C O S W O R T H

BDE ENGINE DETAILS — ISSUE 12 7th March 1979

Capacity	109.25 cu. in. 1790 cc	Bore	3.373" 85.7 mm	Stroke	3.056" 77.6 mm

Compression Ratio: 11.7 to 1

H. P. Rating: 245 bhp @ 9000 rpm

Torque: 153 lb. ft. @ 7000 rpm

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 & BA 0510 washer.	
	It is recommended that "Silastic" is used under the washer to prevent oil leaks.	
Valve Timing	Inlet valves fully open	102° A.T.D.C. $\pm$ 1°
	Exhaust valves fully open	102° B.T.D.C. $\pm$ 1°

Lap pulleys onto cams. With timing set correctly and belt correctly tensionsed, timing marks on pulley rim should line up horizontally in the centre of 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 (cold)	.009"/.010" inlet	.012"/.013" exhaust
Timing belt tension	measured on longest free belt rung with a Burroughs gauge - correct reading 90/100 (see instructions).	

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Valve Springs — Cosworth Part No. PP 1656 Pair of Springs.

Fitted length of outer	1.26"/1.27"
Free length of outer	1.44"

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

Lucas "Opus" ignition with distributor fitted with Cosworth type solid mounted pick up. Ignition timing is about 37° 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. PP 0404

Oil System

See Cosworth Drg. BA 0330 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.

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FUEL INJECTION

See Cosworth Drg BA 0331 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 .093 stroke at full throttle, using Fuel Cam FA 0224 and datum pin DA 0159. These figures being achieved with the datum pin set at 1 notch from lean.
The stroke should not be less than .093 at full throttle otherwise piston life will be shortened.
A feeler gauge Part No. FA 0262 is available to check the stroke at full throttle.

Full throttle position of the cam is when its straight edge is at 45° 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° 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° 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 air free fuel at a positive head to the high pressure electric pump (Cosworth part no. DA 8059).
The Bendix pump should have a capacity of at least 20 gall/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) and will 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 p.s.i. by adjusting the pressure relief valve if necessary.

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

Throttle Slide Assembly.

It is inadvisable to dismantle the assembly while it is still bolted to the engine, as the balls and rollers may find their way down an inlet port. Thus, the assembly should be removed from the engine before dismantling, and the balls and rollers must be replaced in the correct order, as shown on Drg. BA 0332, otherwise slide inefficiency will result.

Exhaust System
With 'short' trumpets FA 0284 assembly use 4 into 1 exhaust system made of 18 SWG tube.
4 x 1 7/8 in. o/dia. x 27 in. long into
1 x 2 1/4 in. o/dia. x 28 in. long

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Electrical System

See Drawing No. BA 0382.
Current engines use PP 1082 (Thyristor Speed Limiter) set to cut out at 9,200 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 N54R or equivalent. If cold starting proves difficult on N54R, 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 15 lb. ft.

Cooling System - Refer to Drawing No. 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 engine 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 9,000 rpm; 8.500 rpm in first and second gears. Drivers should be aware that due to the Tachometer reading lag it is quite easy to exceed 8,500 rpm in low gears even though the tacho reading is well below 8,500 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.

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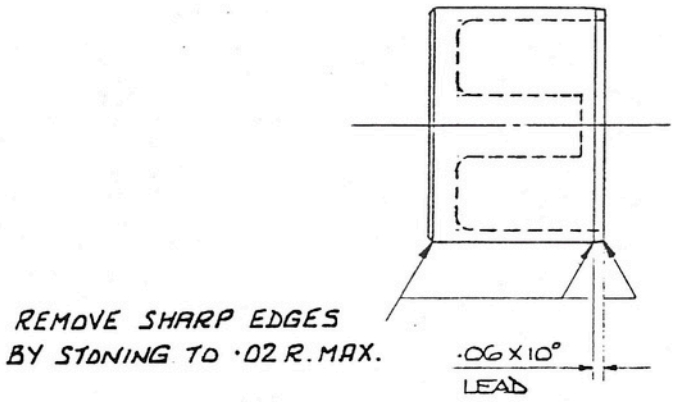
TAPPETS

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 Tappet Piston - Exhaust Side Only)
FA 0196 Tappet Piston - Inlet Side Only) which are already modified.



Camshaft Oil Seals: (PP 1281)

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

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 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 ½" 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 ¼" 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.

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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 to normal direction of rotation until the inner rotor port just starts to crack open. This point should be 18° A.T.D.C. with number 4 cylinder on FIRING STROKE.

To re-time the metering unit, set engine at 18° 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, then order of tighteneing is:- 8, 3, 7, 4, 9, 2, 10, 1, 6, 5.

RUNNING-IN.

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

Torque	Rpm	Time
44 lb. ft.	3,500	To full oil prsssure
52 lb. ft.	4,000	30 min.
70 lb. ft.	4,500	30 min.
88 lb. ft.	5,000	30 min.
105 lb. ft.	5,500	30 min.

Then inspect tappets and test

RELATED DRAWINGS

BA 0335	Engine general assembly (2 sheets)
BA 0330	Recommended oil system
BA 0331	Recommended fuel system
BA 0332	Throttle assembly
BA 0382	Ignition and charging circuit diagrams
BA 0383	Recommended cooling system
BA 0353	Exhaust flange
BA 0389	HEAD GASKET SEALING INSTRUCTIONS.
FA 0289	ASSY. CRANKSHAFT BUNG

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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 past under head engine oil on threads)
Cylinder Head (Soc Cap Hd)	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 BA 0509	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	10 mm	9 lb. ft.	Graphite grease 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.	

PISTONS - BA 0304 - 1800 cc

Gap on all rings should be .015/.022 in. when fitted in the 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 when measured at room temperature.

It will be necessary to do a trial assembly to check the position of the piston crown relative to the top face of the block at T.D.C. The pistons should be .004/.006 in. down the bore at T.D.C. so the piston crowns will need machining so that this is achieved.

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.