SECTION B ENGINE

SECTION B.

E N G I N E

List of Illustrations:-

ENGINE.

		A to E Series	F Series Onwards
SILVER WRAITH :			
SILVER DAWN :		A & B Series	C Series Onwards
BENTLEY :		A to L Series	M Series Onwards
Number of cylinders	-	6. In line.	6. In line.
Bore	-	3¼".	3⅜".
Stroke	-	4½".	4½".
Piston displacement	-	4,256 c.c's.	4.566 c.c's.
Compression ratio	-	+6.4:1	+6.4:1
H.P.	-	29.4.	31.54.
Sump capacity	-	2 gallons.	2 gallons.
Sparking plugs	-	14 m/m.	14 m/m.
Firing order	-	1,4,2,6,3,5.	1,4,2,6,3,5.
Weight	-	640 lbs. approx.	
Suspension	-	2 point.	2 point.

+ See cylinder head types.

The larger bore engine incorporates "Full-Flow" oil filtration instead of "By-pass" filtration, and is easily recognised by the large oil filter, and also the hinged-type oil filler cap on the rocker cover.

PHANTOM IV :

Number of cylinders	-	8. In line.
Bore	-	3½".
Stroke	-	4½".
Piston displacement	-	5,675 c.c's.
Compression ratio	-	6.4:1.
H.P.	-	39.2.
Sump capacity	-	2¼ gallons.
Sparking plugs	-	14 m/m.
Firing order	-	1,6,2,5,8,3,7,4.
Weight	-	790 lbs. approx.
Suspension	-	2 point.

The crankcase and cylinders are a cast-iron mono-bloc casting, the top portion of the cylinders being fitted with short "Bricrome" inserts, except early series which were "Flash Chromed".

The detachable cylinder head is of aluminium alloy.

Overhead inlet, and side exhaust valves are fitted, the inlet valve seats being of nickel chrome steel.

CYLINDER BLOCK.

Material	-	Cast Iron
Standard cylinder bore dia.	-	$3.5005^{"+1}$ and $3.625^{"+1\frac{1}{2}}$
Cylinder bore tolerance (requiring re-bore)	-	.005" ovality

RECONDITIONING BORES:

The best method of determining the condition of the cylinders in an engine before reconditioning is the use of a dial gauge.

To use, the dial gauge is inserted in the cylinder bore, see Fig. B1. It is then turned spirally or completely rotated at as many points as may be desired, taking readings at each point.

If the dial gauge is set to correspond with the exact diameter of the standard bore, it is easy to determine the oversize piston as well as the amount of metal which must be removed from the cylinder walls.

Any reliable type of boring bar may be used. The operating instructions issued by the manufacturer should be followed explicitly.

The cylinder bores should be re-bored in stages of plus .005" to suit oversize piston range.

After the cylinder bores have been re-bored to within .003" of the size desired, they should be finished or polished with an expanding type hone.

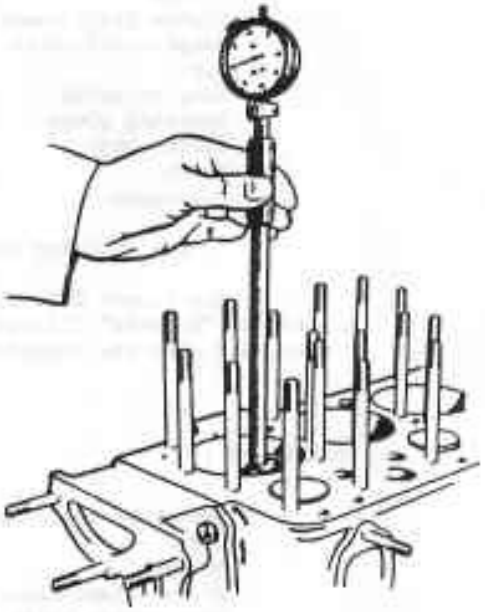

FIG. B1. CHECKING CYLINDER BORE.

Honing stones (Rough)	-	Carburundum C-180-N-VGN
(Fine)	-	Carburundum C-320-N-VGN
Spindle Speed	-	180 R.P.M.
Lubricant	-	Duckham's Aquicut H.M. Soluble oil, with paraffin
Honing	-	33⅓% oil to 66 2/3% paraffin
Boring	-	70 - 75% paraffin

In operating, the hone is placed in the cylinder bore and expanded until it can just be turned by hand. The hone is then operated, up and down, in the bore until it begins to run free. Then the expanding nut, on the top of the hone, is tightened and the hone is again passed up and down, in the bore, until it runs free.

It should be noted that the standard core size is 3.5005" or 3.625" and that any oversize must be to the full size, e.g. if it is necessary to re-bore to fit .010" oversize pistons, the cylinder bore size must be 3.5105" or 3.635", it is not permissible to be on the minus side.

BRICROME INSERTS:

Originally, the top 2.250" of the cylinder bores were "flash chromed" to a thickness of .0015" on the bore diameter. This was later superseded by the fitting of short "Bricrome" inserts.

Where reconditioning is necessary to the original "chromed" bores, it will be necessary to bore out and fit the short inserts.

These inserts are available with a wall thickness of .062" and are intended to cover re-boring up-to and including the maximum standard oversize of plus .040".

If the lower part of a cylinder is badly scored, i.e., too deeply to clean up to match with the remaining bores, a three-quarter length liner is available for fitting to the lower portion.

To fit inserts, remove cylinder head studs and set up the crankcase absolutely true with the original cylinder bore.

Check the new inserts for parallelism at the ends and correct if necessary. (See Fig.B2).

The bottom face must be machined perfectly true. Any slight discrepancy on this end will cause a gap on one part of the "butt" joint.

When boring out for fitting the .062" inserts, adjust the boring cutters so that the first cut is heavy enough to get underneath the original chromium plating. Counterbore to a depth relative to the length of the new insert.

Measure the outside diameter of the inserts in six places and taking the mean diameter of these measurements, bore out the cylinder block, allowing for .0025" to .0035" interference between the insert and the cylinder bore.

Prior to pressing in the inserts, check chamfer at bottom of counterbores is smaller than that on inserts, to ensure clearance and no interference on the butt joints when inserts are fully pressed home.

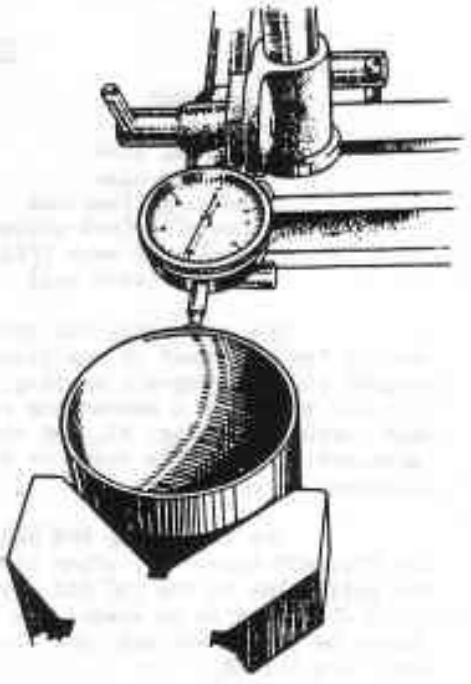

FIG. B2. CHECKING END FACE OF INSERT.

Press in the inserts DRY, with hydraulic press, pressure required approximately 3 tons.

If fitting two inserts to the one cylinder bore, press in lower one and upper one together from the top.

Grind off ends of inserts flush with top surface of crankcase.

Bore straight through inserts, or inserts and original cylinder bores to the nearest standard oversize, allowing .003" for honing. Replace the cylinder head studs.

Hone bores to required size, taking care that, owing to the differences in texture of the insert and bore, to guard against scoring.

CORE PLUGS:

Steel core plugs with an aluminium joint washer are now standard for the crankcase and in a case where one is defective and leaking, it should be replaced with one of .062" oversize on thread diameter.

Care must be taken when removing the defective plug, not to damage the female threads in the block; after removal, clean up threads with suitable tap, and screw in new plug, using a little "Heldite", with a two pin spanner.

CONNECTING RODS.

Material	- Chrome Molybdenum Steel.
Length	- 7.950" centre to centre.
Journal size	- 1.999" (Standard).
Bearing size	- Pre-sized bore to suit diameter of C/pin.
Running clearance	- .0015" - .003".
End play (rod-piston)	- .004" - .014".
Small end bush (fixed)	- .75025" + ¼ bore (reamed in position).
Weight (with cap)	- 1 lb. 12 ozs. approx.

The connecting rod should be checked for alignment of the piston and gudgeon pin with big-end bearing, for both bend and twist, on a connecting rod alignment fixture, see Fig. B3, and corrected as necessary. Allowable twist or bend in alignment is .001".

The connecting rod bolts are of the "fitted" type; if, after cleaning up the bolt holes in the rod and cap, the bolts are found to be slack, the holes should be reamed out and .004" oversize bolts are fitted.

The connecting rod bolt nuts should be pulled down using a box spanner and a six inch tommy bar.

The connecting rod should be installed on the crankshaft so that the oil spray hole is facing towards the "thrust"

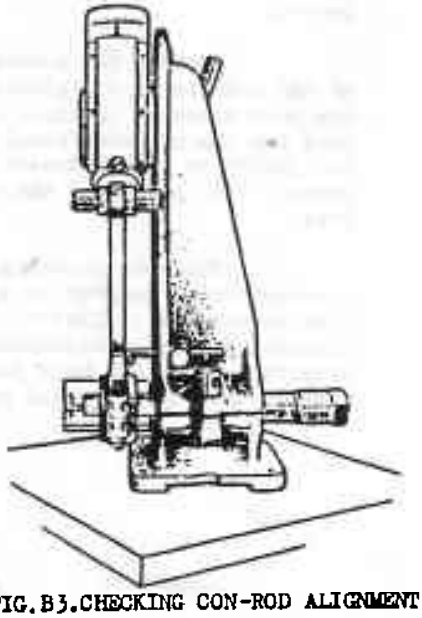

FIG. B3. CHECKING CON-ROD ALIGNMENT.

side of the engine.

On production, both the rod and the cap are etched with the number of the cylinder to which they are to be assembled. The numbers are etched on the "non-thrust" side. When the rods are being re-assembled they should be placed back into the same cylinder from which they were removed with the etched numbers opposite the "thrust" side.

The connecting rod big end bearings are of the pre-sized steel backed strip type, having a copper and lead-indium bearing facing. They should be discarded and new ones fitted if the lead-indium plating has worn through on any part.

PISTONS.

Piston material	-	Aluminium alloy.
" type	-	Split skirt.
" length	-	4.270".
Clearance top	-	.020".
" bottom	-	No clearance on thrust dia.
Groove depth		
Compression	-	.129".
Oil scraper	-	.1425".
Number of Rings		
Compression	-	2.
Oil scraper	-	1.
Ring Width		
Compression	-	.176".
Oil scraper	-	.092".
Ring gap (all)	-	.014".
Gudgeon pin dia.	-	.750".
" " length	-	3.475".
" " fit in piston	-	.0002" interference, cold.
" " fit in rod	-	Running fit.

FITTING PISTONS:

The pistons are cam ground to the desired eccentricity at the top of the skirt and this eccentricity is progressively reduced so that it is substantially less at the bottom of the skirt. This gives a more uniform bearing with minimum friction.

Oversize pistons are normally available in steps of .005" up to .040" oversize. The gudgeon pins are individually fitted to each piston and should be kept strictly in combination.

In fitting pistons it is most important that the correct clearance, .003" - .0035", at the top of the skirt is obtained, and the only reliable method is to measure the cylinder bore with a dial gauge and the piston with a suitable micrometer.

Fitting should be done at normal room temperature, 70°F.

PISTON RINGS:

To check the ring gap, insert the piston ring into the cylinder bore about 1" from the top and measure gap with feeler gauge. See Fig.B4.

If the ring gaps are less than the recommended clearance, remove the ring and with a very fine file, dress the ends until the correct clearance is obtained.

Side clearance of ring in groove is measured with a feeler gauge with the ring fitted in groove but not installed on piston. The back side of the ring should be rolled entirely around the groove, to ensure that the ring is free and does not bind at any point.

The oil scraper and intermediate compression rings are marked "TOP" on the upper side of the ring and they must be installed with the marked side towards the top of the piston.

The rings should be installed in sequence over the top of the piston. Do not remove rings over the piston skirt, as this is liable to cause scoring.

The gaps in the three rings should not be in a vertical line, neither should there be any ring gap over the gudgeon pin. It is therefore desireable to stagger the gaps so that they are equally spaced around the circumference of the piston.

FIG. B4. CHECKING RING GAP.

ASSEMBLING:

The piston should be assembled to the rod so that the slotted side of the piston is opposite to the oil spray hole in the connecting rod and also the thrust side of the cylinder.

The gudgeon pins having a slight interference fit, assembly will be eased if the piston is first immersed in boiling water for a short period.

In slipping the piston back into the cylinders, use extreme care and do not force the rings into the bore. Compress the rings with a Ring Clamp until they enter the cylinder freely.

CRANKSHAFT AND MAIN BEARINGS.

CRANKSHAFT.

	SILVER WRAITH : SILVER DAWN : BENTLEY :
Material	Nitrided chrome molybdenum steel
Number of journals	7
Journal size	2.750" - ½ (standard diameter)
Journal length	No. 1 - 1.825" Nos.2,3,5 and 6 - 1.400" No. 4 - 1.875" No. 7 - 2.100"
Number of crankpins	6
Crankpin size	1.999" - ½ standard diameter
Balance weights	Detachable
Crankpin length	1.375"
Thrust washer (Overall thickness)	.092" - 2

NOTE:- With the introduction of the 3.625" bore engine the crankshaft end webs were strengthened, which means that the crankshaft for the 3.500" bore engine is not interchangeable with the shaft for the 3.625" bore engine. Also, the Front and Rear main bearing shells have also been reduced in width to suit, thus rendering these also non-interchangeable.

3.625" bore engine.

Journal length	- Front 1.450"
	- Rear 1.850"
Width of Main Bearing Shells	- Front 1.118"
	- Rear 1.468"

PHANTOM IV :

Material	- Nitrided chrome molybdenum steel
Number of journals	- 9
Journal size	- 2.750" - ½ (standard diameter) Bearing housing 2.9175
Journal length	- No. 1 - 1.9375" (Tunnel)
	Nos.2,3,4,6,7 and 8 - 1.400"
	No. 5 - 1.875"
	No. 9 - 2.100"
Number of crankpins	- 8
Crankpin size	- 1.999" - ½ Bearing housing 2.1415 inch
Crankpin length	- 1.375"
Balance weights	- Integral with webs
Thrust washer (Overall thickness)	- .092" - 2

Alternative crankshafts may be used on production, either "EN.19" or "Hykro" steel. This specification is always stamped on the front web or flange and must be checked for the "Hardness" figure of the nitriding.

EN.19	- 570 V.P.N. min.
Hykro	- 800 V.P.N. min.

The crankshaft is balanced statically twice, once as a detail crankshaft only, and again with oil caps and flywheel fitted. It is supported in steel backed copper-lead-indium split type shell bearings, which are detachable and can be renewed in certain cases without the necessity of removing the crankshaft.

End thrust is taken by the two alloy metal split thrust washers, arranged either side of the centre main bearing. The lower halves of these washers are keyed to the bearing cap to prevent rotation. Note: Front end washers are etched "X" on original assembly.

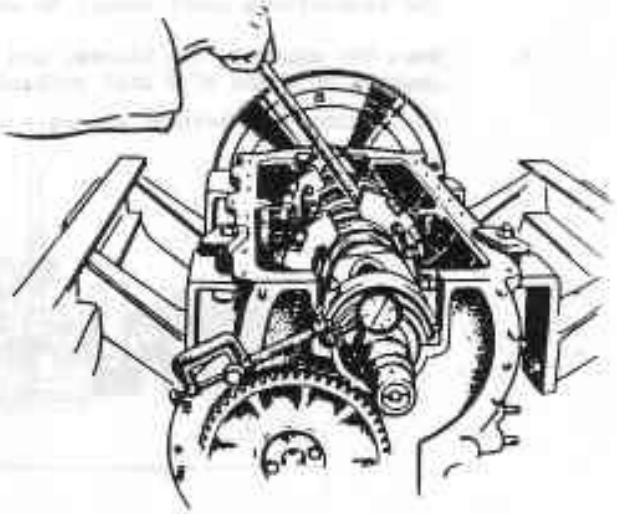

FIG. B5. CHECKING CRANKSHAFT END FLOAT.

The crankshaft end float is:- .002" - .006". (Measured on centre journal.)

INSPECTING THE CRANKSHAFT:

Before inspecting the crankshaft for wear or bowing, check whether the journals or crankpins have previously been re-ground.

1. Mount the crankshaft on a suitable stand and check with a michrometer for wear on the journals and crankpins.
Any wear of the journals must be taken into account when checking for bow.

2. Mount the six-throw shaft with the journals, Nos. 1 & 7 in a pair of vee-blocks placed on a marking out table, and ensure that the crankshaft axis is parallel with the table and free to rotate.

Before mounting crankshaft, it would be advisable to use a test bar on the vee-blocks to ensure that the crankshaft will be parallel with the table. If a test bar is not available, the journals, Nos. 1 & 7 should be checked for diameter, and after the crankshaft is mounted on the vee-blocks, a second check should be made with a dial height gauge over the journals. If the axis is not parallel, packing pieces should be inserted under the vee-blocks.

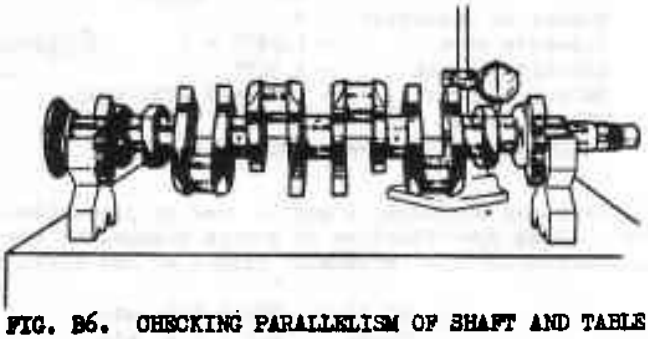

FIG. B6. CHECKING PARALLELISM OF SHAFT AND TABLE.

The eight-throw shaft should be mounted on journals 3 and 9.

3. Turn the shaft in the blocks, and test for bowing on the centre journal by means of a dial indicator mounted on a scribing block.

The maximum permissible bow is:- .010".

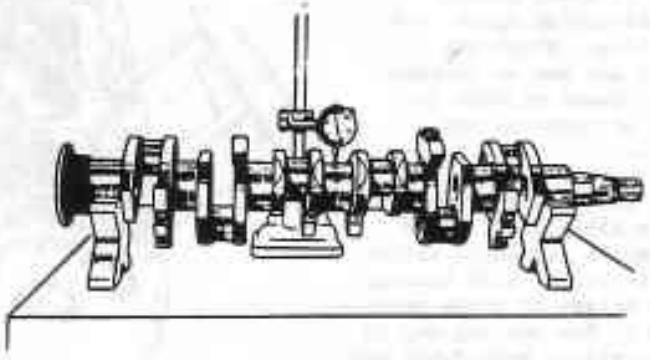

FIG. B7. CHECKING CRANKSHAFT BOW.

The errors due to ovality of the journals must be taken into account in arriving at the figure for bowing which will be half the maximum dial reading of the indicator.

4. Next, turn the shaft so that the webs of each crankpin are at first parallel, and then at right angles to the table and check the parallelism of the crankpins in each instance.

In checking the crankpins and journals for wear, the fact that the shaft may have been reground, should be taken into account.

If it is found that it is necessary to regrind the journals or crankpins, a hardness test must be made to establish whether the shaft should be renitrided before returning to service. This test should be made on a crankpin or journal that has had the greatest amount removed from its diameter by the grinding operation, or, in the case of a seizure, on that part of the bearing most effected by the heating (this can usually be seen by the "temper" colours remaining on the bearing surface.)

The minimum hardness figure for reground crankshafts is either 570 or 800 V.P.N., see page B7, using a 10 kg. load for the Vickers Diamond Pyramid Machine; and a crankshaft that has been subjected to bearing seizure should be rejected if less than this figure is registered.

REGRINDING AND LAPPING:

As previously stated, the journals and crankpins of a crankshaft which have become scored or rendered outside the limits of ovality, may be restored to a satisfactory working condition by regrinding, lapping and polishing. The combined operations should result in the diameter of the journals or crankpins being reduced in multiples of .010" to a maximum of .060" undersize.

Grinding should not be resorted to, unless it is necessary to remove more than .005" to restore a true diameter. Up to this amount, the journal or pin should be rectified by lapping only.

When regrinding journals, no metal should be removed from the crank-web. For details of the stages of regrinding, see table below:-

STAGES OF REGRINDING.	DIAMETER OF JOURNALS.	DIAMETER OF CRANK-PINS.
1	2.740 - $\frac{1}{2}$	1.989 - $\frac{1}{2}$
2	2.730 - $\frac{1}{2}$	1.979 - $\frac{1}{2}$
3	2.720 - $\frac{1}{2}$	1.969 - $\frac{1}{2}$
4	2.710 - $\frac{1}{2}$	1.959 - $\frac{1}{2}$

The shaft should be set up on the grinding machine, using an adaptor for the flanged end, and a centring plug for the other end when grinding the journals.

Proceed to run the machine, centring the end journals to as fine a limit as possible, and checking by means of a suitably mounted dial indicator. Grind the journals 2 or 7 true, and adjust the supporting blocks of the machine into position under either journal. Proceed to grind the shaft, working from the end according to which journal has been made true. The grinding wheel must not be allowed to touch the journal before the crankshaft is thoroughly wetted with the grinding lubricant, and this should be fed in liberally on the ingoing side of the wheel. In order to avoid cracking, it is desirable that arrangements should be made to heat the lubricant and maintain it at a temperature of 65 degrees to 69 degrees C. On no account must the grinding wheel touch the side radii of the crank-web. Stops must be arranged on the machine to limit the travel of the grinding wheel to approximately 0.010" on each face. The radius of the wheel should be carefully controlled to ensure that the grinding fades out not more than half-way round the radius.

Grinding should be to .001" of finished size.

When regrinding the crankpins, the crankshaft is set up on the throw-blocks which form the normal equipment of the grinding machine. The same precautions as for the journals should be observed, and the centre pair of crankpins ground first. Having reground the necessary pins and/or journals, a final operation should be effected whereby the front face of the driving flange is ground true. This should only necessitate a light skimming with the grinding wheel.

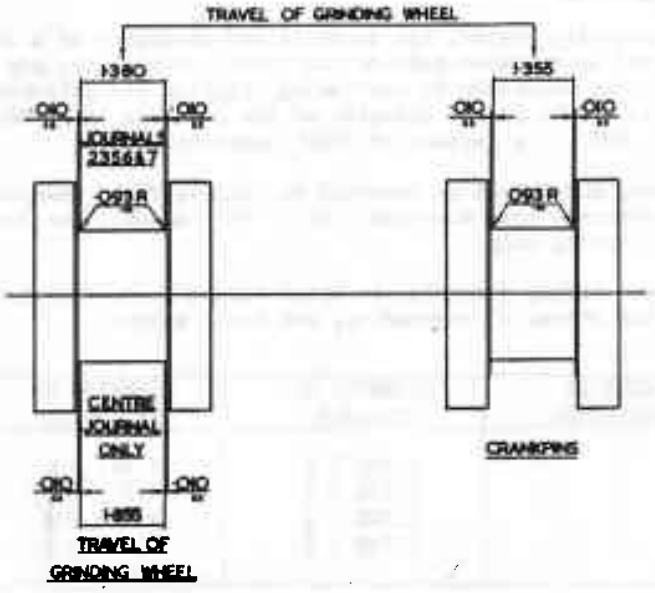

FIG. B8. GRINDING WHEEL.

Various coolants or lubricants may be employed in regrinding the crankshaft. Of these, water with the addition of soda in the proportion of 1 lb. to 50 gallons of water and sufficient soap solution to produce a mixture which can be frothed easily is the simplest. A recommended grinding wheel for the above operation is a 80K. Upon completion of the grinding operation, the crankshaft should be tested magnetically for cracks with the greatest care, ensuring that all electrical connections are carefully made, and the crankshaft supported on proper clamps to obtain a good electrical connection to the magnetizing apparatus.

In no case should upper and lower half bearings be interchanged, and care must be taken to see that the locating lips correctly register in their recesses.

On new engines, or engines to be fitted with reground crankshafts and undersize main bearings and correct size thrust washers, the correct clearances are:-

Diametrical clearance	-	.002"	- .0035".
End float	-	.002"	- .006".

TO RENEW A BEARING WITHOUT REMOVING CRANKSHAFT:

1. Remove the lower half.
   It is not necessary to remove the oil pump assembly, although it is easier if this is done. It must be remembered that if the oil pump is removed the ignition will need retiming.

2. Unlock the nuts retaining the main bearing caps, slacken off, but do not remove.

3. Remove the cap of the bearing to be renewed.
   If more than one bearing is to be renewed only one cap is to be removed at a time.

4. Slide the top half of the bearing out, around the crankshaft journal using a thin strip of flexible steel. The bearing should be pushed out in the direction of rotation of the crankshaft.

   The new half bearings may be inserted in the opposite direction.

   The thrust washers may be renewed in the same way.

   Note the size stamped on the back of the removed bearing and replace accordingly.

5. Remove the lower half of the bearing from the bearing cap and replace the corresponding half of the new bearing.

   NOTE:- It is essential that all parts concerned should be thoroughly clean and oiled with clean engine oil before assembly.

MAIN BEARING INSPECTION:

(i) The main bearings and thrust washers should be removed from the crankcase and their respective caps, and thoroughly washed in paraffin.

(ii) Visually inspect. Reject bearings obviously damaged, or those showing any wearing through of the lead indium plating.

A range of pre-finished undersize bearings are available in steps of .005" for use with reground crankshafts.

No reaming is necessary, if the crankshaft has been reground, say .015", undersize from standard, a set of .015" undersize bearings will give the correct running clearance.

To check the bearing fit, all bearings must be fitted and bolted down, when the crankshaft should be free enough to turn by hand.

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No filing or shimming of bearings or caps is permissible.

CRANKCASE OIL FLOW CHECK:

When the crankshaft has been installed in an overhauled engine, and before proceeding with further rebuilding, a check should be made to ensure that there is a satisfactory oil flow to the main bearings, connecting rods and camshaft bearings.

All external outlets should be blanked off and a suitable oil pump to give approximately 30 lbs./sq.in. pressure, should be connected to the crankcase oil pump flange. Operate pump; slowly turn crankshaft and check oil flow to main bearings, connecting rod big-ends, connecting rod small ends and camshaft.

Remove and check size of spray hole in oil jet to camshaft centre gear, this should be .0748" + .003". If necessary, open out to suit using a No.48 morse drill.

CRANKSHAFT DAMPER.

SILVER WRAITH :
SILVER DAWN :
BENTLEY :

Slipping Load - 14 lbs. + 1 lb. at $1\frac{7}{8}$" radius.
(Drive assembled less driving springs)

Two types of Low Inertia Spring Drives are fitted, known as the "Wraith" and "Bench" types. The "Wraith" type must be fitted to the crankshaft in a partly assembled condition, whereas the "Bench" type can be assembled and offered up as a complete unit.

The device is a composite component and deals with two different and distinct conditions.

1. The Spring Drive - provides a flexible coupling between the crankshaft and the crankshaft pinion, maintaining a constant pressure at the driving teeth, irrespective of the variations in load, by means of radially disposed coil springs interposed between dog members which are attached to the crankshaft and pinion.

2. The Vibration Damper - deals with the torsional vibrations of the crankshaft by means of friction imposed on the inertia of a small flywheel, using cotton duck washers loaded by coil springs.

NOTE:- As the starter dog is attached to the floating part of the device, it is essential that the engine is turned from the rear at the main flywheel, in its normal direction of rotation, when timing the engine.

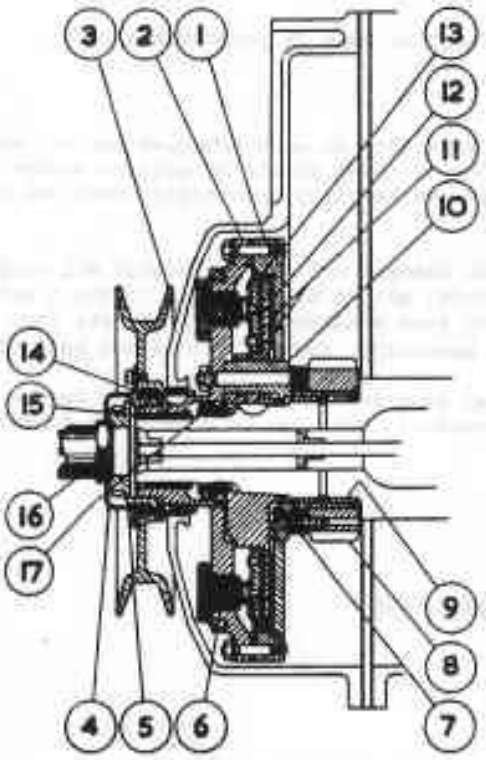


FIG. B9. "WRAITH" TYPE.

1. Damper Wheel (Rear)
2. Damper Wheel (Front)
3. Fan Pulley.
4. Star Locking Plate.
5. Withdrawal Nut (Pulley).
6. Damper Spring.
7. Distance Piece.
8. Crankshaft Pinion.
9. Bush (Rear).
10. Driven Dog.
11. Friction Washers.
12. Friction Drive.
13. Pressure Plate.
14. Serrated Nut.
15. Bush (Front).
16. Starter Dog.
17. Serrated Nut.

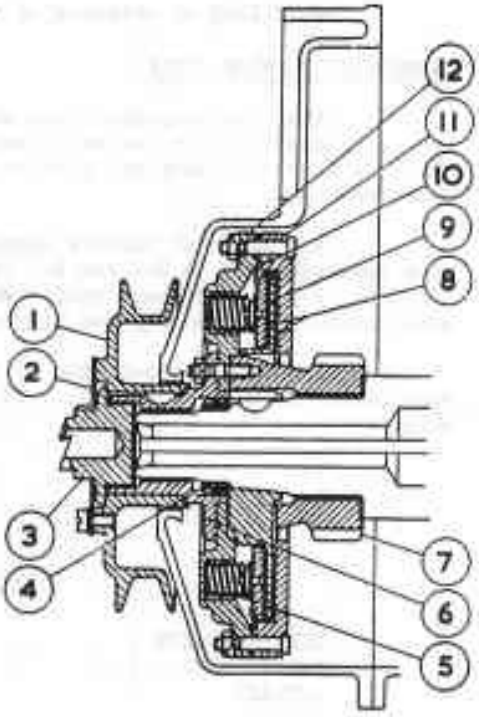


FIG. B10. "BENCH" TYPE.

1. Fan Pulley.
2. Locking Plate.
3. Starter Dog.
4. Serrated Nut.
5. Damper Spring.
6. Hub.
7. Crankshaft Pinion.
8. Friction Washers.
9. Friction Drive.
10. Pressure Plate.
11. Damper Wheel (Rear).
12. Damper Wheel (Front).

DERANGEMENT OF DAMPER:

Mechanical failures are unlikely, inefficiency is mainly due to lengthy periods of idleness, such as car storage, resulting in the cotton duck washers adhering to the friction plates, producing engine vibration periods noticeably at 2,500 engine r.p.m., half the torsional period of the crankshaft.

COTTON DUCK WASHERS:

It is essential that new cotton duck washers are fitted at each overhaul period as these become ingrained with carbon and superficially glazed.

The new washers should be immersed in oil, (S.A.E. 20), overnight and afterwards placed under a press for approximately twelve hours to flatten.

They should then be assembled and "ironed" by movement of the damper wheels backwards and forwards to reduce to a uniform thickness, especially at the scarf joint. Afterwards check by using spring balance as illustrated.

FRICTION FACES:

Check all friction faces for scoring and regrind or turn as necessary.

The sectional drawing, (Fig.B12) illustrates the limits to which they may be safely ground or turned.

PHANTOM IV:

The rubber tuned harmonic balancer consists of a small flywheel, attached to and driven by the crankshaft through a friction disc, mounted over five rubber bushed bolts.

With the engine running, any torsional vibrations of the crankshaft are damped out by the movement of the flywheel on the rubber mounted bolts.

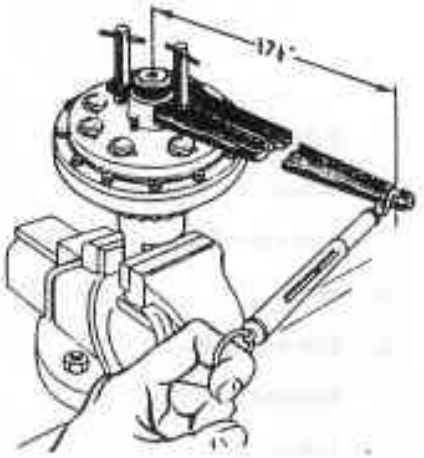
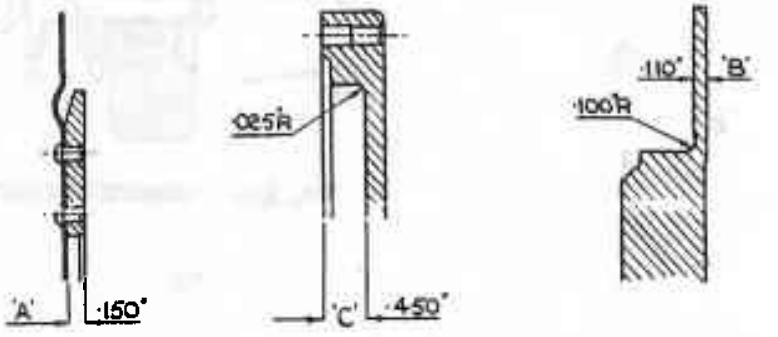


FIG. B11. CHECKING SLIPPING LOAD OF DAMPER.



PRESSER PLATE REAR DAMPER WHEEL FRICTION DRUM

FIG. B12. GRINDING LIMITS.

NOTE:- The starter dog is attached directly to the end of the crankshaft and therefore in this case, turning of the engine for timing purposes may be done by means of the starting handle.

1. Pulley.
2. Damper Springs.
3. Friction Disc.
4. Hub.
5. Starter Dog.
6. Flywheel Bush.
7. Rubber Bush.
8. Flywheel.

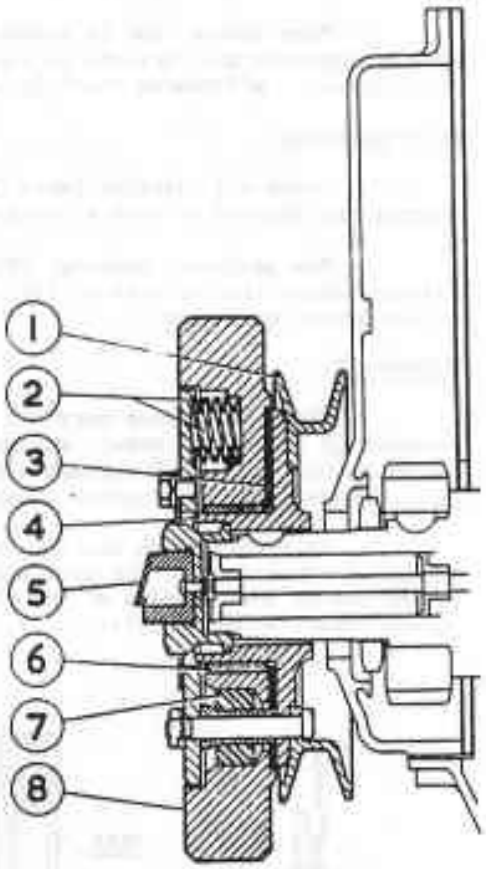


FIG. B13. HARMONIC BALANCER.

CAMSHAFT.

SILVER WRAITH :
SILVER DAWN :
BENTLEY :

Drive	-	Helical toothed gear.
Bearings	-	Four Babbit lined steel shells.
End thrust	-	Spring loaded button to plate on Wheelcase.
End float	-	.002" - .006".
Bearing clearance	-	.002" - .003".

Valve Timing	-	Silver Wraith and Silver Dawn.
Inlet opens	-	12° after T.D.C.
Inlet closes	-	35° after B.D.C.
Exhaust opens	-	44° before B.D.C.
Exhaust closes	-	6° before T.D.C.
Valve Timing	-	Bentley.
Inlet opens	-	$3\frac{1}{2}$° after T.D.C.
Inlet closes	-	$43\frac{1}{2}$° after B.D.C.
Exhaust opens	-	$40\frac{1}{2}$° before B.D.C.
Exhaust closes	-	$1\frac{1}{2}$° before T.D.C.
Camshaft journal diameter	-	1.998" - $\frac{1}{2}$.

CAMSHAFT.

Two types of cam formation have been employed on the Bentley camshaft, namely the "High-Lift" and "Low-Lift". As a means of identification the "High-Lift" Part No. is RE.5157, this has now been superseded and all models are fitted with the long duration "Low-Lift" type.

In the event of a new camshaft being required for an engine previously fitted with a "High-Lift" type, a "Low-Lift" type should be fitted, and in such case, new inlet valve springs, will be required.

Whenever a camshaft is removed from an engine, the journals should be checked with a micrometer for ovality, this must not exceed .001".

Next, mount the camshaft on "Vee" blocks and check the alignment by means of a dial indicator, if this is more than .002" the camshaft should be straightened.

NOTE:- During the straightening operation, care must be taken to protect the centre journal to prevent damage to its surface.

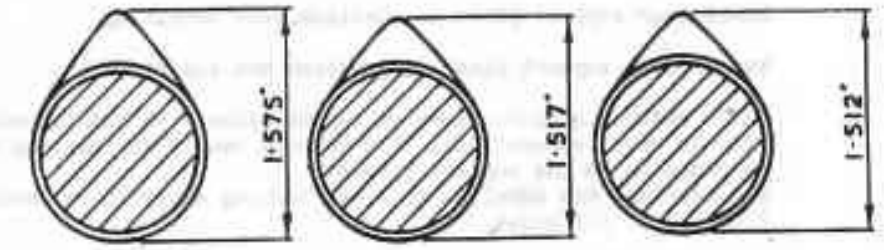


FIG. B14. CAM MEASUREMENTS.

A further check should be made of the wear on the cams, see Fig. B14.

The wear limit is .016" if this is exceeded the camshaft must be replaced.

CAMSHAFT BEARINGS:

All the camshaft bearings are pressed into the crankcase and accurately line reamed at the time of assembly. The bearings are lubricated through holes which line up with the oil passages from the main bearings.

To remove, replace and line ream the camshaft bearings in service, a special set of tools is necessary. See Fig. B15.

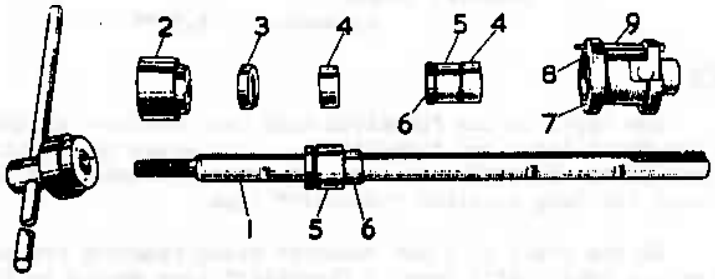


FIG. B15. CAMSHAFT BEARING TOOLS.

1. Arbor
2. Front Support
3. Locating Washer
4. Bearing Retainer
5. Camshaft Bearing
6. Bearing Support Piece
7. Rear Support
8. Locating Dowel
9. Retaining Bolts

METHOD OF OPERATION:

1. Remove camshaft bearing cover from rear facing.

2. Mount rear support piece in position, note dowelling.

3. Mount front support piece in position and insert bar.

4. Mount bearing support piece on bar complete with bearing and clip in required position. The bearing bar is slotted and dowelled in position on the support pieces.
   The bearings are dowelled onto the bearing supports to ensure correct location of oil holes.

5. Rotate handle to draw bearing into position.

6. Withdraw bearing support piece and fit "Martell" cutter, ream through to correct size.

   Camshaft bearing bore - 2.000" + $\frac{1}{2}$.

CAMSHAFT GEARS:

Two types of driving gears have been used, originally a "Fabric" gear was fitted and this has now been superseded by an "Aluminium" gear. In any case of failure of an original "Fabric" gear, replacement should be by the "Aluminium" gear.

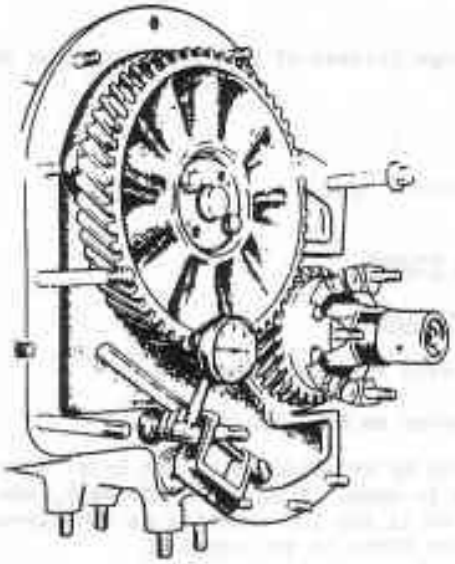


FIG. B16. CHECKING RUN-OUT OF CAMSHAFT GEAR.

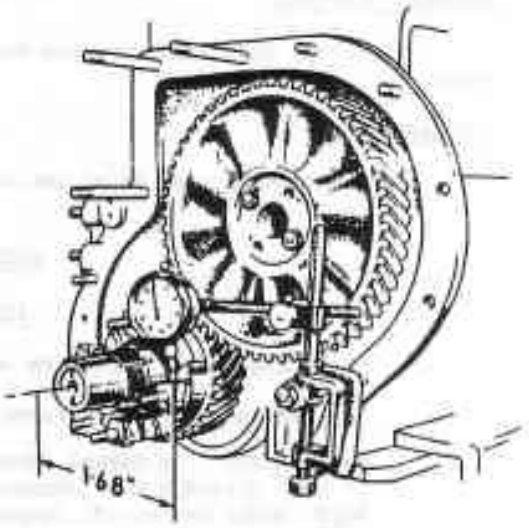


FIG. B17. CHECKING PINION BACKLASH.

NOTE:- When the "Fabric" gear is replaced by the "Aluminium" gear it will also be necessary to replace the crankshaft pinion as these are paired on a rig to give the correct backlash .002" - .005".

ASSEMBLY:

Check that the three lock plates on front cover for camshaft location plate are locked up before fitting cam wheel. Also, check spring is assembled in plunger before fitting.

PHANTOM IV :

Drive	-	Helical toothed gear
Bearings	-	Six Babbit lined steel shells
End thrust	-	Spring loaded button to plate on wheelcase
End float	-	.002" - .006"
Bearing clearance	-	.002" - .003"
Valve Timing		
Inlet opens	-	$3\frac{1}{2}^{\circ}$ after T.D.C.
Inlet closes	-	$43\frac{1}{2}^{\circ}$ after B.D.C.
Exhaust opens	-	$40\frac{1}{2}^{\circ}$ before B.D.C.
Exhaust closes	-	$1\frac{1}{2}^{\circ}$ before T.D.C.
Camshaft journal dia.	-	1.998" - $\frac{1}{2}$.

CAMSHAFT:

The camshaft is of the long duration low-lift type and the same remarks apply with regard to checking as for the Silver Wraith and Bentley camshafts.

CAMSHAFT BEARINGS:

Except that there are six bearings instead of four, the previous remarks apply.

CAMSHAFT GEARS:

The driving gear is of the aluminium type.

ENGINE TIMING.

ALL MODELS.

The valve timing should be set with the engine cold.

1. Set and lock the inlet valve rocker on No.1 cylinder to .030".
2. Turn camshaft in normal direction of rotation until the inlet valve in No.1 cylinder just commences to open. Turn the crankshaft, see NOTE, under Crankshaft Damper, until the I.O. marking on the flywheel coincides with the timing pointer fixed to the housing.

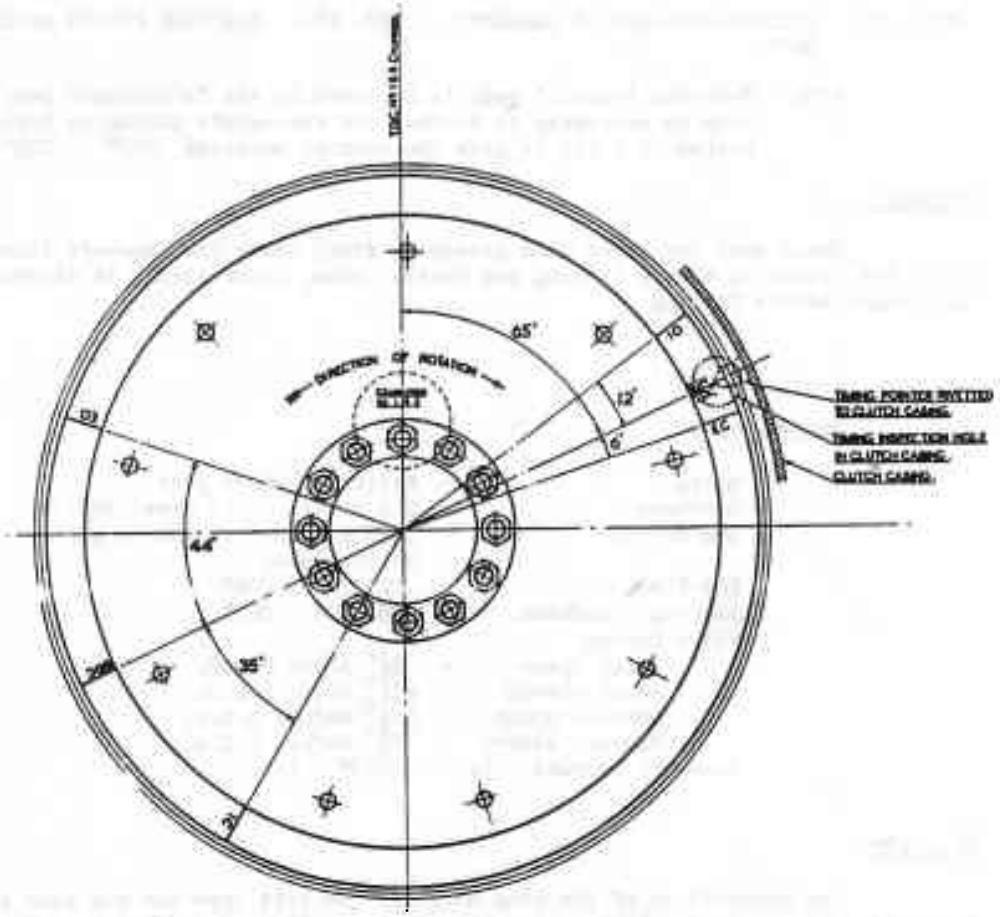


FIG. B18. VALVE TIMING.

On later series cars, a rationalised form of flywheel marking is incorporated. Flywheels are only marked with the T.D.C. position and four marks either side of this position designated 5, 10, 15, 20° Early or Late.

The valve timing remains the same, the Bentley and Phantom IV should be set on T.D.C. and the Silver Wraith and Silver Dawn on the 10° Late marking.

NOTE:- Reference to Fig.B18, IGN/TDC marking on flywheel is 65° before or after True TDC of Nos. 1 and 6, owing to positioning of inspection hole on clutch casing to suit Right or Left-hand chassis.

3. Adjust the camshaft gear on the hub to mate with the crankshaft pinion.

The hub of the crankshaft gear is provided with either four or eight holes. One tooth on the camshaft gear is equivalent to a movement of 1.75" approx: measured on the flywheel periphery, and it should be possible to obtain a final valve timing to within $\frac{7}{8}$", i.e., $\frac{1}{2}$ tooth setting, or 7/16", i.e. $\frac{1}{4}$ tooth setting, of the flywheel marking, according to whether four or eight hole camshaft gear is fitted.

NOTE:- In actual practice, owing to the crankshaft pinion and spring drive unit being keyed on to the shaft, and the camshaft gear being retained by studs to the camshaft, the above operation will be somewhat difficult procedure. Therefore, it is recommended that the studs in the camshaft should be temporarily withdrawn and replaced with setscrews. Care must be taken to replace the studs when the correct position has been found.

It is preferable that the timing should be on the "late" side rather than "early".

4. On completion, reset and lock the inlet valve rocker to .006".

WHEEL CASE.

Crankshaft bore dia.	- 2.4375"	+ 2.
Acme thread dia.	- 2.425"	- 2.
Clearance	- .006"	- .008".

The wheelcase is dowelled to the crankcase by three fitting bolts, except in the case of certain early models where two taper dowels are used.

It is essential that the correct clearance, as above, is maintained, and this should be checked with a feeler gauge, using an alignment sleeve.

VALVES AND TAPPETS.

Seat Angle	-	45°
Valve guides	-	Inlet - cast iron.
	-	Exhaust - bronze.
Valve clearance in guide		
Inlet	-	.0015" - .003".
Exhaust	-	.0035" - .0055".
Spring pressure		
Inlet inner, compressed to	-	1.300", 12 - 17 lbs.
Inlet outer, compressed to	-	1.600", 40 - 48 lbs.
Exhaust, compressed to	-	1.525", 40 - 48 lbs.
Valve rocker clearances		
Inlet	-	.006" (Cold.
Exhaust	-	.012")

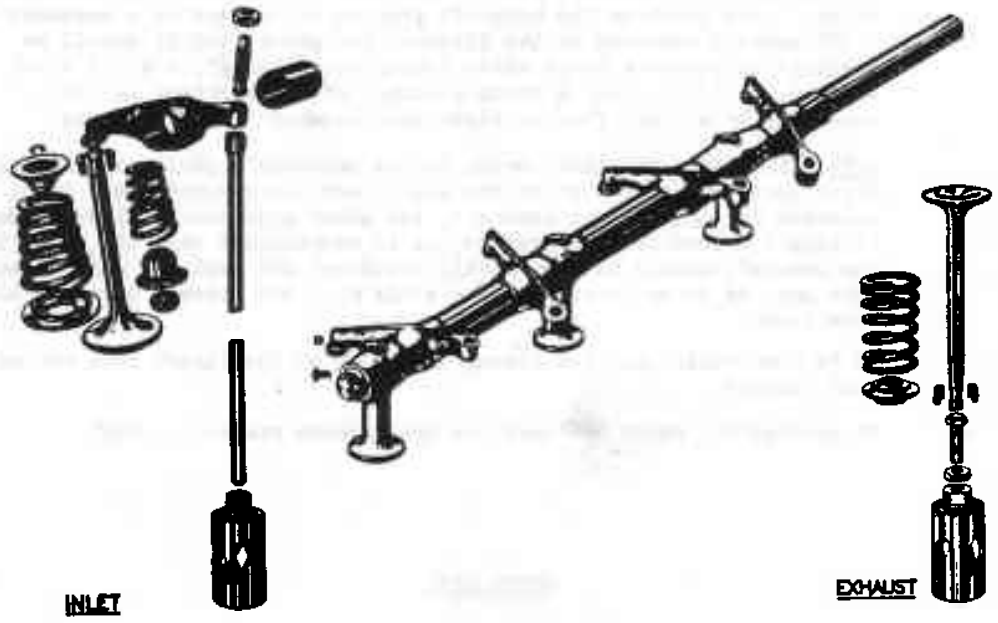


FIG. B19. VALVE ROCKER MECHANISM.

VALVE GUIDES:

The clearance between valve guides and valve stems is most important. Lack of power and noisy valves may be due to worn guides.

The inlet valve guides should be checked with a new inlet valve and similarly the exhaust valve guides should be checked with a new exhaust valve owing to the difference in stem diameters.

Cast iron inlet valves guides are pressed into the cylinder head and these as supplied are .331" internal diameter, and must be reamed in position to .3437" + $\frac{1}{2}$.

The bronze exhaust valve guides require a special tool for drawing into the crankcase. These guides as supplied, are .370" + 2 internal diameter, and must be reamed in position to .3755" + $\frac{1}{2}$.

Replacement guides are .002" oversize on the outside diameter to retain the correct interference fit.

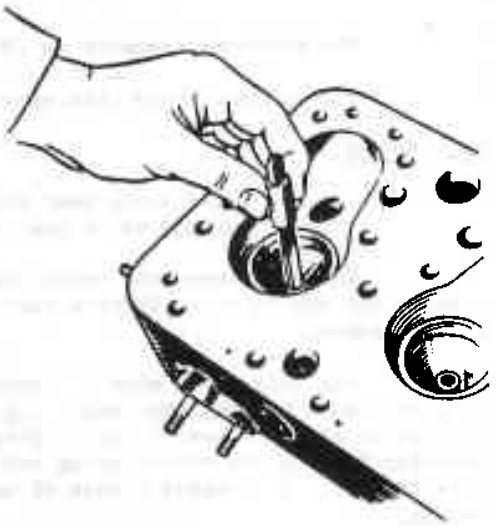


FIG.B20. CHECKING INLET VALVE GUIDE WITH PLUG GAUGE.

VALVES:

The exhaust valves have "Stellited" facings, a special heat resisting metal.

When valves are removed, the valve stems and heads should be cleaned on a buffing wheel to remove all carbon, etc., the condition of the valves and valve stems can then be checked.

Valves that are pitted or burned, can be refaced on a standard valve grinding machine. After refacing, machine to maintain dimension "A" and "B" (Figs. 21 and 22). To check for perfect contact, apply a little Prussian Blue to seat and replace valve, give the valve a half turn to the right and then to the left, if the Blue is equally coated, the grinding is perfect. On the other hand if the "Blueing" is uneven, indicating an uneven spot, the valve must be re-ground until it seats properly.

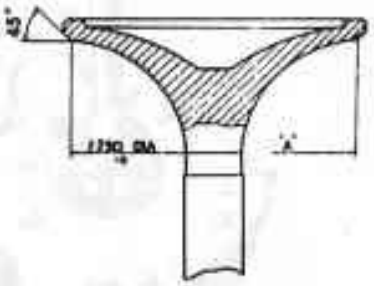


FIG. B21. INLET VALVES.

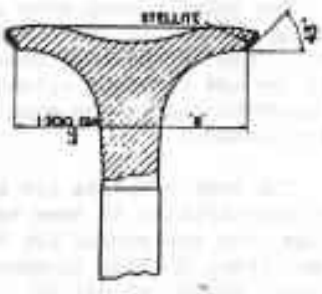


FIG. B22. EXHAUST VALVES.

Check the valve stem diameters, with a micrometer, for wear.

Inlet valve stem diameter	.3422"	- .3416" min.
Exhaust valve stem diameter	.372"	- .37125" min.

VALVE TAPPETS:

The valve tappets are directly operated by the camshaft and are located slightly off-centre with the cams, which results in spinning the tappets so that the cams do not engage the same point each time the valves open.

The inlet and exhaust valve tappets are graded in steps of .00025" to give a selective fitting. They should be a light push fit in the bore (dry).

The working clearance is .0005" - .001".

The exhaust valve clearance adjustment is on the bottom tappet.

VALVE SEATS:

Inlet valve seat diameter - 1.750" + 5.
Exhaust valve seat diameter - 1.625" + 15.

Reconditioning the valve seats is an important operation to ensure engine economy and operation. Extreme care should be used to maintain the stated limits and clearances.

The valve seat must be ground to the proper width and angle, good judgement must be used when narrowing a valve seat to ensure that the seat contacts the centre of the valve facing. This should be checked by smearing a little Prussian Blue on the valve facing and pressing the valve into its seating, without rotating it. A complete circle of marking should appear on both valve seat and facing.

On completion of these operations, great care must be taken to make certain that all grinding dust and foreign matter is removed from the valve, seatings, guides and ports of both the cylinder head and the cylinder block, and also the tappet chamber.

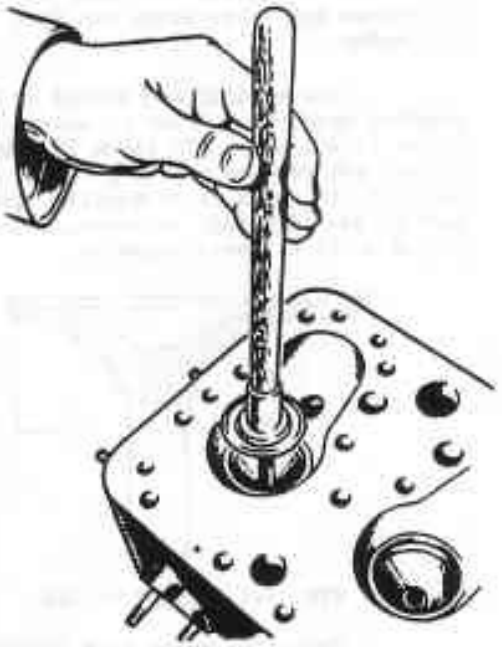


FIG. B23. CHECKING VALVE FACE AND SEATING.

ROCKER ARMS AND SHAFTS:

The inlet rocker arms are handed being off-set to the right and left-hand. The left-handed being fitted to the odd numbered cylinders and the right-handed to the even numbered cylinders.

The rocker shafts are hollow, and have holes drilled in them to allow oil to pass into the rocker arm bushes. The rockers being drilled through to allow a small amount of oil to lubricate the push rod end and the contact point with the valve stems.

On the Phantom IV the rocker shaft is in two sections, one end of each rocker shaft is plugged, and they must be installed on the cylinder head with the open ends to the centre pedestal.

The dome headed adjusting screws are screwed into the rocker arms and locked with locknuts. All adjustments to the inlet valve clearance is done at this point, no adjustment being provided at the bottom tappets.

CHANGING INLET VALVE SPRING IN SITU:

Remove rocker cover and rocker shaft assembly.

1. Rocker Shaft.
2. Rocker Arm.
3. Ball-headed adjusting screw.
4. Lock nut.
5. Feeler gauge in position.

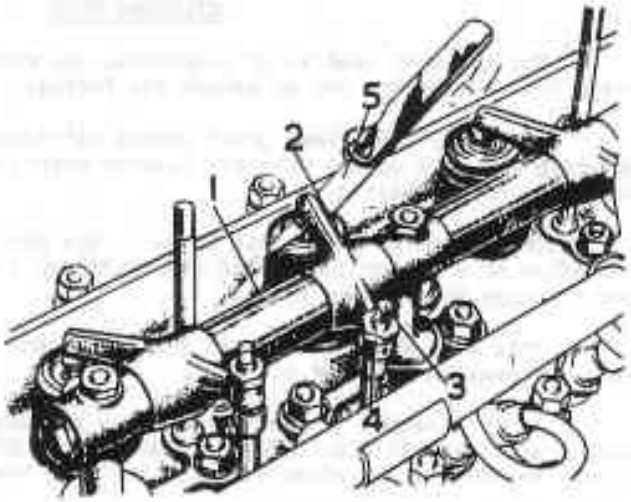


FIG. B24. ADJUSTING INLET VALVE ROCKER CLEARANCE.

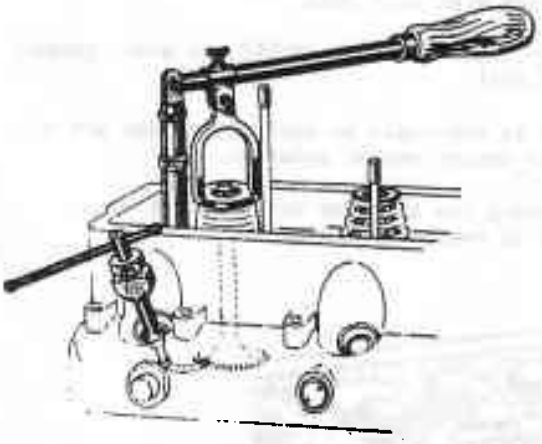


FIG. B25. INLET VALVE SPRING COMPRESSING TOOL.

the hollow of the apprdpriate valve head of the spring to be removed. While holding in position, tighten locking nut.

Operate the valve spring compressing tool from a convenient stud and remove the valve wedges, release and withdraw top washer and springs. If valve stem packing is to be replaced, the small retaining ring will have to be removed from groove in valve stem.

Place the valve spring compressing tool and the valve holder in position as shown in Fig. B25. The locking nut in the valve holder should first be unscrewed to release the split taper collet which grips the spindle and the bent portion of the latter inserted through the sparking plug hole. Then, screw the holder into position.

The spindle should then be turned and simultaneously pulled away from the head, so that it is bearing in

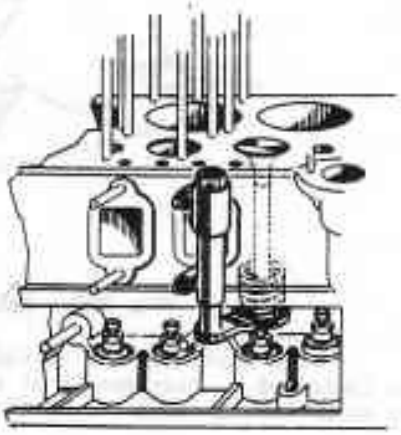


FIG. B26. EXHAUST VALVE SPRING COMPRESSING TOOL.

CYLINDER HEAD.

The cylinder head is of aluminium, and great care must be taken when removing from the engine not to damage the facings.

If the cylinder head joint proves difficult to "break", this may be done by motoring over the engine with the starter motor, with the sparking plugs in position but not connected.

The return of high grade fuels to the home market has made possible the introduction of a new cylinder head (RE.19451) on the 3.625" bore engine only, giving a higher compression ratio.

This head when fitted with the copper and asbestos gasket (RE.14764) gives a compression ratio of 6.75:1.

It is possible to further increase the compression ratio to 7.12:1 by fitting a steel gasket (RE.16320) in place of the C/A gasket, but this modification must only be carried out after consultation with the London Service Department.

At present the Bentley Continental Sports Saloon is fitted with cylinder head (RE.16876) and a C/A gasket (RE.14764) giving a ratio of 7.27:1. In no circumstances must the steel gasket be fitted with this head.

Future production will be with cylinder head (RE.19451) and steel gasket (RE.16320) giving a compression ratio of 7.20:1.

Whenever the head is removed, it is advisable to check and clean the oil way, in the head and cylinder block, to the centre rocker pedestal.

When decarbonising or reconditioning the cylinder head, only a blunt rounded tool or wire brush, should be used to remove the carbon.

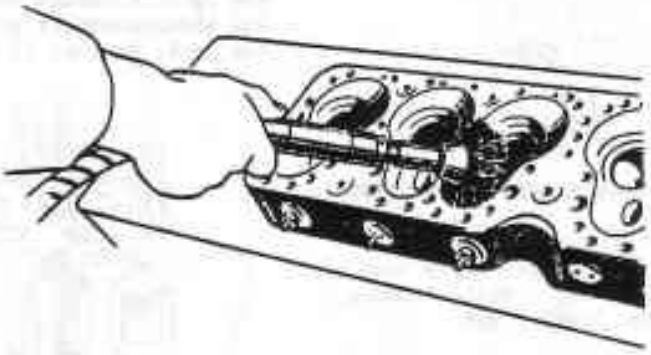


FIG. B27. DECARBONISING CYLINDER HEAD.

When replacing the cylinder head, the nuts should be tightened in the order indicated. They should be tightened down gradually, from the centre, a few turns at a time, so that the head is not distorted.

After the engine has been run for a while on test, the cylinder head nuts should be given a final tightening.

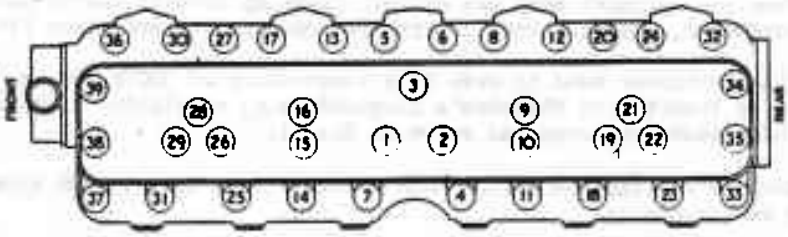


FIG. B28. ORDER OF TIGHTENING CYLINDER HEAD NUTS.
(6 cylinder engines).

CYLINDER HEAD GASKET:

Whenever the cylinder head is removed, the cylinder head gasket should be discarded and a new one fitted when the head is replaced.

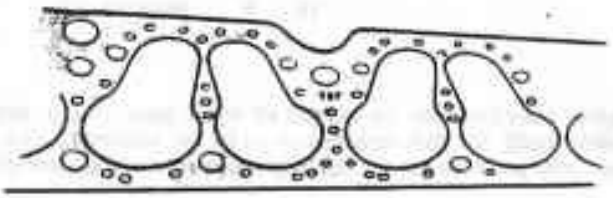


FIG. B29. CYLINDER HEAD GASKET.

The gasket is marked "TOP" on one side and this should be placed uppermost on the cylinder block to make contact with the cylinder head.

When replacing the C/A gasket, it is recommended that a little jointing compound is smeared along the exhaust side edge to ensure that no leak should occur on this side, the coolant connections being on the outside of the cylinder studs.

SPARKING PLUG ADAPTORS:

If the thread of the adaptor is defective, the adaptor may be removed and replaced with either a standard or oversize one as necessary.

The sparking plug adaptor has a .002" interference fit in the cylinder head, and this must be retained.

To remove the adaptor, unscrew the locking ring - left-hand thread - and, using a square tapered drift, a few light taps should ensure a good "bite", unscrew the insert with a suitable spanner. The latter having a right-hand thread.

To replace adaptor, clean up female thread in cylinder head, then place head in oven at a temperature of 300°F for one hour. Coat the male thread of the insert with Whitmore's Compound No.5, or similar grease. Remove the head from the oven and screw the insert into position, right-hand thread. Face off if necessary. Afterwards, screw in the locking ring, using a suitable peg spanner.

When the cylinder head has cooled, clean up threads and measure with suitable micrometer, select insert to give the required interference fit.

Place cylinder head in oven at a temperature of 300°F for one hour. Coat threads of insert with Whitmore's Compound No.5, or similar type of grease. Remove cylinder head from oven and screw in insert.

Machine off the spannering head on valve seat insert, and lock seat in position by centerpopping.

The seat should now be ground and finished as described on page B.24.

ENGINE LUBRICATION.

Capacity - 16 pints, Silver Wraith.
" " Silver Dawn.
" " Bentley.
18 " Phantom IV.

TYPE:

The engine lubrication is supplied by a positively driven gear pump mounted in the lower half of the crankcase with an external oil relief valve unit to control the maximum pressures to the high-pressure and low-pressure systems.

The system provides positive high-pressure lubrication to all the main, connecting rod and camshaft bearings, and also a low-pressure supply to the overhead rocker shaft and the timing gear.

The high-pressure supply is approximately 25 lbs./sq.in.
The low-pressure supply is approximately 5 lbs./sq.in.

Two types of lubrication are employed, namely "By-pass" and "Full-flow" filtration. See diagrams (Figs. B.30 and B.31).

On all chassis previous to:-

Silver Wraith - F Series.
Silver Dawn - C Series.
Bentley - M Series.
Phantom IV - B Series.

the system used was "By-pass", i.e., a bleed from the high-pressure oil gallery was taken through the external by-pass oil filter. (See Fig. B.30).

On the above series and onwards, full-flow filtration is employed, i.e., the oil is delivered direct from the pump to an external "full-flow" filter and from there returned to high-pressure system. (See Fig. B.31).

OIL PUMP:

The oil pump is a positive gear type and runs at half the engine R.P.M. It consists of two spur gears enclosed in a housing; in operation, oil is drawn from the crankcase sump through a floating fine mesh screen. The oil then passes through a pipe to the oil pump and from there to the oil distribution system.

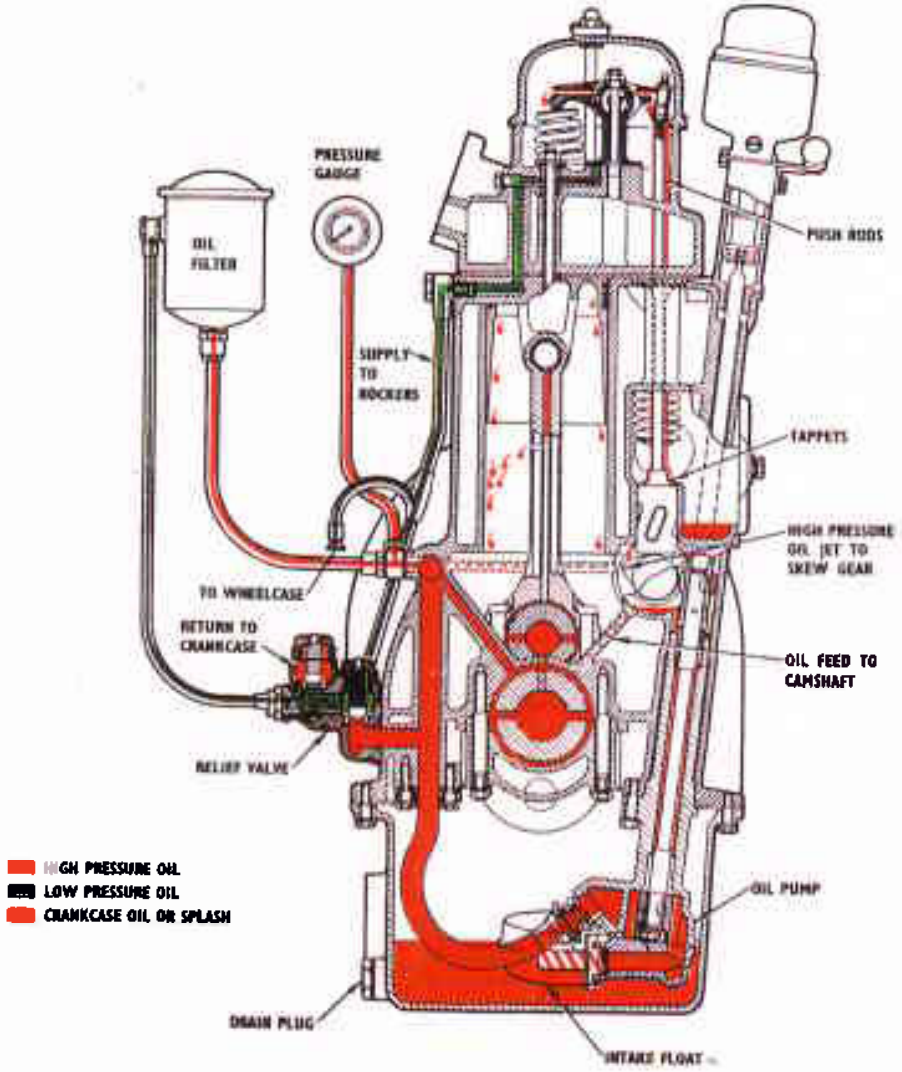


FIG. B.30 ENGINE LUBRICATION SYSTEM (BY-PASS)

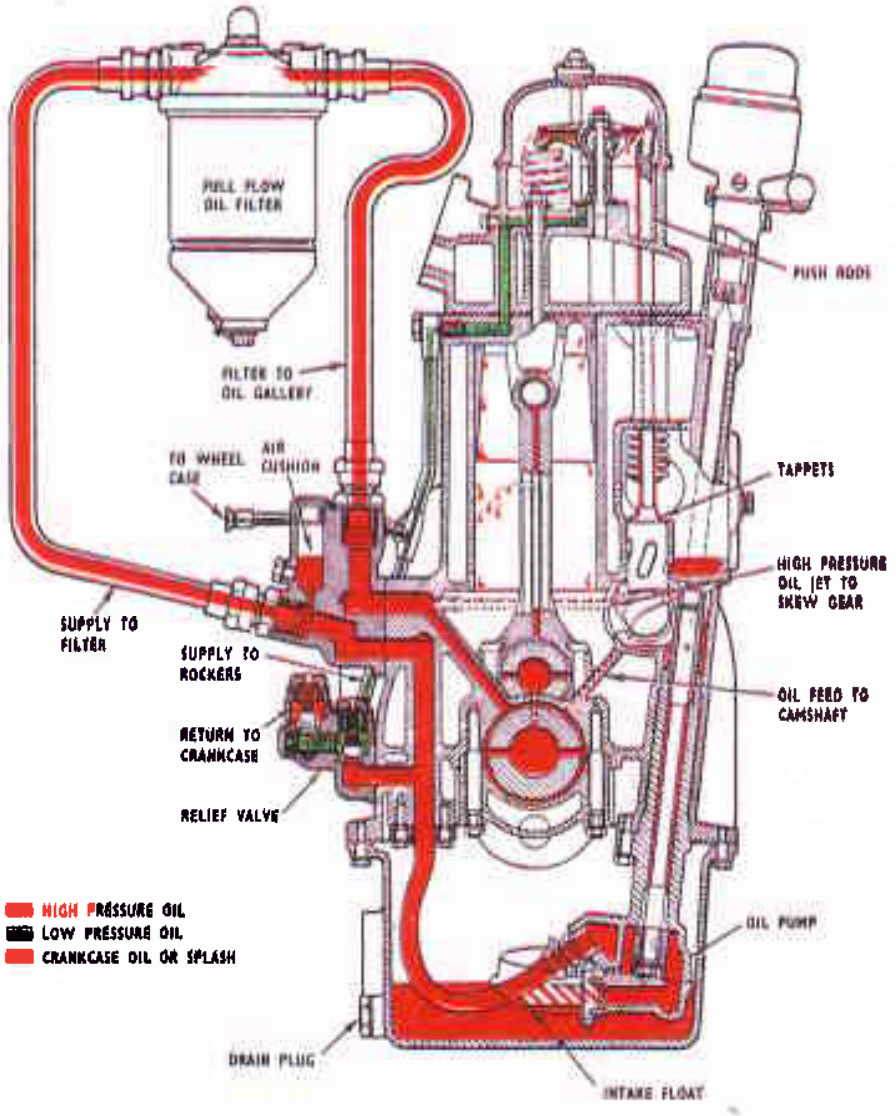


FIG. B.31.—ENGINE LUBRICATION SYSTEM (FULL-FLOW) A952

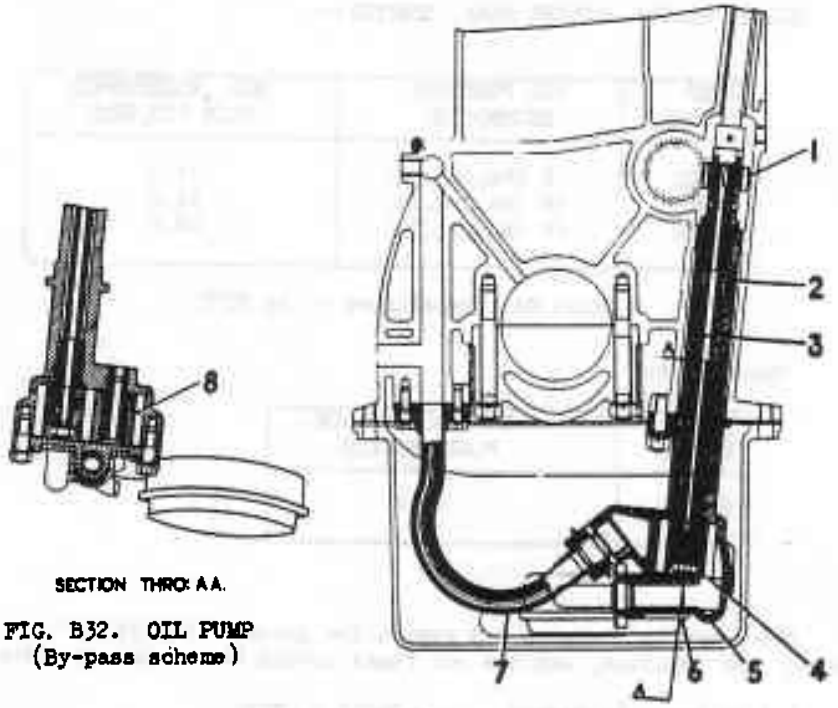


FIG. B32. OIL PUMP
(By-pass scheme)

1. Driven gear, upper.
2. Oil pump casing.
3. Oil pump driving shaft.
4. Driving gear, lower.
5. Oil pump cover.
6. Pump float.
7. Oil delivery pipe.
8. Oil pump driven gear.

To dismantle the oil pump it will be necessary to remove the ignition distributor, as a combined drive from the camshaft operates both units.

1. Remove the distributor cover and set engine with rotor arm in firing position for No.1 cylinder, i.e. No.1 piston is at T.D.C. with both valves closed.

2. Remove the distributor and housing from the cylinder block. DO NOT slacken the distributor clamping plate screw as this would disturb the timing.

3. Note and mark the angular positions of the "flats" on the tongue of the distributor driving shaft for replacement on re-assembly.

4. Disconnect and withdraw the oil pump assembly complete with drive shaft.

The oil pump should be rig flow-tested as under:-

SILVER WRAITH, SILVER DAWN, BENTLEY:-

PUMP R.P.M.	OIL PRESSURE RESTRICTED	MIN. ACCEPTANCE FLOW PTS.MIN.
500	8 lbs./sq.in.	11.2
1000	18 lbs./sq.in.	26.4
1500	28 lbs./sq.in.	42.6

Inlet Oil Temperature to be 90°C.

PHANTOM IV:-

PUMP R.P.M.	MIN. ACCEPTANCE FLOW PTS.MIN.
2000	68.0

Dis-assemble the pump and remove the gears. The fit of the gears in the housing, the backlash, and the end float should be checked as under:-

Fit of gears in casing - .0025" - .005".
Backlash of gears - .005" - .008" at 1.278" pitch diameter.
End float of gears - .0025" - .005".

Re-assemble by reversing the above instructions.

OIL RELIEF VALVES:

Both valves are in series and are not adjustable, no attempt must be made to alter the spring settings by interfering with the springs or varying the number of washers under the plugs. The H.P. valve seat is slotted to ensure a supply of oil to the low-pressure system under all conditions of running.

H.P. valve spring, free length 1.8125" compressed to 1" = 4½ lbs.
L.P. valve spring, free length 1.790" compressed to .900" = 4 ozs.

To dismantle the relief valves, remove the plugs and lift out valves, clean and examine the seats.

If there are any signs of pitting on the valve, remove unit and lightly lap valve onto its seat, using a mixture of Turkeystone Powder and thin oil.

After lapping, thoroughly wash, re-assemble, and refit.

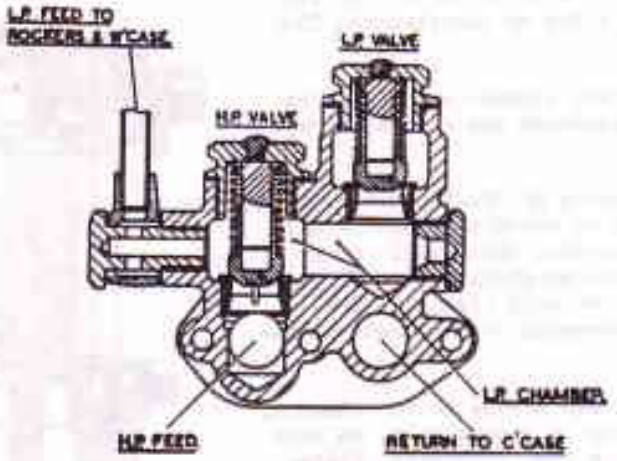


FIG. B33. OIL RELIEF VALVES.

BY-PASS OIL FILTER:

The oil filter is designed so that the element restricts the flow of the by-passed oil to ensure that the by-passing effect of the filter should no appreciably rob the main pressure system.

The element is non-demountable and therefore cannot be cleaned. The element should be discarded and a new one fitted every 10,000 miles.

FULL-FLOW OIL FILTER:

The oil filter is of the felt element type contained within a mesh canister. Oil enters from the top centre and passes through the element to the outside.

1. Yoke screw.
2. Yoke.
3. Cover.
4. Cover washer.
5. Element.
6.)
7.) Return connection.
8.)
9.)
10. Filter bowl.
11.) Feed connection.
12.)

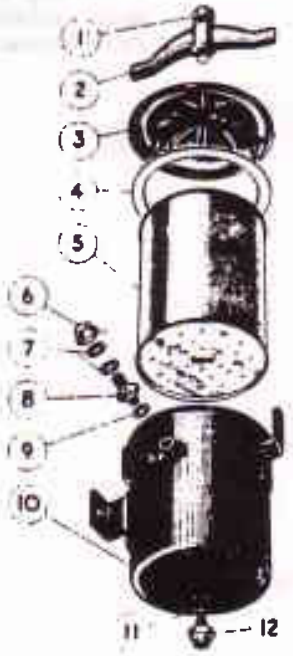


FIG. B34. BY-PASS FILTER.

If the element becomes clogged with sediment, it will be lifted off its seating and so allow an unrestricted flow of oil.

The felt element should not be cleaned, but discarded and renewed every 5,000 miles.

Two types of "full-flow" filters are fitted, one on which the tank is held on by six set-screws, this model is now superseded by one on which the tank is held by one centre bolt fixing. The interior felt elements are interchangeable for both types.

To obtain access to the element, remove set-screws or centre bolt, as case may be, and lower tank containing filter canister. Remove canister and remove either the wing nut or the knurled nut, depending on type, from bottom face and remove bottom cover. Extract felt element and the two felt washers, top and bottom covers, fit new element and washers, refill bowl with oil and re-assemble.

1. Filter bowl.
2. Retaining screws.
3. Mesh canister, containing felt element.

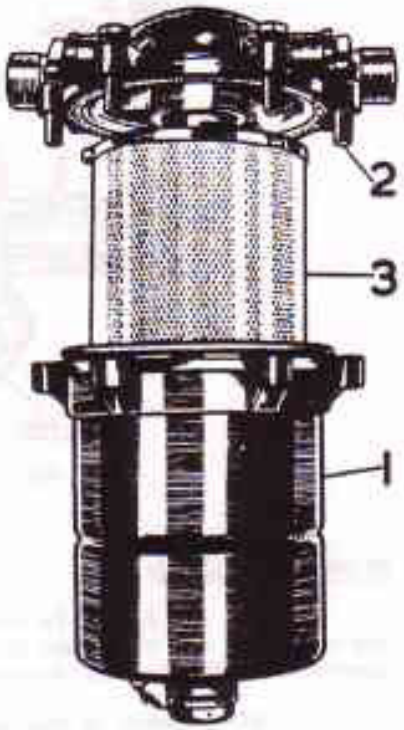


FIG. B35. FULL-FLOW OIL FILTER.