D. NAPIER & SON LIMITED

SERVICE DEPARTMENT INSTRUCTION SCHOOL

COURSE NOTES

ON

THE DELTIC ENGINE TYPE T18-37K

These notes are issued in conjunction with a lecture course given at the Service Department Instruction School. They are intended to provide instructional reading for the Students and should not be quoted as an authority on official matters.

The authority for technical questions is the official Handbook for Napier Deltic Engines, Publication 500 Series.

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INTRODUCTION

TO THE T18-37K COURSE NOTES

Napier "Deltic" engines are water cooled, compression ignition engines, operating on the two stroke cycle.

The name Deltic is derived from the Greek letter 'delta' and has been chosen because of the triangular cross section of the engine, each cylinder block forming a side of an equilateral triangle with a crankcase at each apex. As the engine is an opposed-piston type this arrangement enables each crankshaft to serve cylinders in adjacent cylinder blocks, two connecting rods being attached to each crankpin.

Apart from the arrangement of the cylinder blocks and crankcases, Deltic engines are straight-forward high-speed, two stroke, uni-flow engines that are pressure-charged and liquid-cooled. During the design and development of these engines only well known and well tried engineering practices were used.

The Deltic was originally conceived as an engine to power fast patrol boats of the Royal Navy, the development of this engine being placed in the hands of D. Napier & Son in 1946. From the original conception the 'Deltic' has been 'Born' in many forms, these course notes cover the Type T18-37K Engine.

DEFINITIONS

In the basic design and also in the course of development of the Deltic, there arose various practices and terms which although not new, may not be fully understood since their use is, to a greater or lesser degree uncommon.

These are listed below and explained.

a) Opposed pistons

This system has been used previously, as for example in the German Junkers Jumo engine, and proved highly satisfactory; it comprises the use of two pistons connected to separate crankshafts operating in one cylinder, the space between them forming the combustion space. In the case of the Deltic, each piston controls the opening and closing of inlet and exhaust ports respectively. A further advantage of the opposed piston system exists, in that the necessity for a cylinder head is dispensed with. This enables a large saving in weight to be made and a consequent improvement in the power/weight ratio.

b) Turbo-Blower

When using the two-stroke cycle of operation, it is necessary to ensure that complete cleaning of the exhaust gas, and subsequent filling of the cylinder with air is completed in a single cycle. In order to accomplish this, use is made of a turbo-blower to supply pressurized air to the cylinders.

The cylinder porting is arranged so that both inlet and exhaust ports are open at the same time over a certain period. This allows the air under pressure to pass right through the cylinder driving the exhaust gas before it. The exhaust port then closes before the inlet, ensuring that the cylinder is full of uncontaminated air ready for combustion. This system of scavenging is known as "Uniflow" i.e. the scavenge air passing from the inlet end to the exhaust end of the cylinder.

c) Swirl .

This term is used to describe the rotational movement of the air supplied by the blower on entering the cylinder. This movement is essential to ensure full scavenging of the cylinder and also efficient mixing of the air with the fuel injected subsequently. The swirl movement is imparted to the air entering the cylinder by tangentially cut inlet ports.

d) Quill-shaft

A method of coupling a driving and driven component in an engine which is used extensively in the Deltic. It comprises a shaft at either end of which are splines mating with the two components. Quill-shafts have the advantage of being to some degree self aligning and can be designed and produced in a material which will provide for a degree of torsional flexibility.

e) Phasing

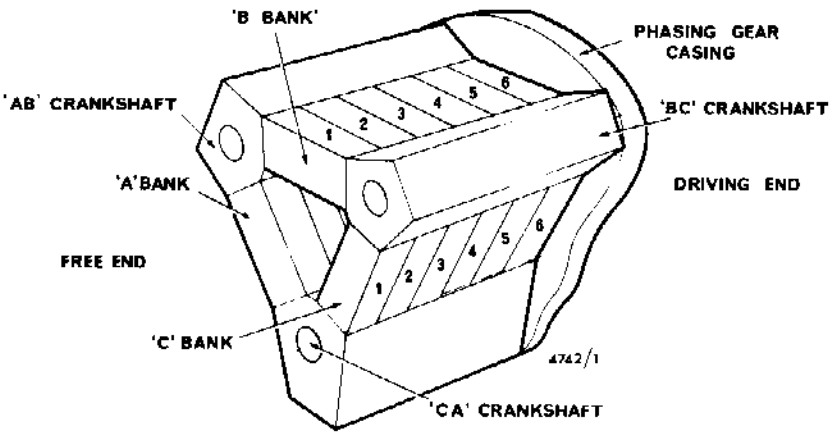
When two or more crankshafts are used it is essential that the timing of these relative to each other is correct. This is termed "Phasing" and a phasing gear case is provided for this purpose. The term is also used on the Deltic to denote the angular difference in position between the inlet and exhaust pistons.

f) Barber Colman splines

A design of spline which, being cut in the form of a taper, combines the advantage of a taper shaft and parallel splines to transmit the drive.

g) Vibration dampers

Since all crankshaft systems suffer from torsional vibration at certain speeds, vibration dampers are fitted to one end of each crankshaft while the drive is taken from the opposite end by means of a quill-shaft. By suitable "tuning" of the damper and quill-shaft, this vibration band can be placed outside the normal running range of the engine.



IDENTIFICATION

IDENTIFICATION

Throughout these course notes, references to components of the engine identify them in accordance with the principles laid down by the British Standard Specification 1599: 1949. Thus the end of the engine remote from the driving end is termed the free end.

Viewed from the free end, the cylinder blocks at the left hand top, and right hand sides are identified by the letters 'A', 'B', and 'C' respectively. The cylinders in each block are numbered from the free end. The left and right hand sides of the engine, when viewed from the free end are identified by the letters 'A' and 'C'. Since the crankcases each serve two cylinder blocks, they are identified by the combined letters of the two adjacent blocks i.e. 'AB' 'BC' 'CA'. The pistons are identified by the particular cylinder in which the piston lies and by the port it controls. e.g. 'C2 inlet' piston.

The serial number of each major unit is on a plate affixed to that unit. The serial number of the engine is on a plate affixed to 'C' side of 'BC' crankcase.

DELTIC ENGINE TYPE

T18-37K

LEADING PARTICULARS

Engine Type	T18-37K
Description	Opposed-piston, liquid cooled, two-stroke, compression-ignition engine with mechanically assisted turbo-blower.
Number of cylinders	Eighteen
Arrangement	Three banks of six cylinders forming a triangular configuration.
Overall Dimensions	Length 154in(391.2cm) Width 75in(190.5cm) Height 84in(213.3cm)
Bore	5.125 in (130.17mm)
Stroke	7.25 in x 2 (184.15mm x 2)
Swept Volume	5,384 in^3 (88.3 l)
Compression ratio	17.9:1 Nominal. 13.8:1 Effective
Expansion ratio	12.2:1
Rated Output - b.h.p.	At 2100 c rev/min 3100 b.h.p.
Piston speed at 2100 c rev/min.	2538 ft/min (12.89 m/sec)
B.m.e.p. at Rated Output	108.5 lb/in^2 (7.62kg/cm^2)
Turbo-Blower	
Type - Turbine	Triple entry, single stage
Blower	Single stage, single speed, double entry, centrifugal.

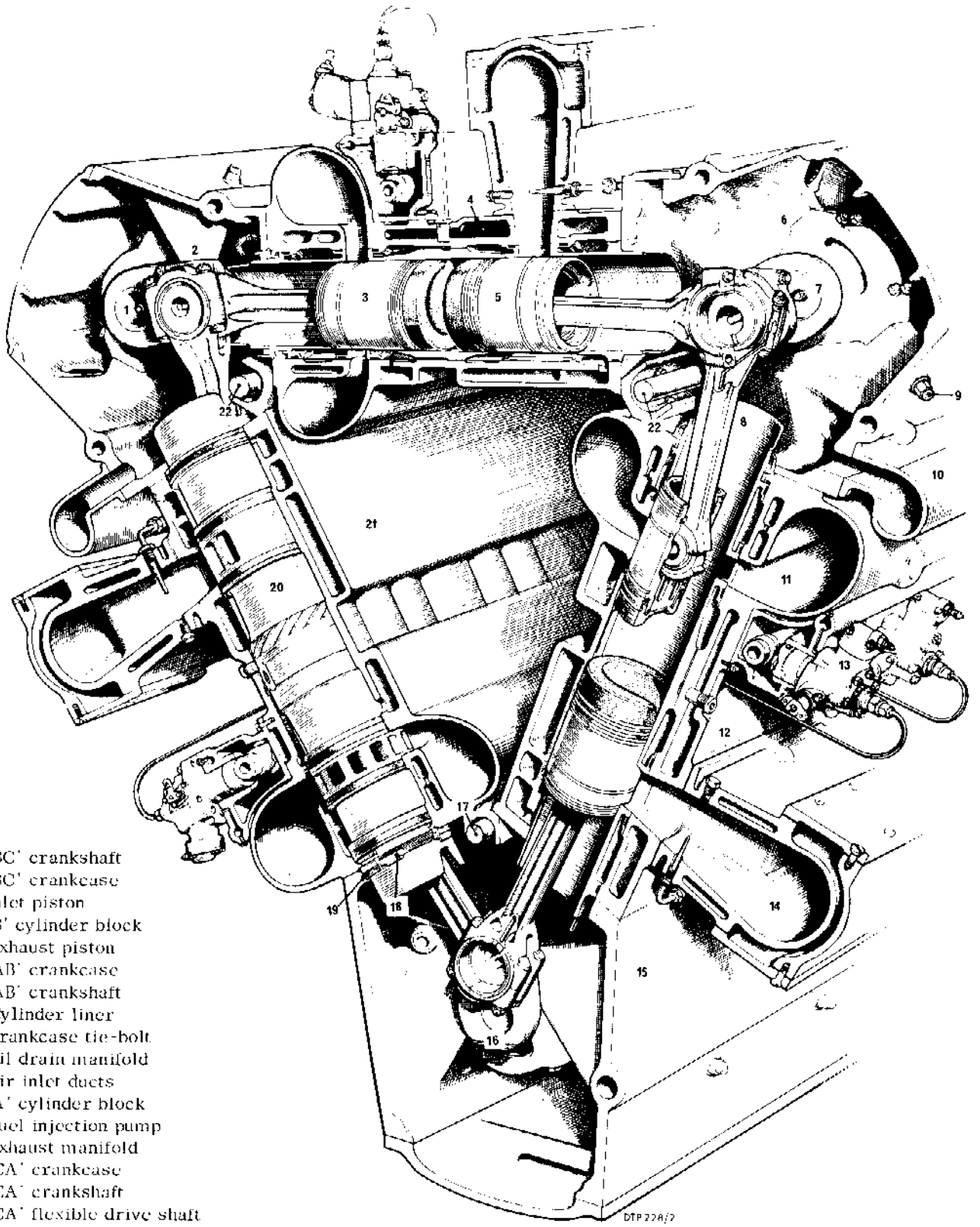
Turbine Wheel . . .	18.042in (45.82cm)
Impeller diameter . . .	15.5in (39.37cm)
Pressure - Blower at rated output . . .	19.01b/in^2 (1.336 kg/cm^2)
Gear Ration - Compressor/ Engine . . .	8.266:1
- Compressor/ Turbine . . .	1.322:1
Fuel - Specification . . .	Diesel fuel B.S. 2869 Class A
- Specific Gravity . . .	0.83 at 60° F.
Net calorific value . . .	18,400 Btu/lb
Circulating Pressure . . .	201b/in^2
Injection Pump . . .	Napier C.A.V. Type FM-120-B6 one per cylinder.
Injector . . .	C.A.V. Type B.D.L. 155 6247 one per cylinder.
Lubrication	
Lubricating Oil . . .	See approved list.
Consumption at 1800 c rev/min . . .	9 Imp.pint/hr
Main Pressure . . .	801b/in^2 nominal (Max rev/min)
Cooling Type . . .	Closed coolant circuit with sea water cooled heat exchanger.
Coolant . . .	Inhibited ethylene glycol mixed 30 parts to 70 parts by volume with distilled or chloride free, soft or artificially softened water.

Approximate Weight Summary

	lb	kg
Net dry weight of engine complete with gearbox . . .	13,630	6182.6
Bi-directional gearbox . . .	2580	1170.3
Phasing gear case . . .	1660	753.0
Turbo blower . . .	1181	535.7
Coolant (engine, and exhaust manifolds only and turbo blower) . . .	450	204.1

Speeds and Rotations

Crankshaft Rotation . . .	'AB and 'BC' Clockwise. 'CA' Anti-clockwise	
Output Shaft		
Gear ratio . . .	Clockwise	1.8574:1
. . .	Anti-clockwise	1.8574:1
Speed maximum . . .	Clockwise	1131 rev/min
	Anti-clockwise	1131 rev/min



1. 'BC' crankshaft
2. 'BC' crankcase
3. Inlet piston
4. 'B' cylinder block
5. Exhaust piston
6. 'AB' crankcase
7. 'AB' crankshaft
8. Cylinder liner
9. Crankcase tie-bolt
10. Oil drain manifold
11. Air inlet ducts
12. 'A' cylinder block
13. Fuel injection pump
14. Exhaust manifold
15. 'CA' crankcase
16. 'CA' crankshaft
17. 'CA' flexible drive shaft
18. Liner retaining ring nut
19. Locking washer
20. Cylinder liner
21. 'C' cylinder block
22. Blower drive shafts

SECTION THROUGH NO. 2 CYLINDERS (FROM D-E)