

Overhauling the PII Engine

by
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Engine # IC55 (in 1932 Rolls-Royce Phantom II Chassis # 40JS) was overhauled over the winter 1993/94. We finished early May 1994. During the following six weeks *Bluebelle* covered 4,657 miles: to Italy by road for the Rolls-Royce Enthusiasts' Club Italian Tour, and to Monte Carlo for the RREC French Section Rally. She went by road to the Euro-Rally in Sweden in 1995, and has travelled over another 20,000 since the overhaul.



Bluebelle :1932 Rolls-Royce Phantom II Barker Sedanca de Ville

In 1992 *Bluebelle* was on the R-REC Euro-Rally in Luxembourg, and in 1993 through France, so the engine was running reasonably well. However, it was fairly noisy, and a well worn camshaft was suspected. The Camshaft is the last item to come out - so this meant a complete engine overhaul. I have always done the regular maintenance of my cars, but I had never stripped down an engine to the last nut (on a PII it is a castle nut with an awkward cotter pin holding the magneto rear strap !).

While these notes refer to the PII, the overhaul of the small horsepower engine is similar.

R-R PII Engine Overhaul - Schedule & Duration***A. Preparatory Work* *One Week***

- Drain Water and Oil

Remove :-

- Front Bumper/Wings/Undertrays/Bonnet
- Radiator Hoses
- Exhaust: downpipe/intermediate pipe/manifold
- Fan Assembly as one unit
- Coil & Ignition harness
- Dynamo/Magneto/Magneto Harness
- Inlet Manifold, Starting & Main Carburettor as one unit, after disconnecting all Control Rods
- Three castellated nuts from bottom of radiator
- Cotters from 16 engine bearer nuts
- Loosen Bearer & Crankcase/Bell Housing nuts
- Spray every nut in sight with WD40

B. Getting Engine Out* *Two Days

- Using Engine Lift remove Radiator/Cylinder Head
- Remove Front chassis member & Starter Motor
- Remove inboard Shock-absorbers (early PII)
- Fit engine slings, take weight with lift, remove all fixing bolts/studs, and *lift* engine out.

C. Dismantling Engine* *One Week

- Fit engine on stand.
- Carefully label all parts.
- Inspect and Measure for Wear.
- Clean/Clean/Clean

D. Ordering Parts/Machining* *Eight Weeks***E. Rebuilding Engine* *Two Weeks******F. Put Radiator & Engine in Chassis* *Two Days******G. Replacing items from Stage A.* *Two Weeks******H. Start Engine/ making adjustments* *Two Days***

John Reynolds (R-R/B Specialist Association Member), who provides a *Flying Doctor* service, kindly agreed to be my guide and mentor. He has an intimate knowledge of these engines, and proposed the work plan. He stayed at our home during Stages B, C, E, & F. He brought special tools, lots of know-how, muscles, and a sense of humour - so essential in the off-moments ! He arranged the machining and overhauled the Con Rods, Oil Pump, Clutch, and Distributor.

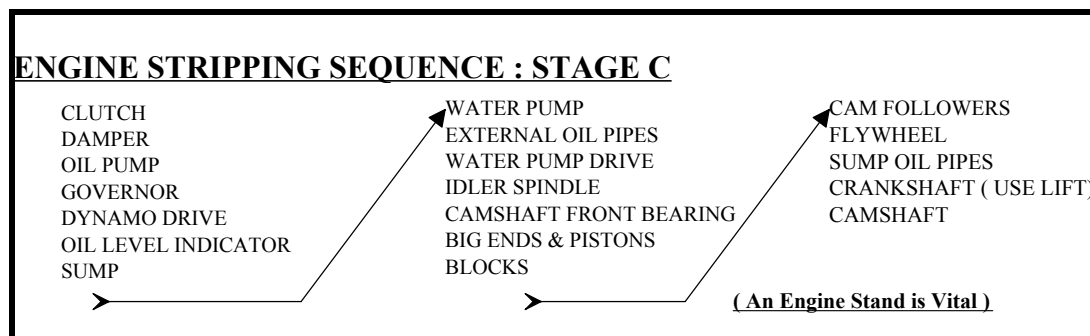
Be Warned

It was not made clear to me before I started that half the job is cleaning! A second-hand parts cleaner helped. Stainless steel brushes, scotch pads, wire wool, litres of cleaner, elbow grease and patience are needed. Cleaning 60 years of carbon and sludge from the Crankshaft and Crankcase took over a week.

The pursuit of excellence, design errors, changes in usage and the environment (e.g.fuel), were why Royce had the policy of continuous improvement. During the overhaul, when the experts disagreed, I made decisions. Blame me if you differ - but I hope Sir Henry would have approved !.

With a little help now and then, I worked alone in Stages A, G, & H.

The front of the car was rewired with the engine out. I overhauled things like the Fan.



At the end of Stage C came "**Decision Time**" :

- What needed to be done ?
- What was wise to do as the engine was stripped down ?
- What was the preferred solution?

Then followed the ordering of parts and getting work scheduled.

1.Cylinder Head.

PII Cylinder heads are aluminium, and they suffer from corrosion if not left with inhibitors in the cooling system. *Bluebelle* has a new head from *Nick Whittaker*, now obtainable from *Ristes*.

2.Valves & Valve Gear.

Exhaust valves are most likely to need replacing, but the exhaust valves and one inlet were cut 45° at the local garage, and all 12 seated OK after grinding in. Rockers did not need re-grinding nor re-bushing, but were cleaned out thoroughly.

3.Cylinder Blocks/Pistons.

Water passages need de-scaling. The blocks on IC55 also needed new copper pipes swaged in.

I had not expected to find any problem with the pistons and bores as the blocks (only eight thousand miles previously - but 28 years before) had been relined and fitted with new standard pistons. When we took out the pistons we found the top ring of each piston was broken, most likely due to the fitter setting wrong gaps. Wear in the bores of up to .008" meant that we had to get the blocks re-bored and a new set of pistons. The wear in the bores came from the broken rings, not helped by the fact that after fitting the new liners the extra oil holes had not been drilled.

I remembered my father's old saying: "If you want a job done properly, do it yourself". I was encouraged by this thought as I carried on cleaning!

The Blocks (re-bore, re-piping, de-scaling) were sent to *Brunts*. The pistons were obtained from *Peter Hepworth* (split skirt +0.0315" (+8mm)) as *Jack Barclay* only had +0.045". I would have preferred +0.015" had they been available.

Ring gaps were a subject of debate. I paid attention to this in view of the broken rings. With modern fuels things probably get hotter. Therefore, the gap should be bigger. The debate centred on whether one suffers loss of power if the Gaps are larger. One view is that you could go up to 0.060" before it would make a

difference! I found no-one really knows. One rule of thumb is 0.003" per inch of piston diameter. As the PII pistons are 4¼" in diameter this equalled 0.012". This compared to the original R-R recommendation of 0.006" for the bottom ring, 0.008" for the intermediate, and 0.010" for the top ring. I discovered that in modern engines the DIN setting is in the range 0.015" to 0.025". I decided after listening to all the views that we should have a Gap of 0.012" on all rings.

4. Connecting Rods.

Con rods need cleaning and crack testing. The external oil pipes taking oil to the little ends need checking - they needed repairing on IC55.

5. Crankshaft - Main & Big End Bearings

The Crankshaft is impressive. The oil ways needed cleaning out - a very dirty job - and all the black carbon removed. It was crack-tested. At least two of the Main Bearings had small holes and several of the bearings showed crystallisation. The crankshaft journals had from Zero to 0.001" wear only. We decided to have the journals ground, and new Big End and Main bearings metallised and line bored to match the Crankshaft. The work was given to *Brunts*, who were also instructed to balance the crankshaft assembly.

6. Crankshaft Vibration Damper.

Thorough cleaning is needed. There is a difference of opinion among the experts on whether to use Cotton Duck-Washers (hygroscopic) or Micarta (Tufnal). I decided on the latter but with oil grooves. New springs may be needed.

7. Clutch. It is sensible to reline while the engine is out. A new centre plate was needed.

8. Water Pump and Pipes. Replacement of Spindle, Thrust Button, bearings and gland packing was needed. The water pipes had corroded , but new ones were obtained from *Dr Ken Brittan*.

9. Oil Pump. Bushes needed replacing but gears were good

10. Hot Spot. This is prone to cracking. *Dr Ken Brittan* makes replacement.

11. Front Wheelcase, Fan, Distributor, Oil Relay. Sensible to replace bearings.

12 Starter/Dynamo/Magneto. The Magneto was overhauled by *Arthur Archer* in Dunmow. The starter and dynamo were cleaned up. New bearings can be fitted.

5. Camshaft and Cam Followers.

The R-R PII camshaft and camfollowers have been a known problem, even more so now that we do not normally use our cars daily. Oil only gets on this camshaft by splash. The wear is further exacerbated by the profile of the Cam lobes and Followers, and because the rectangular Cam followers are in a fixed position in the Cam Guide. (The Phantom I and the small HP R-R have Roller Cam Followers which give little problem).

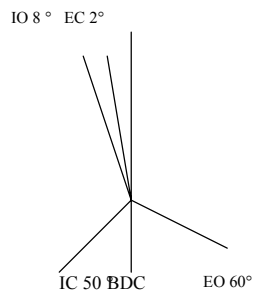
The Camshaft and Cam Followers in IC55 were very badly worn., and I am given to understand this is typical. I became concerned that after the overhaul, and, perhaps, in a comparatively short mileage, I could have a repeat of the problem.

R-R say they have hardened the Cam Lobes and softened the profile on the current replacement camshaft, but the Cam Followers/Cam Guides have not changed. R-R introduced in the mid 1930's for the PII Continental a "High-Lift Camshaft" (0.463" lift versus 0.433" for the standard) which was withdrawn as Camshafts/Cam Followers were wearing out very rapidly on new cars

I took the view that the solution, installed on many PII over the last ten years, by *Herb Wuesthoff*, PII Technical Consultant to the RROC, was the best. He needed my Camshaft, bearings, together with the Cam gear and washers, so that I received a new Camshaft with well proven lobe profiles, correct end float tailored to my engine, with my bearings cleaned and the new camshaft ground to match. The circular cam followers are in specially designed cam guides with ample oil ways. No springs are used, eliminating another potential problem. Excellent cost competitive engineering.

There is no sign of " breathing problems " . Even with a very heavy body *Bluebelle* hits 75 mph easily, and I had a job holding her below 60 mph while running-in.

Following is the procedure recommended for setting the timing.

ROLLS-ROYCE PHANTOM II : CAMSHAFT TIMING with WUESTHOFF CAMSHAFT

Flywheel Timing Marks at 0.020 "

for Wuesthoff Camshaft and Cam Followers

1. Mark Flywheel in degrees using long piece of masking tape. Use TDC as start.

One degree is 0.1354". 55° is 7.5" before / after BDC on perimeter of the flywheel.

(Flywheel is 48.75" on perimeter. $48.75/360 = 0.1354$).

2. Turn Camshaft until #6 Exhaust Valve is just closing and the Inlet is just opening.
3. Using a Clock Gauge, set tappet clearance of #1 inlet at 0.025 in.
4. Turn Camshaft to point where Inlet Valve of #1 cylinder is just before opening on the heel of the cam.
5. Turn Crankshaft to MAI. Mark mesh point of gears for possible future adjustment.
6. Fit Damper onto Crankshaft rotating Camshaft anticlockwise.
7. With tappet #1 at 0.020 timing is as above.
8. Re-mesh Damper and Camshaft Gears till correct. (one tooth equals 0.76" equals 5.6°).
9. Check for consistency on #12 Inlet, Exhaust #2 & #11, which should be as Timing Diagram.

A lot of minor parts are needed for a complete overhaul. Cotter pins and BSF/BA nuts and bolts should be "on shelf " (from *Bernard Wade*, but *Coldwell, Ristes, Fiennes* for special R-R bolts and castle nuts).

I did not check the exhaust manifold with a straight edge till just before I was ready to put it back on. It was very warped. *Arthur Archer* machined it for me - a four hour tricky job on a milling machine.

The fan adjustment bush was worn. Also the bush on the throttle linkage (a well lubricated bush inside, with no lubrication on the outside sphere). Two jobs for *Marcron Precision Engineering*.

I found nobody supplies an Overhaul Kit. The Gasket sets supplied by R-R via *Jack Barclay* do not contain all they used to. Some part numbers that were previously included are now available at extra cost. An Overhaul Kit should include all the gaskets, the valve seals, 84 lock washers, 97 Aluminium Washers, and 11 Bearings. Today one has to find out which R-R/B Specialist has what.

The crankcase, the bulkhead, and other aluminium parts were wire cleaned and further cleaned with Autosol. The blocks, head and other black parts were painted. Parts that needed nickel plating (normally dull) were plated.

Follow the Engine re-building sequence, and the notes on Crankshaft installation and on Pistons. Absolute cleanliness is essential. Oil all parts.

Engine Assembly Sequence and Installation Instructions

Installation Instructions

Crankshaft Installation Lower the Crankshaft carefully with the engine lift into the Crankcase. Put on Main Bearings with lightly tightened nuts. Then :-

- Torque # 7 to 25 lbs.ft and Test (that is : *Turn crankshaft to ensure bearings are free*)
- Torque # 1 to 25 lbs.ft and Test
- Torque # 4 to 25 lbs.ft and Test
- Torque # 2 to 25 lbs.ft and Test
- Torque # 3 to 25 lbs.ft and Test
- Torque # 3 to 25 lbs.ft and Test
- Torque # 6 to 25 lbs.ft and Test

then repeat the sequence at

- 35 lbs.ft
- and then at 45 lbs.ft

Pistons

- Set Ring Gaps (*see notes*)
- Heat Pistons in hot water. Align pistons (skirt to Camshaft), and Con Rods and then fit Gudgeon pins and Circlips.
- Oil piston (starting with # 1) and cylinder inside. Insert piston into cylinder until stopped by Bottom Ring. Use Ring Clamper to compress rings - then tap piston in gently with a wooden handle.
- Turn Engine upright in stand, and put on Big Ends with bolts, but only nip up.
- After last piston (# 6) torque Big End nuts to 30 lbs.ft , but then turn back to ensure shells are seated. Set Big End nuts 30 lbs.ft with cotters in correct position. Change nuts to achieve, and only if essential, file down a nut.

Put Crankcase on Engine Stand. Then assemble in following sequence

:-Camshaft - Cam Guides - Cam Followers

- Dynamo Drive - Water Pump Drive
- Cam Gear/Vacuum Pump & Idler gear
- Crankshaft - *follow installation instructions*
- Flywheel - *preen nuts with 3 punch holes*
- Blocks - *use spacers tubes on studs to secure them before head is on*
- Water Pump - Water Pipes - Extra Oil Pipes
- Damper - *set correct valve timing*
- Pistons - *follow installation instructions*
- Sump (*but do trial fit first*)
- Timing Case (*make a cardboard ring and use to ensure concentric fit of the fan pulley*)
- Fan Pulley - Starter Dog - Cover Plate
- Governor / Oil Relay Assembly / Distributor

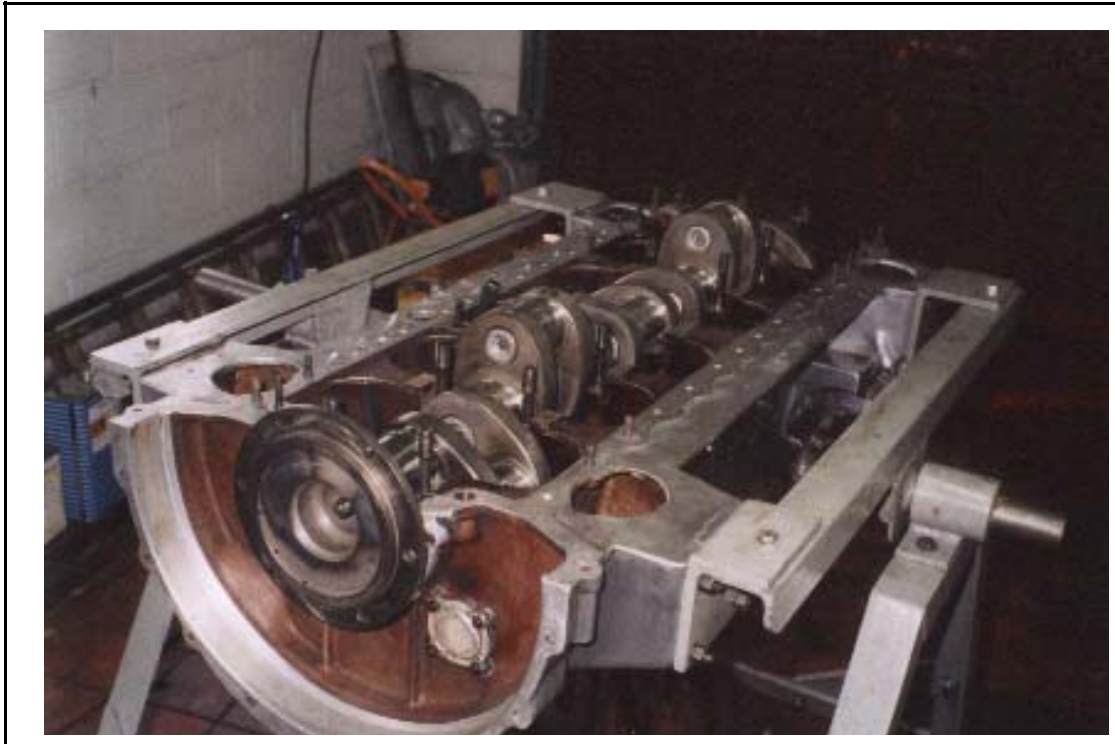
Grind-in Valves and install in Cylinder Head

Install Engine in Chassis Replace Bell Housing bolts/nuts

- Install 16 engine bearer bolts/nuts with cotters

Replace :-

- Cylinder Head - *use engine lift*
- Shock Absorbers
- Front Chassis member
- Radiator - *use engine lift*
- Starter
- Fan Assembly
- Inlet Manifold/Carburettors/Hot Spot
- Exhaust Manifold & Exhaust System
- Coil/Ignition/Dynamo/Magneto
- Hoses/Wings/Bumper/Bonnet/Undertrays



PII Engine # IC55 during Assembly

After assembling the engine, with the cylinder head still off , put engine on slings to engine lift and reinstall in chassis - do not forget the clutch thrust race! Attach the 16 engine bearer bolts and cotters. Then replace the Cylinder Head . Install rocker gear. Reinstall shock absorbers, front chassis mounting, radiator, and starter motor. Replace all the ancillaries removed at Stage A. Check the electrics. Turn on Ignition, and start up!

Finally, as an amateur I have always assumed the engine holds 1½ gallons of oil as indicated. As usual after the overhaul I filled the engine with oil to the correct level. I then turned the engine over and a gallon of oil disappeared. As the engine was empty this quantity filled the crankshaft oil ways, and the oil pipes. This means that you only change 1½ gallons out of 2½ gallons at each oil change as one gallon remains in the oil pipes. *I learn something every day!*

The End