:

Inlet	·003 in. (·076 mm.)
Exhaust	·004 in. (·102 mm.)

Whilst making the above checks ensure that the guides are free from carbon, and the stems from burrs. All components must be oil free.

Valve guides are available in standard size, and +·001 in. (+·025 mm.) and +·003 in. (+·076 mm.) on the outer diameter.

Renew the guides, if necessary, as detailed in para. 2 below.

2. To Renew. It is seldom necessary, to renew the valve guides, but it may be necessary, however, for the purpose of re-grinding the valve seatings where great accuracy is essential to ensure concentricity of the work performed by the stone of the grinder, which operates in conjunction with an expanding pilot inserted in the valve guide.

The valve guides are an interference fit in the cylinder head and removal and refitment is facilitated by the use of Churchill Main Tool R.G. 10A, in conjunction with the Adaptor Sets R.G. 10A-3A and R.G. 10A-6 (see Fig. B.7). If valve guide renewal is necessary, proceed as follows:

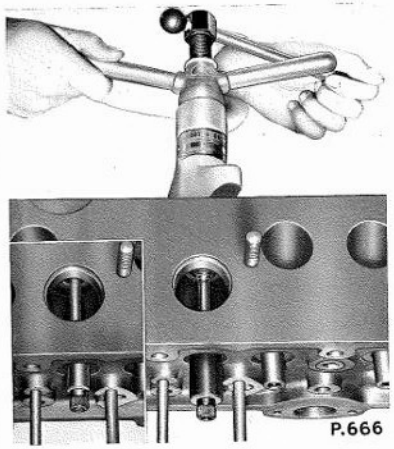


Fig. B.7. Fitting new valve guides, using the Churchill Tool R.G.10A and the adaptor sets R.G.10A-3A and R.G. 10A–6 (Inset shows the method of valve removal)

(*a*) Screw the centre bar, R.G. 10A-3A, Code 4, into the centre screw of the main tool and locate the adaptor, R.G. 10A-6, over the centre bar so as to abut the body of the tool. The taper face of the latter adaptor must face away from the body of the tool.

(*b*) To remove a valve guide from the cylinder head, insert the centre bar, R.G. 10A-3A, Code 4, down through the combustion chamber and the valve guide bore until it is possible to screw the knurled nut on to the lower end of the centre bar, noting that the taper face of the adaptor, R.G. 10A-6, registers squarely on the valve seating (see Fig. B.8). Withdraw the valve guide through the combustion chamber and when clear of its housing remove the main tool complete with valve guide from above. Release the knurled nut and slide off the valve guide from the centre bar of the tool. Repeat this procedure to remove all remaining valve guides.

(*c*) To fit a new valve guide to the cylinder head, utilise again the main tool R.G. 10A together with the adaptor sets R.G. 10A-3A and R.G. 10A-6, maintaining the latter adaptor in the same position on the body of the main tool as it assumed during the removal operations. Insert the centre bar, R.G. 10A-3A, Code 4, down through the combustion chamber and the housing for the guide until it protrudes below the cylinder head sufficiently to allow the valve guide, followed by the locating adaptor, R.G. 10A-3A, Code 3 (inlet valve guide), or R.G. 10A-3A, Code 2 (exhaust valve guide) to be

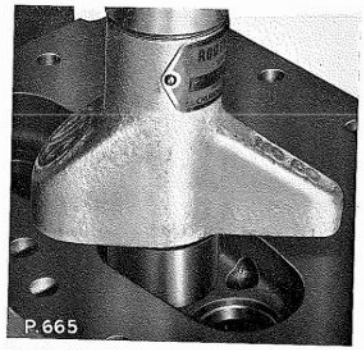


Fig. B.8. Correct location of the Churchill Adaptor R.G.10A–6 on the cylinder head valve seating, during valve guide renewal

fitted over the centre bar of the tool. Finally screw the knurled nut on to the threaded end of the centre bar. Ensure the adaptor, R.G. 10A-6, registers squarely on the valve seating (see Fig. B.8). Draw the valve guide into position, noting that when the guide is drawn down to the depth of the locating adaptor it automatically assumes the correct height above the spring seating. Repeat this procedure to refit the remaining valve guides.

Notes: (i) When fitting the new guides it is important that the prescribed interference fit in the cylinder head of ·0002/·0017 in. (·005/·043 mm.) is maintained.

(ii) The valve guides must also be fitted the correct way up and for this reason the word "TOP" is stamped on one end of each guide. The end of the valve guide marked "TOP" must be positioned uppermost and adjacent to the spring seatings on the top face of the cylinder head.

(iii) It is essential that the guides are fitted to the correct ports, i.e., inlet, or exhaust according to length, to avoid fouling the spring cups. To assist in identification the inlet guides are ·40 in. (10·16 mm.) shorter in overall length than the exhaust guides.

For additional identification, observe the inlet guides are tapered externally at each end, however the lower (port) end has the acute taper, whilst the exhaust guides are tapered externally at the lower (port) end only and the bore at the upper end is chamfered slightly internally. The lower (port) end of the valve guide is the opposite end to the one stamped "TOP".

(iv) Should the Churchill Tool not be available for valve guide removal, or refitment, these operations may be accomplished using a suitable piloted drift, noting that upon fitting, the valve guides must project above the bottom of the spring seating by ·71 in. (18·034 mm.) in the case of the inlet guides, and ·86 in. (21·844 mm.) in the case of the exhaust guides.

Valve Seatings.

1. To Inspect. Inspect the cylinder head for cracks, especially in the region of the valve seats. A cracked head must be renewed. Examine the valve seating for excessive pitting, or other damage and correct by re-grinding the cylinder head valve seatings, using for this operation the Hall Eccentric Valve Seat Grinder (see para. 2). Light pitting will be corrected by the action of "grinding-in" the valves, but on no account should badly pitted valves and seats be "ground-in" together (see also under "Valve Grinding").

2. To Re-grind. The valve seats in the cylinder head should be re-ground accurately using preferably the Hall Eccentric Valve Seat Grinder, as shown in Fig. B.9,

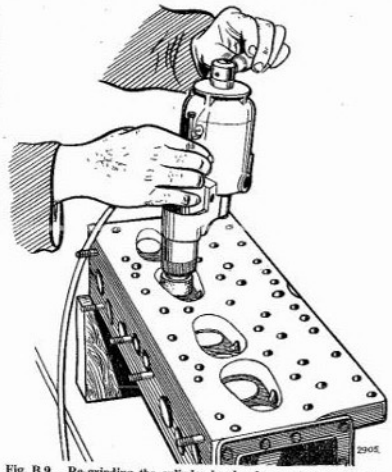


Fig. B.9. Re-grinding the cylinder head valve seatings, using the Hall Eccentric Valve Seat Grinder

or alternatively, the Churchill Valve Seat Cutters, comprising a Main Tool 316X [Pilot 316-11] and a Cutter Set 317 [317-22 (45° Cutter), 317T-22 (15° Cutter), 317P-22 (75° Cutter) and 317G-22 (Glaze Breaker) for exhaust valves, and 317-30 (45° Cutter),

317T-30 (15° Cutter), 317P-30 (75° Cutter) and 317G-30 (Glaze Breaker) for inlet valves], as shown in Fig. B.10 may be used.

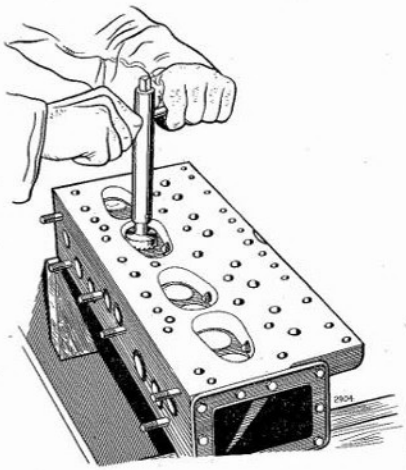


Fig. B.10. Re-cutting the cylinder head valve seatings, using the Churchill Tool 316X and the cutter set 317

It is most important to note that the re-ground valve seat in the cylinder head must be concentric within the required limit of ·002 in. (·051 mm.) total indicator reading with the bore in the valve guide. This degree of accuracy will only be assured if new valve guides are fitted, or alternatively the original guides are within the designed limits and free internally from all carbon deposits, for it cannot be over emphasised that the highest possible degree of concentricity should exist between the valve seatings and the valve guide bore (see also under "Valve Guides"). In order to further maintain accuracy the expanding pilot of the valve seat grinder must be a close fit in the valve guide, the split ring on the end of the pilot being finally expanded when in position to grip and align the pilot with the bore of the guide.

With this in mind install the expanding pilot in the valve guide, using the hand wrench provided (see Fig. B.11), pressing down initially against the taper shoulder on the pilot, and then finally expanding the pilot split ring in the guide by means of the knurled knob on the top of the hand wrench. Release and then withdraw the wrench from the pilot.

Dressing the Grinding Wheel. The grinding wheel must be dressed before commencing grinding operations on the valve seatings, and this is accomplished using

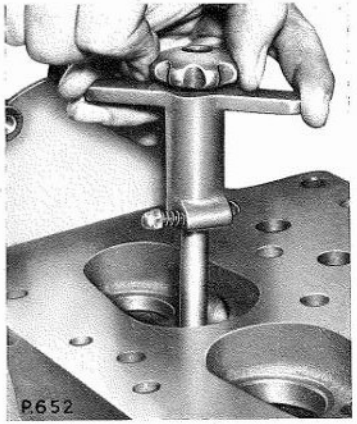


Fig. B.11. Installing the valve seat grinder pilot in the valve guide, using the hand wrench

the dressing fixture, on which the grinder seats, via two pilots (see Fig. B.12) and a guide which passes up through the head of the grinder. Set the diamond dressing tool to an angle of 45° as indicated on the scale, energise the motor and dress the grinding wheel.

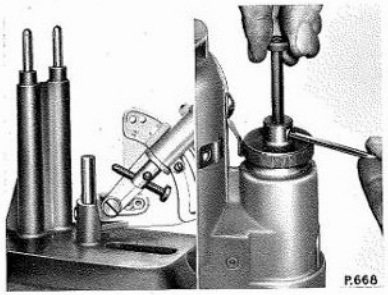


Fig. B.12. Valve seat grinder details
Right hand illustration—Setting the depth rod, using an Allen key
Left hand illustration—Dressing fixture, showing the locating pilots and centre guide

Operating the Valve Seat Grinder. Locate the grinder over the expanding pilot and release the Allen screw positioned directly above the grinding wheel feed adjusting screw. Push down the depth rod against the top of the pilot (see Fig. B.12) and then lock the Allen screw tightly.

Turn the feed adjusting screw until the grinding wheel just clears the valve seating and then balance the grinder by means of the compensating handle (see Fig. B.9).

Start the motor and turn the feed adjusting screw one serration at a time, so feeding the grinding wheel into the valve seating, but only until the wheel is grinding all round the face of the valve seat, noting that before stopping the grinder it is essential to cease the feed on the grinding wheel and allow time for the wheel to grind free. Continue grinding only until all marks have disappeared and a new face is obtained. Turn off the motor at the switch provided, allowing the grinding wheel to stop before lifting the grinder from its pilot.

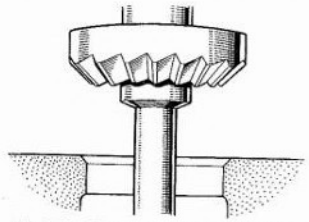


Fig. B.13. Churchill 45° Valve Seat Cutter Tool

When the valve seat face has been re-ground satisfactorily, remove the expanding pilot by means of the hand wrench and check that the corresponding valve, which may now be inserted for trial is not brought too low on its seating as a result of excessive re-grinding of the seating in the cylinder head, causing "pocketing" of the valve (see Fig. B.14—lower illustration). If this condition exists it must be rectified by means of the 15° grinding wheel (alternatively the Churchill 15° Cutter Tool 317T-22, or 317T-30 may be used depending on which valve seat is being recut).

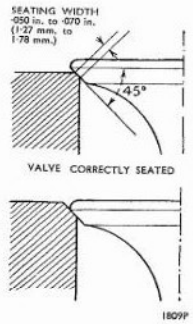


Fig. B.14. Cylinder head valve seatings

Note: "Pocketing" of the valve could result from heavy refacing of the valve seat itself, and if this condition is confirmed, renew the valve.

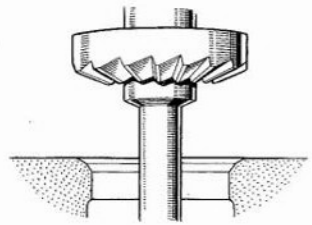


Fig. B.15. Churchill 15° Valve Seat Cutter Tool

Finally examine the face of the newly cut valve seat for width, which must not exceed ·070 in. (1·78 mm.). If the width of the seat exceeds this figure, the 15° grinding wheel (alternatively the Churchill 15° Cutter Tool 317T-22 exhaust, or 317T-30 inlet) may be used to correct it. Occasionally it may be necessary to reduce the width of a seat face from the bottom edge, in which case the 75° grinding wheel (alternatively the Churchill 75° Cutter Tool 317P-22 exhaust, or 317P-30 inlet) may be used, but correction of seat

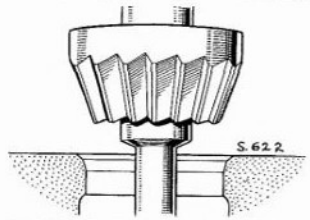


Fig. B.16. Churchill 75° Valve Seat Cutter Tool

width in the throat will rarely be necessary. The above operations should be applied as required, with a view to obtaining a marking on the seat of the valve itself, similar to that shown in Fig. B.14—upper illustration.

Note: Good judgment must be used when reducing seat width to ensure the resulting seat contacts the centre of the valve face and the correct width is maintained. These operations have considerable bearing on valve seat life.

Valves.

1. To Inspect. Examine the seating face of the valves for excessive pitting, and the heads for cracks, distortion and burning. If the valve stems are bent, or worn the valves must be renewed even though they may be otherwise sound. Wear on the stems may be checked by

means of a micrometer from various angles and positions, as the valve stems do not wear uniform over their length.

The stem diameter of a new valve is:

Inlet ·3417/·3422 in. (8·679/8·692 mm.)
Exhaust ·3407/·3412 in. (8·654/8·666 mm.)

Should the stems be in reasonable condition, and the valve heads not burnt, or cracked, reface the seats as detailed in para. 2 below.

2. To Reface. If on examination of the valves it appears unlikely that they would clean up satisfactorily with ordinary "grinding-in", they must be refaced on a suitable valve grinding machine. Generally it will be found that the cylinder head valve seatings are better than the valves themselves as regards condition unless the engine has been in service for a very long time. It is quite practicable to reface the valves and grind them in on the original seatings, if the latter are in good order.

It is always better to renew a badly burnt, or pitted valve, as extended refacing will bring it very low on its seating by reason of the consequent reduction in the effective diameter of the valve face, and "pocketing" of the valve will result (see Fig. B.14—lower illustration). This condition is detrimental to the running of the engine and will cause overheating and loss of power.

When mounting the valve in the grinding machine, perfect concentricity of the valve stem with the chuck, or collet is of the utmost importance, and any "run-out" should be noted and corrected, as necessary, before attempting to grind the valve face. The finished valve face must be concentric to the valve stem within the limit of ·001 in. (·025 mm.) total indicator reading.

The valve face should be ground only until it is just true and clear of marks, to the following angle:

Inlet and Exhaust 45°

The angle given above is calculated from the top face of the valve head, on a line at right angles to the stem axis. Salient dimensions of the valves are given in "Manufacturing Data" at the beginning of this section. It should be noted that inlet and exhaust valves are of a different size.

If, after grinding, the parallel portion of the valve head above the seating face is less than $\frac{1}{32}$ in. (·78 mm.) the valve should be renewed.

A valve which has been refaced as described above must be finally "ground-in" to its seating on the cylinder head (see "Valve Grinding"). Valves are stamped 1—8 from the front of the engine, therefore ensure they are "ground-in" to their respective seating. Very little valve grinding will be required, but it must not be omitted.

Valve Grinding.

1. On no account should badly pitted valves and seats be ground in together as this will give rise to excessively wide seats. When the valves and seats have been re-ground (this is unnecessary if the valves and seats are in good condition) grind them in to give a perfect seating. Care must be taken that the valves which are numbered 1—8 from the front of the engine, are not interchanged.

2. To grind in the valves apply a thin coating of fine grinding paste around the valve face, not allowing it to get on the stem, or other parts of the valve. Apply a light smear of oil to the valve stem.

3. Place the valve on its seating and, by means of a suction grinding tool, rotate the valve from side to side through a few degrees only, using a light pressure. Frequently raise the valve and move round to a new position on its seating and continue grinding. (On no account should the valve be revolved through complete revolutions when grinding, or rings will be formed on the faces with detrimental effects.)

4. The grinding should be continued in this manner until a continuous but narrow ground surface has been obtained both on the valve and the seating.

After thoroughly cleaning off all traces of grinding paste from the valve and seating with a dry cloth, check the valve seat in the following manner:

(*a*) Ensure all traces of grinding paste are removed from the face of the valve and the seat.

(*b*) Smear a thin coat of marking blue on the valve face.

(*c*) Place the valve on its seat and rotate backwards and forwards for approximately $\frac{1}{8}$ in. (3 mm.). Do not rotate more than this amount as an untrue mark will be obtained.

(*d*) To give a good seat a mark should be obtained that is of equal width over the whole circumference of the seat.

5. When the seat is considered satisfactory, thoroughly clean the valve face and the seat. The resulting seat should not be more than ·070 in. (1·78 mm.) in width.

Valve Springs.

1. If possible, the fitted length and load of the springs should be checked. Under test the dimensions obtained should be as follows:

Inner 25 lb. @ 1·58 in. (11·34 kg. @ 40·13 mm.)
Outer 56 lb. @ 1·70 in. (25·40 kg. @ 43·18 mm.)

A maximum loss of 10 per cent on used springs is permissible.

2. A quick visual check may be carried out by placing the springs in a straight line on a surface plate, when any spring that is shorter than the others should be renewed, alternatively used valve springs can be checked by comparing them with new springs under pressure as follows:

(*a*) Position the used and new valve springs end to end on a long bolt and compress them in a press as shown in Fig. B.17. Any loss will then be apparent as the weaker spring will close up first.

3. If either spring of a pair is weak, renew both inner and outer valve springs as a pair. New valve springs are supplied only in pairs, and should not be interchanged.

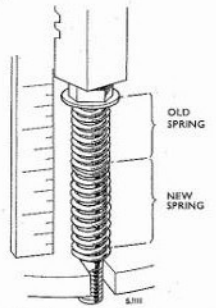


Fig. B.17. Checking valve spring by comparison method whilst under load

4. Examine the spring coils for cracks.

Spring Cups and Cotters.

Examine the spring cups and cotters for cracks, or excessive damage, especially on the mating taper faces, and renew, if necessary. Ensure the "O", or sealing ring groove on the inlet spring cups is free of burrs.

Decarbonising.

1. When removing the carbon deposit from each piston crown, it is always advisable to leave a ring of carbon adjacent to the cylinder bore as this helps to preserve a good seal, and to conserve oil. A convenient method of doing this is to turn the engine until the piston is slightly below the top dead centre position, and insert an old piston ring of correct size in the bore, and press down on the piston crown. In this way all the carbon within the old piston ring may be removed, leaving a ring of carbon around the edge.

2. Remove carbon from the tops of the pistons, the combustion chambers in the cylinder head and also from the valve ports, (see also "Cylinder Head—Inspection and Overhaul", on page B.19). With a suitable scraper clean out the inside of the exhaust manifold.

3. Remove all loosened carbon, preferably by use of a compressed air line.

4. Care must be taken when decarbonising the tops of the pistons, these being of aluminium alloy, and no pointed instruments, or emery cloth may be used. Do not on any account use abrasives for removing carbon, or damage will result.

5. Having attended to the preceding operations and given the valves and seatings any attention that may be required, the engine may be re-assembled.

To Re-assemble.

Reverse the operations for dismantling, noting the following points:

1. Thoroughly flush out the cylinder head water passages. Ascertain that the interconnecting water passages between the cylinder head and the block are clear. Ensure that all parts are clean before re-assembling.

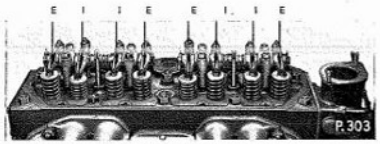
2. Refit the rear cover to the rear of the cylinder head using a new joint.

3. Refit the water distribution tube to the cylinder head with the jet holes facing downwards, followed by the front cover plate, using a new joint. Ensure the front end of the water distribution tube locates in the hole provided in the front cover plate and is a good fit. Secure the plate by means of the two setscrews, coating the threads of the screws with jointing compound.

4. Renew the seals in the inlet valve spring cups if damaged in any way, and give the valve stems a thin coat of oil. Ensure also that the spring cups are fitted to their correct valves (see Fig. B.18), as if an inlet cup

Fig. B.18. Identification of the valve spring cups

is fitted to an exhaust valve, the cup will foul the guide and may cause considerable damage to the rocker gear, push rods, etc. The valve sequence is shown in Fig. B.19.



I—INLET E—EXHAUST

Fig. B.19. Engine valve sequence

5. When fitting the inlet valve spring cups, care must be taken to avoid damage to the sealing ring by over-compressing the spring cups, or the seal will not be effective and oiling of plugs may result.

6. Use a new joint when fitting the water pump to the cylinder head front cover plate, coating the joint with grease. Use a smear of jointing compound on the threads of the pump securing bolts, which engage in the cylinder head.

To Refit.

Before fitting the cylinder head ensure all carbon particles, etc., are removed from the piston crown, also clean out any foreign matter which may have collected around the cylinder bores.

To install the cylinder head, use a new gasket and reverse the removal procedure, observing the following:

1. Ensure the machined faces of both the head and the block are perfectly clean, and then place the new gasket over the cylinder head studs, noting:

(*a*) The cylinder head gaskets are coated with varnish before leaving the factory to enable an efficient gas tight joint to be obtained, thus the practice of coating gaskets with a jointing compound, or grease before assembly is unnecessary.

(*b*) All gaskets are marked "TOP" on one side and this side must face uppermost.

2. It is important that the cylinder head be positioned initially rearward of its final location point so as the distributor driving shaft can be inserted through its respective bore in the cylinder head (so as to clear the cab scuttle) and rest on the top face of the cylinder block. Move the cylinder head forward and as the head assumes its final position, guide the distributor driving shaft into the cylinder block until fully inserted, when upon turning the shaft the lower end will correctly engage the oil pump driving pinion sleeve.

3. The cylinder head nuts should be tightened initially a little at a time in the recommended sequence as shown in Fig. B.4, finally tightening the nuts to a torque wrench reading of 56/60 lb. ft. (7·74/8·30 kg. m.). This should be repeated again when the engine is hot.

4. When refitting the rocker shaft assemblies, refer to the appropriate heading under "Rocker Shaft Assemblies, Push Rods and Tappets", in the opposite column.

5. Refit the inlet and exhaust manifold assembly as detailed on page B.50.

6. Adjust the valve clearances as detailed on page B.16.

Note: It will be necessary to check, and if necessary, adjust the valve clearances, after the cylinder head nuts have been tightened the second time.

7. Renew the rocker cover joint if it has deteriorated in any way. Refit the rocker cover, followed by the air cleaner to carburettor hose, and the rocker cover breather pipe. Tighten the hose and pipe clips securely.

8. Clean and adjust the sparking plugs as detailed under the "Electrical Equipment" section.

9. Refit the distributor complete with the mounting bracket. Clean and adjust the distributor contact breaker points and finally check the ignition timing (see "Electrical Equipment" section).

10. Complete the installation by reversing the remaining removal operations, adjusting the fan belt as detailed in the "Cooling System" section.

ROCKER SHAFT ASSEMBLIES, PUSH RODS AND TAPPETS

To Remove.

1. Lift the bonnet hood and secure in the open position, also release the internal engine cowl from its anchorage.

2. Disconnect the breather pipe from the rocker cover, also from the branch moulding on the air cleaner hose, and then lift the pipe clear (see "Fuel System" section).

3. Unscrew the two rocker cover cap nuts and lift off the cover taking care not to damage the gasket, or lose the fibre washers fitted beneath the cap nuts.

4. Remove the eight nuts securing the rocker shaft standards to the cylinder head and lift off the twin rocker shaft assemblies.

5. Withdraw the push rods, ensuring that the tappets are not displaced during this operation, as it is important that the latter components are identified to their respective bores in the crankcase. Upon removal of the push rods, locate in a suitable rack so that they can be refitted in their respective original position.

6. Remove the ignition coil from its mounting bracket, after withdrawing the two securing nuts.

7. Remove the external oil filter assembly and the inlet pipe (see page B.58).

8. Withdraw the dipstick. Release the dipstick tube from the clip at the upper end, and from the sump extension tube at the lower end. Lift the dipstick tube clear. Cover the end of the sump extension tube to prevent ingress of foreign matter.

9. Unscrew and remove the two cap nuts securing the tappet cover to the engine and lift off the cover.

10. Through the aperture thus obtained withdraw the tappets from their bores (see Fig. B.20). The tappets should be labelled 1—8 from the front so that they may be refitted in their original positions.

Fig. B.20. Withdrawing the tappets through the tappet chest aperture

To Dismantle.

Dismantling the rocker shaft assemblies is an identical and straightforward operation involving the removal of the spring clip from one end of the rocker shaft, when it is possible to slide off the rockers, standards, springs and washers from the shaft (see Fig. B.21).

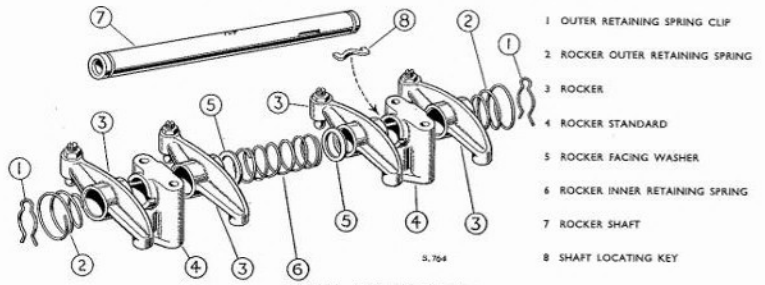


Fig. B.21. Rocker shaft details

Note: Each shaft is located at one end by a key, which engages in the slot provided in the rocker shaft and a keyway machined in the rocker shaft standards. Shafts are positioned so as the oil holes face downwards, and an oil hole in each shaft then aligns with the oil transfer passage located in the centre pair of rocker shaft standards.

Inspection and Overhaul.

1. Examine the internal bore of the rockers and the region of the shafts on which the rockers operate for wear, which if excessive will necessitate the renewal of the faulty components. Check each rocker foot for indentation and renew if excessive wear is present at this point. The rocker shafts should be straight to within ·002 in. (·051 mm.) total indicator reading over their full length.

2. Check the fit of the locating key in the slot in the rocker shaft and the keyway in the rocker shaft standard, if wear is present, allowing the shaft to move within the standard, examine, interchange, or renew the defective components.

3. The ball ended adjusting screws and their locknuts should be removed from the rockers and the following internal passages blown through with compressed air, thus ensuring that no restriction remains to oppose the free flow of lubricant.

(*a*) Drilling through the centre of the rocker shaft standards.

(*b*) Drillings through the arm and boss of the rockers.

4. Examine the small drillings in the rocker shaft and if obstructed they may be cleaned with a piece of wire and then blown through with compressed air. Ensure the central passage of the rocker shaft is clear and that the end sealing plugs are in position and providing an oil tight joint.

5. Examine the spherical end of the adjusting screws and the mating socket in the push rods for failure of the hardened surfaces, renewing the components, as necessary. Inspect the lower ball of the push rods on the spherical seating and their mating socket in the head of the tappets for failure of the hardened surfaces, renewing the components as necessary. Check the push rods for bend. If bend in excess of ·008 in. (·204 mm.) total indicator reading over the length of the push rod is measured, they must be renewed.

Note: When renewing the push rods, use only the solid type, applied in sets.

6. Check the fit of the tappet body in its respective crankcase bore and then examine the lower face of the tappet that contacts the camshaft, any evidence of a ridge across this face indicates that the tappet has not rotated freely within its bore. Renew the faulty tappet, ensuring that the new tappet is free to revolve in the crankcase bore, and observe label identification made during removal operations.

7. Examine the inner and outer rocker retaining springs for damage and renew, as necessary (see "Manufacturing Data").

To Re-assemble.

To re-assemble the rocker shaft assembly carry out the following procedure:

1. Fit a spring clip to one end of the rocker shaft and slide on the components in the following order (see Fig. B.21):

(*a*) Short outer spring, positioned with the larger coil facing outwards.

(*b*) Rocker.

(*c*) Key, fitted to the rocker shaft so that when the shaft is located in the standard, the oil holes face downwards, i.e., the word "TOP" marked on the shaft is uppermost.

(*d*) Rocker shaft standard.
(*e*) Rocker.
(*f*) Plain facing washer.
(*g*) Long inner spring.
(*h*) Plain facing washer.
(*j*) Rocker.
(*k*) Rocker shaft standard.
(*l*) Rocker.
(*m*) Short outer spring, positioned with the larger coil facing outwards.

2. Complete the operation by fitting the spring clip to the groove in the opposite end of the rocker shaft, noting that the locating key may be fitted into either of the two standards, but the oil holes in the shaft must always face downwards, as described previously.

3. Carry out the same sequence of operations to assemble the second rocker shaft assembly.

To Refit.

1. Refit the tappets in their original positions and insert the push rods through the tubes in the cylinder head until they seat on the tappets. Observe correct seating of the push rods through the tappet chest aperture.

2. Fit the tappet cover, ensuring that the joint is in good condition and the fibre washers are in position under the heads of the cap nuts. Tighten the cap nuts evenly.

3. Refit the oil filter container, re-connect the oil inlet pipe and fit the ignition coil to its bracket. Re-locate the dipstick tube in the sump extension and secure the tube at the upper end by means of the clip. Install the dipstick.

4. Slacken all the adjusting screws on the rockers to give maximum clearance and fit the rocker shaft assemblies by sliding the standards over the studs. Seat the adjusting screw ball ends in the sockets of the push rods and tighten the standard securing nuts evenly.

5. Adjust the valve clearances as detailed on page B.16.

6. Refit the rocker cover, ensuring that the rocker cover joint is in good condition and the fibre washers are in position under the heads of the cap nuts. Tighten the cap nuts evenly.

7. Re-connect the breather pipe to the rocker cover and to the air cleaner hose branch moulding.

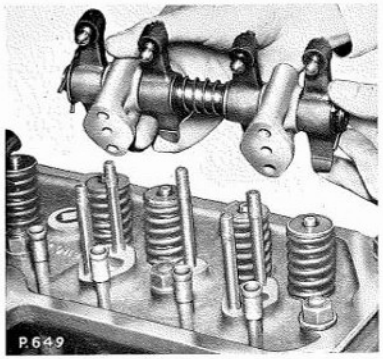


Fig. B.22. Refitting the rear half of the split rocker shaft assembly

TIMING COVER

To Remove.

1. Drain the cooling system, disconnect the water hoses and remove the radiator (see "Cooling System" section).

2. Remove the starting handle dog nut and washer.

3. Jack up the front of the engine, using a wide wooden block between the jack and the sump (oil pan) until the load is just taken off the front mounting rubber.

Note: Do not under any circumstances jack up the engine higher than is necessary, as excessive load will be placed on the rear engine mountings and undue strain will be exerted on the exhaust pipe joint at the manifold, also on the various throttle controls.

4. Withdraw the nuts and bolts that secure the front mounting rubber to the mounting plate bolted to the front chassis crossmember, and the nuts and bolts securing the mounting bracket to the timing cover. Remove the mounting bracket together with the mounting rubber.

5. Withdraw the crankshaft pulley using normal hand pressure only, or if a heavy interference fit is encountered, the use of Churchill Main Tool 55 and the Adaptor Set R.G.55-4 is recommended (see Fig. B.23).

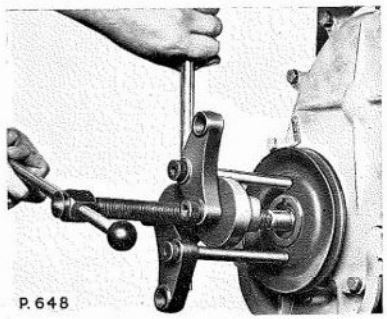


Fig. B.23. Withdrawing the crankshaft pulley, using Churchill Tool 55 and the adaptor set R.G.55-4

6. Remove the bolts and nuts securing the timing cover to the engine front support plate and withdraw the cover.

Inspection and Overhaul.

Examine the oil seal in the timing cover. Should it be damaged, or inefficient in operation, extract the rivets securing the housing and prise off the seal, fitting the new seal by means of new rivets (see Fig. B.24). Apply jointing compound between the seal housing flange and the timing cover.

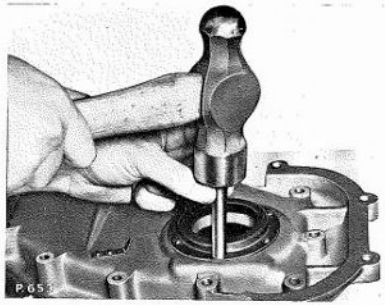


Fig. B.24. Securing the timing cover oil seal, using rivets

To Refit.

Installation is a reversal of the removal procedure bearing in mind the following points:

1. Use a new joint between the timing cover and the front support plate.

2. Centralise the cover over the crankshaft, using Churchill Tool R.G.21 (see Fig. B.25), before tightening the securing nuts and bolts in diagonal sequence.

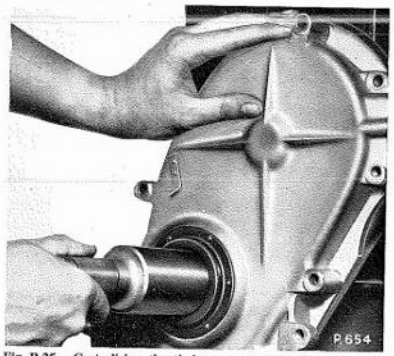


Fig. B.25. Centralising the timing cover, using Churchill Tool R.G.21

3. Adjust the fan belt to the correct tension (see "Cooling System" section), and then tighten the adjusting setscrews and mounting bolts on the dynamo unit.

TIMING WHEELS AND CHAIN

To Remove.

1. Remove the timing cover (see under "Timing Cover—To Remove", on page B.27).

2. Remove the split pin and plain washer from the chain tensioner pivot pin and lift off the tensioner blade.

3. Release the tab washer. Remove the setscrew, tab washer and plain washer that secure the camshaft timing wheel to the front end of the camshaft.

4. Withdraw the oil guard from the crankshaft.

5. To withdraw the timing wheels and chain it is recommended that suitable levers be used behind the timing wheels, applying preferably two levers behind the camshaft timing wheel at diagonally opposite points and one behind the crankshaft timing wheel. Alternatively the Churchill Universal Puller 6312A, applied behind the crankshaft timing wheel will facilitate the removal operation (see Fig. B.26). Lever off both wheels simultaneously keeping them in line to avoid straining the chain, until the camshaft timing wheel is free of the camshaft spigot. It is now possible to slip the timing chain off the crankshaft timing wheel, thus allowing the wheel and chain to be lifted clear of the engine. Complete the removal of the crankshaft timing wheel.

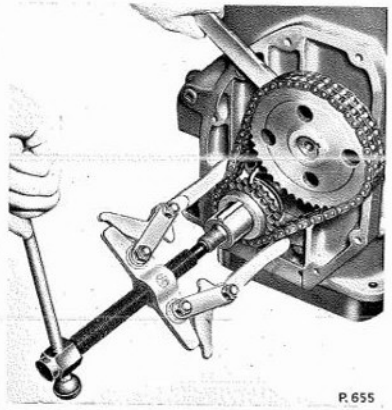


Fig. B.26. Withdrawing the timing wheels and chain, using the Churchill Tool 6312A to facilitate crankshaft timing wheel withdrawal

Note: If a heavy interference fit is encountered when withdrawing the crankshaft timing wheel, the Churchill Universal Puller 6312A must be used.

Inspection.

Thoroughly clean all components in paraffin before inspection. If the timing chain is retained it is important to soak in oil before refitting.

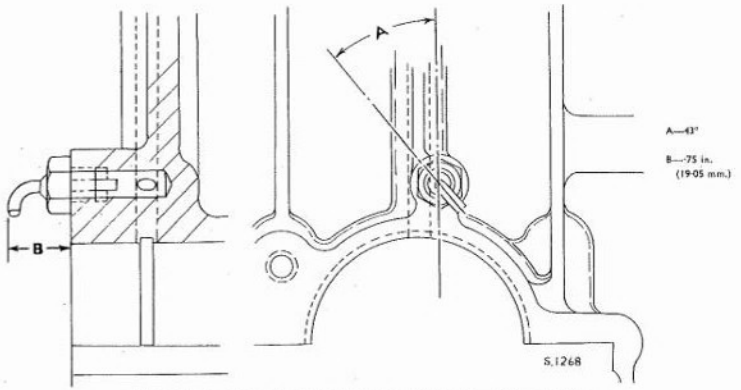


Fig. B.27. Correct location of the timing chain oil jet on the crankcase front face

1. Examine the chain for broken rollers, or links, and for stretch.

2. Examine the teeth of the timing wheels for wear. A new chain must not be fitted to wheels which are noticeably worn, otherwise the new chain will wear rapidly.

3. Ensure the keys are a good fit in the crankshaft and camshaft spigots and in the keyways of the timing wheels.

4. Check the chain tensioner blade for weakness and signs of wear and renew, if necessary.

5. Ensure the timing gear oil feed jet in the front of the cylinder block is not obstructed and is positioned in accordance with the dimensions shown in Fig. B.27.

To Refit.

1. Set numbers 1 and 4 pistons to T.D.C. so that the key on the crankshaft front spigot is to the top.

2. Push the crankshaft timing wheel on to the crankshaft spigot until it is approximately 1·5 in. (40 mm.) from the shaft shoulder.

3. Loop the chain over the crankshaft timing wheel and then enter the camshaft timing wheel into the chain so that the timing dots on the two wheels are on a line struck through the centres of the crankshaft and camshaft spigots (see Fig. B.28), ensuring any slack in the timing chain is on the left hand (non-drive) side of the timing wheels when viewed from the front of the engine, i.e., in the position occupied by the chain tensioner (see Fig. B.29).

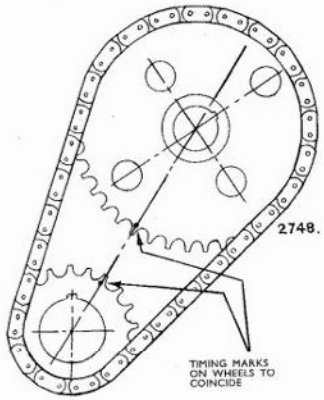


Fig. B.28. Assembling the timing wheels to the timing chain

4. Turn the camshaft until the key lines up with the keyway in the camshaft timing wheel and draw the wheel on to the camshaft, alternately tapping the crankshaft timing wheel until both wheels are fully home. Check again that the timing dots fall on a common line struck through the centre of the crankshaft and camshaft spigots (see Fig. B.28), ensuring any slack in the timing chain is on the left hand (non-drive) side of the timing wheels when viewed from the front of the engine, i.e., in the position occupied by the chain tensioner.

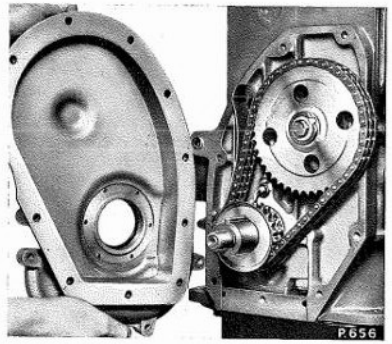


Fig. B.29. Camshaft drive arrangement, showing the location of the tensioner blade

5. Refit the camshaft timing wheel securing setscrew and plain washer, using a new tab washer. When the setscrew has been securely tightened, turn over the tab washer to lock.

6. Fit the chain tensioner to its pivot pin and secure with the washer and split pin.

7. Finally check the setting of the timing wheels as detailed under "Valve Timing", on page B.32.

8. Refit the timing cover and the remaining components (see under "Timing Cover—To Refit", on page B.28).

CAMSHAFT

To Remove.

1. Disconnect the lead from one of the battery terminals.

2. Remove the distributor and its mounting bracket (see "Electrical Equipment" section), and lift out the distributor driving shaft until the lower end is clear of the driving pinion sleeve, then suitably suspend the shaft in this position.

3. Drain and remove the sump (oil pan), after withdrawing the dipstick and tube from their locations.

4. Remove the oil pump assembly and sump filter complete (see page B.59).

5. Remove the rocker shaft assemblies, push rods and tappets (see page B.25).

6. Remove the radiator grille complete with the side panels and lamps (see "Cab and Body" section) and the radiator (see "Cooling System" section).

7. Release the fuel lift pump from the left hand side of the block, noting the number of joints used between the pump flange and the cylinder block face (see "Fuel System" section).

8. Remove the timing cover (see page B.27) and the timing wheels and chain, as detailed under "Timing Wheels and Chain—To Remove", on page B.28.

Note: Prior to removing the camshaft timing wheel, check the end float of the camshaft with a dial gauge, as shown in Fig. B.30. If the end float exceeds ·003 in. to ·005 in. (·076 mm. to ·127 mm.) a new thrust plate must be fitted during installation. (See also para. 4 under "Inspection and Overhaul".)

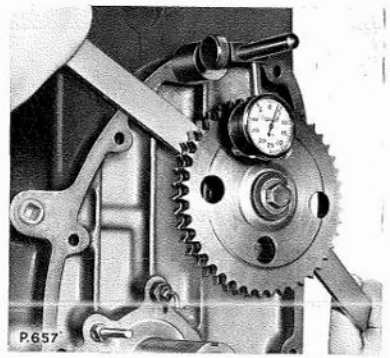


Fig. B.30. Checking the camshaft end float, using a dial gauge

9. Release the two setscrews securing the camshaft thrust plate to the front of the cylinder block and remove the thrust plate.

10. Withdraw the camshaft carefully to avoid damaging the bearings, supporting the camshaft by hand in the tappet chest during the withdrawal operation.

Inspection and Overhaul.

1. Wear on the camshaft journals and bearings will under normal conditions be very slight as the bearings are adequately lubricated. Camshaft bearing clearances can be measured by means of a feeler gauge and the maximum permissible clearances are given under

"Manufacturing Data". However, if it is necessary to renew the camshaft bearings, proceed as detailed in para. 2.

2. To fit new camshaft bearings the engine must be first removed from the chassis (see page B.52) and then the following additional components removed: the clutch housing (see under the "Clutch and Propeller Shaft" section), and the sealing disc located at the rear of the rear camshaft bearing. Replacement camshaft bearings are prefinished to size therefore every care should be taken to avoid damaging the bearing edges.

To facilitate the removal and fitting of the camshaft bearings it is recommended that Churchill Main Tool 32 be used, in conjunction with the Adaptor Sets R.G. 32-3 and R.G. 32-4, proceeding in the following manner:

(*a*) The centre camshaft bearing is removed using the adaptor set R.G. 32-4, in conjunction with the adaptor set R.G. 32-3 (Code 3 only), and the main tool, noting that the centraliser, R.G. 32-3, Code 3, should be located in the front bearing, and the adaptor, R.G. 32-4, Code 7, in the centre bearing. The spigots on both of these removal pads must face forward towards the wingnut of the main tool, i.e., pads located in the rear of the respective bearings. Assemble the main tool and feed the centre screw of the tool from the front of the engine through both the centraliser and the adaptor until it is possible to assemble the "Cee" washer and tommy bar to the centre screw (see Fig. B.31). Holding the tommy bar stationary by hand, turn the wingnut of the main tool and withdraw the centre bearing.

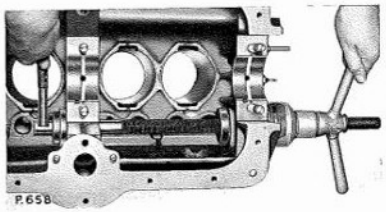


Fig. B.31. Removing the centre camshaft bearing, using the Churchill Tool 32 in conjunction with the adaptor sets R.G.32-3 and R.G.32-4

(*b*) Using the adaptor set R.G. 32-3 in conjunction with the main tool it is possible to remove either the front, or rear camshaft bearing, observing that the spigot of the appropriate adaptor (Code 3 for the front, and Code 1 for the rear camshaft bearing) should be positioned in the bearing to be removed. Feed the centre screw of the main tool through the adaptor and assemble the "Cee" washer and tommy bar to the centre screw. Hold the tommy bar stationary and turn the wingnut of the main tool, thus withdrawing the bearing.

(*c*) To fit a new front, or rear camshaft bearing, use the adaptor set R.G. 32-3 in conjunction with the main tool, as follows:

(i) In the case of the front camshaft bearing, position the bearing on the spigot of the adaptor, Code 4, and locate the stop plate, Code 5, so as the peg on the stop plate engages one of the setscrew holes on the front of the crankcase, which secure the camshaft thrust plate. Enter the integral guide on the adaptor, Code 4, through the front bearing housing to engage the bore of the stop plate, Code 5, i.e., so as the front camshaft bearing just registers in the rear of the housing in the crankcase.

Assemble the main tool and feed the centre screw of the tool through the adaptor, Code 4, until it is possible to locate the "Cee" washer and the tommy bar on the centre screw. The body of the main tool registers over the stop plate.

Refer to the important note on alignment of oil holes given in para. (*e*). Hold the tommy bar stationary and turn the wingnut of the tool until the camshaft bearing is felt to abut firmly against the stop plate, Code 5. Dismantle and remove the tool.

(ii) In the case of the rear camshaft bearing, locate the adaptor, Code 1, in the rear bearing housing with its spigot away from the wingnut of the tool and protruding from the front of the housing. Feed the centre screw of the main tool through the adaptor, Code 1, and position the rear camshaft bearing over the spigot on this adaptor. Enter the bore of the cut-a-way stop, Code 2, on to the centre screw and register its spigot into the opposite end of the rear camshaft bearing, locating the adaptor in such a way that the recessed part clears the projection in the crankcase. Position the "Cee" washer and tommy bar on the centre screw.

Refer now to the important note on oil hole alignment given in para. (*e*). Hold the tommy bar by hand and turn the wingnut of the tool until the stop, Code 2, is felt to abut firmly against the front face of the bearing housing in the crankcase. Dismantle and remove the tool.

(*d*) Fit the new centre bearing, using the adaptor set R.G. 32-4 in conjunction with the adaptor set R.G. 32-3 (Codes 2 and 3 only) and the main tool. Locate the centraliser, R.G. 32-3, Code 3, in the front bearing (as for removal operations) and the adaptor, R.G. 32-4, Code 7, in the centre bearing housing, the latter adaptor located with its spigot away from the wingnut of the main tool and protruding rearwards from the housing. Note that the front camshaft bearing should be in position in order to locate the centraliser satisfactorily.

Feed the centre screw of the main tool from the front of the engine through both the centraliser and the adaptor. Position the new centre bearing on the spigot of the adaptor, R.G. 32-4, Code 7, and then enter the bore of the stop, R.G. 32-3, Code 2, on to the centre screw. Assemble the "Cee" washer and the tommy bar to the centre screw (see Fig. B.32).

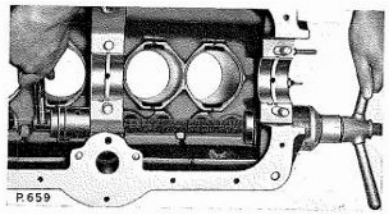


Fig. B.32. Fitting the new centre camshaft bearing, using the Churchill Tool 32, in conjunction with the adaptor sets R.G.32-3 and R.G.32-4

Refer now to the important note on alignment of oil holes given in para. (*e*). Holding the tommy bar stationary, turn the wingnut of the tool until a dimension of 9·062 in. (23·017 cm.) is obtained between the front machined face of the crankcase and the front face of the centre camshaft bearing, as shown in Fig. B.33. Dismantle and remove the tool.

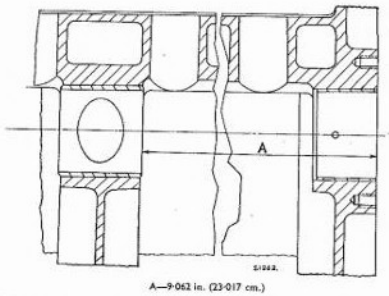


Fig. B.33. Setting dimension for the centre camshaft bearing, taken from the front crankcase face

(*e*) It is important to note before drawing the bearing into position that the oil feed holes in the bearing are in line with the oilways in the housing. In the case of the centre bearing this operation also aligns the cut-a-way in the bearing to the bore in the crankcase, which locates the oil pump driving pinion.

(*f*) The camshaft bearings are of the steel backed white metal lined type and care must be taken not to damage the edges of the white metal during fitting operations. If necessary, remove any burrs, or sharp edges with a scraper. On completion, it is essential that the new bearings, and the cylinder block are cleaned out and the oilways re-checked.

3. Examine the cam lobes, fuel lift pump eccentric and journals for wear, or scores, and the teeth of the gear formed on the centre journal for damage. Renew the camshaft, if necessary.

4. If the camshaft thrust plate is worn, or scored it should be renewed, to ensure the recommended end float of the camshaft is maintained.

To Refit.

1. Fit the camshaft to the cylinder block and secure with its thrust plate.

2. Ensure that number 1 and 4 pistons are at T.D.C. as given by the plain end of the timing plug engaging with its threaded bore in the clutch housing and the recess in the periphery of the flywheel. If the clutch housing and flywheel have been removed, the setting is then obtained when the key on the crankshaft spigot is exactly at the top.

3. Refit the timing wheels and chain as detailed on page B.29 and upon installation of the tappets, push rods and rocker shaft assemblies (see page B.27), check the valve timing as described below.

4. Check that the camshaft has retained the recommended end float of ·003 in. to ·005 in. (·076 mm. to ·127 mm.).

5. Refit the oil pump, ensuring the offset coupling in the oil pump driving pinion is correctly positioned as detailed under "Lubrication System" on page B.61.

6. Refit the distributor and check the ignition timing as detailed under the "Electrical Equipment" section.

7. Complete the operation by reversing the remaining removal operations.

VALVE TIMING

Provision is made for checking the valve timing using one of two methods, i.e., by means of the timing plug fitted in the top right hand side of the clutch housing, or by means of the pointer on the timing cover and the crankshaft pulley (see Figs. B.36 and B.35 respectively).

Either of the two methods tabulated below may be employed to check for correct valve timing, proceeding in the following manner:

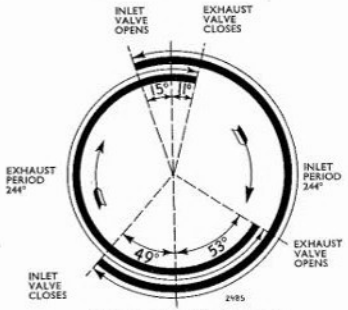


Fig. B.34. Valve timing diagram

The valve timing is normally checked with the timing cover in position, and the chain is then tensioned on the left hand (non-drive) side by the spring blade, alteratively when using the "Timing Plug Method" (timing cover previously removed) it is permissible to tension the chain by hand whilst taking the readings, ensuring that all slack is on the left hand side of the timing chain, viewed from the front of the engine.

Timing Pointers.

To check the valve timing by means of the pointer on the timing cover and crankshaft pulley, proceed as follows:

1. Remove the rocker cover from the cylinder head, after releasing the breather pipe and the cap nuts, ensuring that the cover gasket is not damaged unduly as the cover is lifted clear.

2. It is essential that the inlet valve clearance on number 1 cylinder is set to ·015 in. (·381 mm.).

3. Turn the engine in a clockwise direction viewed from the front, until the **exhaust valve** on number 1 cylinder commences to close.

4. Still rotating the engine clockwise, watch the crankshaft pulley and feel the rocker of number 1 **inlet valve** until the clearance is just taken up, i.e., at the point where a marked tightness is evident when the push rod is rotated by hand (see Fig. B.35).

5. For the valve timing to be correct, the pointer on the crankshaft pulley should come to rest ·72 in. (18·29 mm.) before the pointer on the timing cover, which is equal to 15° (crankshaft revolutions) before T.D.C. (see Fig. B.35). The pointers can be viewed to advantage from directly overhead, to the rear of the fan belt on the right hand side of the engine, and through the aperture formed between the water pump and the dynamo body.

Note: The correct valve timing is absolutely dependent upon the correct fitting of the timing wheels. Therefore should the above check prove the valve timing to be incorrect, remove and refit timing wheels, as detailed on pages B.28 to B.30.

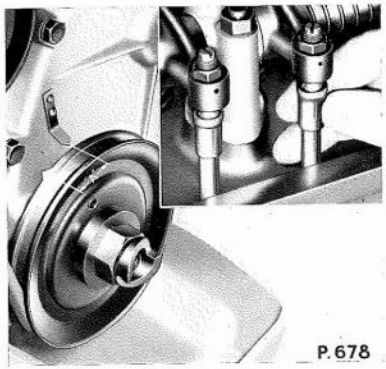


Fig. B.35. Checking the valve timing, using the pointers on the crankshaft pulley and timing cover (The inset shows number 1 cylinder inlet valve push rod rotated by hand, a marked tightness should be apparent as the push rod is rotated when dimension "A" is obtained)

6. After ensuring that the valve timing is correct, reset the inlet rocker clearance on number 1 cylinder to the normal clearance of ·007 in. (·178 mm.), refit the rocker cover and the remaining components. Ensure the rocker cover joint is in good condition, also the fibre washers fitted beneath the cap nuts. Upon fitting the rocker cover tighten the cap nuts evenly.

Timing Plug.

To check the valve timing using the timing plug, proceed in the following manner:

1. Remove the rocker cover from the cylinder head, after releasing the breather pipe and the cup nuts, ensuring the cover gasket is not damaged unduly as the cover is lifted clear.

2. Owing to the design of the camshaft it is only necessary to check the timing of one valve in one cylinder, and for this purpose number 1 inlet valve is normally chosen. **It is essential that the inlet valve clearance on number 1 cylinder be adjusted to ·015 in. (·381 mm.) before checking the timing as the camshaft design is based on this setting.**

3. By means of the timing plug located at the top right-hand side of the clutch housing (see Fig. B.36), position the crankshaft with numbers 1 and 4 pistons at T.D.C. in the following manner:

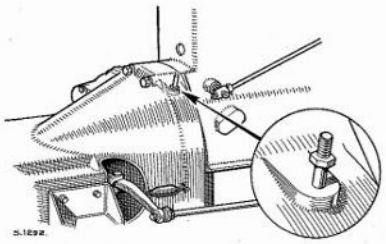


Fig. B.36. Timing plug location in the clutch housing (Inset shows the timing plug reversed for setting the pistons to T.D.C. position on number 1 and 4 cylinders)

(*a*) Unscrew the timing plug, then reverse it so that the plain end passes down through the threaded hole in the clutch housing.

(*b*) Rotate the crankshaft slowly until the timing plug drops into the locating hole in the flywheel. The piston numbers 1 and 4 will now be at T.D.C., but a check should be made to ensure that number 4 piston is on its firing stroke, i.e., both valves closed, denoted by the fact that the corresponding push rods may be turned freely by hand. If necessary, turn the crankshaft one complete revolution to attain this condition.

4. Remove the rear half of the split cover positioned at the bottom of the clutch housing.

5. Scribe a line through the centre of one of the starter ring teeth, then scribe a second line on the front half of the bottom cover immediately in line with the marked tooth (see Fig. B.37).

6. Remove the timing plug and looking from the rear of the engine determine the point at which number 1 cylinder inlet valve opens, proceeding in the following manner. Rotate the engine a ¼ to ½ revolution clockwise from the T.D.C. position to eliminate all slack in the timing chain, and return it anti-clockwise until the inlet valve of number 1 cylinder is on the point of opening, denoted by the fact that the push rod is just nipped, i.e., at the point where a marked tightness is evident when the push rod is rotated by hand. Mark the starter ring tooth which now aligns with the scribed line on the bottom cover (see Fig. B.37).

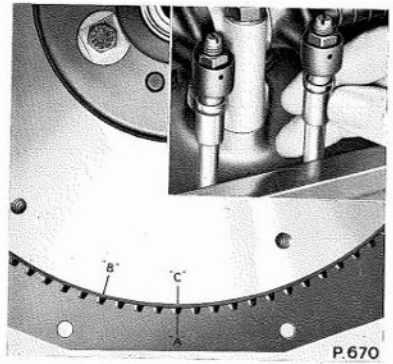
7. Count the number of teeth from the first to the second mark on the starter ring and for the timing to be correct the second mark should lie between 3½ and 5 teeth from the first mark.

Note: As the number of teeth on the starter ring is 102, the distance between the centre lines of adjacent teeth represents 3½° for this check. Thus 3½ to 5 teeth will indicate 12¼° to 17½°; the correct position for the opening of the inlet valve being 15° B.T.D.C., but a position between 12¼° to 17½° B.T.D.C. is acceptable.

8. Should the valve timing be incorrect, the timing wheels must be removed and refitted as detailed on pages B.28 to B.30. Re-check the valve timing.

9. Reset number 1 cylinder inlet valve clearance to ·007 in. (·178 mm.), and fit the timing plug by its threaded end into the clutch housing.

10. Fit the remaining components by reversing the removal procedure. Ensure the rocker cover joint is in good condition, also the fibre washers fitted beneath the cap nuts, and upon fitting the rocker cover, tighten the cap nuts evenly to ensure an oil tight joint results.



A —MARK LINE ON FRONT HALF OF BOTTOM COVER TO ALIGN WITH A TOOTH ON STARTER RING.
B —THE FLYWHEEL MARKED IN ALIGNMENT WITH LINE "A" WITH NUMBER 4 PISTON AT T.D.C. AND ON ITS FIRING STROKE.
C —THE FLYWHEEL MARKED IN ALIGNMENT WITH LINE "A" WITH NUMBER 1 CYLINDER INLET VALVE PUSH ROD JUST NIPPED.
B TO C—THE ANGULAR DISTANCE BETWEEN LINES "B" AND "C" REPRESENTS THE INLET VALVE OPENING POSITION B.T.D.C.

Fig. B.37. Checking the valve timing, using the flywheel and starter ring (The inset shows number 1 cylinder inlet valve push rod rotated by hand)

PISTON AND CONNECTING ROD ASSEMBLIES

To Remove.

1. Drain the engine oil and remove the sump (oil pan), after withdrawing the dipstick and tube from their locations.

2. Remove the floating oil filter after withdrawing the pin that secures it to the oil pump body.

3. Remove the cylinder head assembly (see page B.18).

4. Tap back the lockwashers and remove the nuts and bolts securing the big end caps to the connecting rods.

5. Remove the caps and the bearings. If the original parts are to be used again it is essential that the big end caps be re-assembled to the same rods from which they were removed and the complete rods refitted to the same crankshaft journal. The bearing shells must be kept paired to their respective connecting rod, also maintaining each bearing half in its original position in the big end bore. For the purpose of identification the connecting rods and caps are numbered 1 to 4 from the front of the engine, the number being stamped on the outside of each half of the big end on the opposite side to the oil squirt hole (see Fig. B.38), i.e., to the left hand side of the engine when viewed from the rear.

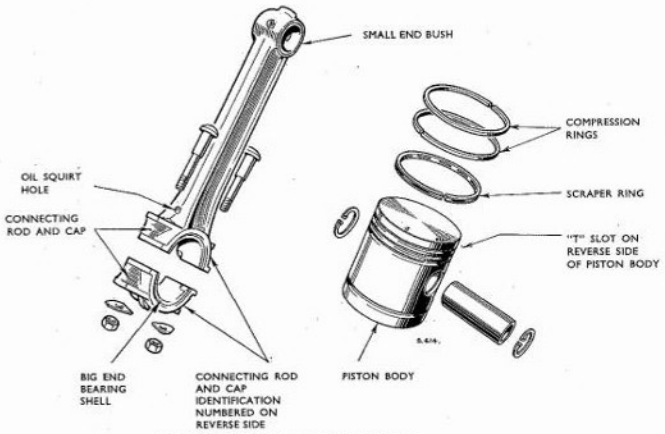


Fig. B.38. Piston and connecting rod details

6. Scrape away the carbon from around the tops of the cylinder bores and slide the pistons up the cylinder bores. Withdraw the piston and connecting rod assemblies from above, noting the radial location of the ring gap in respect to the top chromium plated piston ring only as each piston is withdrawn. If these piston rings are to be refitted they must assume their original positions in order to avoid unnecessary bedding down of the rings on re-assembly, therefore identify the rings to the cylinder block to assist in re-location.

To Dismantle.

1. Remove the rings from the pistons, keeping the piston rings to their respective piston in sets if they are to be used again.

2. Scrape away any carbon that has accumulated in the outer ends of the gudgeon pin bores. Remove the circlips retaining the gudgeon pin in the piston with Circlip Pliers, Churchill Tool 7065A, fitted with type "A" points.

3. As the gudgeon pin is a finger push fit in the piston bosses, excessive heating of the piston is unnecessary to remove the pin, but to facilitate the operation, immerse the piston in hot water before pushing out the gudgeon pin. Separate the pistons and connecting rods. If the original components are being retained, suitably identify the gudgeon pin to its respective piston. The pistons and connecting rods are easily identified as each set of components are numbered 1 to 4 from the front of the engine.

Note: The gudgeon pin must not be driven out while the piston is cold and contracted around the pin.

Inspection and Overhaul.

Pistons.

1. Remove any carbon deposits that have formed on the piston crown, the inside faces of the piston and the piston ring grooves. Do not use abrasives for this purpose.

2. Examine the piston body for score marks. A badly scored piston must be renewed. It is recommended that a careful examination of the cylinder from which the piston was removed be carried out for possible scoring of the bore, if excessive scoring is present it will be necessary to rebore the cylinder block.

3. Check the piston rings for vertical clearance all round their respective grooves (see Fig. B.39). If the clearance is appreciably in excess of ·002 in. to ·004 in. (·051 mm. to ·102 mm.) on either the compression, or

scraper rings, then the piston rings and/or piston should be renewed.

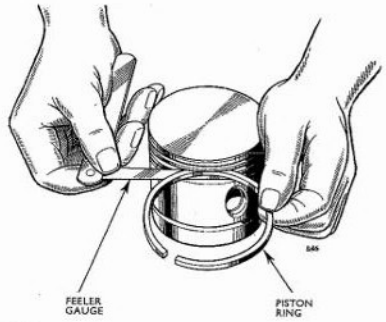


Fig. B.39. Checking piston ring to groove vertical clearance, using a feeler gauge

4. The pistons and cylinder bores are graded thereby enabling selective fitting of new components. The grade letters are stamped on the crown of the piston and the side of the cylinder block above the manifold adjacent to each bore (see also under "Matching New Pistons to a New Cylinder Block").

Note: If new pistons are to be fitted, it must be borne in mind that the maximum weight variation permissible between any pistons in a set is 2 drams (3·55 grm.).

Matching New Pistons to a New Cylinder Block (Service Replacements).

1. Every effort is made in the course of manufacture to ensure that pistons and cylinder bores conform to the designed dimensions on the critical machined diameters, however, normal production methods allow for a minute variation on these diameters and so to ensure an ideal working clearance is maintained between pistons and cylinder bores on all engines, these components are classified in five different grades. The variation in size between each grade letter is ·0004 in. (·010 mm.) and the total difference between the highest and lowest grading limits is ·0020 in. (·051 mm.). Piston and cylinder bore grading tables are given under "Manufacturing Data", and when referring to these tables equivalent diameters for each grade letter in respect of both pistons and cylinder bores are immediately apparent. Always quote the required grade of piston when ordering. It is normal practise to supply cylinder blocks separately, but a set of suitably graded pistons can be supplied to suit any given block. Cylinder blocks complete with pistons are not serviced under one part number.

2. The grading letter stamped on the left hand wall of the cylinder block adjacent to the cylinder bores and on the crown of the pistons should be observed when selectively fitting the pistons to the cylinder bores. Select pistons carrying the same grading letter as the cylinder bores to which they are to be fitted, and then finally check the fit of each new piston in its respective bore, as detailed under "Piston Fitting" on page B.37.

Important: The information given in para. 2 applies to new components being matched for assembly, but it is important to note that this does not apply once the engine has been partly, or fully "run-in", when the piston must be fitted to the cylinder bore, as detailed under "Piston Fitting", on page B.37, in order to ensure the correct piston clearance is obtained. This latter procedure also applies to rebored cylinder bores (see below).

To Rebore Cylinder Block and Fit Oversize Pistons.

1. Pistons are available in an oversize of +·030 in. (+·762 mm.), always quote this oversize when ordering. When reboring cylinders to suit oversize pistons it is imperative that each bore is machined to the actual diameter of the piston to be fitted, plus the specified clearance in the bore, less a small amount for finish honing. Therefore it is essential to check the exact diameter of each individual piston (see "Measuring Piston Diameter", on page B.37) and relate it to a particular cylinder, so that each cylinder can be bored and honed to suit its respective piston.

The honing operation allows the cylinder to be finally taken to size and the piston selectively fitted as detailed under "Piston Fitting".

Important: For service use with rebored cylinders, oversize pistons are not supplied to any particular grade, since grading is incidental to final fitting. Oversize pistons supplied for rebored cylinders are based on Grade "B" diameter.

2. The cutting tool (or tools) of the boring machine must be set to bore the maximum diameter of the piston, plus its prescribed clearance in the bore. This clearance is ·0013 in. to ·0021 in. (·033 mm. to ·053 mm.) in the case of new pistons, which are tin plated to assist "running-in".

Honing of cylinders to a finish after boring is recommended and due allowance must be made for this when setting the boring tool.

The honed finish must give a cross hatched surface, equivalent to 20 to 40 micro inches, i.e., the finish obtained by thoroughly rubbing a used cylinder bore with a piece of worn No. 1 emery cloth to obtain a matt finish.

3. Bores must be produced parallel and round to within ·0004 in. (·010 mm.). The use of a cylinder

gauge, such as the Mercer is recommended for cylinder measurement. Top, middle and bottom of each bore should be measured, both in line with and at right angles to the gudgeon pin axis. As a final check the respective piston should be fitted to the rebored cylinder as detailed under "Piston Fitting", paras, 1 (*a*) to 1 (*c*) inclusive. When the piston has been checked and fits the bore correctly, mark the corresponding bore number on the piston crown.

4. It is advisable to re-grind and reset the cutter after completing each cylinder bore.

Measuring Piston Diameter.

1. Pistons are finished ground slightly oval in the plan view, the greater dimension, i.e., major axis being at 90° to the gudgeon pin hole. In addition to this, the pistons taper slightly from the top to the bottom. In view of this ovality and tapering in design, measurement for the maximum diameter must be made at the bottom of the piston skirt and at 90° to the gudgeon pin boss (see Fig. B.40).

2. Measurements should be taken with a micrometer equipped with a vernier scale.

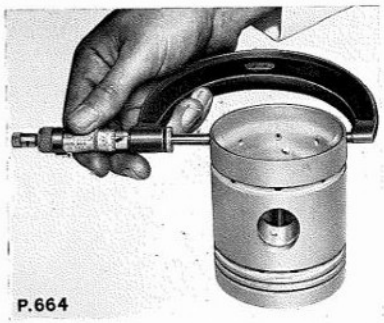


Fig. B.40. Measuring the piston diameter, using a micrometer

Piston Fitting.

1. When fitting a new piston, check for clearance in its respective cylinder bore in the following manner:

(*a*) Thoroughly clean the bore and the outside piston diameter, and wipe dry from an oiled condition.

(*b*) Invert the piston and insert it into the bore along with a feeler strip ½ in. (12·7 mm.) wide and ·0015 in. (·038 mm.) thick. The feeler must be interposed between the skirt thrust face, which is opposite the "T" slot, and the cylinder wall.

(*c*) Push the piston and feeler strip into the bottom of the cylinder bore, and holding the piston, withdraw the feeler strip when a resistance equivalent to 2 to 4 lb. (0·91 to 1·81 kg.) should be apparent, with the piston and cylinder wall wiped dry from an oiled condition (see Fig. B.41).

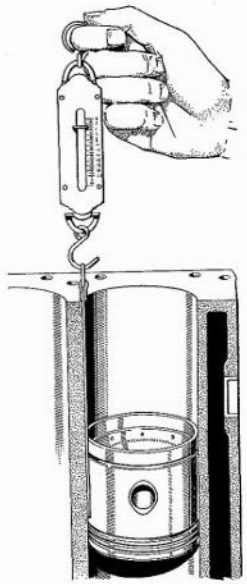


Fig. B.41. Checking the piston clearance in the cylinder bore, using a feeler gauge and spring balance

2. When the piston has been selected and fits the bore correctly mark the corresponding bore number on the piston crown.

Cylinder Liners.

To Fit.

These instructions apply to engines which are not fitted with liners during initial assembly. Some engines however, are fitted with liners during production and these should be dealt with as described under "Cylinder Liners—To Renew".

If the fitting of liners is to prove really successful a high degree of skill on the part of the operator is required, coupled with first-class precision equipment.

If however, after considerable mileage, it should be decided to install liners, it is absolutely essential that

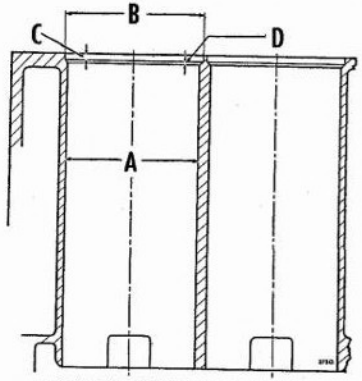
the procedure laid down in the ensuing paragraphs is rigidly adhered to, as otherwise there is every possibility of the operation proving unsatisfactory.

1. Remove the engine from the chassis and dismantle (see under appropriate section sub-headings).

2. Measure the external diameter of the liners and check against the figures detailed in para. 4.

3. Measure the diameter of the cylinder bores below the piston ring travel to establish the amount of material to be removed.

4. The outside diameter of standard liners is 3·3065/3·3075 in. (83·985/84·011 mm.), and to accommodate these liners the cylinder block should be bored to a diameter of 3·3045/3·3055 in. (83·934/83·960 mm.) (see Fig. B.42). It is imperative to strictly adhere to the dimensions given, thus the cylinder block will be bored out to suit the liners and the prescribed interference fit



A—3·3045/3·3055 in. (83·934/83·960 mm.) STANDARD
B—3·4577/3·460 in. (87·898/87·884 mm.)
C—·118/·120 in. (2·997/3·048 mm.)
D—·03/·04 in. (·762/1·016 mm.) x 45° CHAMFER

Fig. B.42. Dimensions for boring the cylinder block to accommodate cylinder liners

of ·001 in. to ·003 in. (·025 mm. to ·076 mm.) will be maintained. Every possible precaution must be taken to ensure concentricity and correct size for the full length of the bore. The recess to accommodate the lip of the liner should be machined without altering the location of the boring machine. This ensures that the recess will be concentric with the bore.

5. Enter the liner perfectly square into its bore and press in from above. To facilitate fitting, a ·25 in. (6·35 mm.) parallel "lead-in" is provided at the lower end of the liner. When inserting the liner, the load should be released several times during the first inch or so, thus allowing the liner to correct any slight malalignment which may be present. Press the liner home exactly flush with the top of the cylinder block. Should the liner protrude slightly above the top edge of the cylinder block (·007 in. (·178 mm.) maximum protrusion), carefully machine the end face of the liner until it is flush with the cylinder block. Ensure that on completion of the operation that no burrs remain on the liner end face. It is essential with the liner fitted, that the slots machined at the bottom, align with the recesses in the base of the cylinder bore, i.e., the slots lie at right angles to the axis of the gudgeon pin.

Important: Finish boring and honing of the liners must not be attempted until all liners have been fitted.

6. When each of the liners has been treated as above, the liners may be finish bored and honed to suit the new standard pistons, allowing for piston clearance as previously described.

7. Cylinder liners may be bored and honed only up to ·030 in. (·762 mm.) maximum oversize.

To Renew.

The method used to remove liners will depend to a great extent on the facilities available. Liners may be drawn out from the top, or alternatively pressed out from below, bearing in mind that a lip is present at the top of the liners.

1. Check the cylinder block for concentricity and correct size over the full length of the bore after removal of the old liners. If the diameter is in excess of 3·3055 in. (83·960 mm.), the correct interference fit will not be obtained.

2. If the minimum permissible interference fit cannot be obtained, the cylinder block can be bored to accommodate liners ·020 in. (·508 mm.) oversize. The outside diameter of oversize liners is 3·3265/3·3275 in. (84·493/84·519 mm.), and to accommodate these liners the cylinder block should be bored to a diameter of 3·3245/3·3255 in. (84·442/84·468 mm.). In this connection it should also be noted that to bore the cylinders in excess of the dimensions given, with a view to the fitting of non-standard oversize liners, may result in failure and, in extreme cases, the collapse of the cylinder walls, and is not in any form recommended.

Important: The interference fit for the above oversize liners is the same as for standard liners.

3. Provided the conditions set out above are fulfilled, press in the new liners from above. Finally, bore and hone the liners to suit the standard pistons.

Cylinder Block Sealing Cups (Water Jacket).

To renew the cups used to seal the cylinder block water jacket orifices, proceed as follows:

1. Drill through the existing sealing cup(s) and lever out using a suitable bar, ensuring that the parent bore in the cylinder block is not damaged during this operation.

2. Using a hand scraper, carefully clean around the parent bore, removing any accumulated foreign matter.

3. Examine the new sealing cups, noting that they are tapered on their outer circumference to provide an interference fit when driven fully home in the block.

4. Apply jointing compound to the outside diameter of the cup and the inside diameter of the bore.

5. Enter the minor diameter of the sealing cup into the parent bore, and using a shouldered drift applied to the outer edge of the cup, drive fully home.

Piston Rings.

1. **Top Compression Ring (Chromium Plated).** These rings require a greater mileage to bed down in their respective bores, and if for any reason the pistons are removed a careful note should be taken of the ring gap position as the piston is withdrawn. This will enable the rings to be refitted in exactly the same radial position in their respective bores, assuming they are in good condition, and ensure that they will again operate in the position, into which they were initially "bedded-in".

Where the need arises to fit new chromium plated rings to polished (part worn) bores, it will be necessary first to remove the glaze from the bores as otherwise these rings inserted into polished bores would never bed down properly.

The procedure to adopt in such cases is as follows:

(*a*) Mask off the bottom of the cylinders to prevent any abrasive matter reaching the crankshaft, or crankcase.

(*b*) Make up a wooden dummy piston which will fit snugly into the bore. Wrap a piece of No. 1, or 1½ grade emery paper round the dummy.

(*c*) This dummy piston, with the emery round it, should then be inserted into each cylinder in turn and moved up and down the bore for about 3 minutes (each cylinder) at the same time rotating it first one way and then the other until the entire cylinder wall is covered with criss-crossed abrasions.

(*d*) Wash down the bores thoroughly and dry them out, ensuring that no foreign matter finds its way into the crankcase.

2. **Second Compression Ring (Taper Faced).** To provide more rapid "running-in", a tapered compression ring is fitted in the second groove from the top of both standard and oversize pistons. It is most important that this piston ring is correctly fitted with its narrow face towards the top of the piston. This face of the ring is marked "T", or "TOP" to indicate the narrow edge (see Fig. B.44). Incorrect fitting will result in higher initial oil consumption.

3. **Scraper Rings.** These are of the slotted type and are fitted in the third ring groove as standard and in the fourth ring groove in service. The fourth ring groove, or skirt groove is located below the gudgeon pin bore and is used to accommodate a scraper ring in service to give additional oil control after the engine has covered extended mileages, when any wear present does not justify the fitting of new components.

Important: At all times extreme discretion should be exercised in the application of the skirt ring in service, as its use could result in excessive oil control and consequently under lubrication of pistons and cylinders.

4. **Piston Ring Gaps and Clearances.** To check the piston ring gap, fit the piston ring to its respective cylinder bore so as it assumes a position at right angles to the axis of the bore. This is readily attained if the particular piston is inserted in the bore momentarily and the piston ring brought to rest on the crown of the piston, thus ensuring that the ring is square in the bore. Check the piston ring gap by means of a feeler gauge (see Fig. B.43), making sure that the rings checked in

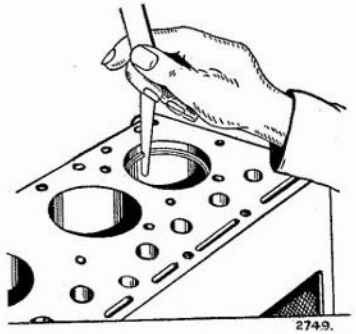


Fig. B.43. Checking the piston ring gap in the cylinder bore, using a feeler gauge

number 1 cylinder belong to number 1 piston, etc., and that the whole assembly of piston and rings are fitted to this bore on final assembly, a number is carried on each piston crown for the purpose of easy identification. The ring gaps for both compression and scraper rings must be within the limits of ·010 in. to ·014 in. (·254 mm. to ·356 mm.) when fitted to their respective cylinder bore. A nominal gap of ·37 in. (9·398 mm.) should be present with the rings free.

With a feeler gauge, check the rings for correct vertical clearance all round their respective piston grooves (see Fig. B.39). This clearance, when new, should be ·002 in. to ·004 in. (·051 mm. to ·102 mm.) for both compression and scraper rings.

Gudgeon Pins and Small End Bushes.

1. Check the gudgeon pins and their respective small end bushes for wear. Also check the fit of the gudgeon pins in their respective piston bosses. The fit of the gudgeon pin at both these points is critical and should be such as to give a finger push fit in the piston bosses, or be such that it is possible to insert the pin in the small end bush by firm hand pressure, both at a room temperature of 70°F. (21·1°C.).

2. Standard replacement gudgeon pins are graded high, medium and low on their external diameter, are identified by a colour coding (see "Manufacturing Data", on page B.10) and should be selectively fitted to the piston bosses and connecting rod small end bush until the aforementioned fits are obtained. The colour code markings identifying each gudgeon pin are located on the end faces of the pin.

3. If wear is evident, as indicated by slackness of the pins in the bushes and/or bosses, renew the gudgeon pins and/or the small end bushes (see "Connecting Rods", para. 2 for bush renewal).

4. Alternatively the connecting rod small end bushes and piston bosses (if the original bushings of the connecting rods and pistons are to be retained, etc.) can be honed oversize, and the +·003 in. (+·076 mm.) gudgeon pins selectively fitted (see also "Connecting Rods," para. 4).

Connecting Rods.

1. Check the connecting rods for correct alignment, using the Churchill Connecting Rod Alignment Jig 335, Mastor Arbor 336, and the Adaptor R.G.336-4, ensuring that before any alignment check is carried out, the small end bush is renewed and a new gudgeon pin used as a gauge, or the original small end bush and gudgeon pin are within the designed limits. The small end and big end axes must be parallel to one another and in the same vertical plane to within ·0005 in. (·0127 mm.) per 1 in. (25·40 mm.) of mandrel length. Any rod mis-alignment below ·015 in. (·381 mm.), as measured over the gauge length, can be corrected by re-setting, but rods with errors outside this figure must be renewed.

Proceed using the Churchill Connecting Rod Alignment Jig 335 in the following manner:

(*a*) Position the Master Multi-purpose Arbor 336 in the jig body, with the screwed end facing outward.

(*b*) Fit the Adaptor R.G.336-4 in the big end of the connecting rod (flats on the adaptor to be located parallel with the big end bolts), and clamp securely. Slide the adaptor complete with the connecting rod on to the arbor so that it abuts the shoulder, and secure by means of the knurled nut.

(*c*) Slide the gudgeon pin into the small end of the connecting rod, until it is centrally disposed. Position the connecting rod in relation to the vertical checking surface of the jig body, using the stop bar, so that the end of the gudgeon pin is just clear of the vertical face. Tighten the clamp, thus securing the arbor in the jig body.

(*d*) Place the Sea Lion, 335/G, on to the gudgeon pin. To check for parallelism between the small and big end bores, note whether the pins vertically in line are both in contact with the vertical face. To check for twist between the small and big end bores, note whether the pins horizontally in line are both in contact with the vertical face. If both pairs of pins contact the vertical face of the jig, the connecting rod bores will be in exact alignment in all planes.

(*e*) If the connecting rod is bent, but the bend present does not exceed the stated overall mis-alignment figure, from which rods can be safely reclaimed, reset the rod using the Bending Bar 30A, until it is in exact alignment as detailed in para. (*d*).

2. **To Renew Small End Bush.** If wear exists in the small end bush such as described under "Gudgeon Pins and Small End Bushes", indicating bush renewal, and advantage cannot be taken of the oversize gudgeon pins available, i.e., when fitting new pistons and standard gudgeon pins, it will be necessary to renew the small end bush, using Churchill Tool 6201, and the Adaptor Set R.G.6201-1, or alternatively renew with the aid of a suitable spigoted mandrel. Proceed using the Churchill Tool in the following manner:

(*a*) Slide the new small end bush into position over the adaptor sleeve, Code 4, and then locate the sleeve into the original small end bush, until the two bushes abut. Assemble the ring, STN.6263, to the body of the main tool. Register the ring over the adaptor sleeve, which protrudes from the connecting rod small end on the side opposite to the new bush. Engage the centre screw at the same time with the adaptor sleeve.

(*b*) Sight the oil hole in the new small end bush and align with the mating hole in the connecting rod small end boss.

(*c*) Grip the adaptor sleeve in a vice by the flats provided, or alternatively hold from turning by means of a spanner similarly applied.

(*d*) Rotate the tommy bar of the tool, thus drawing out the original bush, and simultaneously drawing in the new small end bush. When the new bush is fully home the head of the adaptor sleeve abuts the connecting rod. Ensure the oil hole in the bush aligns with the oil hole in the connecting rod boss.

(*e*) Dismantle and remove the tool.

(*f*) With compressed air, blow through the oilway and oil squirt hole in the connecting rod, thereby clearing away any obstruction that may be present.

(*g*) The new bush should be honed after fitting and it is of the utmost importance that the maximum bearing area between the gudgeon pin and the bush be obtained. This is accomplished by a very high surface finish on both the gudgeon pin and the bore of the bush, the finish being given to the gudgeon pin during manufacture and to the bush by honing, after fitting.

(*h*) It is recommended that the Delapena Honing Machine be used to hone to size the inner diameter of the small end bush in conjunction with the following equipment:

(i) Mandrel	SL.900
(ii) Truing Sleeve	ST.900
(iii) Roughing Stones	E-F.3.J
(iv) Finishing Stones	E-F.6.J
(v) Polishing Stones	E-F.8.J
(vi) Connecting Rod Clamp	

Complete and detailed instructions for the operation of the Delapena Honing Machine are given in a booklet issued with each machine.

Note: Honing in this manner ensures a resulting high surface finish in the small end bush, in addition to other essential factors, such as concentricity, an accurate finished diameter and alignment with the big end bore being maintained.

(*j*) Delapena Honing Fluid is recommended and must be applied liberally. To achieve good results, i.e., high surface finish in the bush, it is important to immerse the work frequently in honing fluid, especially if the machine has not its own built-in supply of honing fluid. This process also keeps the work as cool as possible, therefore assisting in maintaining an accurate finished bore. It is recommended that Delapena Standard Honing Fluid be be used on the small end bush to obtain optimum results.

(*k*) The correct mandrel (SL.900) fitted with the recommended stone, should be used in the honing machine and trued with the appropriate truing sleeve (ST.900) in accordance with the maker's instructions. Approximately ·013 in. to ·017 in. (·330 mm. to ·432 mm.) of material has to be removed from the inner diameter of the bush by honing, until it is possible to insert the selected gudgeon pin by firm hand pressure at a room temperature of 70°F. (21·1°C.), with no lift present (see also under "Gudgeon Pins and Small End Bushes"). When the bush is honed and the gudgeon pin fits the bore correctly, it is important to identify the components, as they must be subsequently assembled together.

Note: +·003 in. (+ ·076 mm.) oversize gudgeon pins are available, and when fitting these gudgeon pins to the pistons and the small end bushes, refer to the instructions given under para. 4.

(*l*) Thoroughly clean the small end bush to remove all foreign matter.

(*m*) Check the connecting rod small and big end alignment as detailed in para. 1.

3. Examine the threads of the cap bolts, and renew the bolts if damage, or stretching is evident. Check the nuts for damage.

4. To Fit Oversize Gudgeon Pins. Gudgeon pins are available in an oversize of +·003 in. (+·076 mm.) being identified by a groove $\frac{1}{8}$ in. (3·2 mm.) wide cut in one end face of each pin. If wear exists in the piston bosses and connecting rod small end bushes (see under "Gudgeon Pins and Small End Bushes") and is not in excess of ·003 in. (·076 mm.) on the diameter, the original components may be retained, and oversize gudgeon pins fitted, proceeding in the following manner:

(*a*) Use the Delapena Honing Machine in conjunction with the equipment tabulated below for enlarging the gudgeon pin bores in the piston bosses and the connecting rod small end bushes:

(i) Mandrel	SL.900
(ii) Truing Sleeve	ST.900
(iii) Roughing Stones	E-F.3.J
(iv) Finishing Stones	E-F.6.J
(v) Polishing Stones	E-F.8.J

Note: When honing the small end bush, a suitable Connecting Rod Clamp must also be used to afford additional support during actual honing operations.

(*b*) Fit the mandrel (SL.900) in the honing machine and true the stone with the appropriate truing sleeve (ST. 900) in accordance with the maker's instructions. First hone the bosses in the piston until the selected oversize gudgeon pin is a finger push fit in the piston bosses at a room temperature of 70°F. (21·1°C.). Similarly hone the small end bush to a finished bore size until it is possible to insert the selected oversize gudgeon pin into the bush by firm hand pressure at a room temperature of 70°F. (21·1°C.). It is important to identify the selected gudgeon pin to the piston and the connecting rod, so as these components are subsequently assembled together.

(*c*) During honing operations, to ensure that accurate bores result, Delapena Honing Fluid must be applied liberally. The work must be immersed frequently in honing fluid during operations to keep it cool and cleanse the honing stone. It is imperative to carry out this instruction faithfully if the machine has not its own built-in filtered supply of fluid. It is recommended that Delapena Standard Honing Fluid be used on the small end bush and on the piston bosses to obtain optimum results.

(*d*) Check the connecting rod small and big end alignment as detailed in para. 1.

Big End Bearings.

1. Examine the bearing shells, making sure they are kept to their respective rods. If signs of wear on the bearing halves is evident, such as scoring, or breaking down of the white metal surface, the bearings must be renewed. Check the running clearance of the big end bearings against the figures detailed under "Manufacturing Data".

Important: It must be clearly understood that under no circumstances may the bearing shells, or the bearing caps be filed to take up wear.

2. If the big end bearings are renewed, ensure the replacements are the same size as the originals. Undersize bearings are stamped, according to their size, on the steel shells.

3. Whilst examining the bearing halves for wear the opportunity should be taken to check the crankpin journals for ovality and scoring, which if present must be corrected by re-grinding all crankpin and main journals to the required diameter to suit one of the undersize bearings offered, these being available in —·020 in. (—·508 mm.) and —·040 in. (—1·016 mm.) undersizes (see also under "Crankshaft and Main Bearings", on page B.46 for details of the journal diameters and re-grinding details).

To Re-assemble.

1. To ensure the correct relationship is obtained between the components upon refitting them to the engine, position the piston so that the "T" slot is on the opposite side of the connecting rod to the oil squirt hole. This will ensure that upon assembly to the engine and the subsequent positioning of the word "Front" stamped on the piston crown towards the front of the engine, the oil squirt hole in the connecting rod will assume its correct position and face towards the thrust, or right hand side of the cylinder block, when viewed from the rear of the engine.

2. Fit a circlip to the groove in one end of the gudgeon pin bore in the piston, using Churchill Circlip Pliers 7065A, with type "A" points. Line up the bore in the piston with the small end bush, then fit the gudgeon pin. Fitting the gudgeon pin to the piston bosses is facilitated by heating the piston in hot water. Insert the circlip in the opposite end of the gudgeon pin bore and ensure it is firmly located in the groove provided, again using the circlip pliers to facilitate the operation. Make certain the circlips fit correctly in the bottom of their locating grooves.

Note: If the original parts are to be used, the pistons which are numbered 1 to 4 from the front of the engine, must be refitted to the connecting rods, also numbered, from which they were removed. This also applies to the gudgeon pins, although they are not numbered.

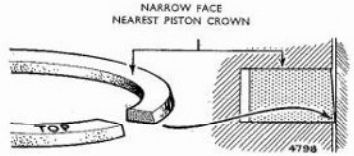


Fig. B.44. Correct assembly of the second compression ring to the piston body

3. Re-assemble the three piston rings to each piston, the ring sequence being as follows:

(*a*) Top— Chromium plated compression ring.

(*b*) Second— Taper faced compression ring.

(*c*) Third— Upper scraper ring.

The taper faced compression ring can be identified by the letter "T", or "TOP" stamped adjacent to the ring gap (see Fig. B.44). When fitted to the piston this identification on the piston ring must be to the top. Smear the piston and rings with lubricant.

Note: Should it be necessary in service to fit a lower scraper ring in the skirt groove, ensure that the dowel in the piston groove locates in the ring gap.

4. Fit the rings to the piston in such a way that the ring gaps are equally spaced around the periphery of the piston and not in line with one another. In order to obtain satisfactory results initially upon refitting original chromium plated piston rings, it is most important to re-locate each ring in its correct radial position, by aligning the marks made during the removal operations, thus the "re-bedding" of the rings to the cylinder bores is avoided.

To Refit.

1. Ensure that all parts are perfectly clean, then fit the big end bearing halves to the connecting rods and the separate bearing caps. Smear the bearing and crankshaft journals with lubricant. The upper and lower halves of the shell type bearings are interchangeable, and it is essential that their locating lips are accurately registered in the recesses formed in the rods and caps. Original bearing halves which are being refitted should maintain their original positioning, i.e., either to the connecting rod, or the bearing cap as applicable. Note also that the oil hole in the upper bearing half is coincident with the oil squirt hole in the connecting rod.

2. To facilitate the refitment of the piston and connecting rod assemblies, it is recommended that the Churchill Ring Compressor R.G. 133 be used (see Fig. B.45); this minimises the risk of breaking the piston rings upon fitting to the cylinder bore. If necessary, a tool can be made up from a steel sleeve of approximately the same internal diameter as the piston external diameter, and about 1 in. (25 mm.) in length. Slit the sleeve through its side and slide it over the rings so that they can be compressed to the bore diameter when entering the cylinders.

3. Insert the connecting rods and pistons into the cylinder bores, from the top, ensuring that:

(*a*) The assemblies are fitted into their corresponding bores, i.e., number 1 piston and connecting rod to number 1 bore.

(*b*) The oil squirt hole in the side of the connecting rod is towards the "thrust", or right hand manifold side of the cylinder block, viewed from the rear.

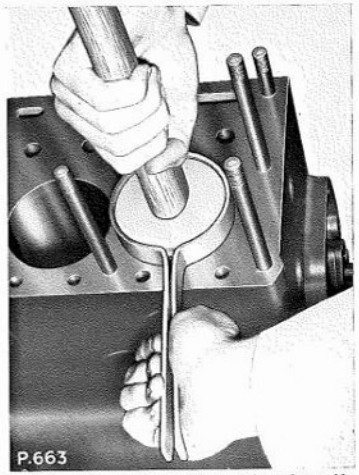


Fig. B.45. Fitting the piston and connecting rod assembly, using the Churchill Tool R.G.133 to compress the piston rings

(*c*) The piston "T" slot is towards the "non-thrust", or left hand camshaft side of the cylinder block, viewed from the rear, i.e., the word "Front" stamped on the crown of the piston is towards the front of the engine.

4. Position the connecting rod together with the upper bearing half over the crankpin journal and offer up the bearing cap together with the lower bearing half, so that the stamped figures on the side of the connecting rod and the cap are coincident.

5. Fit new lockwashers to the connecting rod bolts and secure the caps to the connecting rods with the plain nuts. Tighten the nuts to a torque wrench reading of 27/30 lb. ft. (3·73/4·15 kg. m.) and secure with the lockwashers.

6. Complete the operation by reversing the remaining removal operations, using a new cylinder head gasket, tightening the cylinder head nuts and re-setting the valve clearances, as detailed on pages B.17 and B.16 respectively.

CRANKSHAFT AND MAIN BEARINGS

To Remove Main Bearings and Thrust Washers with Crankshaft in Position.

Removal of the main bearings and thrust washers may be carried out with the crankshaft in position, as detailed in the following:

1. Remove the sump and floating filter, the latter by releasing the split pin in the oil pump body (see page B.59).

2. Release the setscrew at the bottom of the timing cover, also the two setscrews securing the front main bearing cap base to the bearing cap and then withdraw the base.

3. Remove the front half of the split cover positioned at the bottom of the clutch housing.

4. Remove the nuts securing one of the main bearing caps only, and slacken the nuts on the remaining bearing caps. **One bearing cap at a time should be removed.** When removing the rear main bearing cap difficulty may be experienced on account of the felt seals, but the use of Churchill Tool R.G. 11A and the Adaptor Set R.G. 11A-1 is recommended to overcome this resistance. Screw the adaptor R.G. 11A-1 into the $\frac{5}{16}$ in. B.S.F. tapped hole provided in the cap, and locate the side legs of the main tool on the adjacent flange of the crankcase on either side of the rear main bearing. Holding the tommy bar stationary rotate the wingnut until the cap is withdrawn.

5. Withdraw the lower bearing half from the cap and using a suitable metal drift push out the upper bearing half, whilst rotating the crankshaft in the same direction as that traversed by the drift, noting that the metal drift must be applied to the side opposite the locating lip (see Fig. B.46). If the original bearings are to be refitted, identify each bearing half to its respective position.

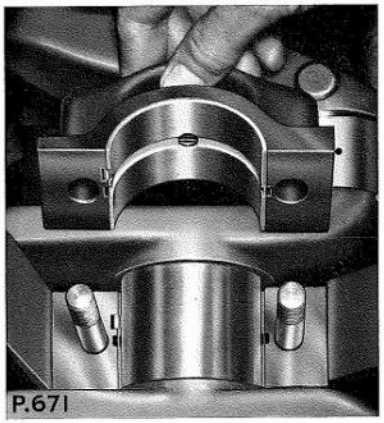


Fig. B.46. Crankshaft main bearings, showing the position of the bearing locating lips and the mating housing recesses

6. Remove the thrust washers if inspection, or renewal is necessary, noting that the lower thrust washer halves will be withdrawn with the rear bearing cap, whilst the upper thrust washer halves, may be removed employing a similar method to that used on the bearing halves, i.e., using a thin metal drift applied to one end of the thrust washer half, push on the drift and at the same time rotate the crankshaft until withdrawal is effected. Identify each thrust washer half to its relative position.

To Fit Main Bearings and Thrust Washers with Crankshaft in Position.

1. When fitting replacement bearings ensure they are the same size as the originals. Bearings are stamped according to their size on the steel shells. Fit the lower bearing half to the cap so as the bearing locating lip engages the recess machined in the cap. Smear the bearing halves and the journal with lubricant. Insert the upper bearing half, plain end foremost until the bearing locating lip engages the recess in the crankcase. Offer up the bearing cap and lightly secure with the nuts. It is recommended that the bearing cap nuts be renewed after once being removed. Due to the offset of the locating registers in the crankcase, main bearing caps can only be refitted one way round.

2. When dealing with the rear main bearing it is also necessary to fit the thrust washer halves, lightly coating the upper thrust washer halves with lubricant and sliding them into the recesses provided on either side of the rear main bearing housing, with the white metal face and oil slots towards the crankshaft. Ensure that the crankshaft has retained the recommended end float of ·002 in. to ·004 in. (·051 mm. to ·102 mm.), which can be checked with the aid of feeler gauges. Thrust washers are available in an oversize of +·005 in. (+·127 mm.), which are clearly marked to this effect on the steel backing, and should be fitted as necessary to retain the recommended end float. Place the lower thrust washer halves in position one each side of the cap, ensuring that the dowels locate each half and the white metal face containing the oil slots is outermost. With the bearing halves positioned correctly offer up the bearing cap and lightly secure with the nuts. It is recommended that the bearing cap nuts be renewed after once being removed.

3. When all the main bearings have been dealt with, tighten the cap nuts to a torque wrench reading of 30/40 lb. ft. (4·15/5·53 kg.m.) for the rear, and 45/65 lb. ft. (6·22/8·99 kg.m.) for the front and centre main bearing caps, starting at the centre bearing and working outwards. After each bearing is finally tightened, turn the crankshaft to ensure that it revolves freely.

4. Fit the front main bearing cap base and secure with the setscrews, including the one on the timing cover.

5. Pack felt into the grooves in the rear main bearing cap and the front main bearing cap base, by cutting the felt into short strips and then tapping it firmly into the grooves with a suitable rod until the grooves are full.

6. Complete the refitting procedure by reversing the remaining removal operations, ensuring that an oil tight joint results at the sump.

To Remove.

To remove the crankshaft and main bearings it will be necessary to remove the engine from the vehicle (see page B.52) and then proceed as follows:

1. Remove the cylinder head and tappets (see pages B.18 and B.25 respectively).

2. Remove the timing cover, timing wheels and chain (see pages B.27 and B.28 respectively), followed by the engine front plate.

3. Remove the sump (see page B.58) and disconnect the oil floating filter, after removing the split pin securing the filter to the oil pump.

4. Remove the piston and connecting rod assemblies (see page B.34).

5. Remove the clutch unit (see "Clutch and Propeller Shaft" section) and the flywheel (see page B.47).

6. Remove the two setscrews that secure the front main bearing cap base and withdraw the base.

7. Release the main bearing cap nuts, these being the self-locking type. It is desirable to renew the nuts after once being removed, therefore ensure that new nuts are used on final assembly.

8. Remove the main bearing caps. Some difficulty may be experienced in removing the rear bearing cap on account of the felt seals, but the use of Churchill Tool R.G. 11A and the Adaptor Set R.G. 11A-1 (see Fig. B.47) is recommended to overcome this resist-

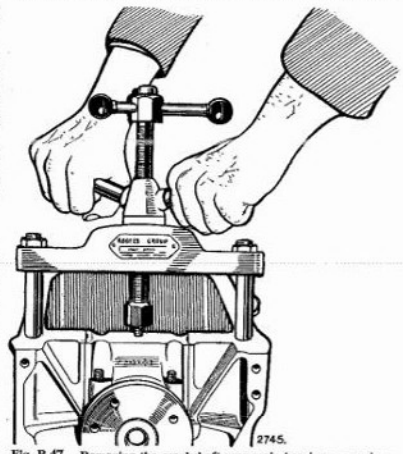


Fig. B.47. Removing the crankshaft rear main bearing cap, using the Churchill Tool R.G.11A and the adaptor set R.G.11A-1

ance. Screw the adaptor R.G. 11A-1 into the $\frac{5}{16}$ in. B.S.F. tapped hole provided in the rear bearing cap, and locate the side legs of the main tool on the adjacent flange of the crankcase on either side of the main bearing. Holding the tommy bar stationary, rotate the wingnut, until the bearing cap is withdrawn. Release the lower main bearing halves, also the lower halves of the crankshaft thrust washers fitted on both sides of the rear main bearing cap.

9. Lift out the crankshaft and remove the upper halves of the thrust washers and main bearings.

To Dismantle the Crankshaft.

1. Remove the stem wheel spigot bearing from the recess machined in the rear of the crankshaft flange with an internal withdrawal tool. To facilitate this operation it is recommended that Churchill Main Tool 7600 be used, in conjunction with the Adaptor Set R.G. 7600-1.

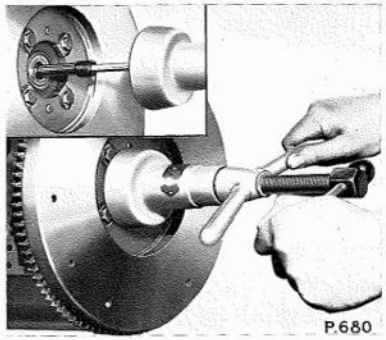


Fig. B.48. Removing the stem wheel spigot bearing from the crankshaft, with the flywheel in position, using the Churchill Tool 7600, and the adaptor set R.G. 7600-1

2. Withdraw the feather key from the front of the crankshaft.

Inspection and Overhaul.

1. Clean the crankshaft thoroughly, paying particular attention to the oilways between the main and crankpin journals. After cleaning, smear the main and crankpin journals with engine oil to prevent rusting.

2. Check all journals for ovality, or scores, which if present must be corrected by re-grinding all the main and crankpin journals to one of the undersizes given in Fig. B.49, for which undersize bearings are available. Journals must be re-ground to the limits given according to the undersize decided, as hand scraping of the bearing halves is not permissible. After re-grinding ensure the radius fillets, shown in Fig. B.49 are present at all the crankpin and main journals. Considerable importance is attached to the blending of these radii so that after re-grinding no steps remain. It is also very important to measure the radius fillets with a radius gauge to obtain accurate results. The width dimensions given for the journals in Fig. B.49 must be maintained. The surface finish on all journals must be 12 micro inches as measured by a Profilometer.

3. The bearing halves are stamped on the shell according to their size. Should the main bearings be renewed without re-grinding the crankshaft, ensure the replacement bearings are the same size as the originals.

4. Examine the stem wheel spigot bearing for slackness and noisy operation.

To Re-assemble the Crankshaft.

1. Insert the stem wheel spigot bearing into the crankshaft (sealed end outwards, i.e., towards the clutch) and using a suitable drift on the outer race of the bearing, tap it into the recess until flush with the crankshaft flange face.

Note: The bearing should be packed with grease on re-assembly. Do not overfill, or the surplus will be forced past the sealed end and thrown on to the clutch friction faces causing clutch slip.

2. Refit the key to the front spigot of the crankshaft, ensuring that it enters squarely and is not a loose fit in the keyway.

3. Blow through the crankshaft oilways with compressed air to clear away any foreign matter that may be present, prior to refitting the crankshaft.

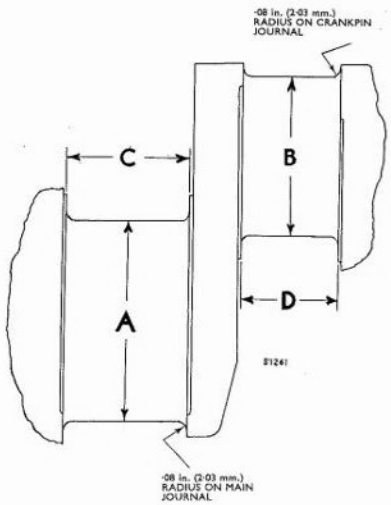
To Refit.

1. Ensure the main bearing housings are perfectly clean, also the mating faces of the bearing caps, then fit the upper halves of the main bearing to the crankcase, ensuring that each locating lip engages the recess in the housings. Smear the bearing surfaces with lubricant.

Note: Undersize bearings are stamped according to their size, and if the crankshaft has been re-ground it is essential that the correct undersize bearings are fitted. The upper and lower halves of the bearings are identical as are the front and centre bearings. The rear bearing is different and not interchangeable with the front and centre bearings, and vice versa. If the original bearing halves are retained they must be fitted in their original positions.

2. Smear the crankshaft journals with lubricant and locate the crankshaft in position in the upper bearing halves.

3. Fit the upper halves of the thrust washers, then check that the crankshaft has retained the recommended end float of ·002 in. to ·004 in. (·051 mm. to ·102 mm.). The thrust washers are steel backed white metal lined, each washer consisting of two halves fitted to both sides



of the rear main bearing. The lower half of the washers are dowelled to the bearing cap, and care must be taken to ensure that the washers fit correctly to the dowels. The white metal face shows two oil grooves and this face must be towards the crankshaft.

Note: The thrust washers are available in an oversize of +·005 in. (+·127 mm.) and these should be fitted if necessary to retain the recommended end float. Oversize thrust washers are clearly marked +·005 on the steel backings.

4. Fit the lower halves of the thrust washers and bearings to the bearing caps. It is permissible to use a little thick grease to hold the thrust washers in position.

5. Fit the main bearing caps and secure using new cap nuts. Due to the offset of the locating registers in the crankcase, main bearing caps can only be fitted one way round.

6. Tighten the nuts to a torque wrench reading of 30/40 lb. ft. (4·15/5·53 kg.m.) for the rear, and 45/65 lb. ft. (6·22/8·99 kg.m.) for the front and centre main bearing caps, starting at the centre bearing and working outwards. After each bearing is finally tightened, turn the crankshaft to ensure it revolves freely.

7. Again check to ensure that the crankshaft has retained the recommended end float of ·002 in. to ·004 in. (·051 mm. to ·102 mm.).

CRANKSHAFT JOURNAL WIDTHS AND DIAMETERS

Journal		Main Journal Diameter "A"	Crankpin Journal Diameter "B"	Main Journal Width "C"				Crankpin Journal Width "D"
				Front	Centre	Rear		
Size	Limit					Standard	Oversize	
Standard	Low	2·2490 in. (57·1246 mm.)	1·93725 in. (49·2062 mm.)	1·945 in. (49·403 mm.)	1·9665 in. (49·9491 mm.)	2·4405 in. (61·9887 mm.)	N/A	1·3125 in. (33·0835 mm.)
	High	2·2495 in. (57·1373 mm.)	1·93775 in. (49·2189 mm.)	1·953 in. (49·606 mm.)	1·9705 in. (50·0507 mm.)	2·4415 in. (62·0141 mm.)	N/A	1·3145 in. (33·3883 mm.)
·020 in. undersize	Low	2·2290 in. (56·6166 mm.)	1·91725 in. (48·6982 mm.)	1·945 in. (49·403 mm.)	1·9665 in. (49·9491 mm.)	2·4405 in. (61·9887 mm.)	*2·4450 in. (62·1030 mm.)	1·3125 in. (33·0835 mm.)
	High	2·2295 in. (56·6293 mm.)	1·91775 in. (48·7109 mm.)	1·953 in. (49·606 mm.)	1·9705 in. (50·0507 mm.)	2·4415 in. (62·0141 mm.)	*2·4470 in. (62·1538 mm.)	1·3145 in. (33·3883 mm.)
·040 in. undersize	Low	2·2090 in. (56·1086 mm.)	1·89725 in. (48·1902 mm.)	1·945 in. (49·403 mm.)	1·9665 in. (49·9491 mm.)	2·4405 in. (61·9887 mm.)	*2·4450 in. (62·1030 mm.)	1·3125 in. (33·0835 mm.)
	High	2·2095 in. (56·1213 mm.)	1·89775 in. (48·2029 mm.)	1·953 in. (49·606 mm.)	1·9705 in. (50·0507 mm.)	2·4415 in. (62·0141 mm.)	*2·4470 in. (62·1538 mm.)	1·3145 in. (33·3883 mm.)

* The dimension given under Main Journal Width—Rear (Oversize) in this table is the recommended maximum oversize (low limit components), to clean up the crankshaft journal side faces removing the minimum of material and then only if damage, etc., exists. This dimension could in certain cases be exceeded up to a maximum of 2·450 in. (62·230 mm.), (high limit components), and if it is necessary to take advantage of this additional oversize limit, a dimensional check must first be made to determine the overall width of the housing and oversize thrust washers available, bearing in mind that an end float of ·002 in. to ·004 in. (·051 mm. to ·102 mm.) **must** result on the crankshaft.

Fig. B.49. Crankshaft re-grinding dimensions

8. Fit the front main bearing cap base and secure with the two setscrews.

9. Refit the engine front plate.

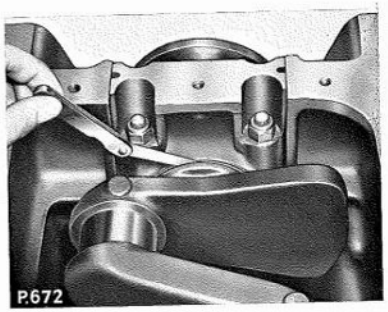


Fig. B.50. Checking the crankshaft end float, using a feeler gauge

10. Pack felt into the grooves in the rear main bearing cap and the front main bearing cap base, cutting the felt into short strips and tapping them into the grooves tightly with a suitable rod (see Fig. B.51).

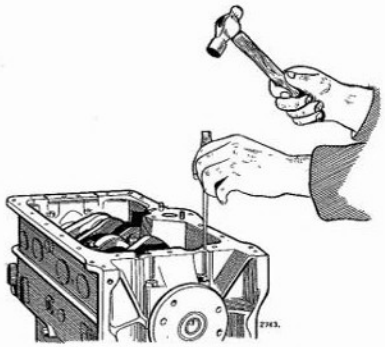


Fig. B.51. Packing the crankshaft rear main bearing cap grooves with felt

11. Re-assemble the engine by reversing the remaining sequence of operations detailed under "Crankshaft and Main Bearings—To Remove", on pages B.44 and B.45.

12. Refit the engine into the chassis. Finally refill the engine with fresh oil of the recommended grade.

FLYWHEEL AND STARTER RING

To Remove.

1. Remove the gearbox (see "Gearbox" section).

2. Remove the two split halves of the bottom cover from the clutch housing, noting the two additional setscrews securing the front half to the crankcase.

3. Remove the clutch (see "Clutch and Propeller Shaft" section).

4. Rotate the engine so that number 1 and 4 pistons are at T.D.C., either by aligning the pointer on the timing case with the pointer on the crankshaft pulley, or alternatively by fitting the plain end of the timing plug housed in the top right hand side of the clutch housing (see Fig. B.36), so as it engages the screwed bore in the clutch housing and the recess machined in the periphery of the flywheel. Remove the timing plug once the flywheel is correctly located.

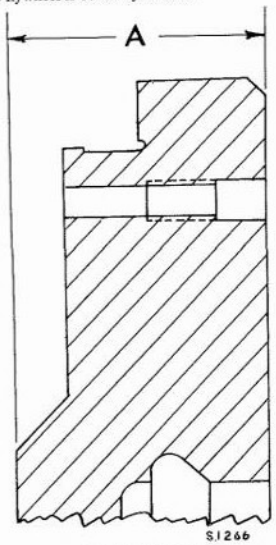


Fig. B.52. Flywheel re-grinding dimension

5. Alternatively identify the flywheel to the crankshaft flange by means of a continuous scribed line on both components, thus ensuring that on re-assembly and alignment of the marks, the flywheel assumes its original radial location about the crankshaft.

6. Tap the tabs of the lockwashers clear of the flywheel securing bolts, lock the flywheel to prevent it from turning, and remove the bolts securing it to the crankshaft flange. Carefully lever off the flywheel from the crankshaft rear flange.

Note: To facilitate removal, screw a stud into an upper setbolt hole before levering off the flywheel, thus preventing it from falling accidentally when once clear of the register, resulting in possible damage to the starter ring.

Inspection and Overhaul.

Flywheel.

1. Examine the friction face on the flywheel. If this is badly scored the face must be re-ground to restore the original smooth finish, but only until original marks are removed. When carrying out this operation the whole of the flywheel face must be re-ground and not the friction area only. Reference must be made to Fig. B.52 whilst carrying out this re-grinding operation, for the minimum thickness on the flywheel of 1·75 in. (44·45 mm.) must not be exceeded. Reinstate the T.D.C. marking on the flywheel friction face as shown in Fig. B.53, if obliterated during re-grinding operations.

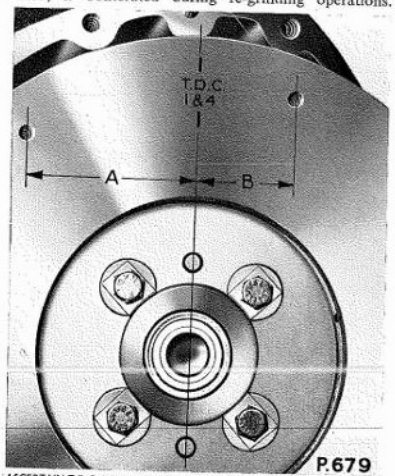


Fig. B.53. Reinstating the T.D.C. mark on the flywheel after grinding the friction face

Ensure all markings are made clear of the friction area on the flywheel, on which the driven plate seats.

2. Examine the threads of the securing bolts and if these appear stretched, renew the bolts.

Starter Ring.

1. Examine the starter ring teeth. If these are damaged, or worn excessively, the ring must be renewed.

2. The starter ring is shrunk on to the flywheel and in the event of wear developing on the teeth, the complete flywheel and ring should be renewed. However, if suitable equipment is available, the starter ring may be removed and a new one fitted by adopting the following method:

(*a*) Immerse the flywheel in a suitable container of clean **cold** water and support the assembly in the water by placing three, or four steel blocks under the starter ring. Arrange the flywheel assembly so that it is partly submerged in the water, starter ring uppermost. The starter ring must be above the water level and it is recommended that approximately $\frac{1}{4}$ in. (5 mm.) clear above the water level be used as a guide.

(*b*) Heat the starter ring evenly round its circumference (using an oxy-acetylene welding torch) as shown in Fig. B.54, thus expanding the ring which will allow the flywheel itself to drop clear. Remove the flywheel from the water and dry thoroughly.

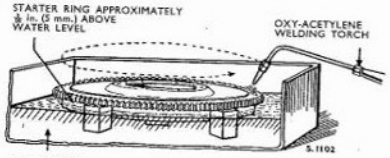


Fig. B.54. Removing the worn starter ring

(*c*) Check the height of the securing lip by means of a straight edge and a feeler gauge. This dimension should be a maximum of ·009 in. (·229 mm.) as shown in Fig. B.55. If the height is greater than ·009 in. (·229 mm.) it must be reduced in a lathe. When carrying out this operation it is most important that the flywheel is located by the dowel holes.

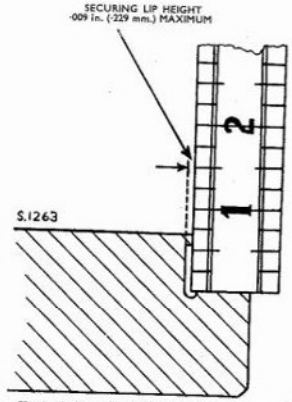


Fig. B.55. Checking the height of the starter ring securing lip

(*d*) Lay the flywheel down on its clutch mounting face, ready to receive the starter ring. Ensure that the registering faces of the flywheel and starter ring are clean and free from burrs.

(*e*) To fit the new starter ring, it must first be pre-heated and this is accomplished by suspending the starter ring from wire hooks in a container of clean engine oil, which has been heated to 392°F. (200°C.) until the ring attains the same temperature as the oil (see Fig. B.56).

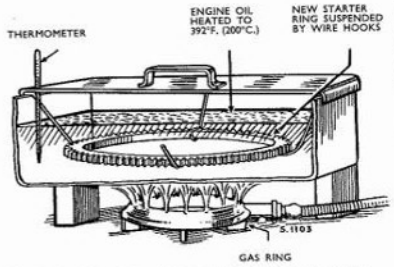


Fig. B.56. Pre-heating the new starter ring prior to fitting

(*f*) To eliminate the possibility of fire whilst heating the oil and the starter ring, keep the container covered by a metal lid to prevent flame from reaching the surface of the oil. Do not allow the starter ring (or thermometer) to rest on the bottom of the container, or a false temperature reading will result.

(*g*) Lift the heated ring from the oil by means of the wire hooks and quickly wipe away surplus oil with a piece of rag.

(*h*) Place the ring in position on the flywheel **with the chamfered sides of the teeth downwards,** and ensure the ring is completely over the securing lip and is square with the flange on the flywheel (see Fig. B.57).

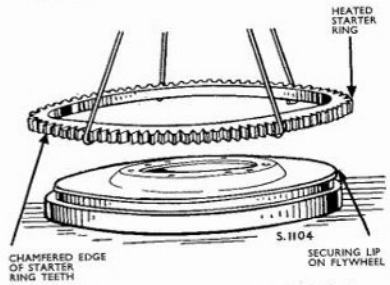


Fig. B.57. Fitting the new starter ring to the flywheel

(*j*) Allow the ring to cool in the atmosphere, when it will contract and thus firmly grip the flywheel diameter.

To Refit.

Reverse the removal procedure observing the following points:

1. Ensure the mating surfaces of the crankshaft flange and the register in the flywheel are clean and free from burrs.

2. The two locating dowels may have been withdrawn with the flywheel and should this be the case, tap the dowels out of the flywheel and refit them in the crankshaft flange.

3. Depending which method of flywheel location is used, proceed in the following manner; ascertain that numbers 1 and 4 pistons are at T.D.C. and fit the flywheel to the crankshaft flange with the letters T.D.C. 1/4 stamped on the flywheel to the top, or alternatively align the scribed lines, which were made during the removal operations, on both the flywheel and the crankshaft flange.

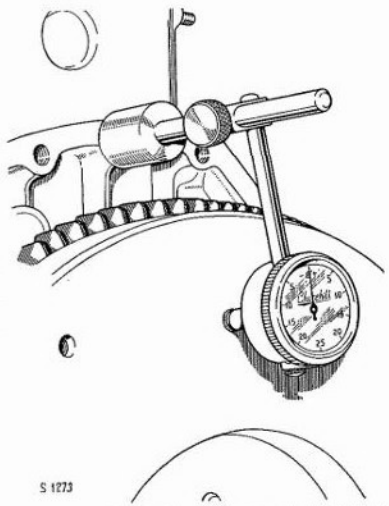


Fig. B.58. Checking the flywheel for "run-out", using a dial gauge

4. Tighten the setbolts in diagonal sequence to a torque wrench reading of 37/43 lb. ft. (5·12/5·95 kg.m.) and check for "run-out" at the outer edge of the flywheel friction face (see Fig. B.58). A total dial gauge reading of ·003 in. (·076 mm.) must not be exceeded. If this figure is exceeded, it is recommended in the first instance, that the flywheel be removed and a careful examination carried out of the mating faces of the flywheel register and the crankshaft flange. Any burrs, or irregularities on these mating surfaces must be removed.

5. If the flywheel "run-out" is within the limits given, lock the setbolts with the new lockwashers.

INLET AND EXHAUST MANIFOLDS

For further information in respect of the exhaust system, refer under the "Chassis Frame, Suspension and Shock Absorbers" section.

To Remove.

1. Raise the bonnet (hood) and suitably support in the open position. Release the internal engine cowl.

2. Slacken the hose clips, remove the rubber hose from the carburettor, and after freeing the hose from the rocker cover breather pipe and the air cleaner cover, withdraw from the vehicle.

3. Disconnect at the carburettor the following:

(*a*) The feed pipe at the float chamber banjo bolt.

(*b*) The pipe to the distributor vacuum advance unit at the sleeve nut provided.

(*c*) The choke inner cable and outer casing at the starter unit.

(*d*) The throttle operating rod at the carburettor throttle lever.

4. Remove the stop on the end of the hand throttle control inner cable, and the knurled nuts securing the outer cable ferrule to the abutment bracket on the manifold. Position the hand throttle control cable clear of the manifold.

5. Remove the drain pipe from the inlet manifold.

6. Remove the nuts securing the exhaust pipe flange to the exhaust manifold, and then free the pipe from the studs. Withdraw the flange joint.

7. Unscrew and remove the stud nuts securing the manifolds to the cylinder head. The complete assembly may then be withdrawn from off the studs, taking care not to lose the two locating rings positioned in the inner inlet manifold ports. Ensure that the carburettor is not damaged in any way as the manifold assembly is withdrawn.

8. Withdraw the manifold joint from off the studs.

To Dismantle.

1. Remove the carburettor after releasing its securing nuts. The gasket can then be lifted off the carburettor mounting studs.

2. Separate the two manifolds after removing the nuts from the four securing studs. Lift off the metal joint from the studs. This operation also frees the hand throttle abutment bracket, which should be located correctly on re-assembly in its original position, i.e., on the rear pair of interconnecting manifold studs.

Inspection and Overhaul.

1. Inspect the manifolds for cracks and check for distortion on the faces that mate with the cylinder head.

2. Blow through the manifold drain pipe to clear away any obstruction. Ensure also that the drain hole in the inlet manifold is clear.

3. The manifold gaskets should always be renewed.

To Re-assemble.

Fit a new metal joint, and register on the interconnecting manifold studs, then position the inlet manifold over the studs and press down using hand pressure until it abuts the joint. Refit the hand throttle abutment bracket and the manifold securing nuts, and leave finger tight.

Note: If the manifolds have been separated, the carburettor should not be installed until the manifold assembly is fitted to the cylinder head, but if the manifolds have not been separated, the carburettor may be fitted prior to installation of the manifolds.

To Refit.

1. Clean the matching faces of the cylinder head and manifolds.

2. Fit the two locating rings to their registers around the two inner inlet ports of the cylinder head.

3. Locate the new manifold gasket in position over the studs.

4. Fit the manifold assembly and secure it to the cylinder head with the nuts and washers, tightening down the nuts by starting from the centre and working progressively outwards. Repeat the tightening procedure. Tighten the interconnecting manifold stud nuts left slack, which secure the manifolds together.

Note: By adopting this procedure the inlet and exhaust manifolds will be in correct alignment.

5. Secure the exhaust pipe flange to the exhaust manifold using the nuts and a new gasket.

6. Complete the refitting operations by reversing the removal procedure, referring under the "Fuel System" section, when installing the carburettor.

ENGINE MOUNTINGS

To Remove and Refit.

1. Raise the bonnet (hood) and secure in the open position, also release the internal engine cowl from its anchorage.

2. Disconnect one of the leads from the battery terminals, to prevent short circuits occurring.

3. Drain the cooling system and remove the top and bottom radiator hoses to avoid strain on these components.

4. To remove the front engine mounting rubber proceed as follows:

(*a*) Jack up the front of the engine, using a wide

wooden block between the jack and the sump (oil pan) until the load is just taken off the front engine mounting rubber.

Note: Do not under any circumstances jack up the engine higher than is necessary, but only high enough to relieve the load on the mounting rubber, as raising the engine to an unnecessary height will place excessive load on the rear engine mountings, and undue strain will be exerted on the engine stabilising tie rod, the exhaust pipe joint at the manifold and on the various throttle controls.

(*b*) Release the earthing wire from the engine front mounting.

(*c*) Withdraw the nuts and bolts that secure the front mounting rubber to the mounting plate bolted to the front chassis crossmember, also the nuts and bolts securing the cast mounting bracket to the timing cover. Remove the mounting bracket together with the rubber and then separate these two components.

(*d*) If required the mounting plate may be removed from the crossmember, after releasing the securing nuts and bolts.

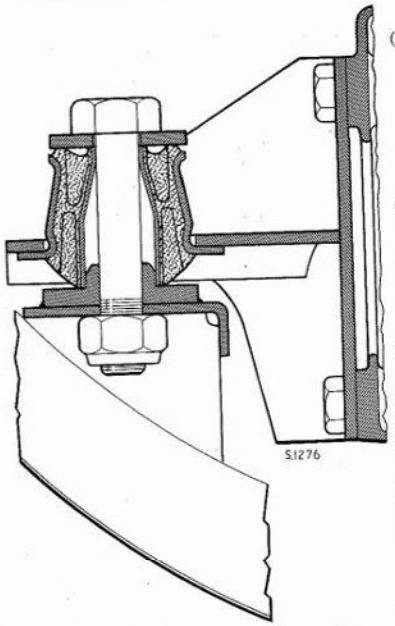


Fig. B.59. Sectional view of the rear engine mounting

5. Refit the front engine mounting rubber and associated brackets, reversing the procedure given for removal in para. 4.

6. To release either rear engine mounting rubbers, proceed in the following manner, dealing with each side in turn:

(*a*) Jack up the rear of the engine, using a wide wooden block between the jack and the sump (oil pan) until the load is just taken off the rear mounting rubber on the side receiving attention.

Note: Do not under any circumstances jack up the engine higher than is necessary, but only high enough to relieve the load on the mounting rubber being removed, as raising the engine to an unnecessary height will place excessive load on the other engine mountings, and undue strain will be exerted on the engine stabilising tie rod, the exhaust pipe joint at the manifold and on the various throttle controls.

(*b*) Unscrew and remove the "Simmonds" nut from the mounting bolt, which passes down through the mounting rubber positioned on the clutch housing bracket (see Fig. B.59). Withdraw the mounting bolt from above, complete with the rebound washer.

(*c*) Release the engine mounting bracket from the clutch housing after removing the four setscrews, and lift it away complete with the mounting rubber. Observe the location of the throttle linkage return spring and anchor plate, the anchor plate being positioned on the rear upper setscrew of the rear engine mounting bracket. Ensure the anchor plate and return spring are positioned correctly on re-assembly.

(*d*) Remove the mounting rubber from the bracket noting that the flange of the mounting rubber is located on the underside of the bracket.

(*e*) Refit the rear engine mounting rubber and associated bracket to the clutch housing by reversing the removal procedure, before dealing with the second rear engine mounting rubber.

(*f*) Remove the second mounting rubber as described previously in paras. 6 (*a*) to 6 (*d*) inclusive.

7. Refit the second rear engine mounting rubber and bracket to the clutch housing, adopting a similar procedure as used on the first mounting rubber (see para. 6 (*e*)).

8. Locate the rebound washers over the centre bolts, and pass one bolt through each rear mounting rubber and its respective crossmember location, securing the bolts by means of new "Simmonds" nuts, from below. Ensure that the centre sleeve of the mounting rubbers are located over the shouldered pads on the chassis crossmember.

9. Finally complete the operation by reversing the remaining removal operations.

ENGINE REMOVAL

Prior to carrying out this operation, drain the water from the radiator and cylinder block, and the engine oil from the sump (oil pan). It is also advisable to drain the oil from the gearbox, as this unit is removed from the clutch housing to facilitate engine removal.

To remove the engine proceed in the following manner:

1. Raise the bonnet (hood) and secure in the open position, also release the internal engine cowl from its anchorage.

2. Disconnect the leads from the battery terminals. Release the battery retaining strap and then remove the battery to obtain access to the radiator grille side panel bolts.

3. Release the radiator grille, complete with the side panels and lamps (see "Cab and Body" section).

4. Remove the radiator (see "Cooling System" section). Remove the radiator baffle panels and the front apron tie bar (see "Cab and Body" section).

5. Release the locknut and unscrew the change speed lever knob. Remove the screws retaining the floor centre panel, and lift off the panel complete, noting that if required the change speed lever bellows may be prised from its seating and pushed through the aperture in the centre panel, thus leaving the bellows in position as the centre panel is lifted clear. Ensure upon refitting the floor panel, that the panel seals are in good condition.

6. In order to provide increased clearance for the clutch housing during engine removal operations, the centre toe panel may be removed, after releasing the centre panel retaining screws, slackening also the side toe panel retaining screws, in order to permit a rearward withdrawal of the centre panel. Ensure upon refitting the toe panels, that the panel seals are in good condition.

7. Remove the gearbox (see "Gearbox" section), noting that it will be necessary to remove the gearbox tower and disconnect the propeller shaft at the gearbox driver coupling, moving the propeller shaft to one side, after releasing the centre bearing hub from its split housing.

8. Remove the distributor and carburettor (see the "Electrical Equipment" and "Fuel System" sections respectively). These operations are not essential to the removal of the engine, their purpose being to safeguard the components from damage during the operation of lifting out the engine. Release the hand throttle outer cable from the abutment bracket located on the inlet to exhaust manifold studs.

9. Disconnect the following electrical leads:

(*a*) The ignition lead at the coil.

(*b*) The two leads at the dynamo.

(*c*) The lead at the oil pressure switch on the right hand side of the cylinder block.

(*d*) The cable at the starter motor.

10. Release the earth wire from its fixing on the engine front mounting.

11. Disconnect the lead from the thermometer bulb positioned in the water pump body thermostat chamber.

12. Remove the heater pipes (when fitted) from their adaptors situated in the water pump inlet pipe and the rear left hand side of the cylinder head.

13. Disconnect the petrol pipe from the tank, at the petrol pump inlet union.

14. Release the exhaust pipe by withdrawing the four nuts and washers, securing the exhaust pipe flange to the manifold.

15. Disconnect the engine stabilising tie rod in the following manner:

(*a*) Remove the bolt, plain washers and shakeproof washer securing the tie rod to the clutch housing.

(*b*) If it is required to remove the tie rod from the vehicle, release the locknut, plain nut, neoprene insulator, and plain washer, enabling the complete tie rod to be withdrawn rearward from its cross-member support bracket.

Note: On re-connecting the engine stabilising tie rod, adjust the nuts on the neoprene insulators until a slight tension on the rod is obtained. Do not over tension the rod.

16. Disconnect the throttle linkage rod (accelerator pedal to relay bracket) from the lever on the relay bracket, the bracket being secured to the right-hand side of the cylinder block. On L.H.D. models release the throttle linkage rod from the cross-shaft lever extension piece. Disconnect the throttle linkage return spring from its anchorage plate located on the rear upper setscrew of the rear engine mounting bracket. On installing the throttle linkage, adjust the linkage if necessary, as detailed in the "Fuel System" section.

17. On R.H.D. models disconnect and remove the clutch operating rod from the lower arm of the clutch pedal, and then withdraw the rod from the clutch withdrawal lever eye.

Note: On L.H.D. models remove the rod from the relay lever and the clutch withdrawal lever.

18. Disconnect the engine mountings in the following manner:

Front. Remove the two nuts and bolts that secure the mounting rubber to the engine mounting plate, which is bolted to the front chassis crossmember.

Rear. Unscrew and remove the "Simmonds" nut from the mounting bolt, which passes down through the mounting rubber in each clutch housing bracket (see Fig. B.59). Withdraw the bolts from above, complete with the rebound washers. The flange of the mounting rubbers are secured by two setscrews and nuts to the underside of each clutch housing bracket.

The bracket in turn being secured to the housing by four setscrews.

19. Remove the thermostat housing and the thermostat (see "Cooling System" section).

20. If the rocker cover breather pipe was not withdrawn with the air cleaner hose, remove it at this stage.

21. The engine is withdrawn forward and to enable this to be accomplished a jib crane, or a swan neck crane modified to incorporate a jib must be used, preferably with no hook, but having a suitable slot, or "under-cut" to house the crossed chains. If a swan neck crane is used, it must be counter balanced to take account of the weight of the engine. The approximate weight of the engine, less gearbox is 494 lb. (224 kg.).

22. Locate a sling under the engine, using a suitable length of chain, crossing it at the top, and positioning the chain so that it runs under the timing cover at the front, and between the sump and the clutch housing at the rear. Position the sling on the crane jib so that when the engine is being lifted, the front of the engine will be on a higher plane than the rear. The sling must be adjusted so that the crane jib is located as near as possible to the rocker cover of the engine and positioned forward to clear the cab scuttle panel, enabling a higher lift to be obtained.

23. Using a locally manufactured support bracket to the dimensions given in Fig. B.60, bolt to the clutch housing, employing the gearbox securing holes. Position a trolley jack and wooden block, or an adjustable height table under the support bracket and raise to take the weight at the rear of the engine, during the initial stages of engine removal.

24. Take the weight of the engine on both the crane and the jack and carefully lever the rear mounting rubbers clear of their locations on the chassis crossmember. Then raise the engine on the crane in progressive stages until it clears the front bumper, at the same time sliding the engine forward along on the support bracket bolted to the rear of the clutch housing, until a vertical lift can be achieved on the crane.

25. Lift the engine out of the chassis, ensuring that the clutch housing and rear mounting brackets do not foul the cab scuttle.

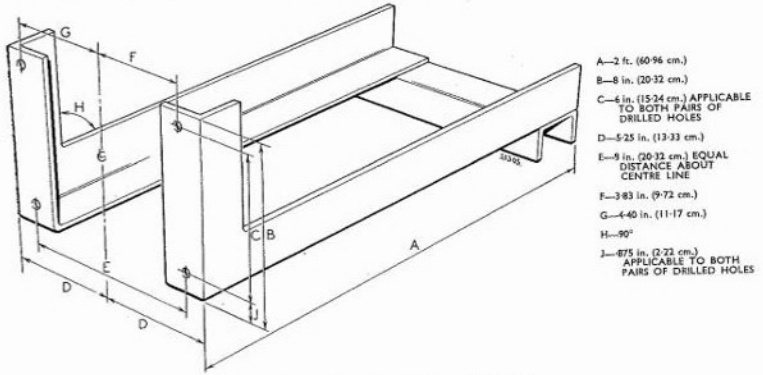


Fig. B.60. Engine removal support bracket dimensions

LUBRICATION SYSTEM

DESCRIPTION AND OPERATION

The main components of the lubrication system are a gauze floating filter, a spur gear type oil pump and a by-pass oil filter. The system also includes a pressure relief valve, which maintains the oil pressure to a pre-set figure.

The floating sump filter pivots freely about the oil pump body, restricted only by a plate on the filter intake tube, which limits the total movement of the filter. The floating filter is retained in position by means of a split pin, which locates in the pump body and in a recess on the collar of the filter intake tube. Lubricating oil is drawn from the sump through the wire gauze floating filter and intake tube to the pump inlet, i.e., suction side of the oil pump. The filter, floating on the surface of the oil prevents circulation of any sludge which may be present, by drawing up the clean oil from just below the surface, whereas any sludge sinks to the bottom of the sump and thus out of circulation.

The spur gear type oil pump is situated on the left hand underside of the crankcase and is driven in tandem

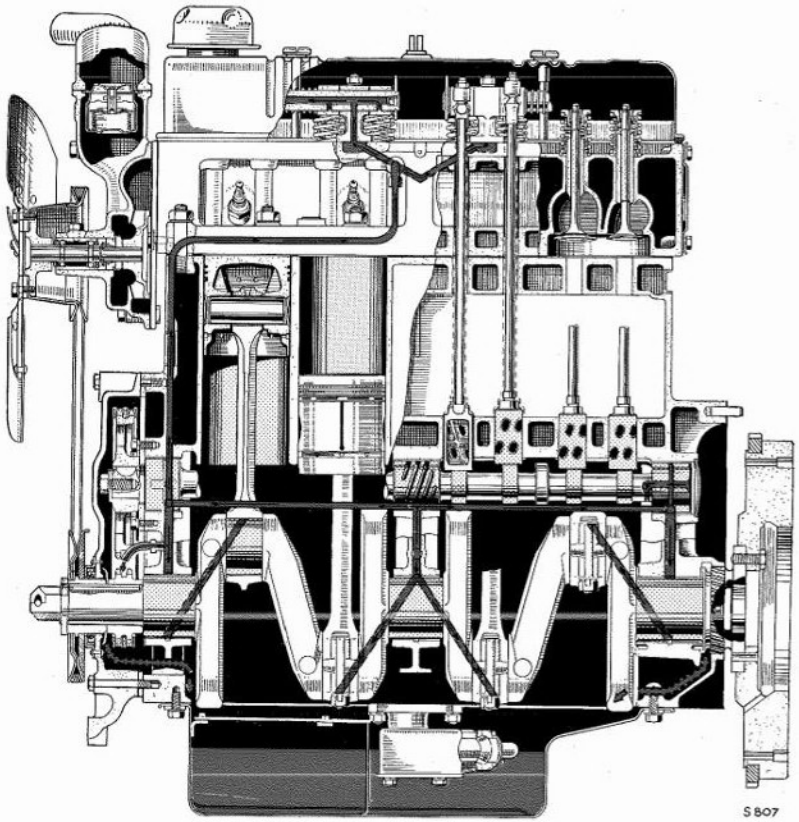


Fig. B.61. Longitudinal section of the engine, showing the oil circulation

with the distributor through helical skew gears, the gear wheel of which is formed integral with the centre journal of the camshaft. The mating skew gear is a machined part of the driving pinion, which is pinned to the upper end of the pump driving shaft, and forms a renewable assembly. The sleeve of the driving pinion operates in a renewable sintered bronze bush pressed into the crankcase. The driving shaft locates in the pump body and a spur gear wheel is pressed and keyed to the shaft at the lower end. This gear wheel engages and drives a similar bushed idler spur gear wheel, which rotates freely on a spindle pressed into the pump body. The internal profile of the pump body is shaped so that the outer diameters of the gear wheels operate in close proximity, and by the action of the gears, oil is drawn in from the suction (inlet) side of pump and transferred to the delivery (outlet) port under a pre-set pressure, due to the inclusion in the system of the pressure relief valve. The gears are enclosed in the pump body by a cover plate, which is secured by four setscrews.

Oil discharged from the pump under pressure enters a vertical passage in the central web of the crankcase and passes to a transverse passage, which carries at its extreme right hand end the oil pressure relief valve. This valve is of the spring loaded plunger type. On the discharge side of the relief valve a vertical outlet passage drains directly into the sump. When the oil pressure is low, the pressure of the relief valve spring is greater than the pressure exerted by the oil, and the valve is held against its seating and the outlet passage to the sump is closed. However, as the oil pressure increases, the relief valve is lifted from its seating and excess oil is allowed to pass direct to the sump, via the outlet passage, thus preventing excessive build up of pressure within the system. The relief valve setting is predetermined by the tension of the spring, is **not adjustable,** and is equivalent to a normal running oil pressure (engine hot) of 45 to 50 lb./sq. in. (3·16 to 3·52 kg./sq. cm.). From the transverse passage carrying the relief valve, oil is forced under pressure downwards to the annulus formed around the centre main bearing, and upwards to meet a second transverse passage, which feeds the centre camshaft bearing and the main gallery running the length of the crankcase on the right hand side of the engine. The main gallery is plugged at the front and rear faces of the crankcase. From the main gallery, oil is fed through transverse and vertical passages at the front and the rear of the crankcase, supplying lubricant to the front and rear crankshaft main bearings, also to the camshaft bearings.

The crankshaft main bearing halves seat in the crankcase and the bearing caps. These seatings have grooves cut to form an annulus around the outside of the bearing halves. Each main bearing half contains a drilled hole by which lubricant is transferred from the outer annulus to an inner groove formed around the internal diameter of the bearing halves, and from this point, oil is distributed to the bearing surfaces of the main bearings and the crankshaft main journals.

Drilled passages in the crankshaft allow oil to flow from the main bearings to the crankpin journals, where it lubricates the working surfaces of the connecting rod big end bearings and the crankpin journals. Oil squirt holes drilled through each connecting rod and mating bearing half, serve to project a stream of oil to the thrust side of the cylinder wall upon each revolution of the crankshaft, thus ensuring that adequate lubrication of the cylinder bores results.

Oil removed from the cylinder bores by the action of the scraper rings on the pistons is fed back through holes in the piston skirt and hence it gravitates down into the sump. The gudgeon pin is lubricated by oil splash, through holes provided in the small end bush and the piston bosses.

The front main bearing feed passage is intersected by a subsidiary drilling carrying an oil jet, which projects forward over the crankshaft timing wheel and directs a jet of oil to lubricate the timing gears and the duplex timing chain. Excess oil which drains to the bottom of the timing cover, returns to the sump, via the apertures formed between the front main bearing cap and the cap base.

An external pipe from the front camshaft bearing connects to an elbow in the cylinder head, which supplies a restricted amount of oil, through drillings in the centre of the cylinder head, to the two inner rocker shaft standards and hence to the hollow rocker shafts. Holes in the underside of each rocker shaft in line with the rocker locations, feed the rocker bearing surfaces. A passage through the arm of each rocker aligns with the drilling along one side of the adjusting screw bore, thus oil is passed down this drilling to lubricate the push rod ends and tappet faces.

The by-pass type oil filter is situated on the upper left hand side of the cylinder block and is mounted by means of setscrews through the filter head on to a machined face on the cylinder block. The oil filter comprises a metal outer container, carrying a renewable element, which is secured to the filter head. The element container seats on a gasket recessed into the filter head, whilst the element carries a sealing ring at the upper end, which is seated by the action of the locating spring at the bottom of the container. An external pipe is utilised and connects the inlet side of the filter to a passage in the crankcase. The oil is passed to this passage from the main gallery, via the camshaft rear bearing, where a groove cut in the rear journal of the camshaft aligns with a hole in each side of the rear bearing, thus permitting free passage of the lubricant to the crankcase passage and hence to the inlet side of the oil filter. Unfiltered oil enters, circulates within the oil container and then penetrates the filter element when foreign matter is removed and the clean oil is passed to the space around the centre bolt. The centre bolt of the container carries at its head a small drilling, through which all filtered oil must pass before reaching the delivery port. This drilling restricts the flow of oil

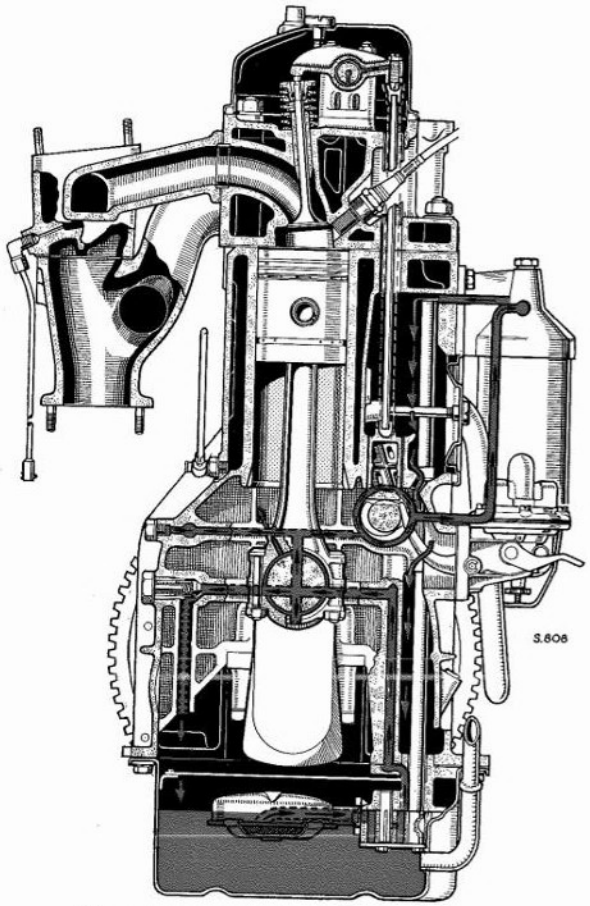


Fig. B.62. Transverse section of the engine, showing the oil circulation

and maintains pressure within the system. The delivery of filtered oil is effected through a passage in the filter head, which mates with a port in the crankcase wall, thus the filtered oil is discharged back into the sump, via the tappet chest.

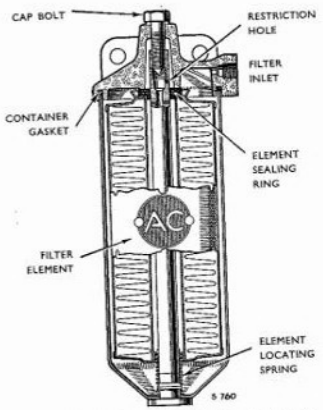


Fig. B.63. Sectional view of the by-pass oil filter

A pressure switch is located on the right hand side of the crankcase and connects with the main oil gallery. The switch works in conjunction with an amber oil warning light located in the combined speedometer instrument on the facia panel.

CRANKCASE DILUTION

Dilution of the lubricating oil may be brought about by the addition of poor quality oil, or by fuel leaking past pistons and rings. The latter condition may be due to worn bores, pistons and rings, and is most likely to occur in cold weather.

Symptoms of crankcase dilution are low oil pressure, rapid wear, overheating, loss of power and emulsification of oil. Emulsification of the oil can also be caused by the presence of water due to condensation, a leaking cylinder head gasket, or a cracked cylinder block.

If inspection confirms that dilution has taken place, ascertain and correct the cause of it, and drain the sump, also the oil filter. Draining should be done immediately after a run, while the oil is hot, as it will then flow more easily. Refill the sump with new oil of the correct grade to the "FULL" level mark on the dipstick. Top up the sump after the engine has run for a short time, to account for the fall in oil level brought about by the initial oil recuperation of the oil filter unit. Oil changes should then be attended to regularly and the correct grade of oil always used.

CRANKCASE BREATHER

The crankcase breather is situated over the engine oil filler cap and should be removed for cleaning and re-oiling at intervals of 6,000 mile (9,000 km.), proceeding in the following manner:

To Clean.

1. Withdraw the oil filler cap from its location on the rocker cover.
2. Clean the filter gauze in paraffin, or petrol and blow dry with compressed air, or alternatively allow to drain dry.
3. Examine the filter gauze for damage and renew the oil filler cap if damage to the gauze exists.
4. Re-oil the filter gauze with clean engine oil and allow the surplus to drain off.
5. Refit the oil filler cap.

BY-PASS OIL FILTER

It is recommended that the oil filter element be renewed every 4,000 mile (6,000 km.).

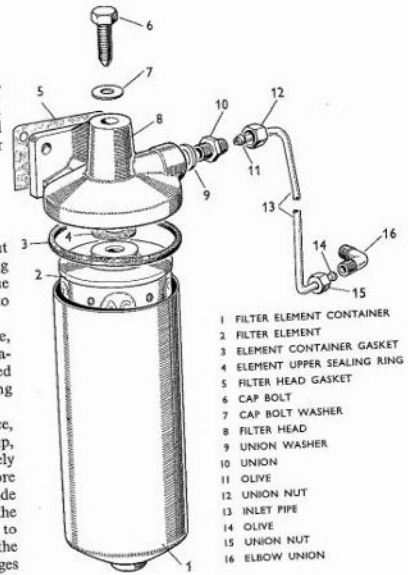


Fig. B.64. Oil filter details

To Renew the Filter Element.

1. Unscrew the cap bolt in the filter head and withdraw the element container from below. The filter element can then be lifted out of the container and discarded. The upper element sealing ring if not withdrawn with the element, should be removed, also the container gasket, which is seated in a recess in the filter head.
2. Empty the oil from the container and wash out any sludge that may have collected in the bottom, with petrol, or paraffin. Ensure the restricting hole at the head of the centre bolt is clear of obstruction. Check the tension of the element locating spring, and renew if weak, or broken.
3. Insert the new element into the container with the fabricated seal cup uppermost, using the new joints supplied with the element, i.e., positioning the small sealing ring in the fabricated seal cup at the top of the filter element and the larger gasket in the recess provided in the filter head. Secure the container to the filter head with the cap bolt.
4. If required the element container can be filled with the recommended grade of engine oil prior to refitting, or alternatively, run the engine for a few minutes to allow the oil to circulate and fill the element container, then stop the engine and wait for the engine oil to gravitate back into the sump. Re-check and top up to the correct oil level.

To Remove.

1. Disconnect the inlet pipe from the elbow on the crankcase and the union located on the filter head.
2. Release the two setscrews securing the filter head to the crankcase wall and lift away the complete filter unit.
3. To dismantle, fit a new filter element, and reassemble the oil filter, refer to paras. 1 to 4 under the heading "To Renew the Filter Element". Whilst the filter is dismantled wash the filter head in clean petrol, or paraffin and blow through the passages with compressed air.

To Refit.

1. Ensure the mating surfaces of the crankcase and the filter head are clean, and free from traces of the old gasket. Ensure the delivery port in the crankcase wall is not obstructed.
2. Refit the filter unit, using a new gasket, ensuring that the setscrews are progressively tightened by diagonal selection.
3. Re-connect the inlet pipe to the elbow in the crankcase and to the union on the filter head. Ascertain on starting the engine that oil tight joints have resulted at these connecting points.
4. If the filter element container is not filled with oil prior to refitting it is important that the engine oil level be checked, and topped up to the correct level, after the engine has been run for a few minutes. Upon stopping the engine, wait for the engine oil to gravitate back into the sump before taking level readings. Top up the sump to the correct level.

OIL SUMP (OIL PAN)

To Remove.

1. Remove the sump (oil pan) drain plug and drain the oil into a suitable container.
2. Withdraw the dipstick and release the dipstick tube from its locations.
3. Remove the securing setscrews and lower the sump, observing that the inlet manifold drain tube clip is secured to one of the sump setscrews on the right hand side of the crankcase. It is advisable to leave one setscrew in the centre position on each side of the sump until the weight of the sump can be conveniently taken by the hand, to avoid distortion of the joint faces.

Inspection and Overhaul.

1. Renew the sump joint if it is damaged, or compressed hard.
2. Remove the screws securing the sump baffle and lift away.
3. Clean out the sump with paraffin, or petrol and wipe clean with dry lintless rag.
4. Refit the sump baffle with the securing screws.
5. With the sump removed, the opportunity should be taken to remove and clean the oil pump floating filter, as detailed on page B.59.
6. Inspect the threads of the drain plug and the corresponding threads in the sump for damage and renew the components as necessary.
7. Examine the flange of the sump for distortion between the setscrew holes. Any slight irregularity may be corrected by light hammer blows using a block of steel as a support. Check the sump for damage, or splitting particularly along the flange edge of the sump. Repair, or renew, as necessary.

To Refit.

Reverse the removal procedure bearing in mind the following:

1. Attach the gasket to the crankcase flange face with a slight smear of grease.
2. Refit the sump, securing initially with two setscrews spaced at diagonally opposite positions and then fit the remaining setscrews. Tighten the setscrews evenly by diagonal selection.
3. Refill the sump to the "FULL" level mark on the dipstick.

Note: Should the refilling of the sump coincide with the fitting of a new oil filter element, allowance must be made for the capacity of the filter unit

otherwise a noticeable fall in the sump oil level will take place when the engine has been run, owing to the initial oil recuperation of the filter unit.

OIL PRESSURE RELIEF VALVE

The oil pressure relief valve is of the non-adjustable type. It is carefully pre-set during manufacture and should not require attention. If it is required to examine the valve and its seating in the crankcase, carry out the following sequence of operations.

To Remove.

Unscrew the hexagon head of the valve body and withdraw the spring and the valve from the crankcase.

Inspection.

1. Examine the sides of the valve for scores and its face for signs of pitting. Renew the valve, if necessary.

2. Renew the valve spring if it is distorted, or if the free length is less than 1·988 in. (50·50 mm.) (see also the dimensions given under "Manufacturing Data").

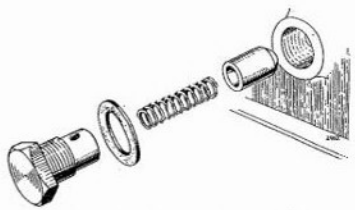


Fig. B.65. Oil pressure relief valve details

3. Check to ensure that the bore in the valve body is clear of obstruction and that the valve is a free sliding fit. Check also that the holes in the valve body side are clear of foreign matter.

4. Renew the fibre washer if it is damaged.

To Refit.

When refitting the relief valve the spring should first be placed in the body, then the valve placed on the projecting end of the spring and the whole assembly inserted and screwed into the crankcase. Ensure that the fibre washer is in position on the body of the relief valve.

OIL PUMP FLOATING FILTER

It is recommended that the oil sump (oil pan) be removed and the oil pump floating filter cleaned at 24,000 mile (36,000 km.) intervals.

To Remove.

1. Remove the sump (oil pan) (see page B.58).

2. Remove the split pin that secures the floating filter assembly to the pump body and withdraw the filter.

Inspection and Overhaul.

Wash the filter gauze thoroughly in petrol, or paraffin both inside and out, and dry by blowing through with compressed air. Examine the filter gauze for damage and renew the filter, if necessary.

To Refit.

1. Refit the filter to the pump body and secure it with a new split pin. Open out the ends of the pin sufficiently to retain it in the pump body.

2. Refit the sump (see page B.58) and refill with the correct grade of lubricant to the "FULL" level mark on the dipstick.

OIL PUMP

To Remove.

1. Withdraw the dipstick and release the dipstick tube from its locations.

2. Remove the tappet cover.

3. Set the engine at T.D.C. with number 1 cylinder firing, by using either the pointers on the timing cover and crankshaft pulley, or the timing plug screwed in the clutch housing, proceeding as detailed in para. (*a*), or (*b*) on page B.60.

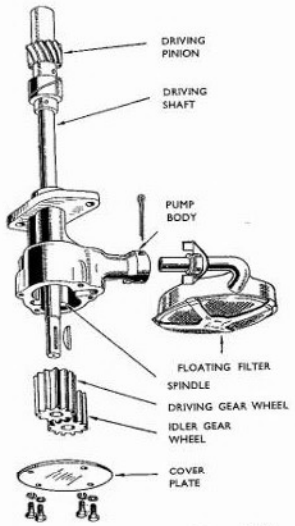


Fig. B.66. Oil pump details

(*a*) Rotate the crankshaft until the pointer on the crankshaft pulley rear rim exactly aligns with the stationary pointer on the timing cover, ascertaining that the push rods on number 1 cylinder can be rotated freely by hand. It may be necessary to rotate the crankshaft one revolution to obtain this condition, when the timing pointers must again exactly align.

(*b*) Unscrew the timing plug from its location on the clutch housing and reverse it, so that the plain end engages the screwed bore in the clutch housing. Rotate the crankshaft until the timing plug is felt to register in the recess provided in the periphery of the flywheel. Ascertain that the push rods on number 1 cylinder can be rotated freely by hand, if not, rotate the crankshaft one complete revolution to obtain this condition, when the timing plug must again locate in the recess on the flywheel. Remove the timing plug.

4. Remove the distributor (see "Electrical Equipment" section), and raise the driving shaft until its lower end clears the coupling on the driving pinion, and suitably support in this position.

5. Drain and remove the sump (oil pan) (see page B.58).

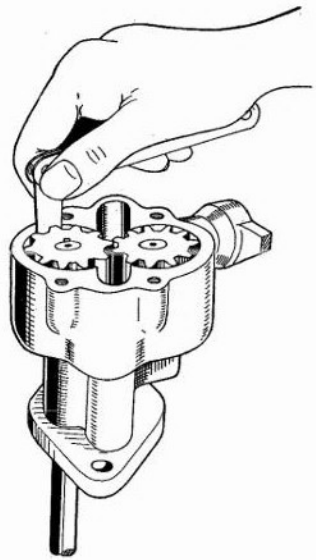


Fig. B.67. Checking the oil pump gear side clearance, using a feeler gauge

6. Remove the split pin securing the floating filter to the pump body and withdraw the filter.

7. Remove the nuts that secure the oil pump to the studs on the crankcase and withdraw the pump.

To Dismantle.

1. Withdraw the cover plate setscrews and remove the cover plate.

2. Before dismantling further, check the gear wheel clearances in the following manner:

(*a*) Check the clearance between the gear wheel teeth and the pump body, as shown in Fig. B.67. The minimum clearance should not be less than ·0019 in. (·048 mm.) and the maximum not more than ·0049 in. (·124 mm.).

(*b*) Check the end float of the gear wheels in the pump body by placing a straight edge across the face of the body and measuring the clearance between the straight edge and the end face of the gear wheels with a feeler gauge, as shown in Fig. B.68. The manufacturing limits are ·0015 in. to ·0035 in. (·038 mm. to ·089 mm.).

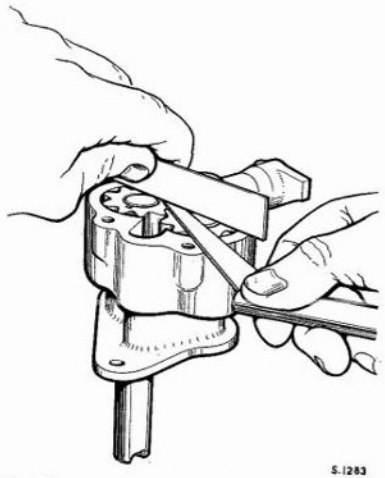


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Fig. B.68. Checking oil pump gear end clearance, using a feeler gauge and straight edge

3. Remove the bushed idler gear wheel from its spindle.

4. Slide the pump body along the driving shaft, thus exposing the driving gear wheel. Withdraw the gear from the shaft with a suitable withdrawal tool, or alternatively tap the shaft out with a soft metal drift, suitably supporting the gear.

5. Remove the Woodruff key from the shaft, thus enabling the shaft to be withdrawn from the pump body.

6. The idler gear wheel spindle is a press fit in the pump body and need only be removed when renewal is necessary.

Inspection and Overhaul.

1. Examine the inner face of the cover plate for wear, or scores. Provided that wear is not excessive the pump cover may be refaced using fine emery cloth on a surface plate.

2. Examine the pump body for cracks, or any signs of wear on the internal profile of the gear wheel chamber. Any signs of the gear wheels having fouled the profile of the chamber indicates wear at the gear wheel locating points (see also para. 6). Check the pump body for wear in the bore, which carries the driving shaft, and if wear is detected, the pump body complete must be renewed, for as mentioned previously this bore determines the location of the driving gear wheel in the pump chamber and therefore must be accurately maintained.

3. Inspect the driving shaft for wear on the diameter of the shaft, in the area which operates in the oil pump body, also inspect the shaft coupling tongue and slot for wear, or damage. The driving pinion is secured to the upper end of the driving shaft and the two components are renewable as an assembly.

4. Check the fit of the sleeve integral with the driving pinion, in its mating bush located in the crankcase, immediately below the tappet chest. If excessive wear is detected on the bush it may be driven out with a suitable drift from below. When fitting the new bush, tap in from the top of the crankcase, externally tapered end of the bush foremost, using a suitable stepped drift having a ·7282 in. to ·7284 in. (18·496 mm. to 18·501 mm.) diameter fitting pin, until the upper face of the bush is flush with the crankcase ledge. The bore diameter of the bush fitted in the crankcase is ·7280 in. to ·7290 in. (18·491 mm. to 18·517 mm.). The driving shaft will require renewal as an assembly, if excessive wear exists on the driving pinion sleeve.

5. Examine the teeth, and the top and bottom faces of the gear wheels for wear, or scores. The overall length of the gear wheels should be 1·2475 in. to 1·2485 in. (31·687 mm. to 32·712 mm.).

6. Check the fit of the idler gear wheel on its spindle. If the idler gear bush is worn, renew both the idler gear wheel and the driving gear wheel as a pair, also the idler spindle (to fit a new idler spindle, see "To Re-assemble", para. 1).

Note: The oil pump gear wheels **must always** be renewed in pairs.

To Re-assemble.

1. If the idler spindle has been removed (see "Inspection and Overhaul", para. 6), suitably support the pump body and press in the new idler spindle, plain section into the body, until the end of the spindle assumes a position just below the cover plate face on the pump body.

2. Insert into the pump body, the driving shaft and pinion assembly, with the driving pinion outermost and positioned on the same side of the pump body as the mounting flange. Fit the Woodruff key to the innermost end of the driving shaft.

3. Align the keyway in the driving gear wheel with the key in the shaft and press on until the gear wheel is abutting the shoulder on the driving shaft.

4. Position the driving gear wheel in the pump body by pulling on the shaft.

5. Fit the idler gear wheel to its spindle.

6. Prior to fitting the cover plate, check the clearances between; (*a*) the gear teeth and the pump body, and (*b*) the gear wheel end face and the pump body cover plate surface, as detailed in para. 2 under "To Dismantle".

7. Pour a small quantity of engine oil into the pump body and then secure the cover plate with the setscrews.

Note: No jointing compound is required when fitting the cover plate.

To Refit.

The ignition distributor takes its drive from the helical skew gear on the driving pinion of the oil pump driving shaft, through an offset tongue and slot type coupling, which can only be coupled one way. Therefore, on refitting the pump it is essential that the driving pinion is meshed to the corresponding gear on the camshaft, so that the rotation of the offset coupling slot at the top of the pump driving shaft assembly is timed in relation to the rotation of the camshaft.

To refit the oil pump, proceed in the following manner:

1. Ensure that the engine is at T.D.C. with number 1 cylinder on its firing stroke.

2. Set the coupling slot in the end of the pump driving shaft assembly at 90° to a line passing through the centres of the pump fixing stud holes in the pump body, so that the larger segment is on the same side as the boss, which locates the floating filter intake tube. This location gives the approximate basic setting.

3. Offer up the oil pump and secure to the crankcase with the nuts and spring washers. After fitting the oil pump, it should be checked to ensure that the coupling slot has assumed the position shown in Fig. B.69, noting that due to the meshing of the helical skew gears, the coupling slot has rotated clockwise viewed from above and is now diagonally opposed with the large segment positioned outwards, the engine maintaining its original setting of T.D.C. with number 1 cylinder firing.

If this setting is not attained remove the pump and correct by rotating the coupling a tooth at a time in the required direction until the correct position is obtained. Check that the distributor body assumes its original angular location and ascertain by refitting the driving shaft and offering up the distributor.

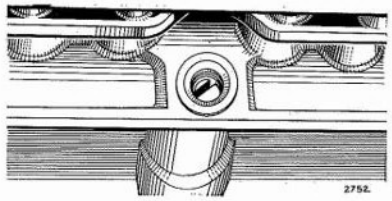

Fig. B.69. Correct location of the offset slot in the driving pinion, after fitting the oil pump, with the engine set at T.D.C. and firing on number 1 cylinder

4. Refit the floating filter and secure it to the pump body with the split pin.

5. Engage the distributor driving shaft tongue into the coupling slot in the oil pump driving shaft assembly, noting the offset slot, which allows the connection to be made in one position only. Observe correct assembly through the tappet chest aperture.

6. Refit the tappet cover using a new joint, if necessary.

7. Refit the sump (see page B.58), and fill up to the "FULL" level mark on the dipstick with the recommended grade of lubricant.

8. Refit the distributor and check the ignition timing (see "Electrical Equipment" section).

OIL PRESSURE SWITCH

To Remove and Refit.

1. Disconnect the lead to the switch at the "Lucar" connector provided.

2. Remove the switch unit, using a suitable spanner, applied to the hexagon on the switch. Do not run the engine, whilst this switch is removed, otherwise no warning of oil pressure failure will be given. Temporarily seal the hole in the crankcase adaptor to prevent the entry of dirt, etc.

3. Refit the switch by reversing the removal procedure, fitting a new fibre washer between the adaptor and the crankcase if the original is deteriorated in any way.