COSWORTH DFR "89"/"90" ISSUE 2

Ford 3.5 Litre F1 Engine Details:-

Capacity	3494 c.c 213.22 cu.ins	Bore	3.543" 90.0 mm	Stroke	2.703" 68.6 mm

Compression ratio: 12.5:1 (approx)

Configuration: 90 degree Vee 8

Firing order: 1-8-3-6-4-5-2-7 Max R.P.M. 11,000

Cylinder numbering

FRONT

	5	1	
L.H.	6	2	R.H.
BANK	7	3	BANK
	8	4	

REAR

IMPORTANT DIMENSIONS

Crankshaft		
DFR "89"	End Float	.0090"/ .0110"
DFR "89"	Main Journal Dia	2.3750"/2.3755"
DFR "90"S/B	Main Journal Dia	2.1255"/2.1259"
	Con Rod Journal Dia	1.9370"/1.9375"
Connecting rods	End float (big end)	.006"/.012"
Piston Rings	Gaps on all rings	.010"/.016"
Valve Timing	Inlet valves fully open	99° ATDC
	Exhaust valves fully open	102° BTDC
Valve lift	Exhaust, less tappet clearance	.410"
	Inlet, less tappet clearance	.460"
Tappet clearance	Exhaust (cold)	.015"/.016"
	Inlet (cold)	.009"/.010"
Piston Squish Heights	Below the outer raised land on cylinder block	.025"/.027"
Cylinder Head Sealing	Stand off measured from	

Rings	outer raised land on cylinder block	.002"

ENGINE MOUNTINGS; DRAWING DR4570 (LOW SUMP)

For top front mounting details see sheet 1, ref holes G. To avoid crushing the magnesium cam cover when fitting the front top engine mountings, position load spreading washers, part number DA0017, in the spot facing on the underside of the cam covers. Using 5/16 UNF bolts carefully tighten to 16-18 lbs.ft.

For top rear mounting details see sheet 2, Ref holes F. Each cam cover has 4 off 1/4 UNC helicoiled mounting holes located on the rear, torque fixing bolts to 8-10 Ibs.ft.

For lower front engine mounting details refer to sheet 4.

ENGINE MOUNTINGS; DRAWING DA5141 (TALL SUMP)

Use load spreading washers, part number DA0017, as required on front and rear mounting points.

WATER SYSTEM; DRAWING DR4571

The engine contains 6.3 litres of water.

Maximum water flow is 360 litres per minute (79.2 imp. galls.) with a 1 bar pressure drop across the external water system at 11,000 RPM.

Maximum water temperature measured at the cylinder head outlet is 100° centigrade, with a 30 psi. cap fitted to the header tank.

OIL SYSTEM; DRAWING DR4572

The oil tank capacity must be large enough to allow for an oil consumption of 4.55 litres during a Grand Prix.

Maximum oil temperature is 100° centigrade measured in the oil tank.

Oil pressure is 3.5-4.0 bar

Care must be taken to allow the oil temperature to reach 50° centigrade before exceeding 7,000 RPM. Bearing failure may occur if the engine speed exceeds 7,000 RPM with cold oil.

FUEL SYSTEM; DRAWING DR4574

Fuel is delivered via a Cosworth mechanical submerged fuel pump to 8 solenoid injectors at a fuel pressure of 5 bar.

ELECTRONIC MANAGEMENT

Fuel injection duration and ignition timing are dependent upon information fed into the E.C.U. by the three primary sensors on the engine.

1) Throttle position sensor. (T.P.S.).

2) Crankshaft sensor.

3) Phase sensor. (Half speed).

ELECTRICAL SYSTEM

Earths must be connected directly to the battery. All connections etc. must be water proof during wet conditions. Refer to the installation drawings for all other recommendations.

SPARK PLUGS.

Champion G54V, part number PP0162, always smear the spark plug threads with Graphogen prior to installation and torque to 9 lb.ft.

Use special pliers to remove H.T.leads, gripping the moulded spark plug boot. Do not pull directly on the lead.

Due to the tight fit of the plug lead into the distributor cap it is not advisable to change the leads from cap to cap.

STORAGE

Valve springs in engines which have their camshafts installed might fail prematurely if the springs are left compressed for a prolonged period of time, i.e. camshaft lobe near or at full lift. Therefore it is important that the crankshaft is rotated through 180° in the direction of rotation, at least once per week.

SETTING UP PROCEDURES

T.P.S. set at 5°, throttles closed with a .010" slide gap.

Crankshaft trigger set at 20° BTDC, compression stroke No.1.

Phase trigger set at 45° BTDC, compression stroke No.1.

The T.P.S. can be set by using either the Cosworth Engineering Console, part number DR3487, or the Cosworth Sensor Calibrator, part number DA3055 with lead DR9072.

See drawing number DR4954 to set the throttles and/or T.P.S. using the Cosworth Engineering Console.

SENSOR CALIBRATOR

SETTING THE CRANKSHAFT TRIGGER:

1) Rotate the engine to 20° BTDC compression stroke No.1.

2) Connect the sensor to the calibrator lead marked "CRANK".

3) Depress the "ON" button and slowly rotate the crankshaft trigger disc in the direction of rotation until the red L.E.D. marked "Hall Pick Up" switches from on to off. Tighten the retaining bolt to 70 1b. ft. and recheck the point at which the L.E.D. is switched.

SETTING THE PHASE TRIGGER:

1) Rotate the engine to 45° BTDC, compression stroke No.1.

2) Connect the sensor to the calibrator lead marked "CAM".

3) Depress the "ON" button and slowly rotate the phase trigger in the direction of rotation until the red L.E.D. switches from on to off. Tighten the retaining bolt to 35 1b.ft. and recheck.

NOTE.
The red L.E.D. switches from on to off when the sensors "see" the transition of the trigger from metal to air.

SETTING THE T.P.S.:

1) Ensure the slides are correctly set.

2) With the slides in the closed position connect the T.P.S to the calibrator lead marked "TPS".

3) Depress the "ON" button and slowly rotate the body of the T.P.S. until the green L.E.D. marked 5-6° comes on. Carefully tighten the securing nuts. Check that the remaining LEDs are activated as the throttles are slowly opened. Recheck closed throttle.

RECHARGING THE SENSOR CALIBRATOR

For optimum recharging of the internal Ni-Cad batteries, ensure that the batteries are fully discharged. Then recharge by connecting the sensor lead marked "RECHARGE" to a 12 volt battery or suitable 12 volt power supply. A full recharge will take 10 to 12 hours.

CHARGING PLUG CONNECTIONS

Terminal 2 = negative.

Terminal 3 = 12 volts positive.

FUEL CALIBRATOR

Percentage variations in fuelling to suit ambient conditions is obtained by using the fuel calibrator, part No.DA8693.
The adjustment required is calculated by the following.

$$100 \cdot \frac{bd}{1013} \cdot \frac{(273+16)}{(273+t)} - 100 = \%\ \text{correction}$$

where;

bd = barometric pressure for the day in millibars.
t = temperature for the day in degrees centigrade.

CYLINDER LINERS AND SEALING RINGS

FITTING CYLINDER LINERS;

Heat the block to 110° centigrade, lubricate the liner "O" rings with a silicone grease (M.S.4 or similar), taking care to remove the excess. Run a fillet of R.T.V. (Silastic or similar) around the radius between the seating flange and liner wall, at 45° covering ¼ - ½ of the seating flange width, and smear Silastic on the lands adjacent to the liner "O" rings as shown on page 7.

Fit an individual liner into the hot cylinder block and immediately pull the liner down. Each liner must be held at the full clamping torque of 65 lb.ft for 1 or 2 minutes to ensure that the Silastic has been correctly displaced.

i.e.

A thin film of Silastic under the liner seating flange, with a fillet of Silastic filling the small annulus between the liner wall and cylinder liner location.

NOTE:

Before selecting a new set of cylinder sealing rings it is important that the liners are seated correctly. If you have not fitted liners in this manner before carry out a few test runs to ensure that your results are repeatable, and that the Silastic has been displaced as shown.

SELECTING SEALING RINGS:

Allow the block to cool down to room temperature. With the liners clamped down measure the depth of the sealing ring recess, relative to the outer raised land of the cylinder block, at four points around the top of each liner.

i.e

Front, rear and both sides

Then add .002" to determine the thickness of each individual head joint. Ensure that the difference between the combined heights of adjacent liners and sealing rings, relative to the cylinder block, does not exceed .0005".

These solid joints are reusable and should only be replaced if they show signs of damage or if the liner is replaced.

See page 8, 8b & 8c for clamping tool recommendations.

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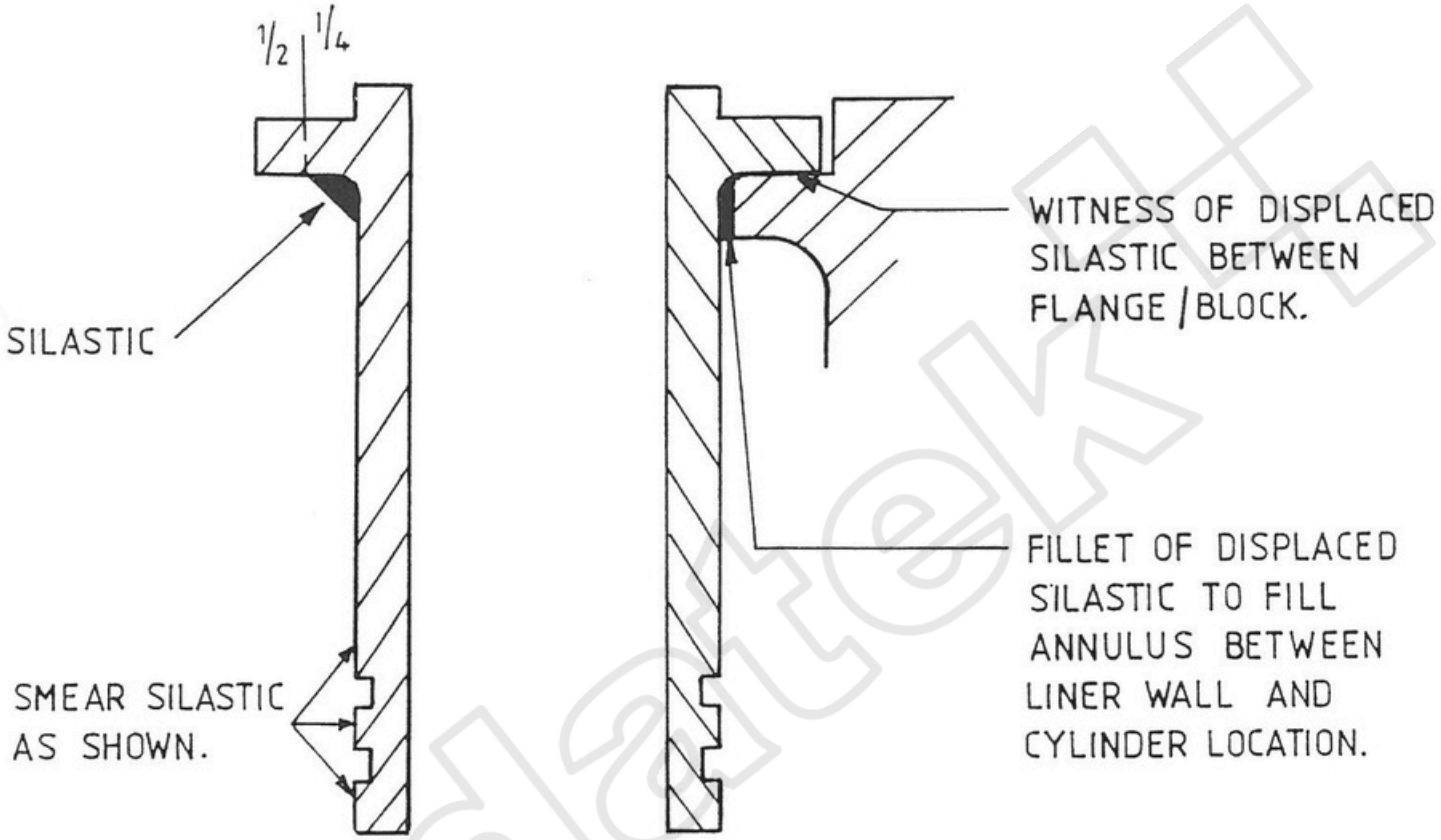
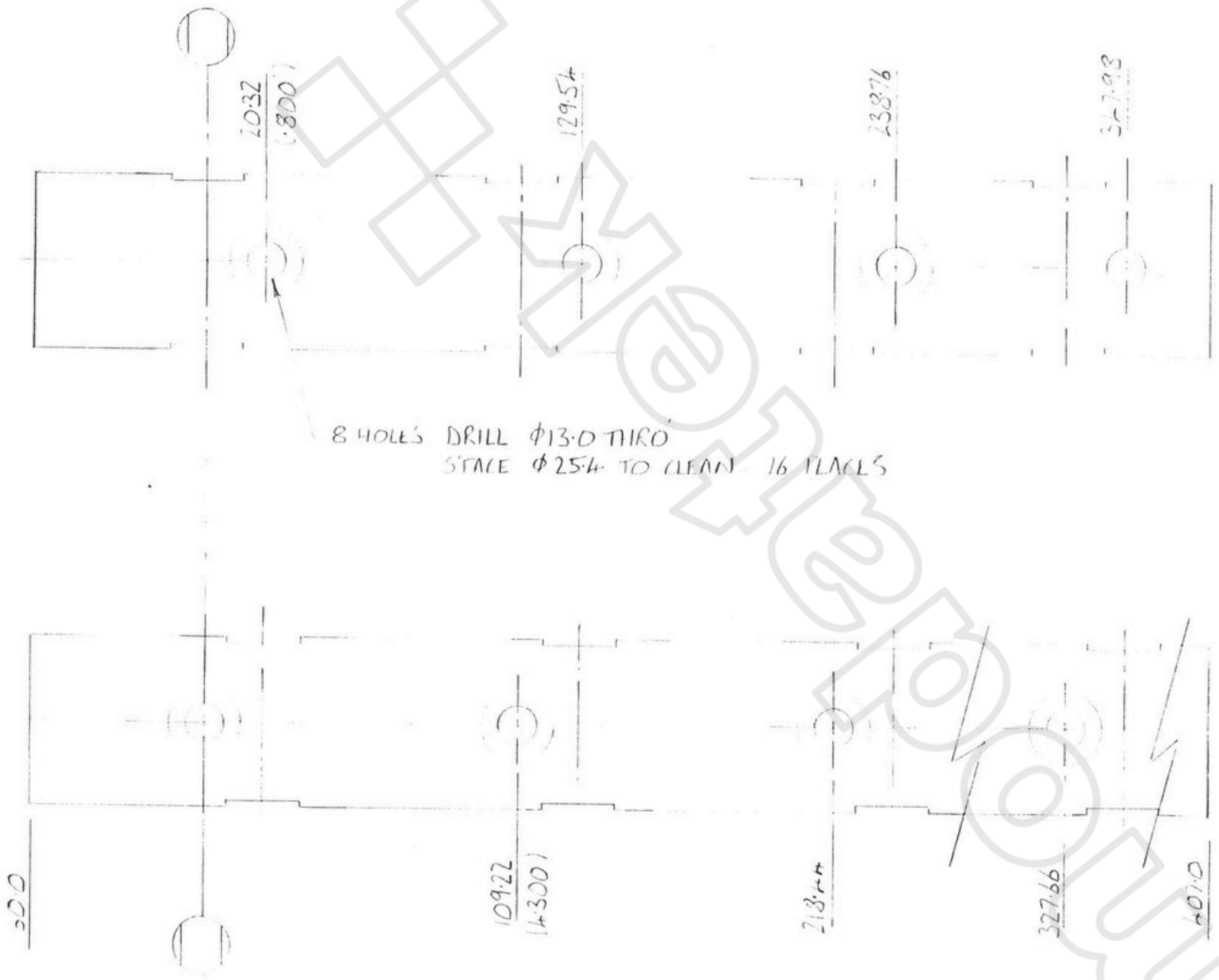
CYLINDER LINERS.

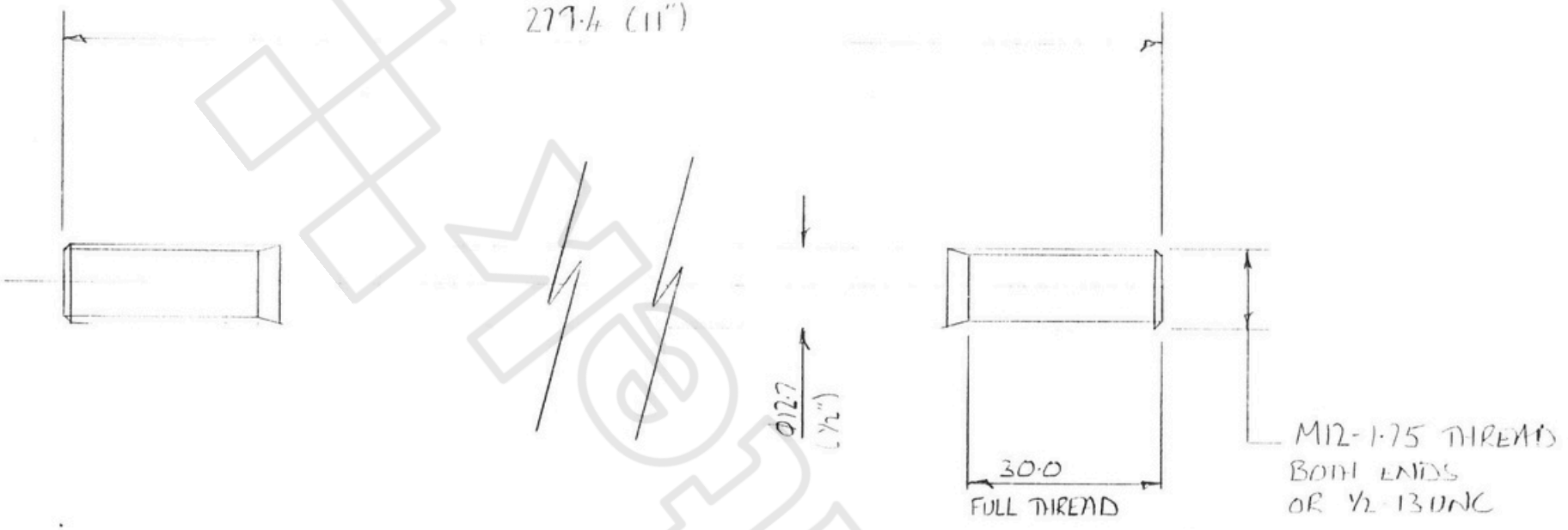


MS 4 ETC ON 'O' RINGS, REMOVE EXCESS, SMEAR SILASTIC ON LANDS ADJACENT TO 'O' RINGS.

UNDER THE SEATING LAND RUN A FILLET OF SILASTIC AT 45° COVERING 1/4 \ 1/2 OF THE WIDTH OF THE FLANGE.

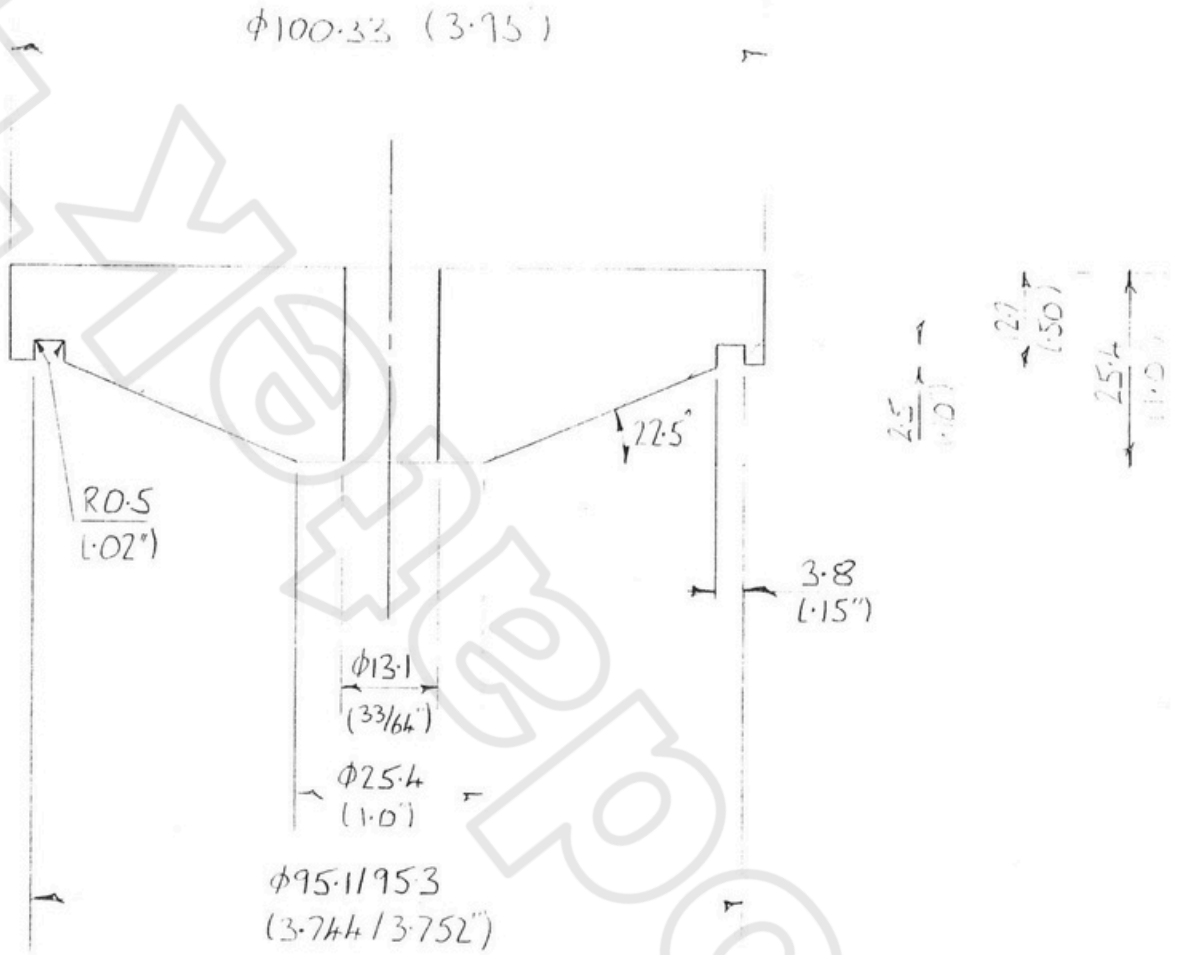


MANDREL - LINER SEATING TOOL
MATERIAL - MILD STEEL EN3B OR ALUMINIUM BAR HE 30 TF



STUD - LINER SEATING TOOL

MATERIAL - MILD STEEL BAR EN.3B



LINEAR SLATING TOOL
MATERIAL - MILD STELL EN3B
UNTOLLERANCED DIMENSIONS ±0.25
ANGLES ± 1°

8c

FITTING PROCEDURE FOR DFR INTERMEDIATE MAIN CAPS

1) Lightly oil the tapered sleeve and refit to its dowel, orientate the slot towards the front of the engine and gently nip the 6/32 S.C.H. to prevent rotation of the sleeve.

2) Apply a thin film of A.S.P. to the main cap (cap to sump mating face). Fit the correct main bearing cap and place a .004" feeler strip between the cap and block on both sides, outboard of the 5/16 studs.

3) Fit the 3/8 and 5/16 washers, lightly oil the stud threads and washer faces, gently and evenly tighten the 3/8 U.N.F. nuts until the main cap lightly grips the .004" feeler strips.

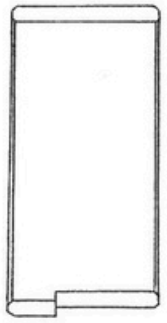
4) Tighten the 6/32 S.C.H., using a standard Allen key only, and remove both .004" feeler strips.

5) Torque the 3/8 U.N.F. nuts to 15 1b.ft, then the 5/16 U.N.F. nuts to 13-14 1b.ft .

6) Finally tighten the 3/8 U.N.F. nuts to 43-45 1b.ft

COSWORTH

CAM BEARING LAYOUT.



PP0593

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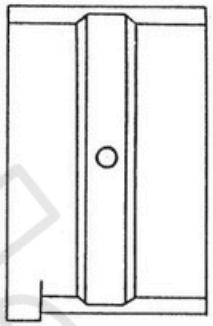
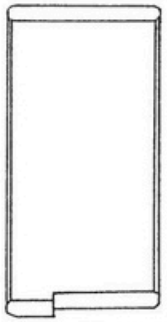


DA1370



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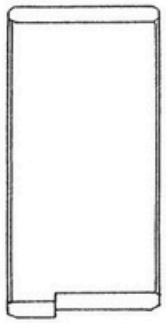

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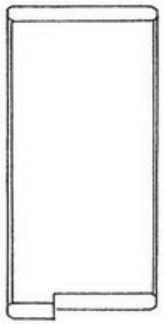
UPPER SHELLS



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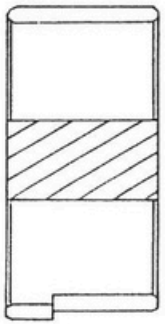

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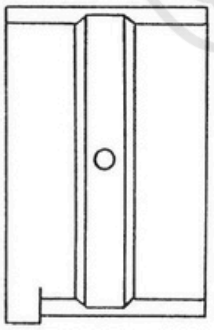

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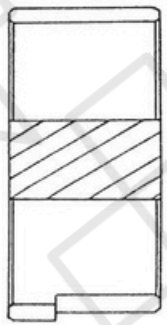
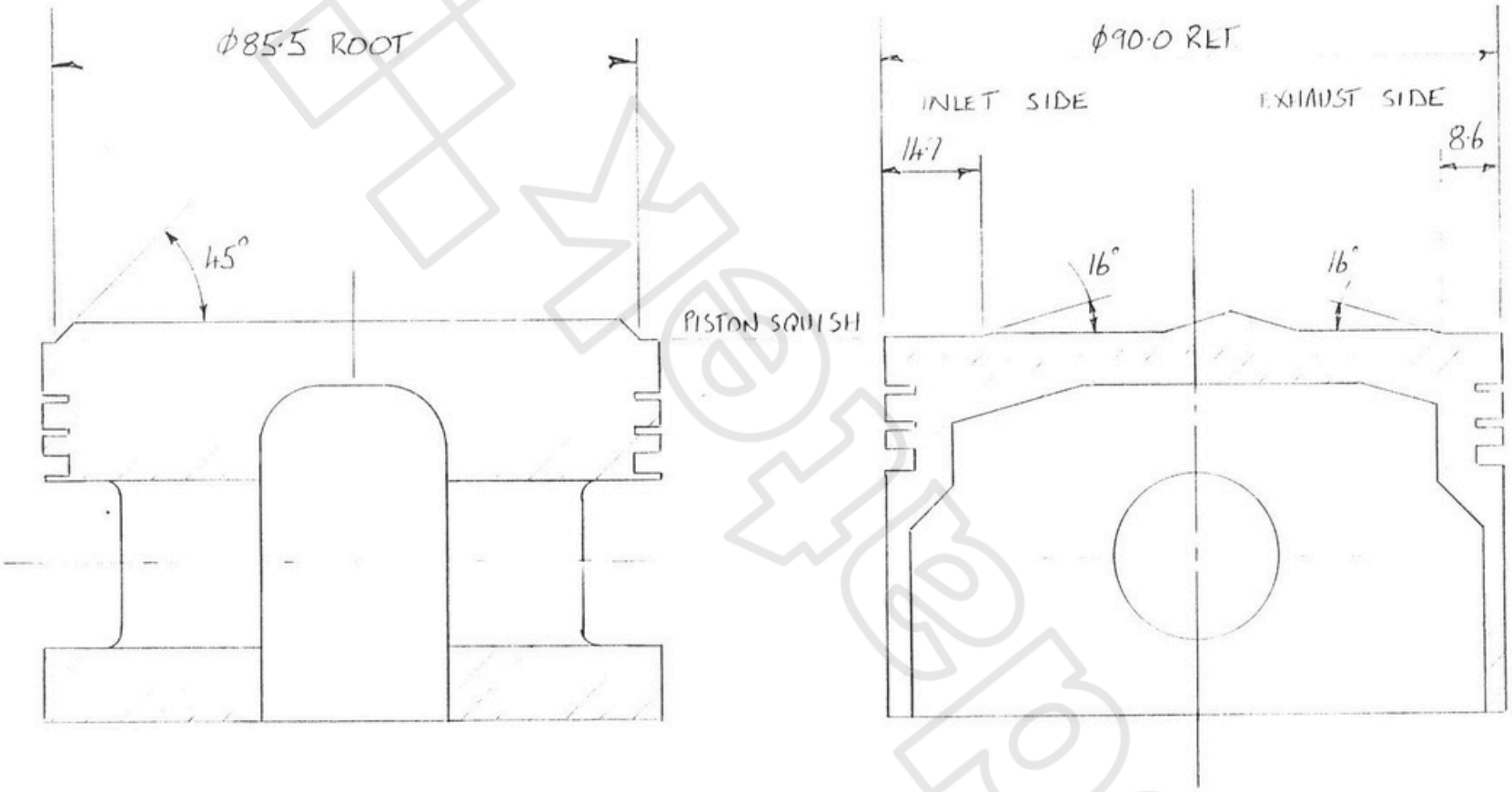


DA0656

PP0593

LOWER SHELLS



PISTON SQUISH MACHINING DETAILS

TIGHTENING SEQUENCE FOR CYLINDER HEADS AND SUMP

Seal the lower crankcase to block mating faces with a thin film of Wellseal applied to the block face.

The cylinder head should be fitted dry.

Ensure that the main cylinder head or lower crankcase 3/8 UNF nuts are fully torqued before tightening the 5/16 UNF side stud nuts.

Tightening sequence, 3/8 UNF nuts.

7 3 1 5 9

FRONT REAR

8 4 2 6 10

Then tighten the side nuts to 13-14 lb.ft, starting from one end and work your way around the component in numerical sequence.

DFR SERVICE ITEMS

The following is a list of items which have a service "life" i.e. components that are replaced after a prescribed amount of running time.

REBUILD ENGINE AFTER 500 MILES.

COMPONENT	MILES	COMMENTS
Pistons	500	
Valve springs	500	
Water transfer tube retaining washers	500	
Throttle rose joints	500	
Throttle position sensor	500	
1st & 2nd compound gear bearings	500	

The condition of the piston rings and liners should be carefully checked. But do not use old cylinder liners with new rings or vice versa.

If the engine has been subjected to 12,000 RPM or more then it must be removed from the chassis and given a full rebuild.

The following is a list of components which must be replaced during the next rebuild, irrespective of its service life, if the indicated R.P.M. has been reached or exceeded.

COMPONENT	R.P.M.
Inlet valves	11400
All valve springs	11400
Exhaust valves	11600
Valve spring retainers	12000
Big end bolts	12000

OTHER WORK IF THE ENGINE REACHES OR EXCEEDS 12000 R.P.M

Check con rods for twist and bend, limits .0025" over a 6" mandrel, do not attempt to straighten rods.

Overhaul the second compound gear.

DFR TORQUE SETTINGS

Note:- Engine oil on threads and underhead unless otherwise stated.

Main cap stud nuts 3/8 UNF	43-45 lb.ft
Main cap stud nuts 5/16 UNF	13-14 lb.ft
Big end bolts	41-42 lb.ft *
Main bearing stud nuts 3/8 UNF	43-45 lb.ft
Sump side nuts 5/16 UNF	13-14 lb.ft
Cylinder head stud nuts 3/8 UNF	48-50 lb.ft
Cylinder head side stud nuts 5/16 UNF	13-14 lb.ft
Cam cap stud nuts 5/16 UNF	13-15 lb.ft
Cam gear socket caps 1/4 UNF	16-18 lb.ft
Cam cover socket caps 10-32	32-35 lb.ins.
Alternator drive quill	27-29 lb.ft *
Rotor arm carrier soc. cap	12 lb ins
Phase trigger bolt	35 lb.ft
Flywheel bolts	53-55 lb.ft *
Crankshaft trigger bolt	70 lb.ft
Clutch bolt nuts	13-15 lb.ft
Auxiliary pump pulleys	40 lb.ft
2nd compound pulley	32 lb.ft
All 1/4 UNC soc. caps	46-48 lb.ins

* NOTES;

Big end bolts; Use anti scuffing paste underhead, engine oil on threads.

Flywheel bolts; Do not use Loctite.

Alternator quill; Use Loctite 602 on threads, Torque up using a Cosworth adaptor.

Screw bungs in cylinder head are fitted with Silastic.