THE DIESEL ENGINE

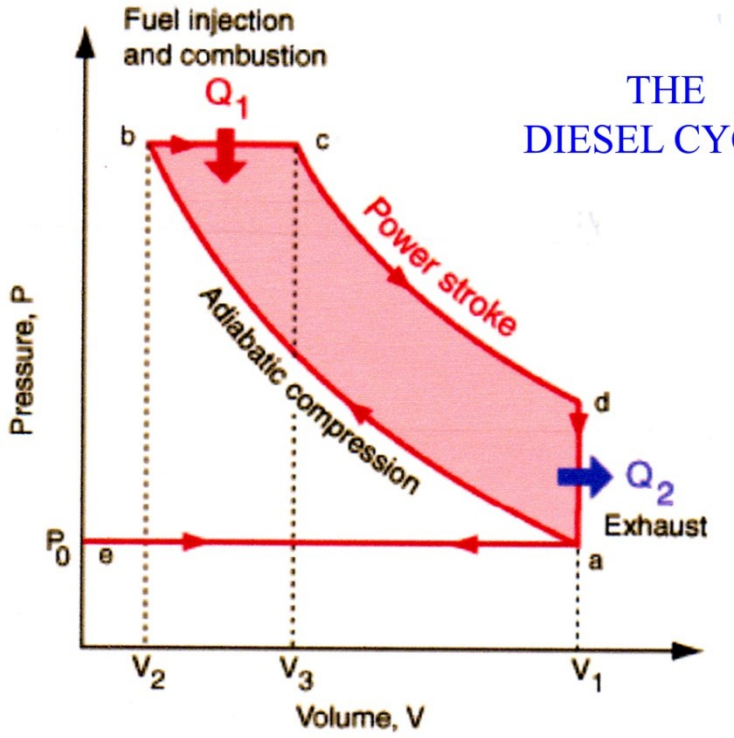
From Dr. Diesel to the local companies John G. Kincaid and Scotts' who built Slow Speed Diesel Engines mainly for Ships

Dr. Rudolf Diesel

Born in Paris 18th March 1858
of German Parents

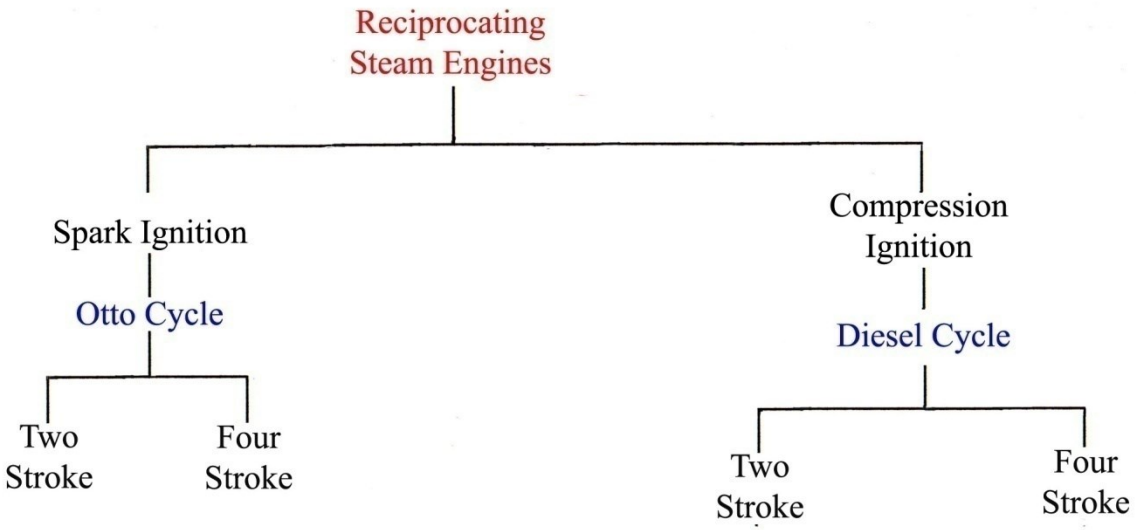
Was granted Patent 608,845 for
an Internal Combustion Engine

Died 29th September 1913
by accidental Drowning

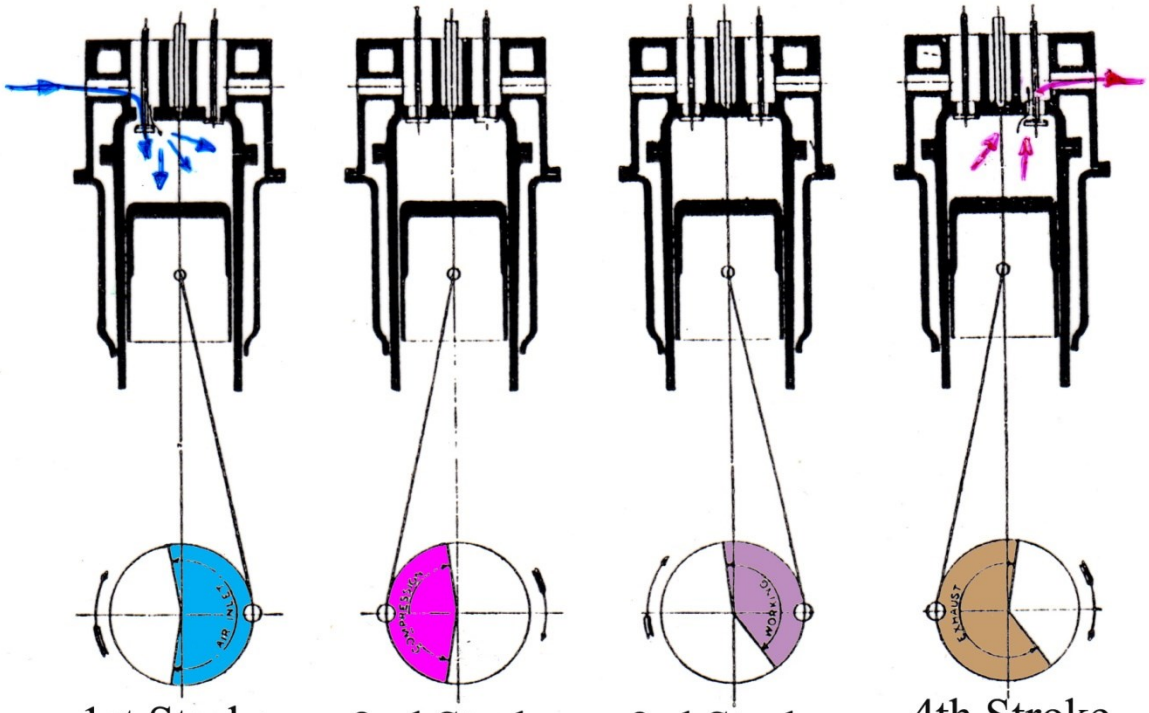


THE
DIESEL CYCLE

The Diesel Engine



Four Stroke Cycle



1st Stroke
Charging

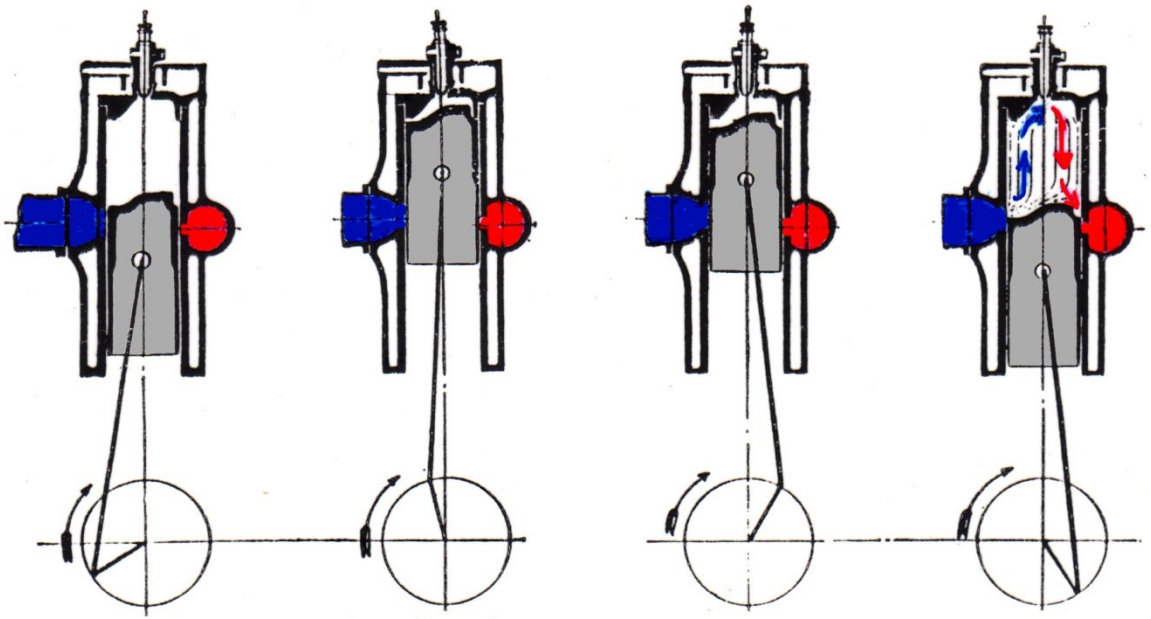
2nd Stroke
Compressing

3rd Stroke
Working

4th Stroke
Exhaust

Two Stroke Cycle

Typical of Large Diesel Engines



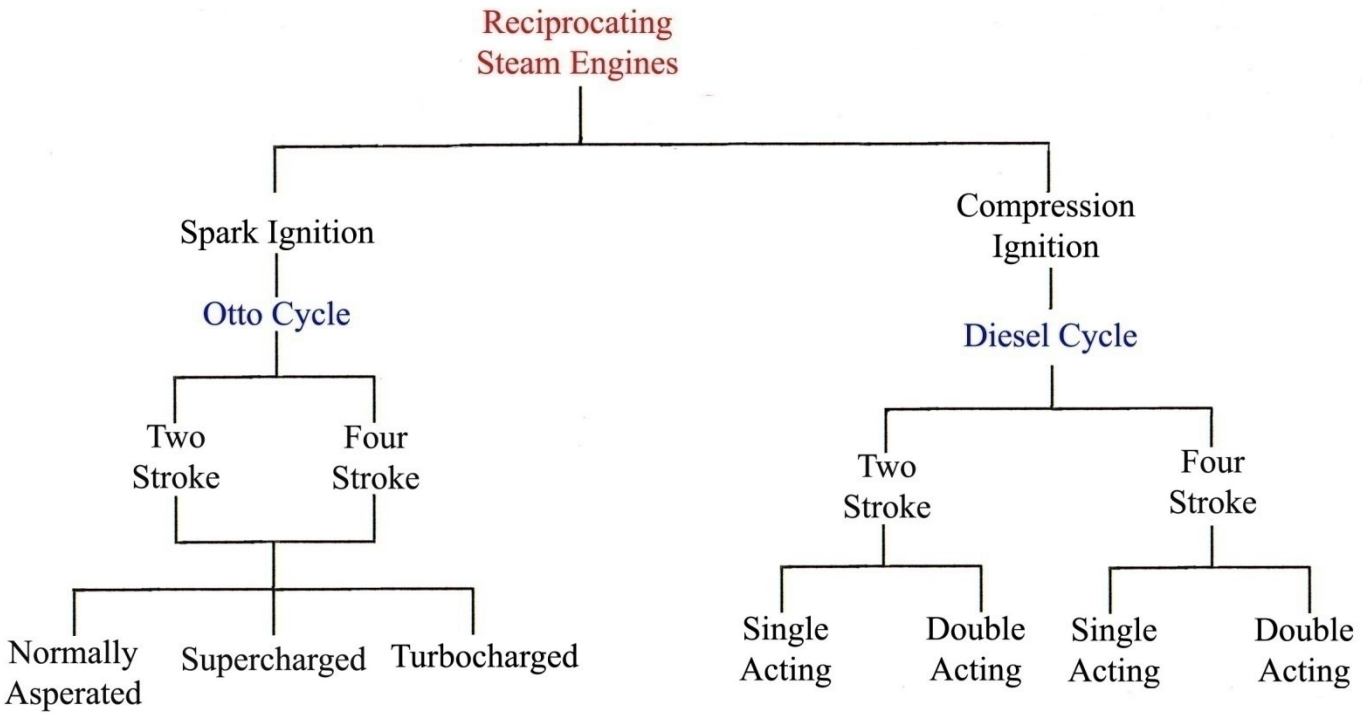
1st Stroke Compressing

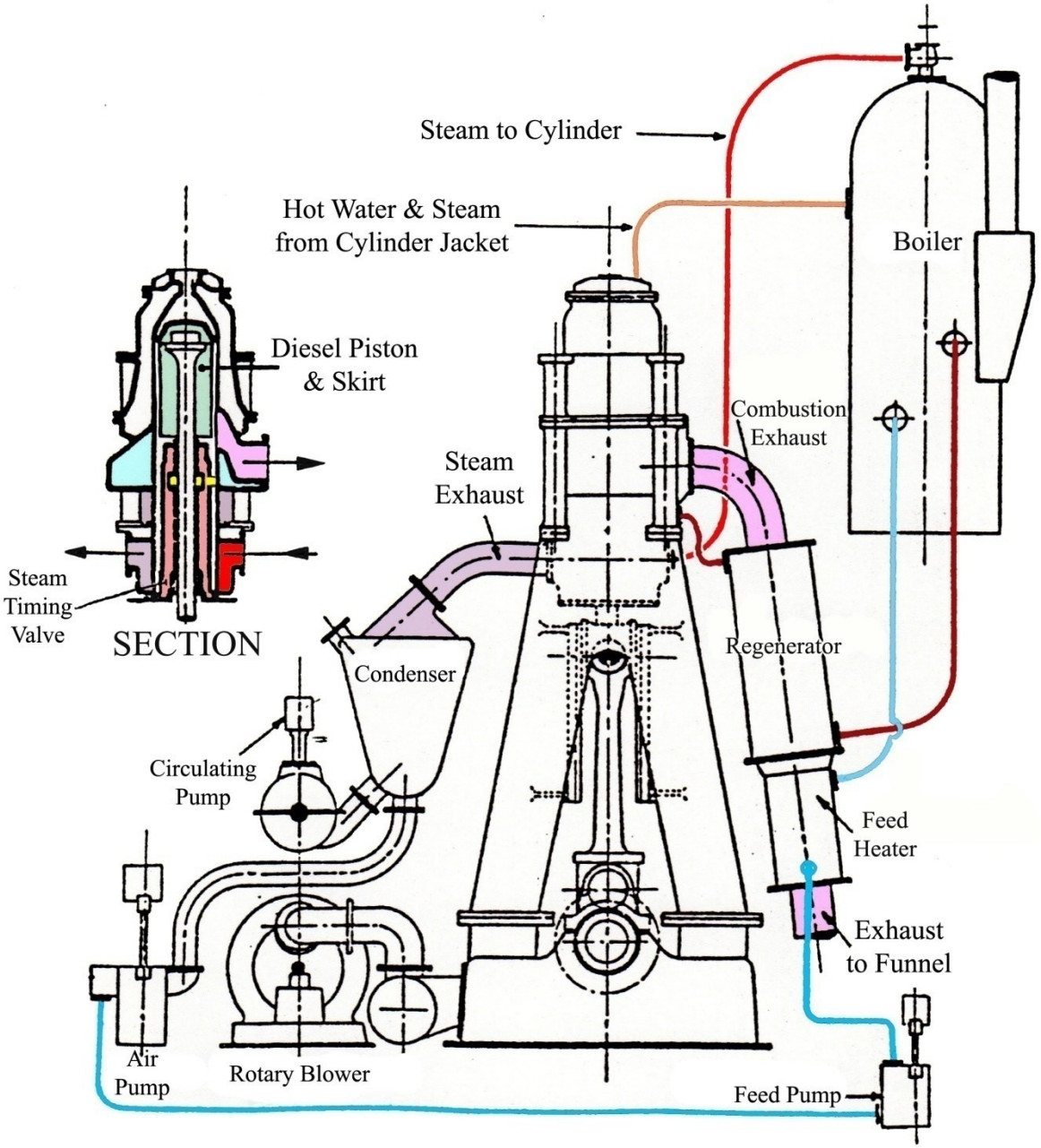
1st Stroke Injection

2nd Stroke Ignition

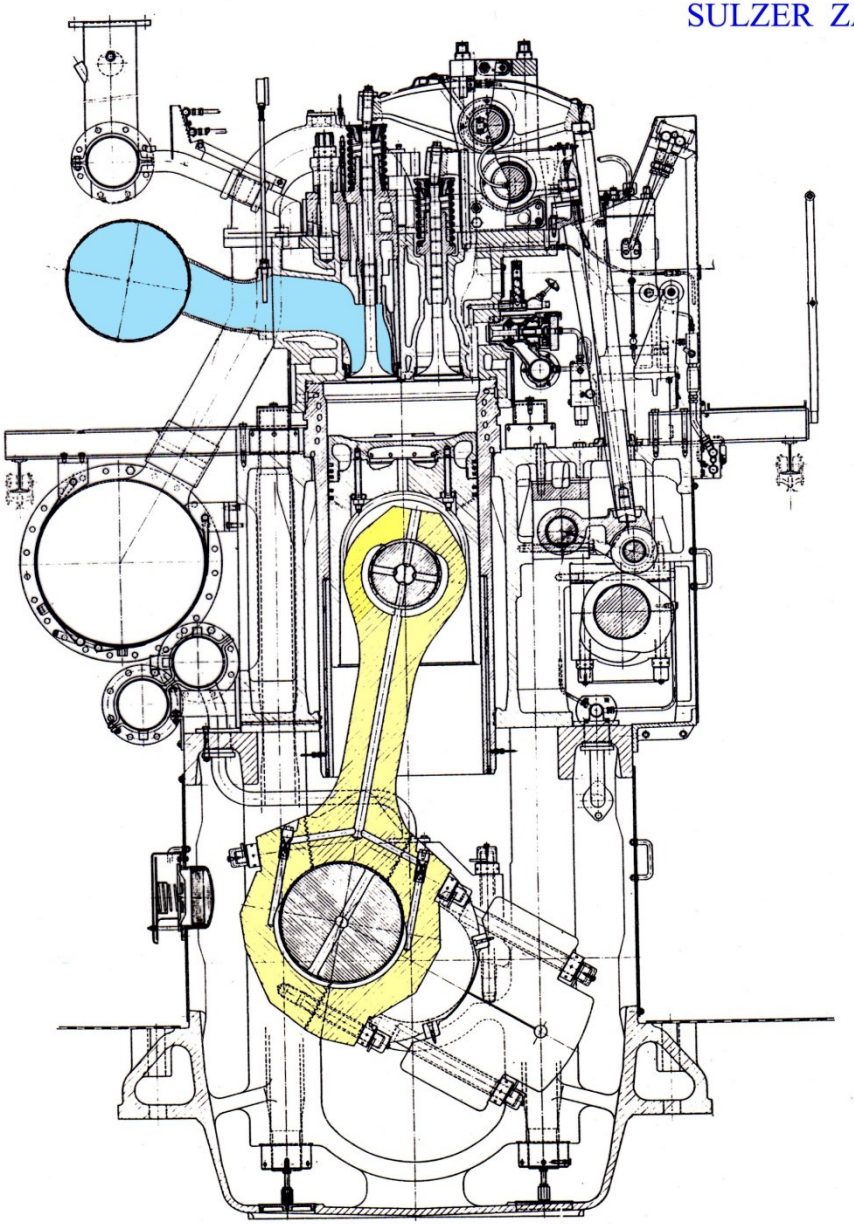
2nd Stroke Expansion Exhaust

The Diesel Engine



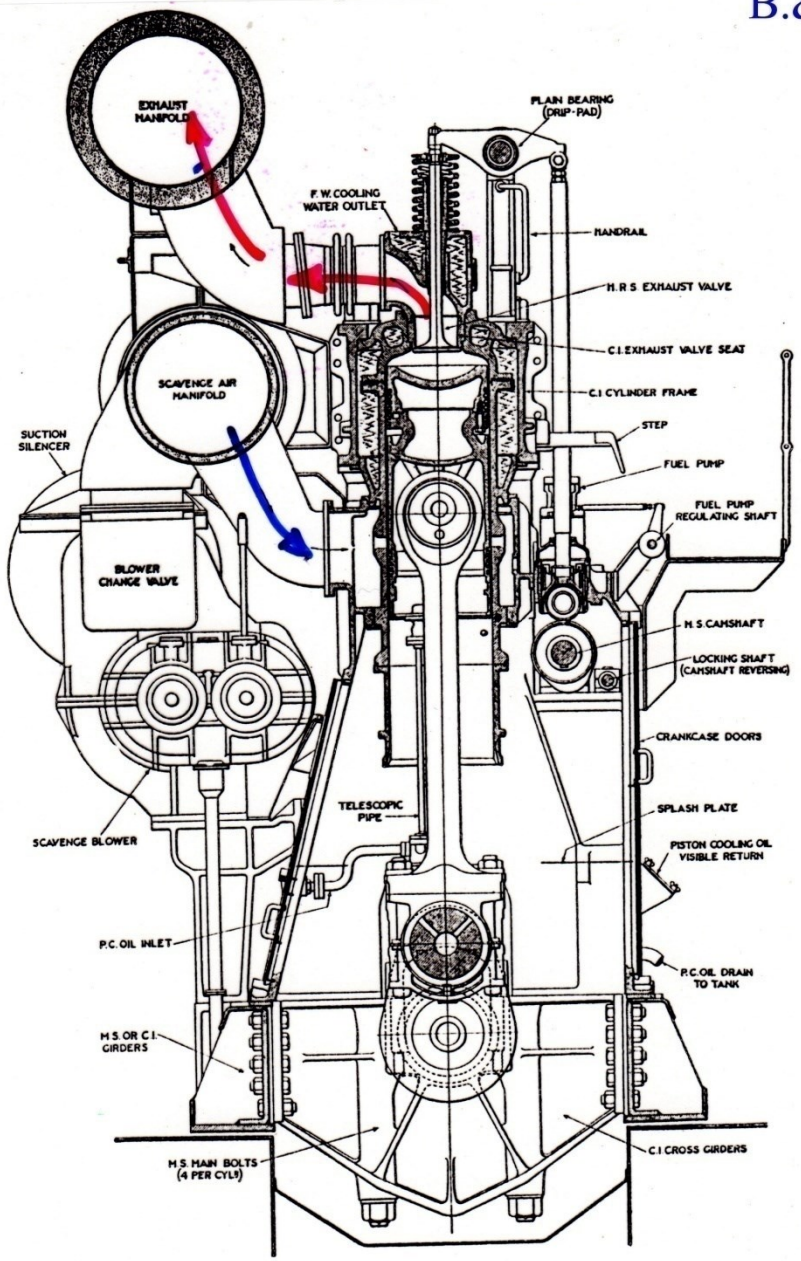


Arrangement of Still Engine



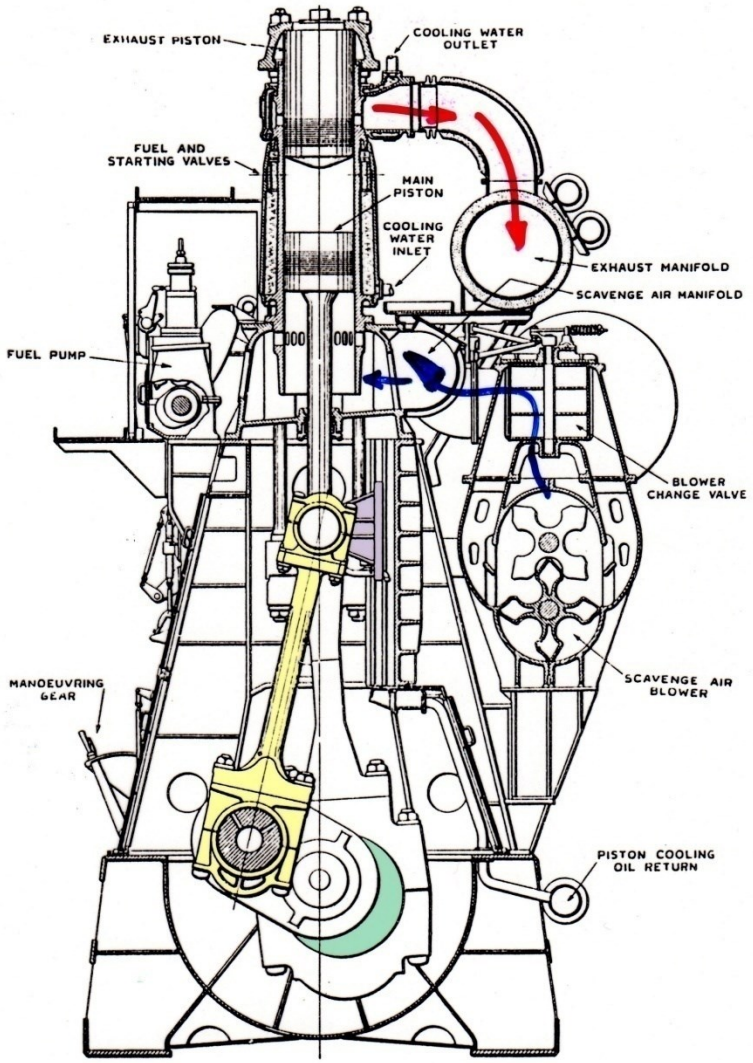
Normally Asperated Single Acting Trunk Piston
Four Stroke Diesel Engine

B.&W.



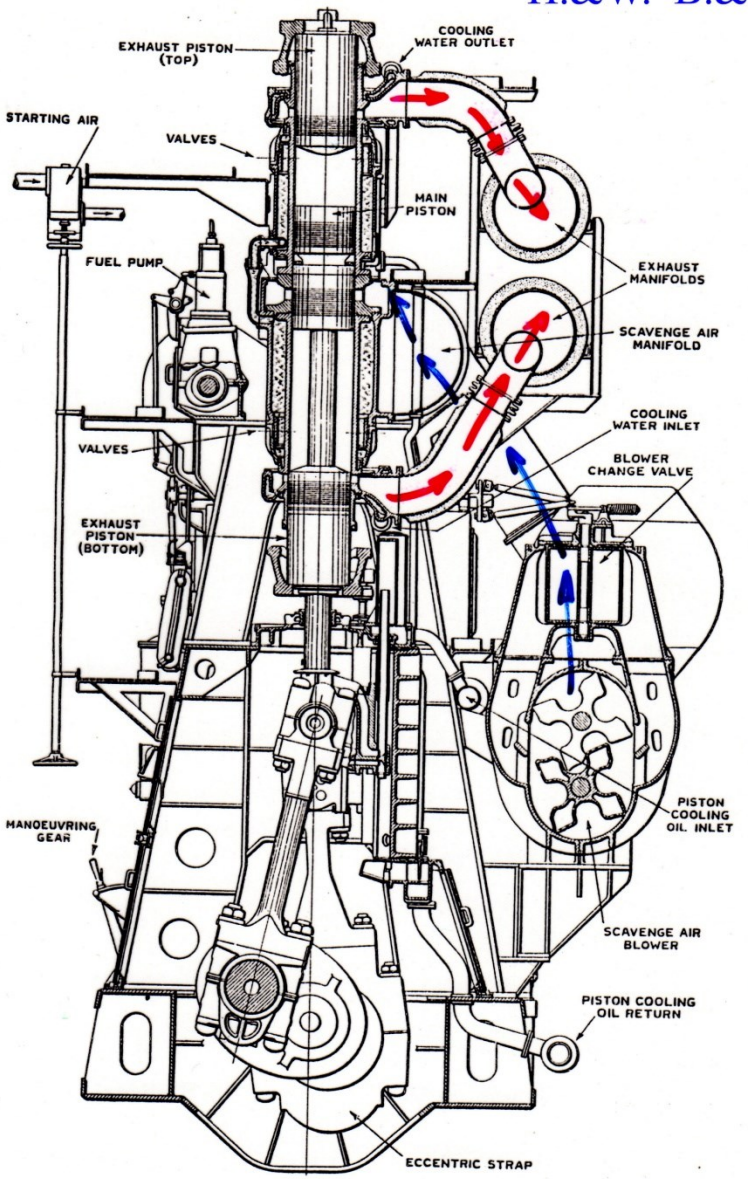
Single Acting Trunk Piston Two Stroke
Supercharged Diesel Engine

B.&W.



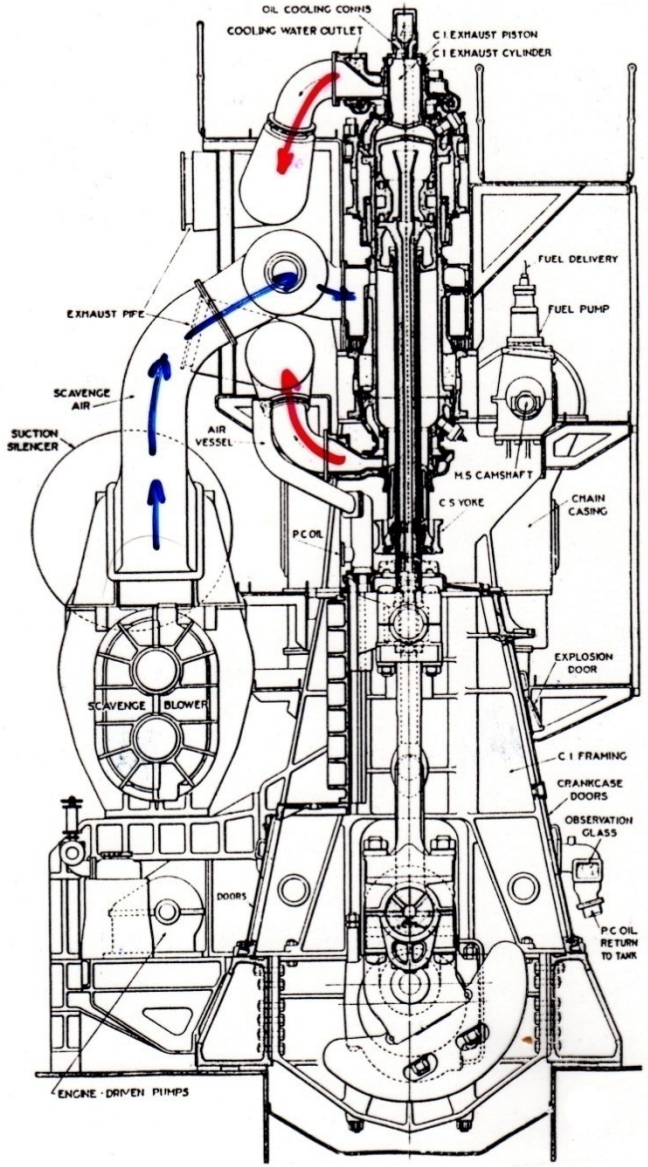
Single Acting Opposed Piston Crosshead Supercharged Diesel Engine

H.&W. B.&W.



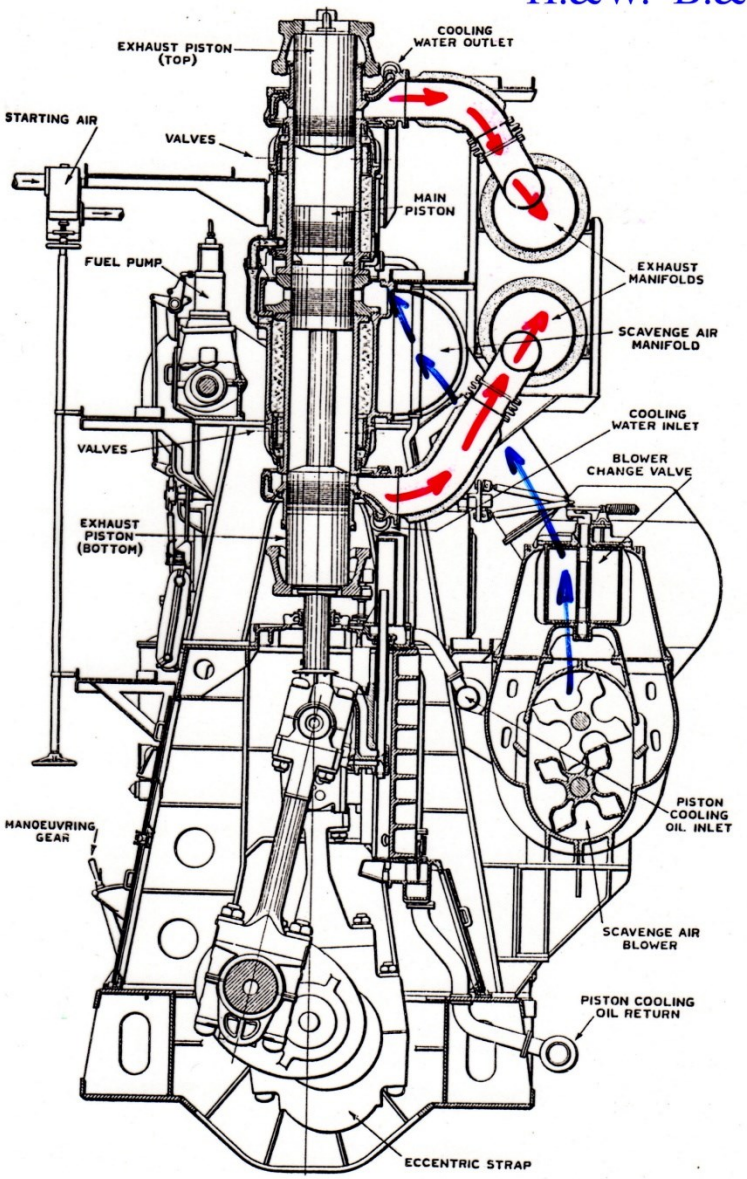
Double Acting Opposed Piston Crosshead
Supercharged Diesel Engine

B.&W.

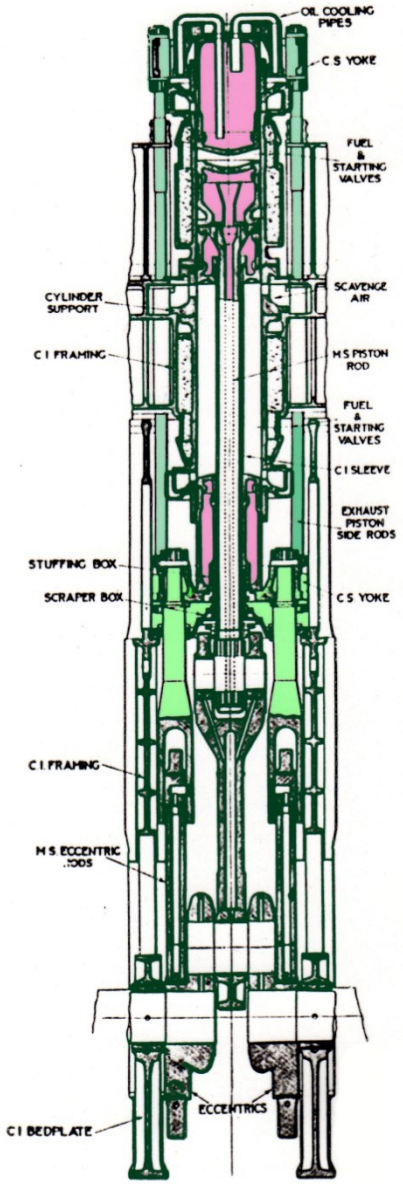


Double Action Opposed Piston Crosshead
Supercharged Diesel Engine

H.&W. B.&W.

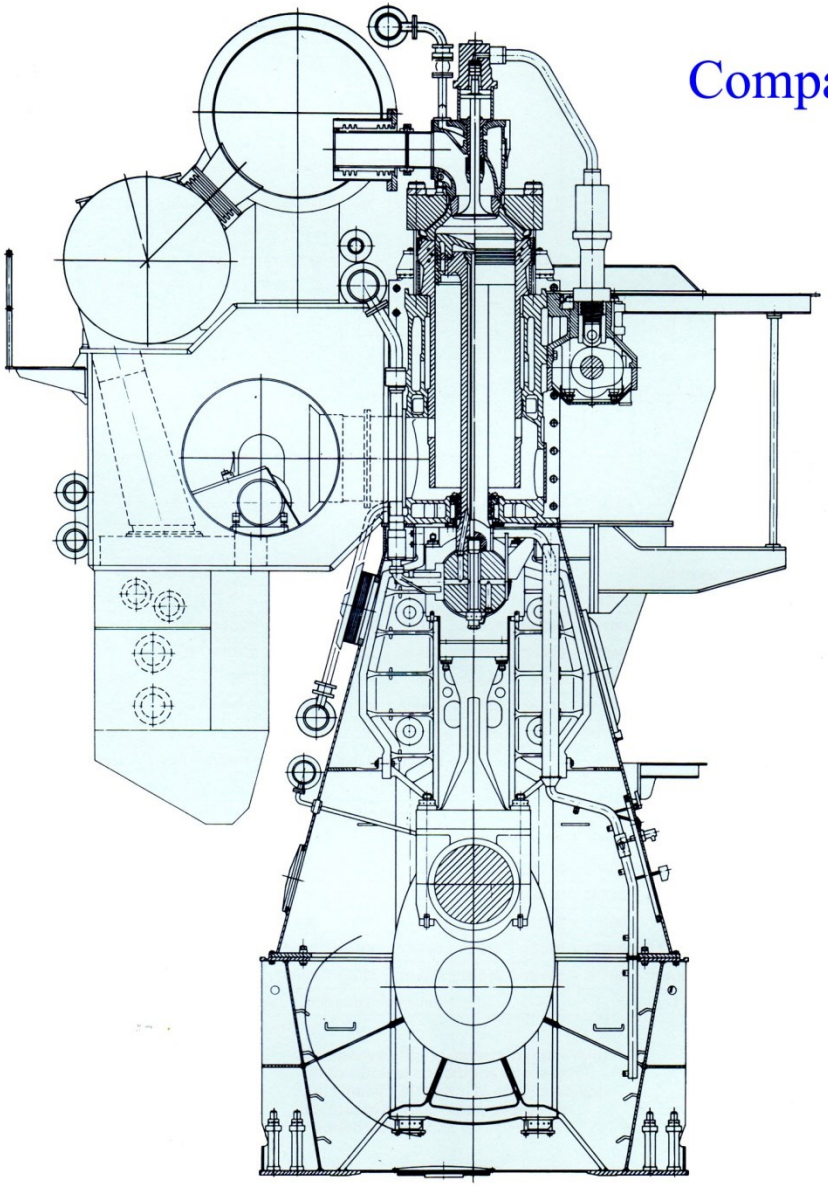


Double Acting Opposed Piston Crosshead
Supercharged Diesel Engine

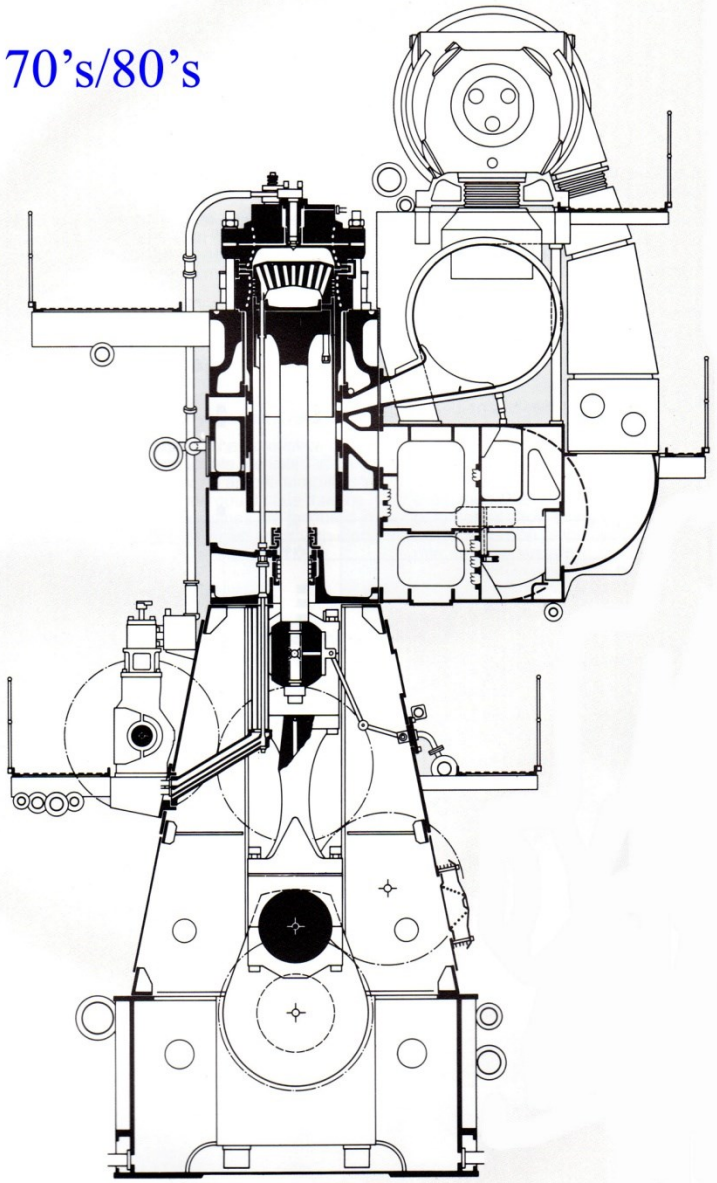


Section Through Double Acting
Double Opposed Piston Engine

Comparison at 70's/80's

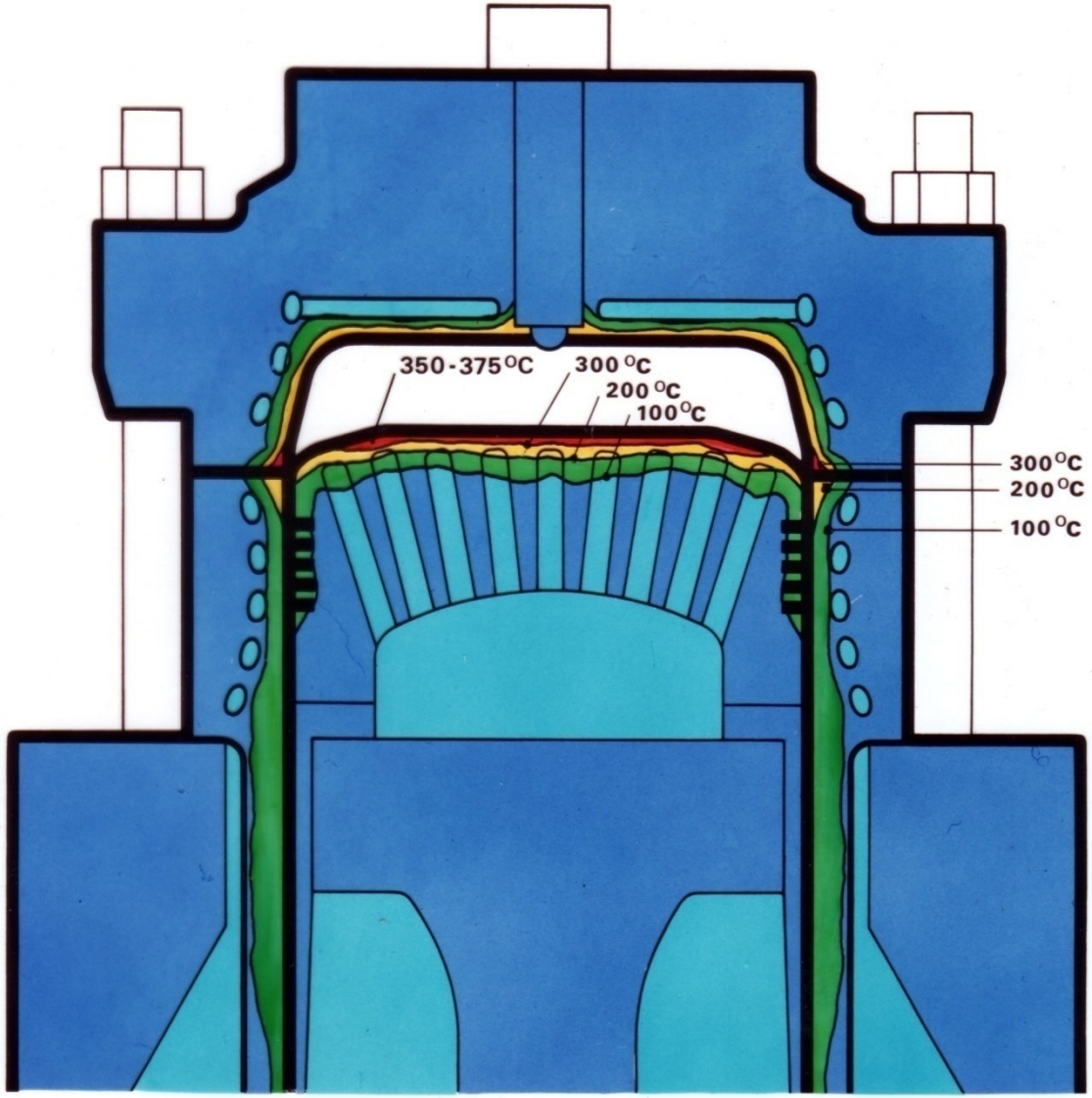


M.A.N. - B.&W. GB/GBE



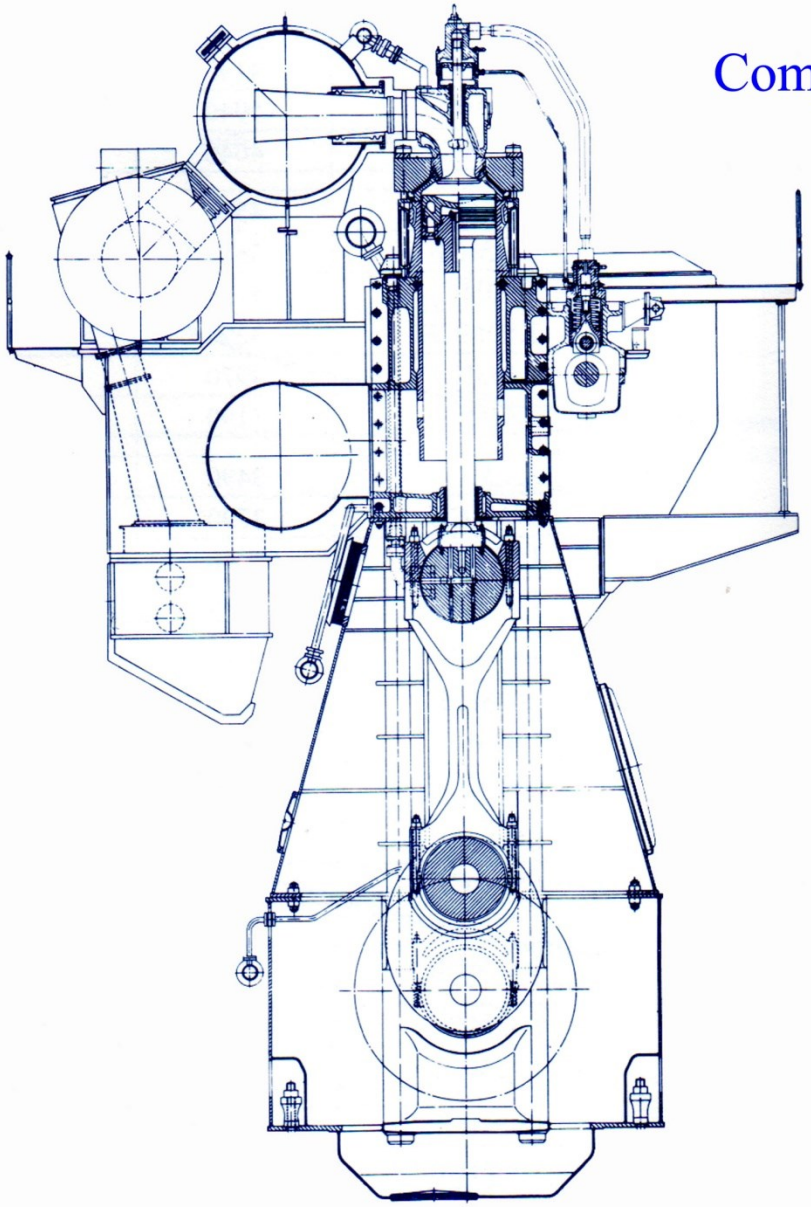
SULZER RND..M

- No valves — no hot spots
- Simple shape of combustion space
- Optimum bore-cooling
- Controlled cylinder lubrification
- No system oil contamination (stuffing box)
- Long time interval — complete combustion

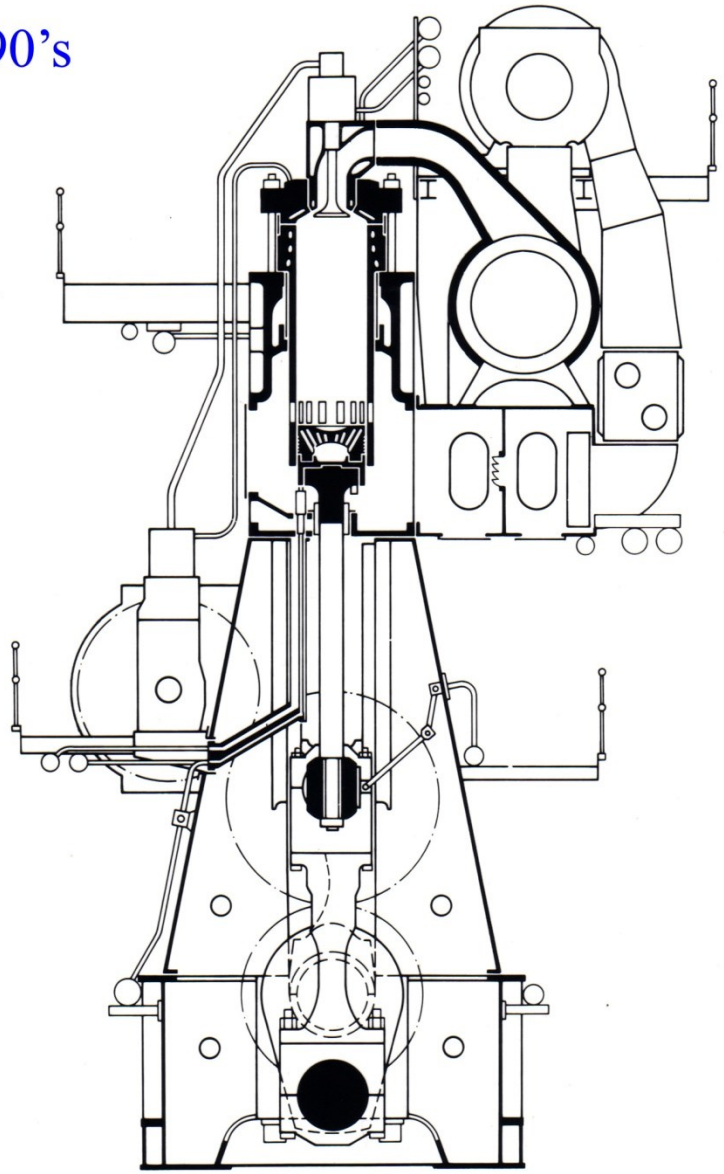


SULZER RND..M Cylinder Cover & Piston

Comparison 90's

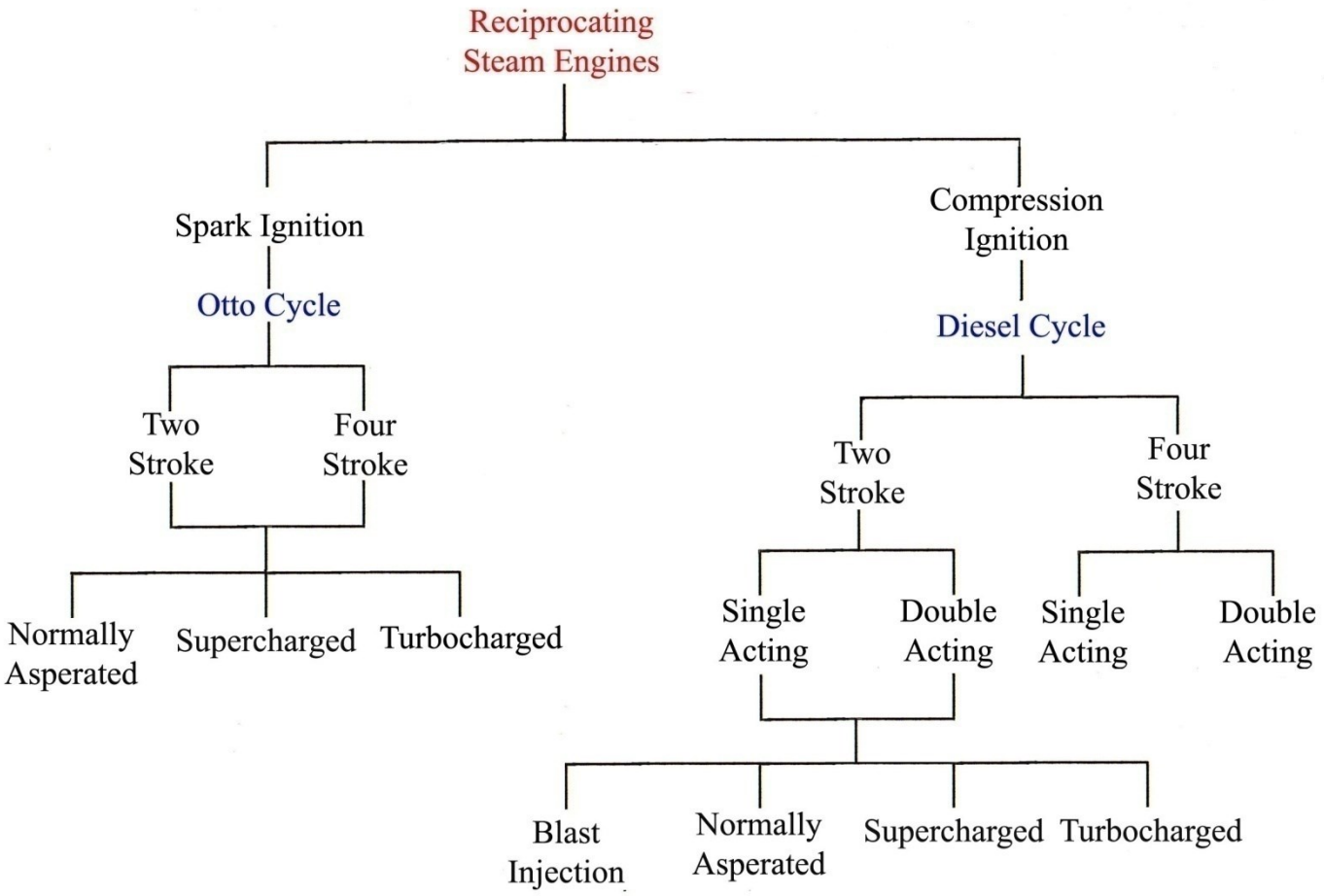


M.A.N. B.&W. K MC



SULZER RTA

The Diesel Engine



AIR-BLAST INJECTION

Early Diesel Engines including Dr. Diesel's were supplied with fuel atomised and delivered by Compressed air and forced into the cylinder via a nozzle - similar to a carburator on a petrol engine.

NORMALLY ASPERATED

The air required to clear out the exhaust gas and charge the cylinder for the next combustion cycle is at atmospheric pressure, although in the larger crosshead type engines this air is boosted by being compressed by the underside of the piston prior to entering the cylinder.

SUPERCHARGED

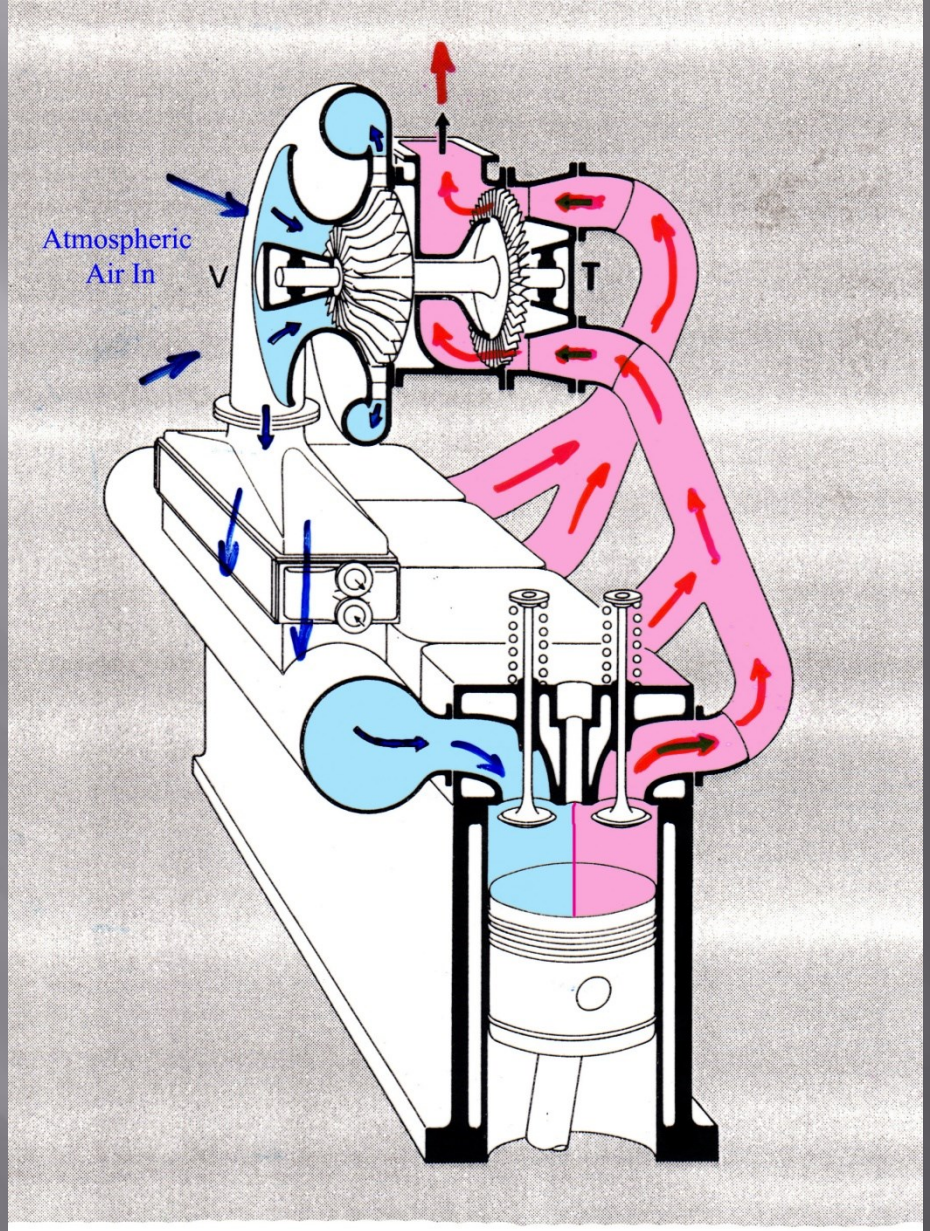
An engine is said to be supercharged when it is supplied with air at relatively low pressure (a few pounds per square inch) supplied by geared Engine driven or motor driven rotary compressors. While the additional air thus supplied allows more fuel to be burnt efficiently per stroke, thereby increasing the power output, unfortunately the power required to supply the excess air more or less equates to the power increase obtained.

The advantage is more power to the shaft at no increase in engine size.

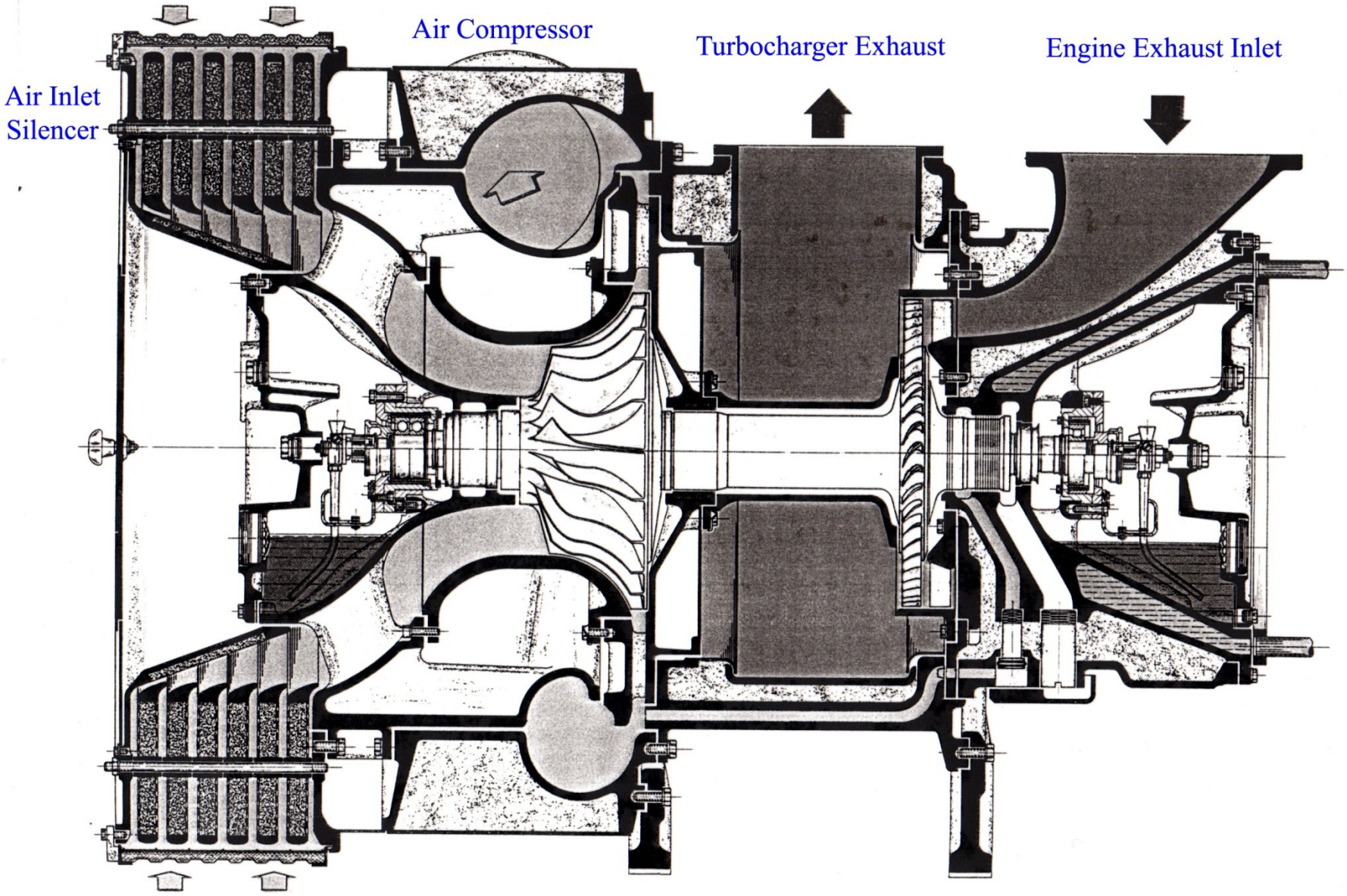
TURBOCHARGED

Turbo charged engines utilise the energy left in the engine exhaust to drive a gas turbine which in turn drives a rotary air compressor on the same shaft supplying high pressure air (up to 2 bar)

As with the supercharger this increases the power output, although in this case the advantage comes relatively free after the initial on cost of a turboblower installation and allows for considerable power/weight advantage over the alternatives.

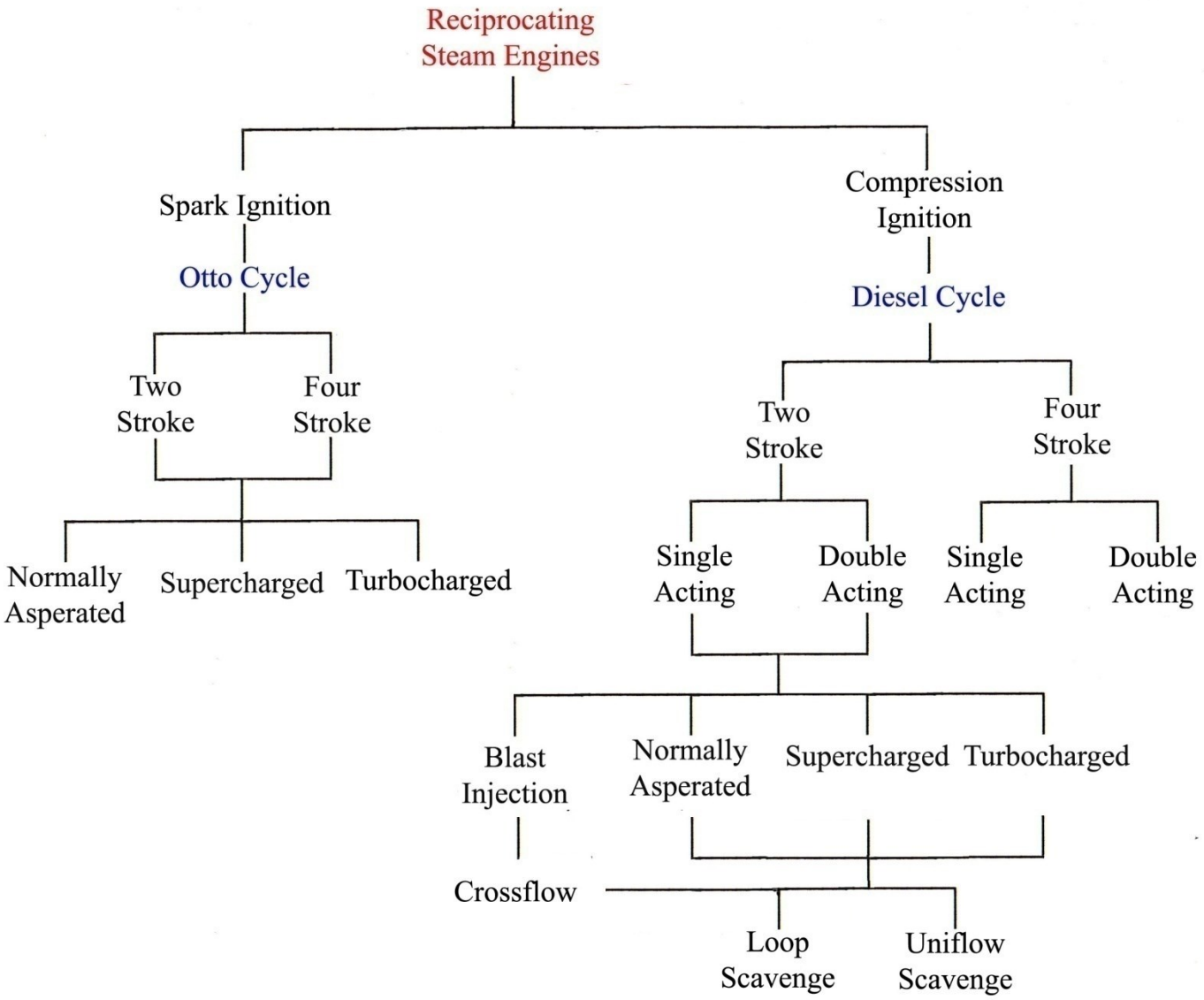


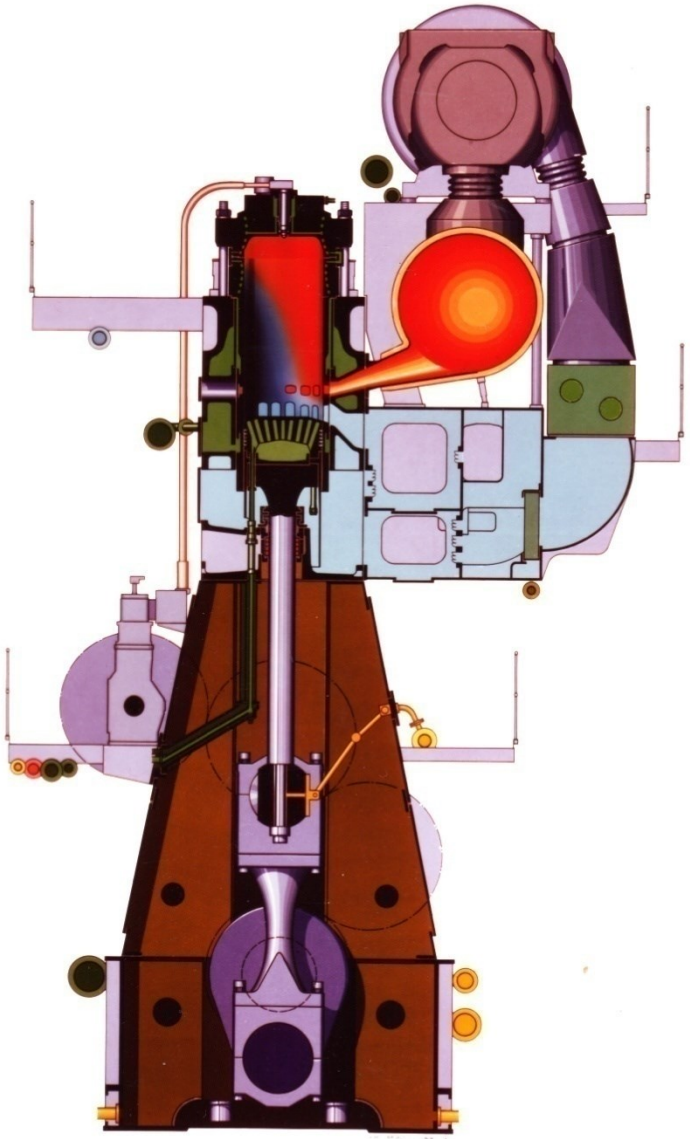
Turbocharging



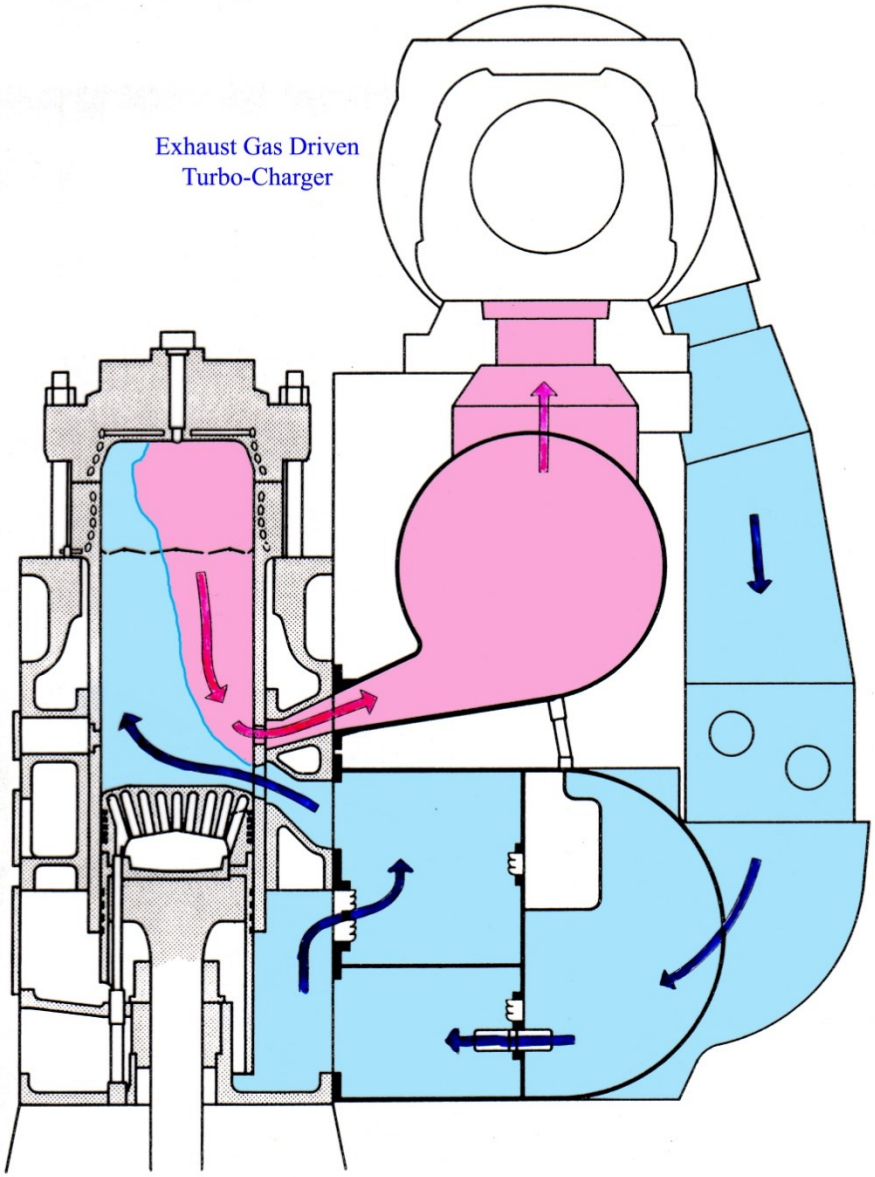
Typical Exhaust DrivenTurbocharger

The Diesel Engine

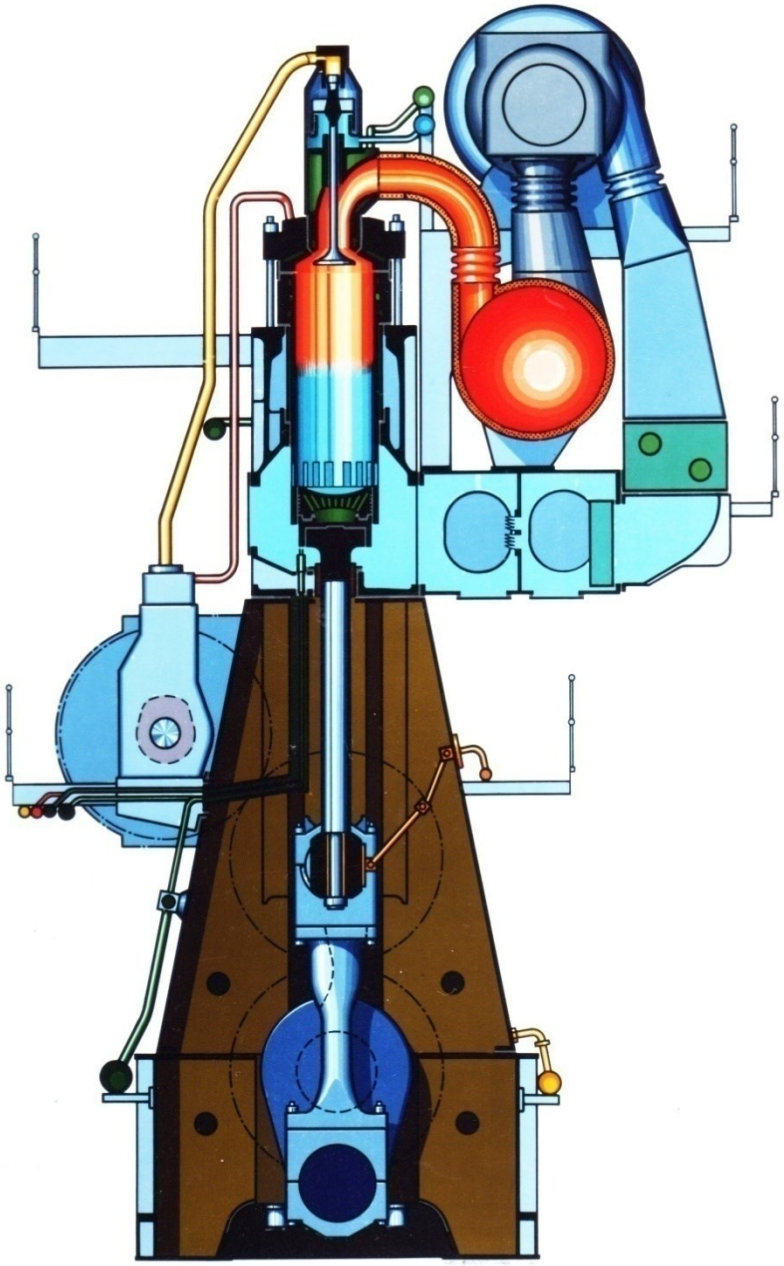




Loop Scavenging

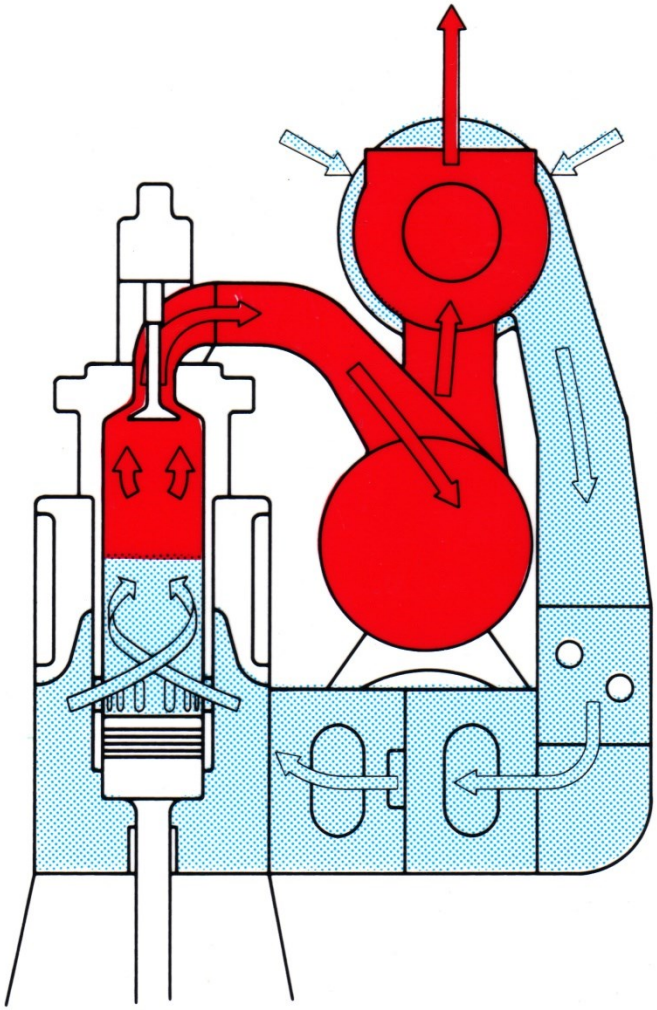


Loop Scavenging



Uniflow Scavenging

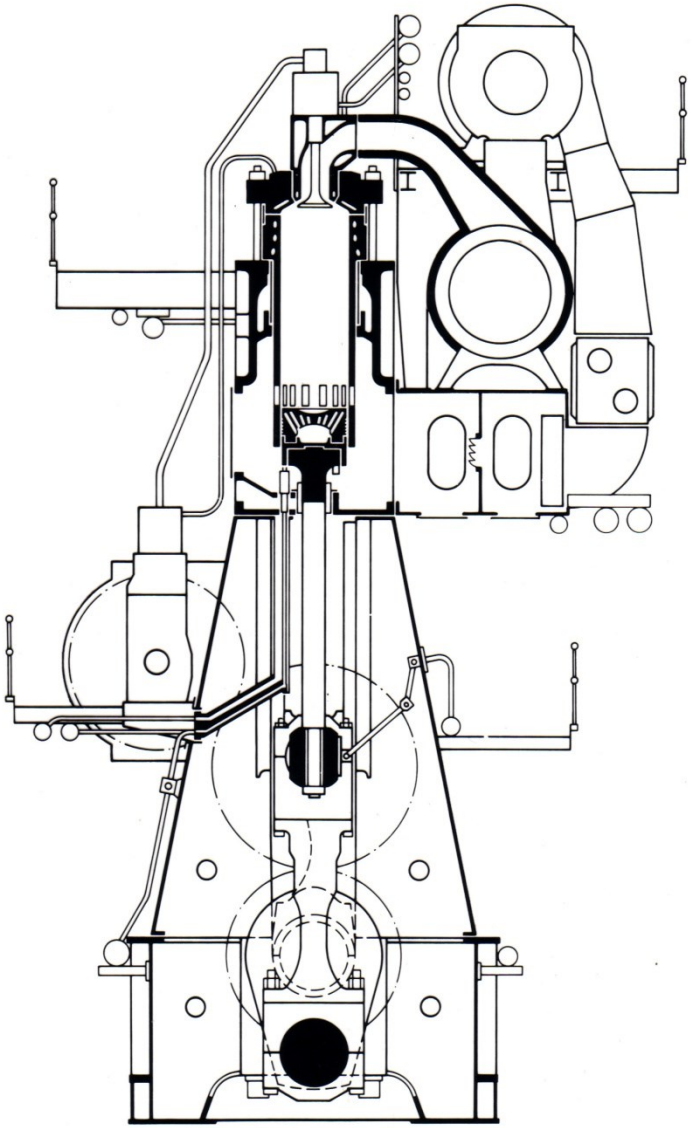
Uniflow Scavenging



Much better Scavenging obtained by introducing a central Exhaust Valve.

The Last Engine

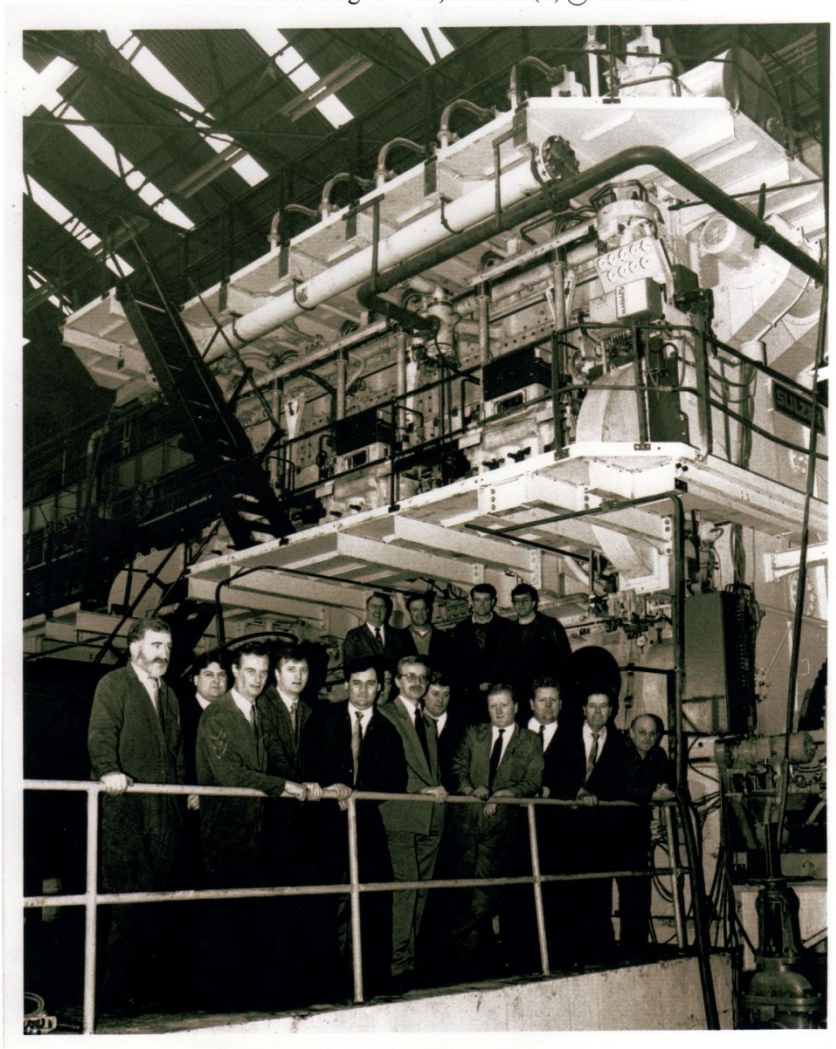
SULZER RTA Type Diesel Engine



Some Design and Construction Information

The Last Engine Built in "KINCAID'S"

6RTA62 Sulzer Engine – 15,500 BHP(M) @ 106 RPM



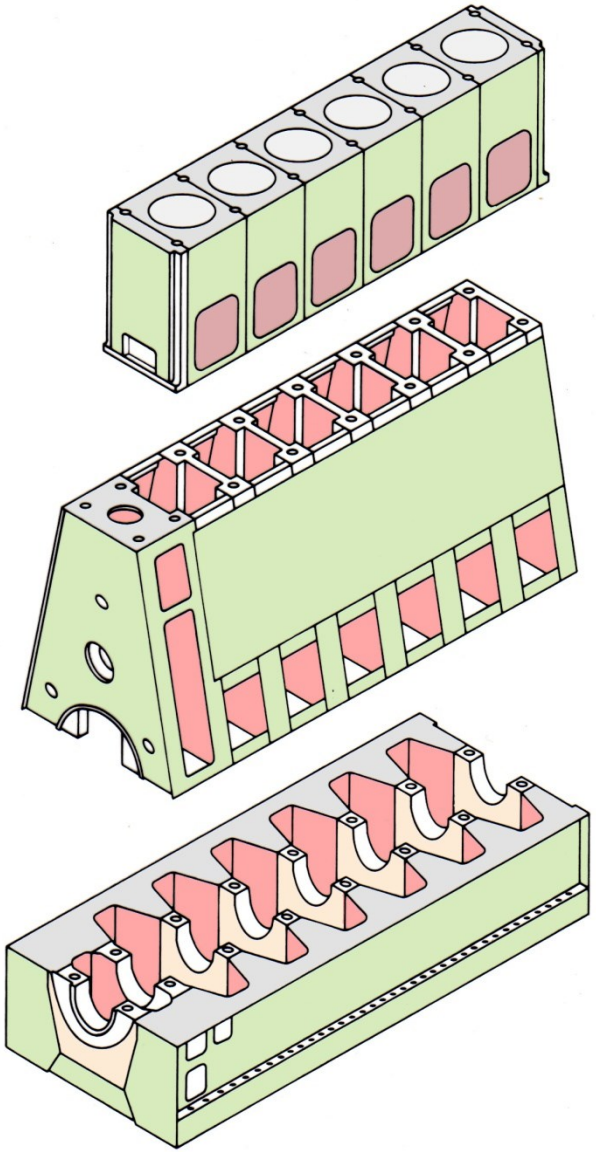
Back Row

Willie Kane (Erection Manager), Joe Blakie & Jim Kilpatrick (Coppersmiths), & Larry Sorrell (fitter).

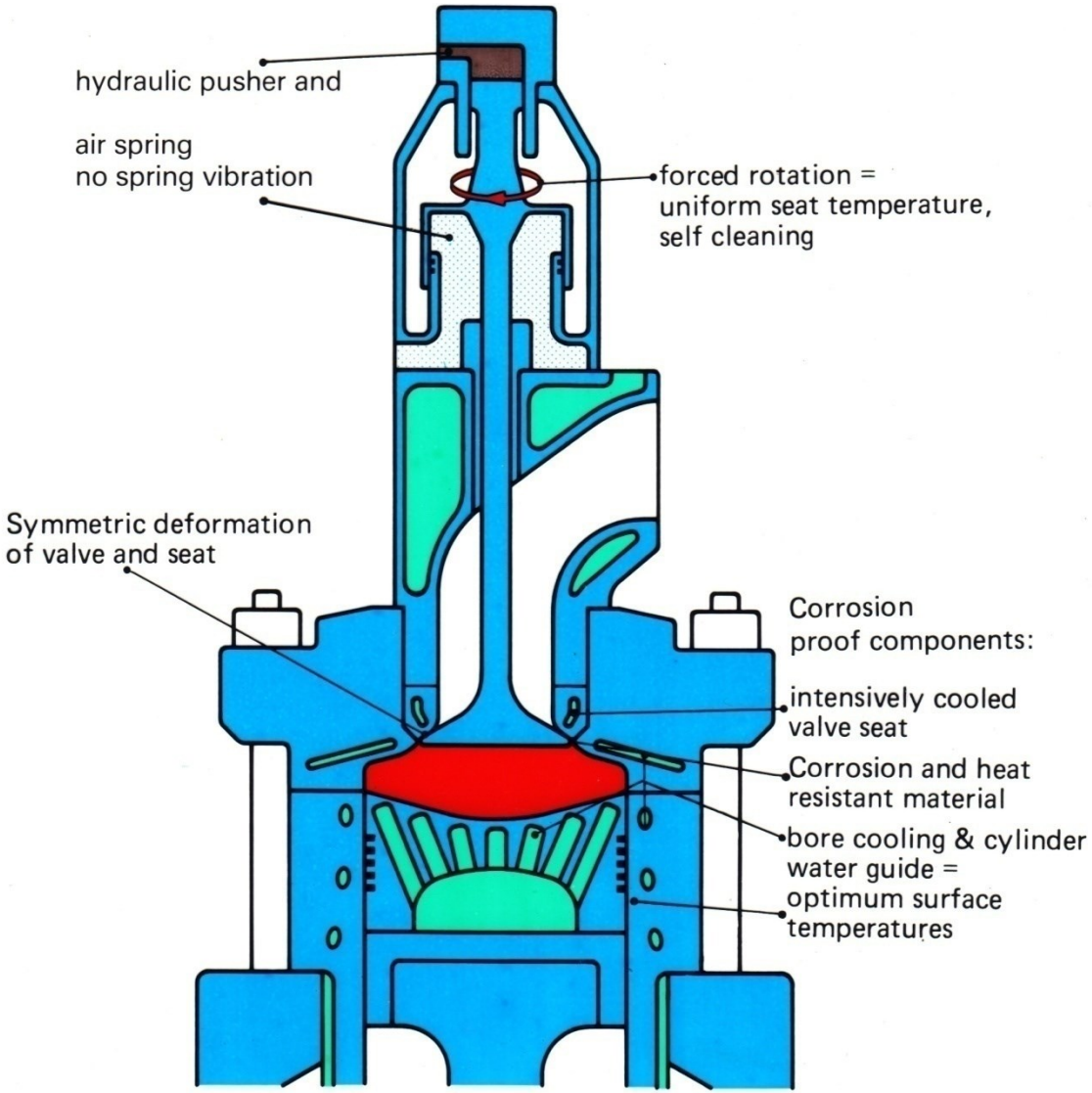
Front Row (The Proposed Service Group)

Tom McKenzie, Sam Creelman, Jim Allan, Eddie McKenzie, Billy Mooney, Odd Turvall (Kaværner Production Manager), Paul Clark, (Chargehand) Jim Carroll (Foreman), Tommy Murphy, Neil Langdon & Alan McGilp. Plus Iain Crawford (Foreman), usually at Govan during Engine installations.

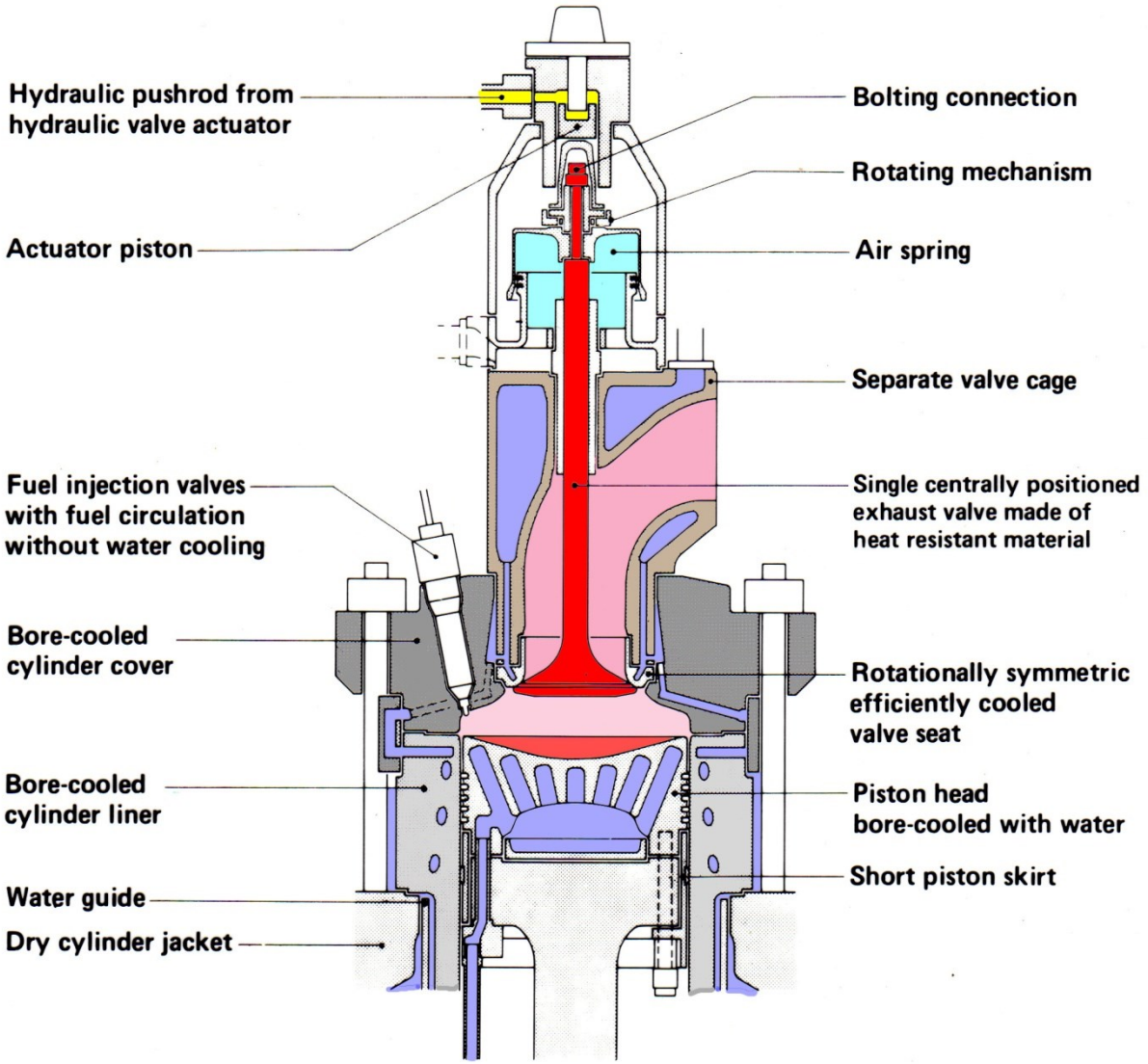
Bedplate, columns and cylinder jackets RTA engines



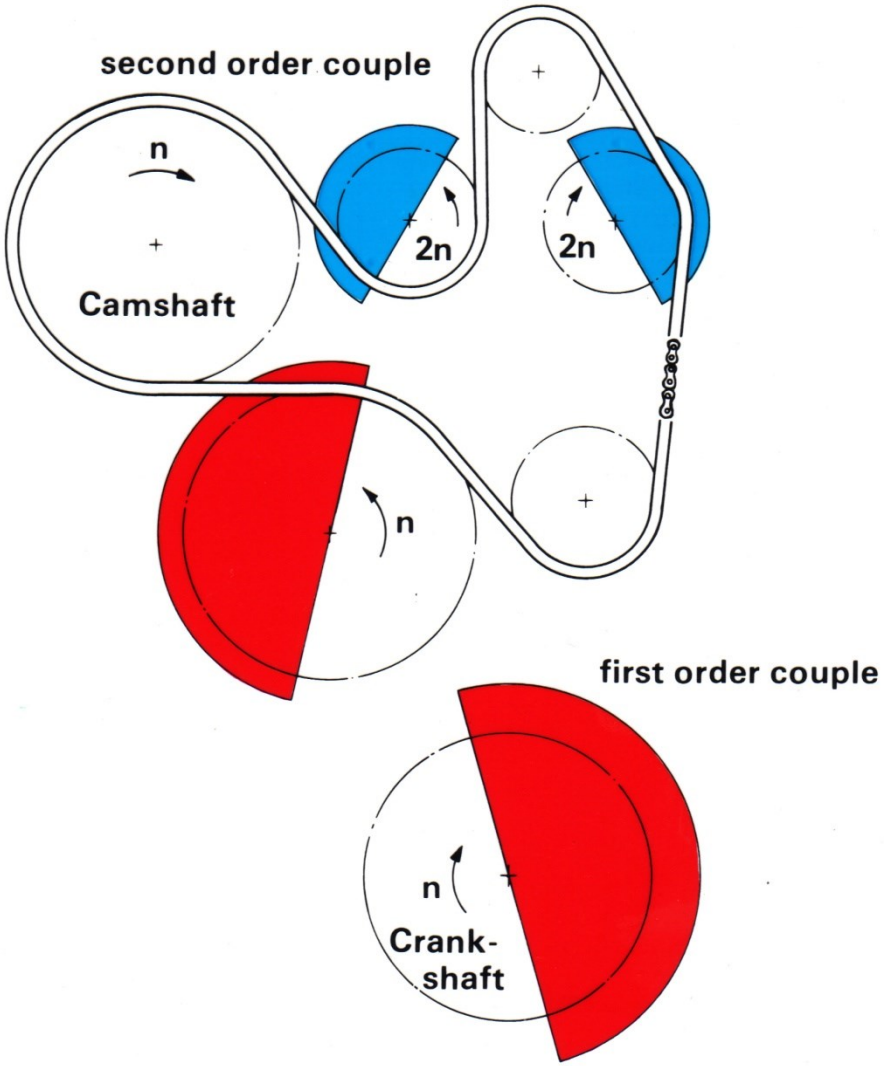
Reliability for low quality fuels

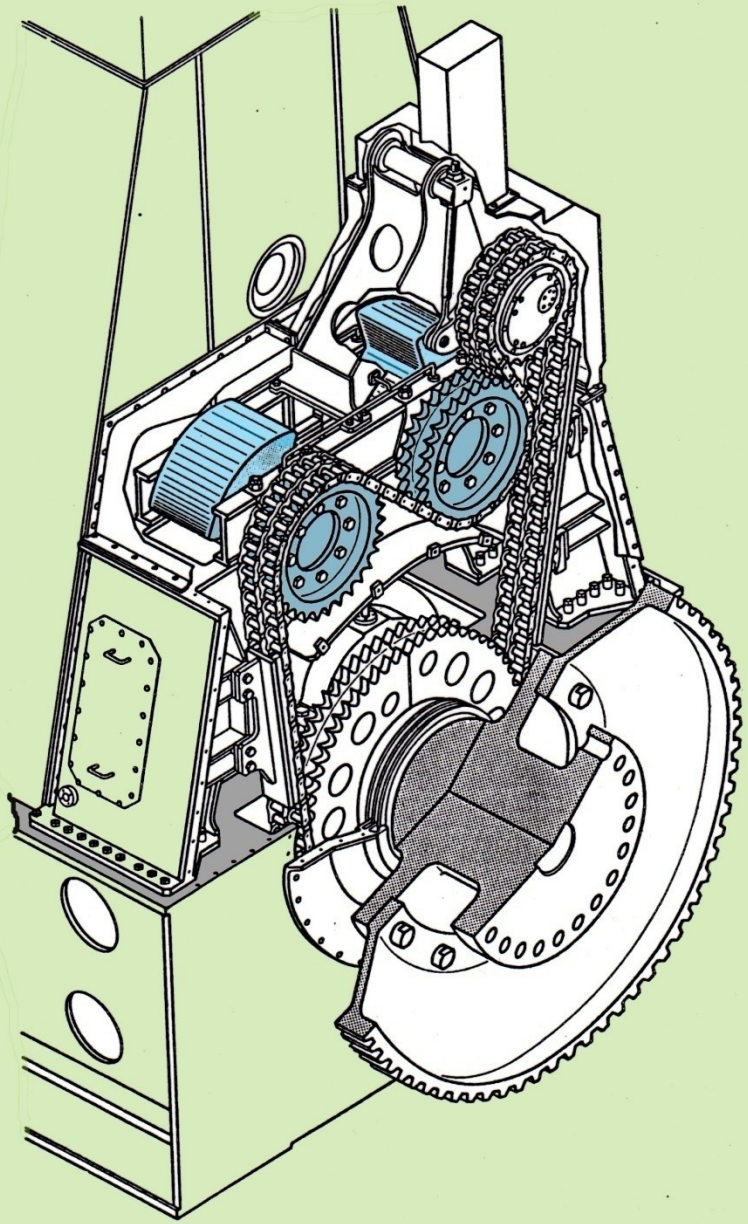


Combustion space and exhaust valve RTA

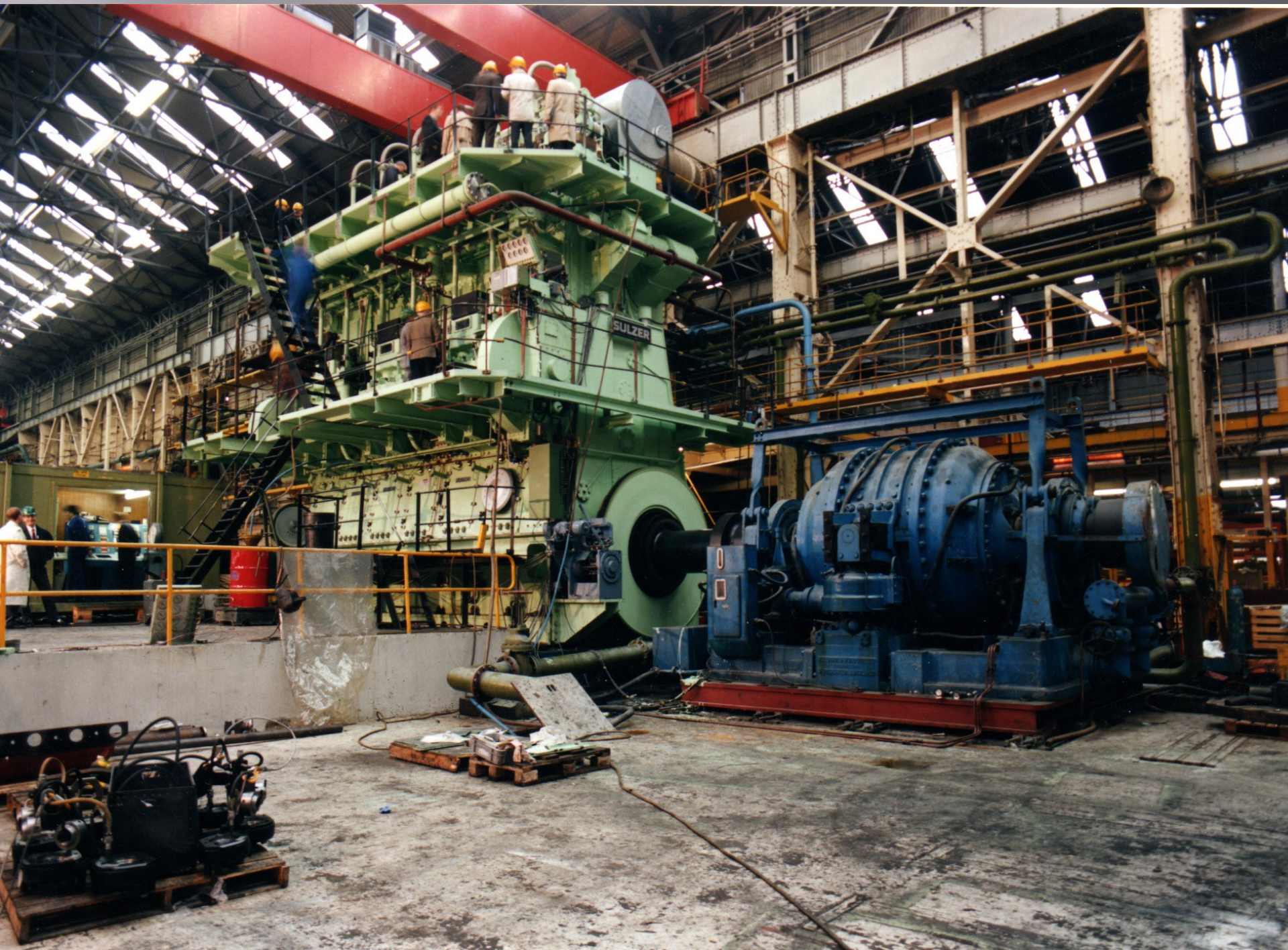


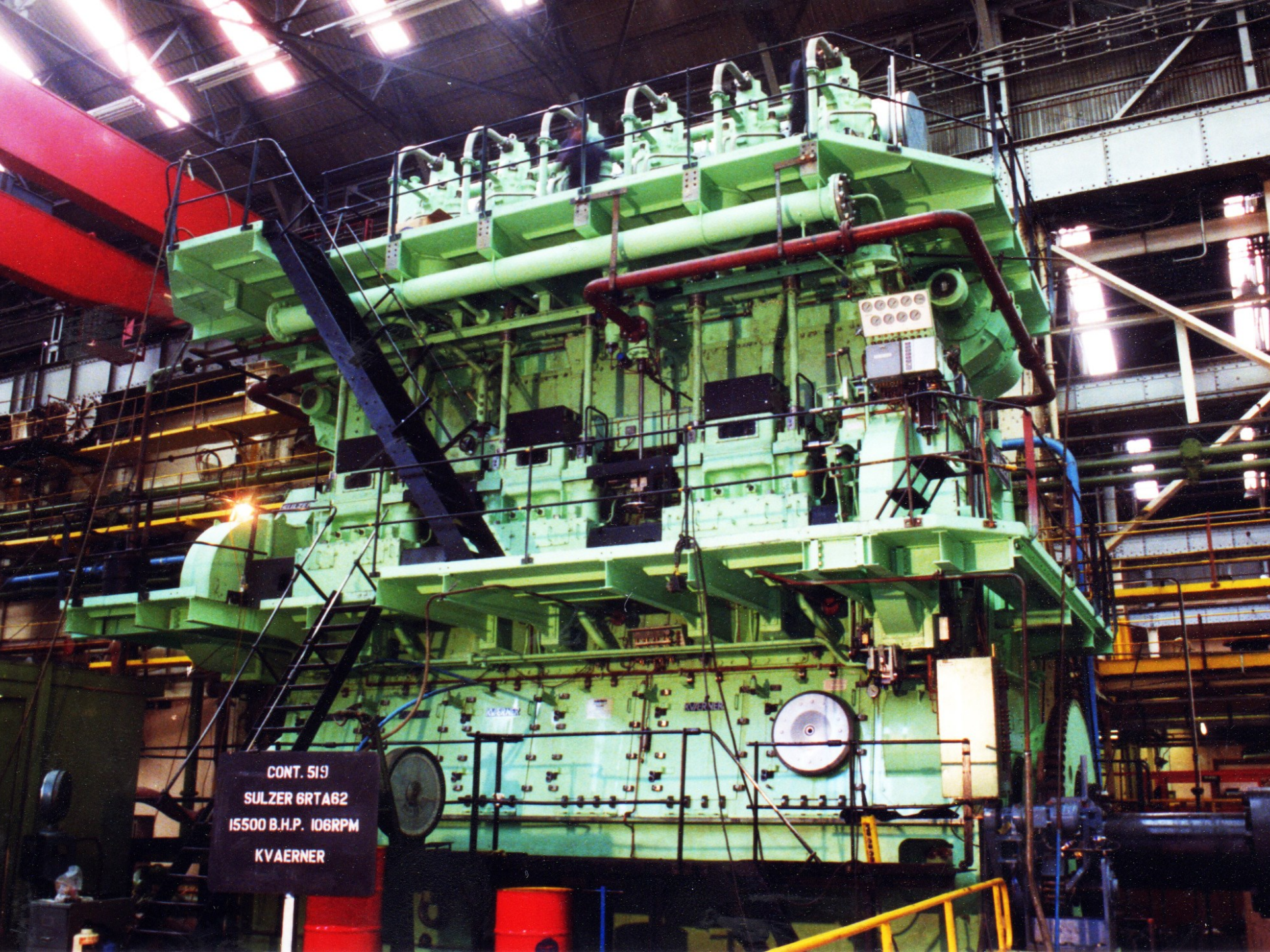
RTA Balancing gear for compensation of first and second order couple





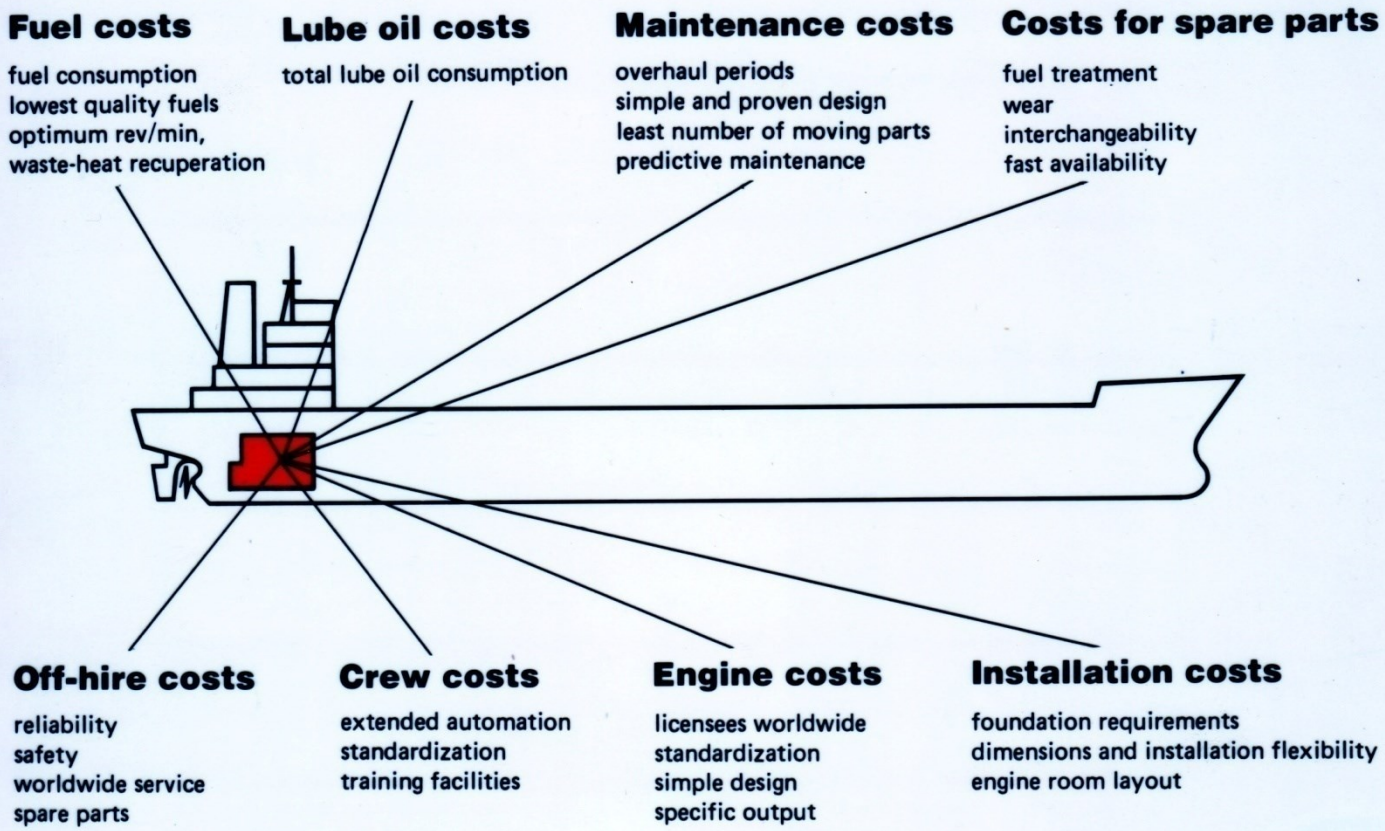
The Intigrated Lanchester Balancer


SULZER

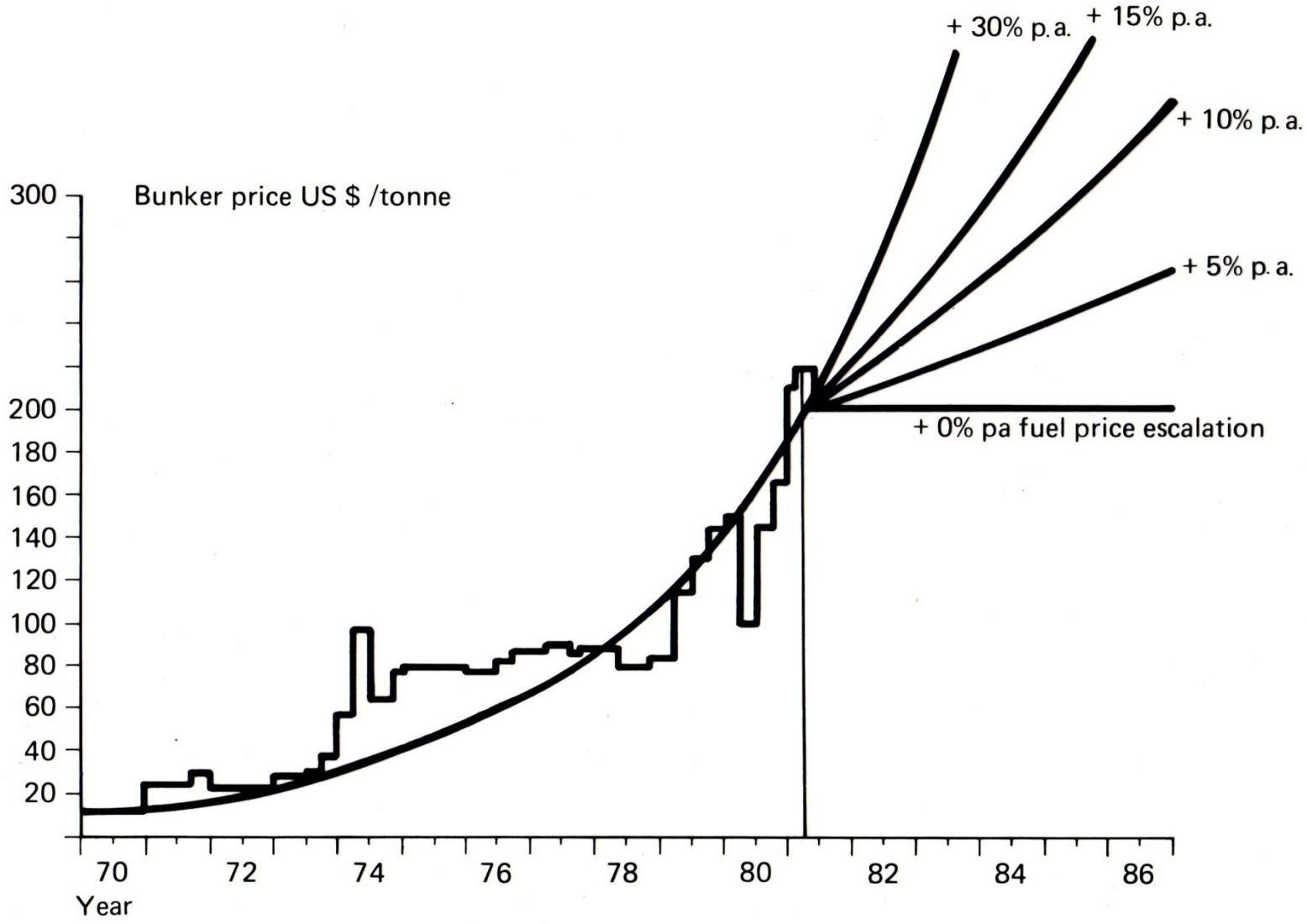

CONT. 519
SULZER 6RTA62
15500 B.H.P. 106RPM
KVAERNER

Various Commercial Aspects of Operating Ships

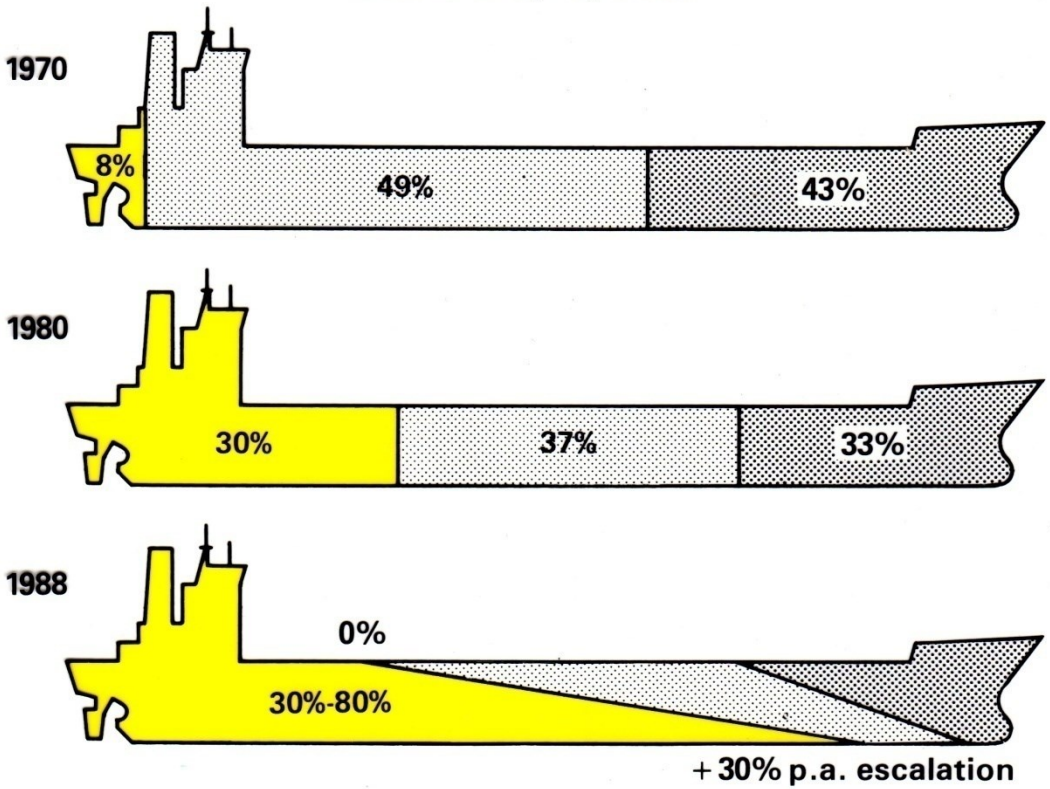
This is Sulzer Sales Department Data
& Projections from 1970 to the late 80's


Fuel costs
fuel consumption
lowest quality fuels
optimum rev/min,
waste-heat recuperation
Lube oil costs
total lube oil consumption
Maintenance costs
overhaul periods
simple and proven design
least number of moving parts
predictive maintenance
Costs for spare parts
fuel treatment
wear
interchangeability
fast availability
Off-hire costs
reliability
safety
worldwide service
spare parts
Crew costs
extended automation
standardization
training facilities
Engine costs
licensees worldwide
standardization
simple design
specific output
Installation costs
foundation requirements
dimensions and installation flexibility
engine room layout

Fuel prices

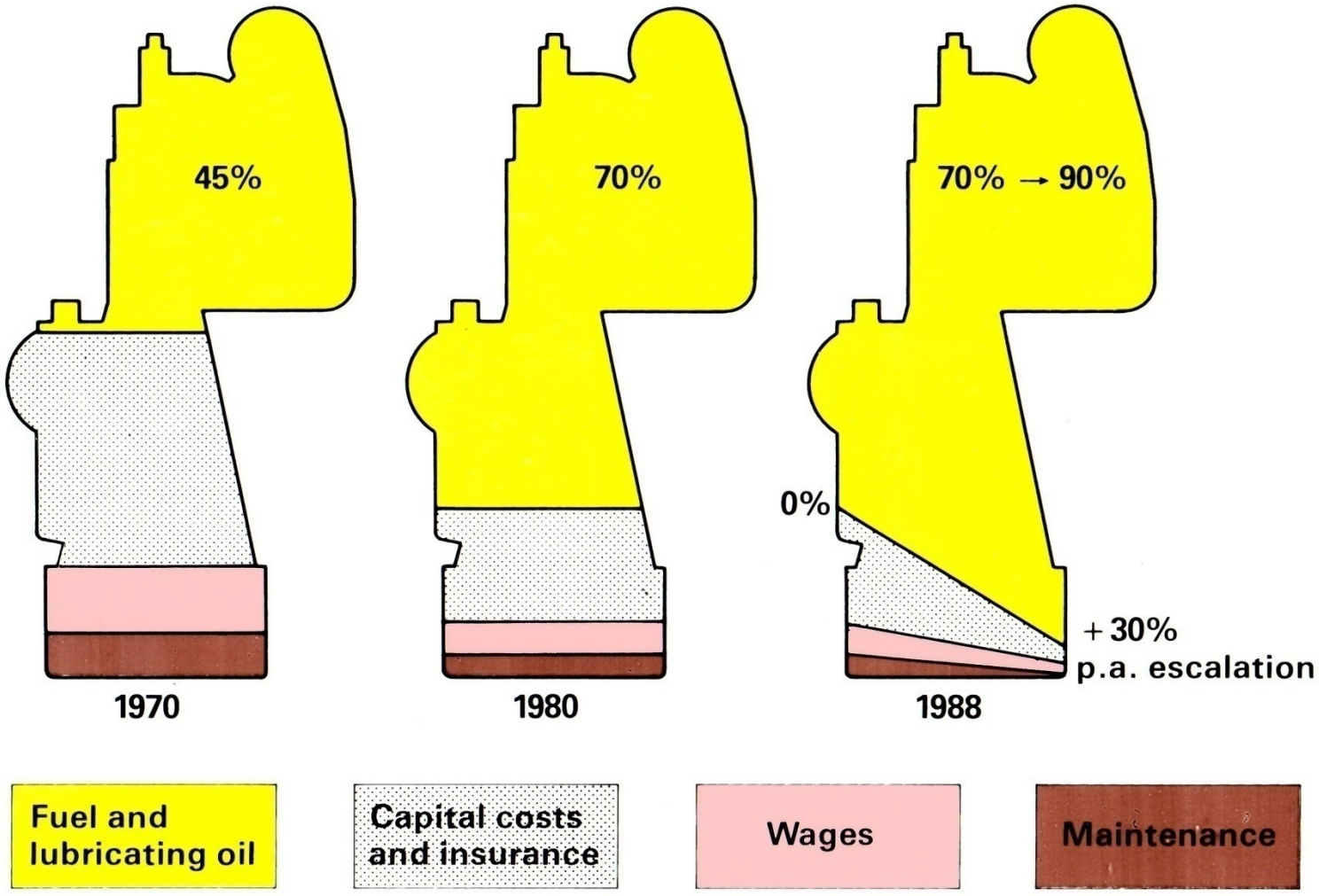

+ 30% p.a.
+ 15% p.a.
+ 10% p.a.
+ 5% p.a.
+ 0% pa fuel price escalation
Bunker price US $ /tonne
300
200
180
160
140
120
100
80
60
40
20
70
72
74
76
78
80
82
84
86
Year

Ship related running costs
170 000 dwt Bulk Carrier
(same ship speed)

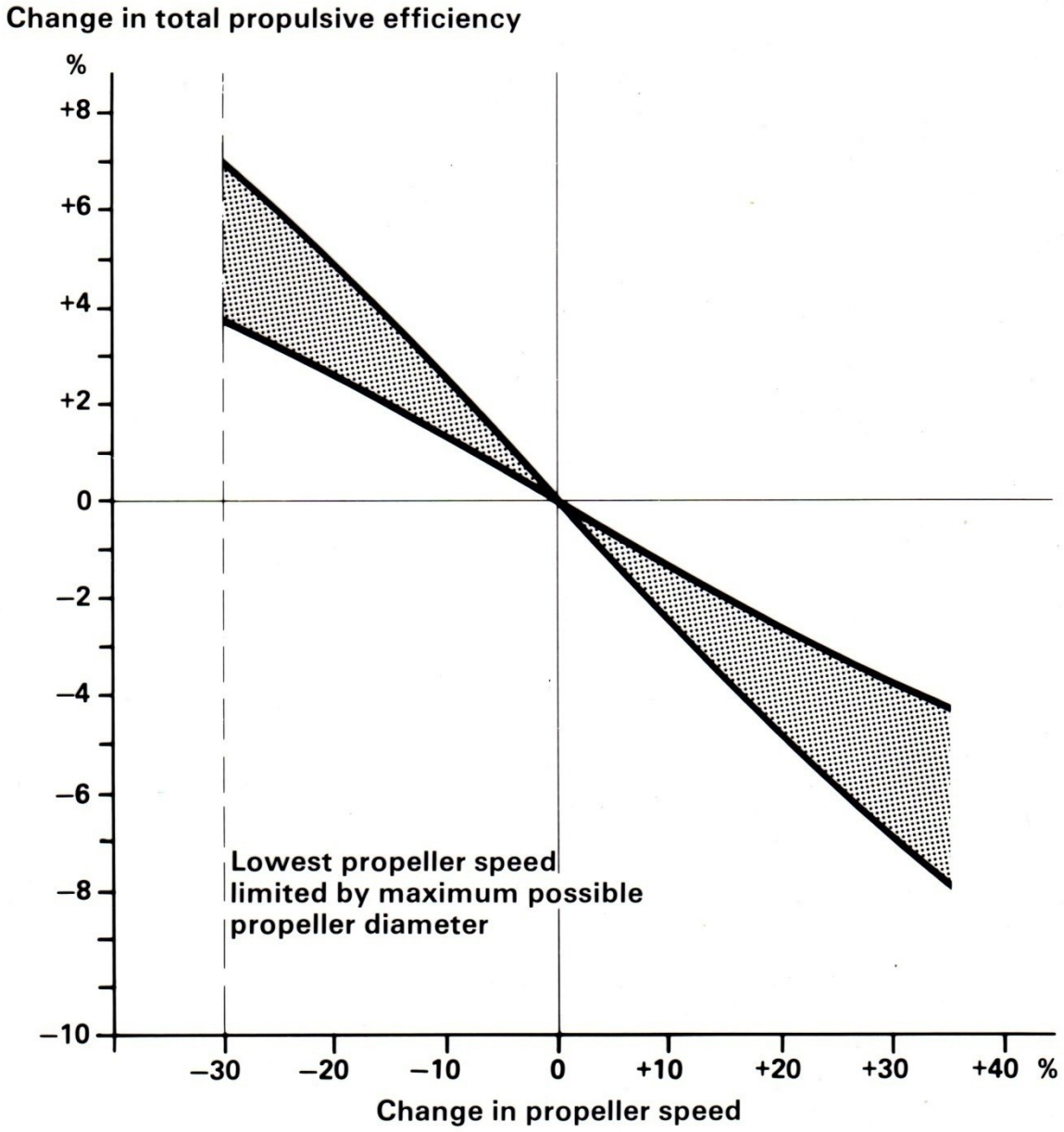


Voyage costs	Daily costs	Capital costs
fuel, port/canal fees	crew, administration, insurance, lube oil, maintenance, docking and repairs	interest, depreciation

Engine related running costs — 170 000 dwt Bulk Carrier



Lower propeller speeds yield higher propulsive efficiency



Engine development goals

- low shaft speed
- lowest specific fuel consumption
- ability to burn low-quality fuels
- lowest lube oil consumption
- possibility for efficient waste-heat recovery and supply of auxiliary energy
- high safety and reliability standard
- ease of maintenance

The End

Any Questions ?