

## C O S W O R T H

## BDH ENGINE DETAILS

ISSUE 12. 7TH, MAY 1981

Capacity	79.23 cu. in. 1298.4 c.c.	Bore	3.189" 81.00 m.m.	Stroke	2.480" 62.99 m.m.
Compression Ratio:	11.3 to 1				
H.P. Rating:	190 BHP @ 10,000 RPM				
Torque:	108 lb. ft. @ 8500 PRM				
CYLINDER NUMBERING	FRONT 1 - 2 - 3 - 4 REAR				
IMPORTANT DIMENSIONS ETC.					

## Crankshaft:

End Float .002" / .011"

Main Bearing Dia. 2.1260"/2.1255"

Crankpin Dia. 1.9375"/1.9370"

## Connecting Rods

End Float (Big End) .004"/.012"

## Jackshaft

Jackshaft Part No. BA 0502

End Float .003"/.007"

Jackshaft pulley is bolted to jackshaft with:-

1 Bolt 3/8 UNC &amp; BA 0510 washer

It is recommended that 'Silastic' is used under the washers to prevent oil leaks.

## Timing Belt Tension

Measured on longest free belt run with a Burroughs gauge - correct reading 90/100.

## Gudgeon Pins

End Float .001" interference / .001" clearance

## Piston Rings

Gaps on all rings .015"/.022"

## Valve Timing

Inlet valves fully open  $102^{\circ}$  A.T.D.C.  $\pm 1^{\circ}$ Exhaust valves fully open  $102^{\circ}$  B.T.C.D.  $\pm 1^{\circ}$ 

Lap pulleys onto cams. With timing set correctly and belt correctly tensioned, timing marks on pulley rim should line up horizontally in the centre of the engine, when No. 1 piston is at T.D.C. firing. If the marks do not line up it is advisable to remark the pulleys so that the engine may be easily re-timed on rebuild.

## Valve Lift

.410" less the tappet clearance

## Tappet Clearance

.009"/.010" inlet .012"/.013" exhaust.

Valve Springs

Cosworth Part No. PPI65b

Fitted length of outer 1.26"

Free length of outer 1.45"

Fuel Injection Timing

No. 1 starts to inject at 18° A.T.D.C. with No. 4 firing.

Ignition

Firing order 1 - 3 - 4 - 2

Ignition timing is about 34° B.T.D.C.  
Timing is set on test with timing light at 7000 rpm, and may vary slightly from engine to engine for maximum performance.

Oil Filter Element

Part No. PPO404

Oil System

See Cosworth Drg. BA 0285 for layout of recommended oil system, which shows oil pipe sizes etc.

Note that pipes into the oil/air separator, built into the top of the tank, should enter tangentially with the oil scavenge pipe ahead of the engine breather pipe.

Oil pressure when hot should be 70 psi min. rising to 80 - 90 psi at normal running speeds. Care must be taken to allow the oil temperature to reach 50°C before exceeding 7000 rpm otherwise bearing failure may occur due to running at high speed with cold oil.

Max. permissible oil temperature is 100°C, measured in the tank.

If the oil pumps are dismantled for any reason, it is essential to check that the shaft turns freely on re-assembly before fitting to the engine. If it is not possible to turn the shaft easily then the drive gears may suffer. Any dirt in the pumps will have a similar effect.

FUEL INJECTION.

See Cosworth Drg. BA0331 for layout of recommended fuel system.

The metering unit fuel cam is set to the correct stroke during assembly, and the settings currently used are .005 in stroke at closed throttle and .064 in. stroke at full throttle, using fuel cam FA0231 and datum pin EA0230. These figures are achieved with the datum pin set at 1 notch from lean. The stroke should not be less than .064 in. at full throttle otherwise piston life will be shortened.

Full throttle position of the cam is when its straight edge is at  $45^{\circ}$  to the axis of the metering unit. At this angle the stroke should be adjusted, if necessary, by shimming to give full throttle stroke as above. Then, with the metering unit mounted on the engine, the threaded rod should be adjusted so as to hold the cam in the  $45^{\circ}$  position with the throttle fully open. From this setting one or two turns of the threaded rod will give the correct stroke at closed throttle. DO NOT open the throttle by moving the fuel cam. (Note: It is not necessary to have the cam at exactly  $45^{\circ}$  at full throttle, since the cam gives constant stroke over a large number of degrees near full throttle).

The low pressure "Bendix" pump passes fuel around a primary circuit to supply fuel at a positive head to the high pressure electric pump (Cosworth part No. DA8059). The Bendix pump should have a capacity of at least 20 galls/hour at 1 p.s.i., and be mounted as low as possible in the chassis. The high pressure pump is to be mounted with its outlet union vertically upwards. Both the Bendix and the high pressure pumps are to be left switched on whilst the engine is running.

The de-aerator should be about 2 in. dia. x 6 in. high (min.) to allow air bubbles to rise to the surface and escape, thus providing air-free fuel to the high pressure pump. Inlet and outlet unions should be arranged tangentially to induce a rotary flow in the fuel.

Fuel should be 99 octane (RM) min. and metering unit feed pressure should be maintained at 120/140 psi by adjusting the pressure relief valve if necessary.

NOTE: Fuel pumps should be left on during short pit stops, to prevent fuel from evaporating from metering unit thus possibly causing a failure of cable drive soldered joints, due to increased friction in the metering unit.

Throttle Slide.

It is inadvisable to dismantle the throttle slide assembly whilst still bolted to the cylinder head otherwise balls and/or rollers from the slide bearing track may fall down the inlet ports. After removing from the cylinder head it may be carefully dismantled on the bench, noting the arrangement of the balls, rollers and spacers in the bearing tracks, in order that they are re-assembled in the same sequence, as any change in the arrangement will result in slide inefficiency see Drawing No. BA 0332. The Nylatron packing on the right hand of the manifold should be positioned on re-assembly to give a slide opening of .030", and the screw tightened to trap the packing. This will give the throttle setting for idling. Ensure that the idling stop abuts to the slide over the full width.

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Electrical System

See Drawing No. *BA049B*  
Current engines use PP 1305 (Thyristor Speed Limiter) set to cut out at 10,300 rpm.

The engine must be connected to a Negative Earth (ground) system.

It is advised that all electrical connections are smeared with *SILICONE* grease (we suggest Midland Silicones MS4) especially when the engine is operated in wet conditions.

Spark-plugs - *CHAMPION NS4R* or equivalent. If cold starting proves difficult on *NS4R's* a set of *N60* may be used for initial warming-up but should not be used for racing purposes. Before removing plugs, clear all dirt from recess. Use special pliers to remove H.T. leads - do not pull directly on leads. Use graphite grease on plug threads and torque to 14-16 lbs/ft.

Cooling System - Refer to Drg. BA 0383.

A 'Barseal' capsule should be added to the cooling system each time the engine is fitted in the chassis. In cold weather the usual precautions should be taken against freezing.

GENERAL.STARTING FROM COLD & WARMING UP.

Set mixture datum pin to full rich, switch on electrical pump, fully open throttle and crank for three or four seconds with starter motor. Ease off throttle to approx. 1/3 open and switch on ignition whilst engine is being cranked.

Reduce throttle opening when engines fires.

Observe that oil pressure has come up, adjust rpm to 2,300 and hold at this rpm or reading near this which gives best running and minimum mechanical clatter.

As soon as water temperature gauge needle is off the stop i.e. 30°C increase rpm to between 4,000 and 4,500, again choosing a point which gives best running and minimum mechanical clatter. Turn mixture datum adjusting pin to middle notch, to weaken mixture.

Keep rpm steady until water temperature reaches 60-70°C and oil temperature is rising. See also under oil system.

COLD WEATHER CONDITIONS.

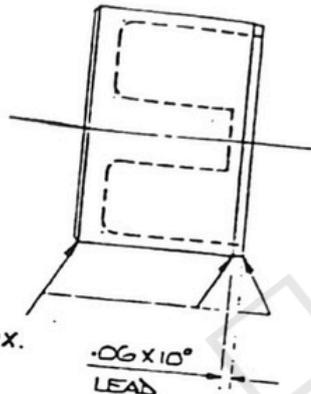
It has been found that some Fuel Metering Unit failures have been caused by attempting to start the engine in very cold weather. We therefore suggest that when the general temperature is below 5°C the Metering Unit is warmed before any attempt at starting is made.

REV. LIMITS.

Recommended limit is 10,000 rpm; 9,500 rpm in first and second gears. Drivers should be aware that due to the Tachometer reading lag it is quite easy to exceed 9,500 rpm in low gears even though the tacho reading is well below 9,500 rpm. This is a major cause of engine failure. The engine must not be allowed to idle under 2,000 rpm or excessive cam and tappet wear may be experienced. Also see note under Oil System above.

TAPPETS

Standard tappets may be used, but the modification shown in the sketch below is recommended to avoid excessive wear of the tappet bores, or use BA 0276 tappets which are already modified.

Camshaft Oil Seals: (PP1281)

To prevent failure in service it is recommended that the garter spring is removed, the ends untwisted, degreased and reassembled with Loctite 602.

CAM CARRIER

It is recommended that 'Silastic' is used to make an oil tight joint between the cylinder head and cam carrier and that the paper gasket is omitted.

BELT TENSION AND VALVE TIMING

The engine is supplied with BA 0511 Water Pump Assembly, which has a smaller than standard retaining clip, water pump bearing (BA 0512). A standard retaining clip (PP 0099) will foul the timing belt as it runs under the top tensioning pulley.

All pulley's are to be sprayed with A.D.F. (air drying lubricant film - Molybdenum Disulphide) on initial assembly.

Belt tension should always be set with a cold engine. Tension is adjusted by moving the eccentric idler pulley.

To check tension, turn engine in its normal direction of rotation to T.D.C. number 1 cylinder firing. Tension should be checked midway between the exhaust camshaft pulley and the crankshaft pulley. It is important that each time the tension is being adjusted and checked the engine is brought up to T.D.C. number 1 cylinder firing in its normal direction of rotation. It is essential that the belt is not overtensioned, as this will result in premature tooth failure.

We recommend the use of a Burroughs Tension Gauge BT 33-86F 4-18 and the tension should be set at 90/100 gauge reading. Alternatively a Gates Tension Tester may be used, and for 1/2" belt deflection a gauge reading of 11/15 lbs. should be obtained.

On new engine build the camshaft pulleys are marked on the front rims on their horizontal centre line. These marks line up in the centre with the engine at T.D.C. number 1 cylinder firing. A further mark is on the rear rim of the exhaust camshaft pulley, which lines up with a scribed line on the cam cover, with the engine again set at T.D.C. number 1 cylinder firing. When checking the timing marks, or timings, always turn the engine in its normal direction of rotation, with the belt correctly tensioned.

The camshaft pulleys are a taper fit on the camshafts, and have two 1/4 UNC tapped holes to facilitate removal. On new engine build the end of each camshaft and pulley hub face are scribed with a horizontal line in order that the pulleys can be re-fitted in their original position.

INJECTION TIMING

Unscrew the banjo from number 1 cylinder fuel outlet and carefully remove the banjo body from the fuel metering unit. Remove excessive fuel and turn engine in normal direction of rotation until the inner rotor port just starts to crack open. This point should be  $18^{\circ}$  A.T.D.C. with number 4 cylinder on **FIRING STROKE.**

To re-time the metering unit, set engine at  $18^{\circ}$  A.T.D.C., slacken exhaust camshaft retaining bolt and turn the metering unit drive pulley in normal direction of rotation until number 1 port cracks open. Re-tighten camshaft pulley bolt and carefully replace banjo.

TAPPET ADJUSTMENT

Rotate engine forwards to T.D.C. (cam pulley marks lined up). Mark Metering Unit drive pulley to housing and remove belt. Remove main camshaft belt, having slacked off eccentric pulley, to remove tension from belt. (N.B. always refit belts to run in the same direction as before).

Retain tappet up against the cams, preferably by inserting 8 spring clips between adjacent tappets. Remove surplus oil from tappet chambers with a syringe. Slacken off hex. head bolts, ensuring cam carrier lifts evenly. Carefully lift cam carrier assembly vertically until clear of the valve stems and shims. Some shims may stick to the tappets and some to the valve stems. When rebuilding an engine it is advisable to stick the shims to the valve stems with grease, whilst carrying out tappet adjustments, to ensure the shim remains on the valve stem whilst removing the carrier.

CYLINDER HEAD

Number bolts 1 - 5 exhaust side, 6 - 10 inlet side, the order of tightening is:- 8, 3, 7, 4, 9, 2, 10, 1, 6, 5.

EXHAUST SYSTEMS

With 'short' trumpets FA 0284 assy. use 4 into 1 exhaust system made of 18 SWG tube.

4 x 1 7/8" O/Dia. x 27" long into 1 x 2 1/4" O/Dia. x 28" long.

RUNNING-IN

Standard running-in procedure on a dynamometer is as follows:-

Torque	Rpm	Time
30 lb. ft.	3500	To full oil pressure.
44 lb. ft.	4000	30 min.
57 lb. ft.	4500	30 min.
66 lb. ft.	5000	45 min.

Then inspect tappets and test.

RELATED DRAWINGS

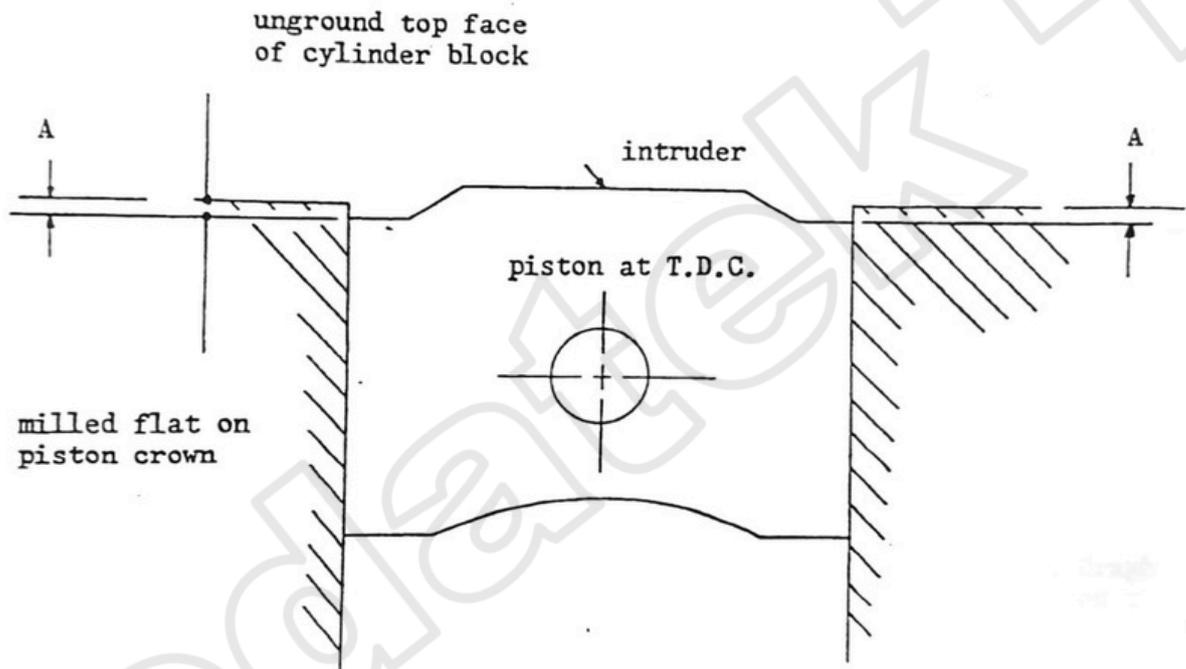
BA 0436	Engine general assy. (2 sheets)
BA 0285	Recommended oil system.
BA 0331	Recommended fuel system.
BA 0332	Throttle assy.
BA 0438	Ignition and charging circuit diagrams.
BA 0383	Recommended cooling system.
BA 0137	Exhaust flange.
BA 0543	ASSY. CRANKSHAFT BUNG

PISTONS - PA 0058

Gap on all rings should be .015/.022 in. when fitted in bore. Pistons are normally supplied with gudgeon pins ground to the correct length and circlips ground flat and parallel. Circlips should be fitted with ground face outwards and gudgeon pin end float should be .001 in. interference to .001 in. clearance, measured at room temperature.

It will be necessary to do a trial assembly of the pistons in the block to check the position of the piston relative to the top face of cylinder block at T.D.C.. It will be necessary to grind the top face of the block to achieve the correct dimension (see below).

Also check that the top face of the cylinder block is parallel to the main bearing bores. If it is not, it will be necessary to pack up one end of the block before grinding the top face for squish clearance.



With piston at T.D.C., measure dimension 'A' on both sides of piston and adjust piston to make both equal. Repeat for each cylinder. Record each dimension as measured.

Then amount to be ground off block. =

Smallest value of A measured - .005 in.

e.g.

If value for A in No. 1 bore = A1 = .011 in.

and A2 = .012 in., A3 = .011 in., A4 = .013 in.

Then the amount to be ground from block = .011 in. - .005 in.  
= .006 in.

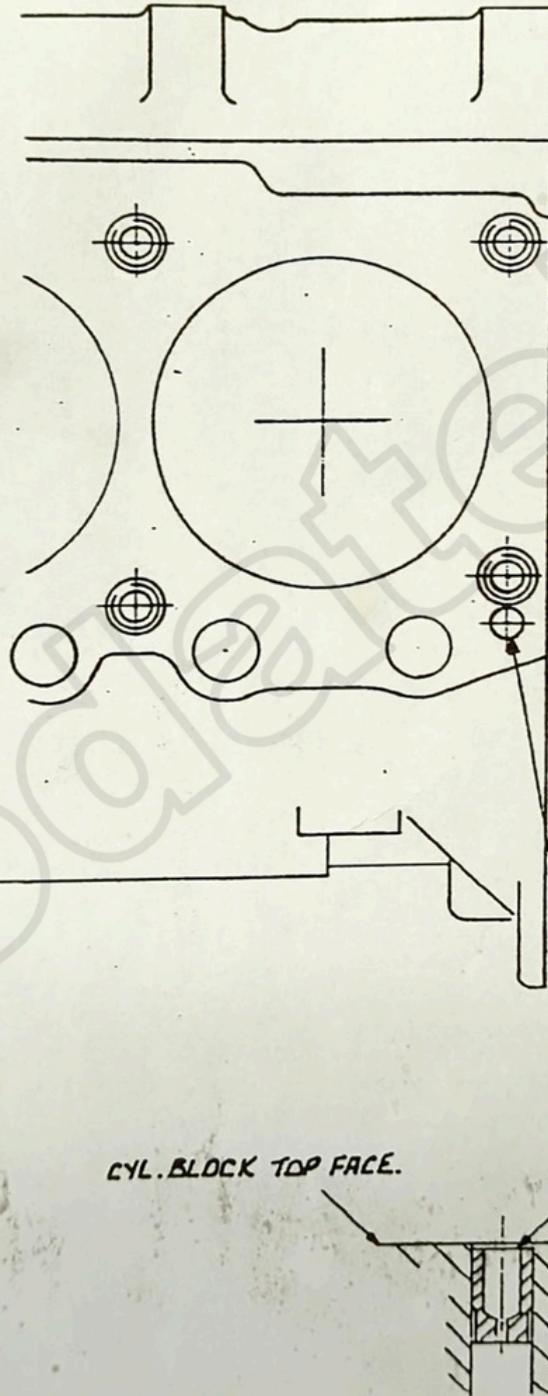
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BOLT TORQUES - Engine Oil on threads and under head unless otherwise stated.

Flywheel/Crank (12 Bolt)	3/8 UNF	50-55 lb. ft.
Big-End	"	41-42 lb. ft. (anti-scuffing paste under head engine oil on threads)
Cylinder Head ( <i>Soc. CAP Hd</i> )	7/16 UNC	62-65 lb. ft. (oil under head)
Main Cap	7/16 UNC	65-70 lb. ft.
Cam Pulley	3/8 UNF	20-25 lb. ft.
Jackshaft Pulley	5/16 UNC	15-20 lb. ft.
Jackshaft Pulley BAQ509	3/8 UNC	20-25 lb. ft.
Idler Pulley Nut	7/16 UNC	30-35 lb. ft.
Crankshaft Pulley	7/16 UNC	35-40 lb. ft.
Cam Carrier/Cylinder Head	1/4 UNC	8-10 lb. ft.
Clutch Bolt Nuts	5/16 UNF	13-15 lb. ft.
Sparking Plugs	14 mm	14-16 lb. ft. Graphite greas on threads.
Other		
1/4 Bolts (sump, front cover etc.)		5-7 lb. ft.
5/16		10-15 lb. ft.
3/8		20-25 lb. ft.

BD CYLINDER BLOCKS.

The cylinder block should be finally cleaned before assembly. Main oil gallery bungs and the cam carrier / cam shaft oil feed restrictor can then be fitted. The restrictor, part number BA 0356, should be fitted flush to just below the cylinder block top face.



FRONT FACE CYL. BLOCK.

CYL. BLOCK TOP FACE.

BA0356 RESTRICTOR-CAM OIL FEED  
FITTED FLUSH TO JUST BELOW  
TOP FACE.