

C O S W O R T H

Issue 2 16th Dec. 1981

Ford 3.9 Litre (normally aspirated) Engine Details - Cosworth D.F.L. 3.9.

Capacity: 241.35 cu.ins. Bore 3.543" Stroke 3.06"
 3955 c.c. 90.0 mm 77.7 mm

Compression Ratio: 11.5 to 1 (approx.) Configuration 90° Vee 8

H.P. Rating: 540 B.H.P. - 400 kW (min.) @ 9.250 r.p.m.
 Torque: 340 lbs. ft. - 461 Nm (min.) @ 7000 r.p.m.
 Weight: 370 lbs - 168 kg.

CYLINDER NUMBERING

	L.H. Bank	
	8 7 6 5	
Rear		Front
	4 3 2 1	
	R.H. Bank	

IMPORTANT DIMENSIONS ETC.Crankshaft

End Float .009"/.011" obtained by grinding steel
 backing on 1 off thrust bearing.

Main Journal Dia. 2.3755"/2.3750"

Con-rod Journal Dia. 1.9375"/1.9370"

Connecting Rods

End Float (big end) .006"/.012"

Piston Rings

Gaps on all rings .017"/.022"

N. B. fitted gap on lapped periphery oil control ring may be .030" max.

Valve Timing

Inlet valves fully open 102° ATDC
 Exhaust valves fully open 102° BTDC

Valve Lift

.410 less tappet clearance

Tappet Clearance

(cold)

.009/.010 inlet .015/.016 exhaust

Oil FilterUnit construction pumps

Use only element Cosworth Part No. PP2427.

COSWORTH DFL 3.9 Litre

Fuel Injection Timing

No. 1 starts to inject @ 30° A.T.D.C. - No. 4 cylinder power stroke.
N. B. 30° crank rotation is equal to .261 piston travel from T.D.C.

Ignition:

Firing order 1 - 8 - 3 - 6 - 4 - 5 - 2 - 7

Ignition timing is set @ 7000 r.p.m. whilst the engine is on test: maximum ignition advance - Contactless and Lucas C.D. 32° . This should not be altered. However, if it has been the following procedure should be adopted:-

Unscrew the banjo bolt from No. 1 cylinder fuel outlet on the metering unit (N.B. when replacing the 'O' rings on the banjo bolt and also the rubber seal in the metering unit body, should be liberally coated with "Redex" or similar to prevent shearing, and the bolt tightened to 90 - 100 lb. ins.) Remove excessive fuel and turn the engine in a clockwise (normal rotation) direction until the rotor port is just visible. This point should be 30° A.T.D.C. with No. 4 cylinder on power stroke.

Contactless Ignition (and Lucas C.D.)

With the engine set as described above, the rotor arm should now be set at 4° past the vertical i.e. brass contact approaching No. 5 cylinder post in distributor cap. If this is not the case then adjustment may be made as follows:-

Remove rotor arm, slacken $10/32 \times \frac{5}{8}$ lg. socket cap head and rotate DA 0827 adaptor until desired position is obtained tighten socket cap head to 36 lbs. ins.

Crank Trigger/Damper

See also Cosworth data sheet 0284.

Should the trigger position be altered for any reason, the following procedure should be adopted:-

Connect ignition timing box PP2383 to pick-up signal wires, turn flywheel to 32° B.T.D.C. and rotate damper slowly in direction of engine rotation until light comes on. Torque $\frac{5}{8}$ U.N.F. bolt to 200 lbs. ft. taking care not to move damper (N.B. copperslip on threads and bolt underhead). Turn the engine backwards approx. 45° and recheck point at which timing light is energised. N.B. 32° crank shaft rotation is equal to .296 piston travel from T.D.C.

Note : Tapers must be oil free.

COSWORTH DFL 3.9 Litre

Engine Mountings.

The top 5/16 UNF bolts should have washers (Part No. DA 0017) against the magnesium DA 0098 cover, carefully tightened to 16/18 lbs. ft. to avoid crushing the magnesium alloy.

On the lower mounting points, flat washers of .06" min. thickness must be used under the chassis bolt heads.

The lower front mounting DA 0004 is marked "RT" (right top). If the mounting is removed it should be replaced with the letters "RT" towards the top of the engine.

Oil System.

Reference drawing No. DA 1768.

DL 8361 crankshaft assy. (DL 1475 axially drilled crankshaft). Oil pressure when hot to be 45 p.s.i. minimum - 52/62 p.s.i. at normal running speeds.

Care must be taken to allow engine oil to reach 50°C before exceeding 7000 r.p.m. as bearing failure may follow running at high speeds with cold oil. Maximum tank oil temperature 100°C.

Fuel System.

See drawing No. DA 1582 - (this system has proved itself in service) and Data Sheet DS 0151.

The electro/mechanical fuel pump does not need to be turned off as this is done automatically when the pump becomes mechanically driven.

It is recommended that to reduce metering unit wear or the possibility of seizure:

- (a) ½ % by volume of engine oil is added to normal pump fuels.
- (b) 1 % by volume of engine oil is added to Avgas fuel.

The fuel cam is set to the correct angle/clearance during assembly and should not be altered. See Data Sheet No. 0151 for alternative "altitude" fuel cams.

When using DA 8304 fuel filter assy, it is imperative to only use filter PP 2374 with thick rubber sealing washer (felt washer type are known to fail in service through glue dilution!).

COSWORTH DFL 3.9 Litre

Electrical System.

See drawing No. DX 1578.

The engine must be connected to a -VE earth (ground) system. Earths are to be connected directly to batter not via chassis. It is advised that all electrical connections are smeared with silicone grease (we suggest Midland Silicons MS4) especially when operating in wet conditions.

Spark plugs - Champion GV503/G54V or equivalent with capacitive discharge type ignition systems.

Before removal, clear all dirt from recess. Use special pliers to remove H.T. leads - do not pull directly on leads. Always put a small amount of colloidal graphite (we recommend Graphogen) on sparking plug threads before fitting and torque to 9 lbs. ft.

THROTTLE LINKAGE.

The four throttle return springs are not designed to return a car cable, pedal etc. and will require supplementing to suit each installation.

General.

The engine must not be allowed to idle under 2000 r.p.m. or excessive cam and tappet wear may be experienced.

The rev limit is governed by the control system which is set to cut out above 9,550 r.p.m.

If a "Smith's Chronometric" tacho-head is fitted, then the specification for the head is "4:1 - clockwise".

Storage.

Whilst engines are not in use, Cosworth recommend that the crankshaft should be turned through 180° once per week. This will prevent any one pair of valve springs being at full compression max. stress for long duration, which may lead to early spring failure during running.

Summary of Drawings Applicable.

- DL 1858 - Engine General Assy (3 sheets).
- DL 1857 - Exhaust System.
- DX 1578 - Wiring Diagram.
- DA 1582 - Fuel System.
- DA 1768 - Oil System.
- DA 1769 - Cooling System.
- DA 1884 - Crank Damper.
- Data Sheet DS 0132 - Stud heights and torques.
- DS 0144 - DFV "O" Ring Schedule.
- DS 0284 - Assy Procedure for Ignition Trigger.
- DS 0247 - Fitting Remote Fuel Pump Drive to DFV Inlet Cam.
- ~~DS 0278~~ - Fitting Instructions for Unit Const. LHS Auxiliaries.
- ~~DS 0279~~ - Fitting Instructions for Unit Const. RHS Auxiliaries.
- DS 0151 - Fuel Cam Data Sheet.

COSWORTH DFL 3.9 Litre.

STARTING FROM COLD AND WARMING UP.

Set mixture datum adjusting pin, to full rich, switch on electric fuel pump, fully open throttle and crank for 3 - 4 seconds, with starter motor. Ease off throttle to approximately $\frac{1}{2}$ open and switch on ignition whilst engine is still being cranked.

Close throttle when engine fires.

Observe that oil pressure has come up, adjust r.p.m. to 2,300 and hold steady at this r.p.m. - or a reading near this which gives minimum mechanical clatter.

Do not switch off supply to electro/mechanical pump.

As soon as the water temperature gauge needle is off its stop, i.e. 30°C, increase r.p.m. to between 4,000 and 4,500 again choosing a point where mechanical clatter is minimised. Turn mixture datum adjusting pin to middle notch, to weaken mixture.

Keep r.p.m. steady till water temperature is 60° - 70° and oil temperature is rising.

COLD WEATHER CONDITIONS.

It has been found that some fuel metering unit failures have been attributable to attempting to start the engine in very cold weather. We therefore suggest that when the general engine temperature is below 5°C, the metering unit is warmed before any attempt is made to rotate it.

STRIPPING AND ASSEMBLY NOTES.

It is of the utmost importance that a torque wrench is used on all assembly work. We recommend that only a "Bending-beam" type is used.

The cylinder head side stud nuts must be released before the main head nuts are released. The cylinder head nuts must be released gradually and evenly, starting from the centre and working towards the outside. The same procedure must be followed for the cam covers and crankcase lower-half stud nuts.

Order of tightening 7 3 1 5 9
FRONT 8 4 2 6 10 REAR

for heads and sump.

For camshaft removal, remove tacho drive and spindle and L.H. cam carrier rear end cover. Remove cams from only one bank at a time.

R.H. Bank Turn engine to T.D.C., No. 1 cylinder.
 Line up timing gears with marks on cover.
 Remove cams. N.B. take care that cam lifts evenly.

L.H. Bank Turn engine 450° in direction of engine rotation
 from No. 1 T.D.C. to No. 5 T.D.C. Line up marks as above.
 Remove cams.

When replacing, make sure correct marks line up as above, and that the gears mesh as the cam is lowered.

N. B. Cam must be pulled down evenly.

COSWORTH DFL 3.9 Litre.

Before the cylinder heads can be removed, the alternator/distributor/metering unit assembly must be removed.

It is suggested that the engine be rotated until T.D.C. No. 1 firing. The $\frac{1}{4}$ " UNC plug near the alternator air-inlet gauze should then be removed, and the engine turned slightly so that the nearest gap between the alternator drive gear teeth is directly below this plug-hole. A pointed $\frac{1}{4}$ " UNC screw should then be used to lock the gear in position. Care must be taken not to rotate the engine while the screw is in place. Mark the position of the flywheel so that the distributor assembly may be replaced in the same position. Remove the high pressure petrol pipe linking manifolds, throttle cross shaft, etc. After removing the four retaining screws, the unit may be taken out by sliding it towards the rear of the engine, off the quillshaft splines.

On re-assembly it is imperative that the distributor unit is replaced with the correct splines in engagement or the fuel and ignition timing will be wrong. Use anti-scuffing paste on splines.

Never strip the throttle assembly whilst the manifold is fitted to the engine, or rollers may fall down the inlet track.

The centre distances of the timing gears are very critical, and nothing should be done which will affect them. If idler gears are removed it is essential that they go back on the same bank as they were when removed, otherwise the gear backlash may be altered and cause gear failure.

FITTING CYLINDER HEAD SEAL AND CYLINDER HEAD

The solid cylinder head joints used in the DFL are re-usable and should only be replaced if they show signs of damage on their seating land or if the cylinder liner is changed. The top of the block has been relieved except for around the edge.

To fit a new set of cylinder head seals it is initially important to ensure that the cylinder liner flanges are pulled down onto their locations properly. Having heated the block to 100°C and fitted the liners using Wellseal as water sealant under the liner flange the block should be allowed to cool to room temperature and the liner then pulled down using a plate across the top of the liner and a $\frac{1}{2}$ " UNC bolt torqued to 65 lb. ft. and threaded into a mandrel in the main bearings. The depth of the cylinder head seal recesses from the top of the block edges should then be measured at four points around the top of each liner. From these measurements the individual thickness of each head seal may be calculated so that the head is .0015"/.0025" clear of the block edges and the step between the tops of adjacent rings does not exceed .0005". The head seals should be fitted with the chamfer facing the liner flange.

With the sealing rings and all 'O' rings in place and the head finished ground, smear silastic on all head nut washers to prevent oil from running down the studs and out of the head joint. Torque the head nuts to 30lbs. ft. then 40 lbs. ft. and finally 53-55 lbs. ft. with oil on threads and underhead of nut. Check the backlash between DA0127 cylinder head idler gear and DA0125/6 cylinder block idler gear this should be .002"/.006". The side studs should now be torqued to 14-16 lbs. ft.

COSWORTH DFL 3.9 Litre.

CRANKSHAFT BUNGS.

DL 1475 current crankshafts have axially reamed galleries using Bungs Part No. DL 1781.

Tool No. DL 1782 is required to insert and extract bungs.

The long shafted tool used to insert/extract the bung in No. 2 main.

The short shafted tool used to insert/extract bungs in front and rear mains.

CARE TO BE TAKEN WITH

All 'O' rings connected with oil pressure pump and scavenge pump. Particular care to be taken with 'O' ring fitted to oil pressure pump inlet flange. Damage to this 'O' ring - allowing suction of air - will give low oil pressure reading and possibly lead to bearing failure.

When refitting cylinder heads, ensure that all 'O' rings and seals are in place, especially the 'O' ring between the head and cam carrier for camshaft oil feed. New compression seals should be used on re-assembly.

Special washer part No. DA 0272 - the flat face must go against the Magnesium Cam Cover.

SA 0073 to be fitted with indentation to aluminium face.

Note : the six external main-bearing stud nuts should be tightened to a 'proving torque', released, and then re-tightened to the final assembly torque.

COSWORTH DFL 3.9 Litre

TORQUE SETTINGS - Engine oil on thread and underhead, unless otherwise stated.

Big end bolts	41-42 lb. ft.	Anti-scuffing paste underhead engine oil on threads.
Main Bearing Stud Nuts (6 External)	50 lb. ft.	Initially for proving
	43-45 lb. ft.	Final assembly.
(Main Cap Stud Nuts) (Tapered Dowel Type)	43-45 lb. ft.	
(Main Cap Side Stud Nuts 5/15 UNF)	13-14 lb. ft.	
Cylinder Block Side Stud Nuts (Cad. Plated - Bright)	13-14 lb. ft.	
Sump Sideplate 10-32 UNF screws	25 lb. in.	Loctite 270 Underhead.
Cylinder Head Stud Nuts	53-55 lb. ft.	
Cylinder Head Side Stud Nuts (Cad. Plated - Bright)	13-14 lb. ft.	
Cam Gear Screws $\frac{1}{4}$ UNF	16-17 lb. ft.	
Cam Cap Stud Nuts	13-15 lb. ft.	
Cam Carrier Cover Stud Nuts	16-18 lb. ft.	
Flywheel Bolts	53-55 lb. ft.	Do <u>not</u> use Loctite.
Clutch Bolt Nuts	13-15 lb. ft.	
Front Eng. Mtg. 5/16" Screws	18-20 lb. ft.	
Front Eng. Mtg. $\frac{3}{8}$ " Screws	34-36 lb. ft.	
Cam Cover 10-32 UNF Screws	32-35 lb. in.	
Metering Unit Outlet Banjo Bolts	90-100 lb. ins.	
Injectors	6 lb. ft.	
Sparking Plugs	9 lb. ft.	Graphite grease underhead and on threads.
Alternator Drive Quill	30-32 lb. ft.	Loctite 602 underhead and on threads.
Metering Unit Rear Mounting Bracket		
$\frac{1}{4}$ UNC mounting bracket fixing screws	48 lbs. ins.	
$\frac{1}{4}$ UNF Mtg. Bracket/Mtg. Block Screws	48 lbs. ins.	Plus the resistance of stiff nuts.
Bungs in cylinder head are fitted with SILASTIC.		
All $\frac{1}{4}$ UNC Soc. Cap Hd. Screws	46-48 lb. in.	
See separate sheet for stud fitting details. DS 0132.		