

# The Engine World and their „Reccords“

Dr. Günther Herdin

HTL Vortragsreihe „neue Technologien  
und Innovationen“

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# Shown Reccords

- ✓ **Größte Leistung Serienfahrzeug**
- ✓ **Bester Kraftstoffverbrauch Serienfahrzeug**
- ✓ **Schlechtester Kraftstoffverbrauch eines Motorkonzeptes**
- ✓ **Kleinster 4 Takt Motor**
- ✓ **Kleinster 2 Takt Motor**
- ✓ **Größte Zylinderanzahl eines gebauten Serienmotors**
- ✓ **Größter Mitteldruck eines Saugmotors**
- ✓ **Größter Mitteldruck eines Seriendieselmotors**
- ✓ **Leistungsstärkster Formel 1 Turbo Motors**
- ✓ **Größter Mitteldruck eines Seriengasmotors**
- ✓ **Bester Wirkungsgrad eines Gasmotors**
- ✓ **Größte Leistung eines Schiffsdiesel 2 Takt Motors**
- ✓ **Größter je in Österreich gebauter 2 Takt Gasmotor**
- ✓ **und einige andere interessante Ingenieurleistungen aus der Motorenwelt**

# Bugatti Veyron EB16.4 Super Sport

## Bugatti Veyron 16.4

power	883 kW	←
displacement	7.993 l	
cyl. config.	double VR8	
bore	86 mm	
stroke	86 mm	
torque	1500 Nm/2200 rpm	
BMEP	22.09 bar	
speed	6000 rpm	

### performance

top speed	434.2 km/h	
0 – 100 km/h	2.46 sec	←
0 – 300 km/h	14.6 sec	

### fuel economy

EPA City Cycle	29 l/100 km	
top speed fuel	78 l/100 km	←



# Bugatti Veyron 16.4 Engine Components

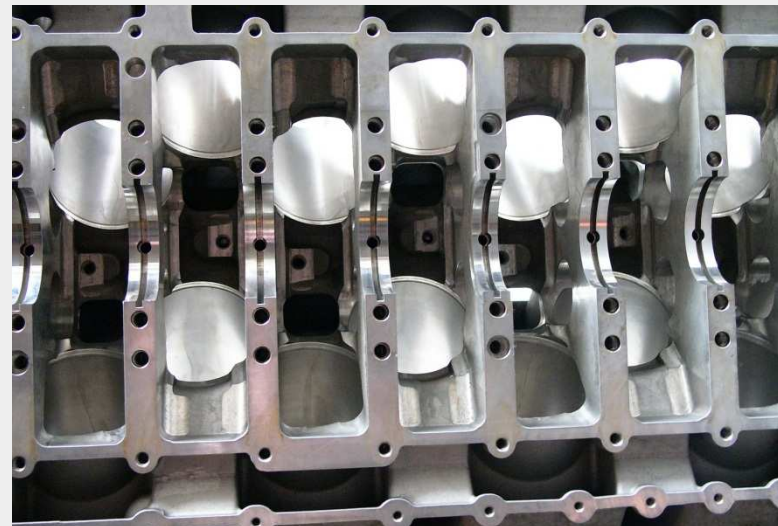
**piston & con rod**



**top view crank case**



**view from crank shaft**



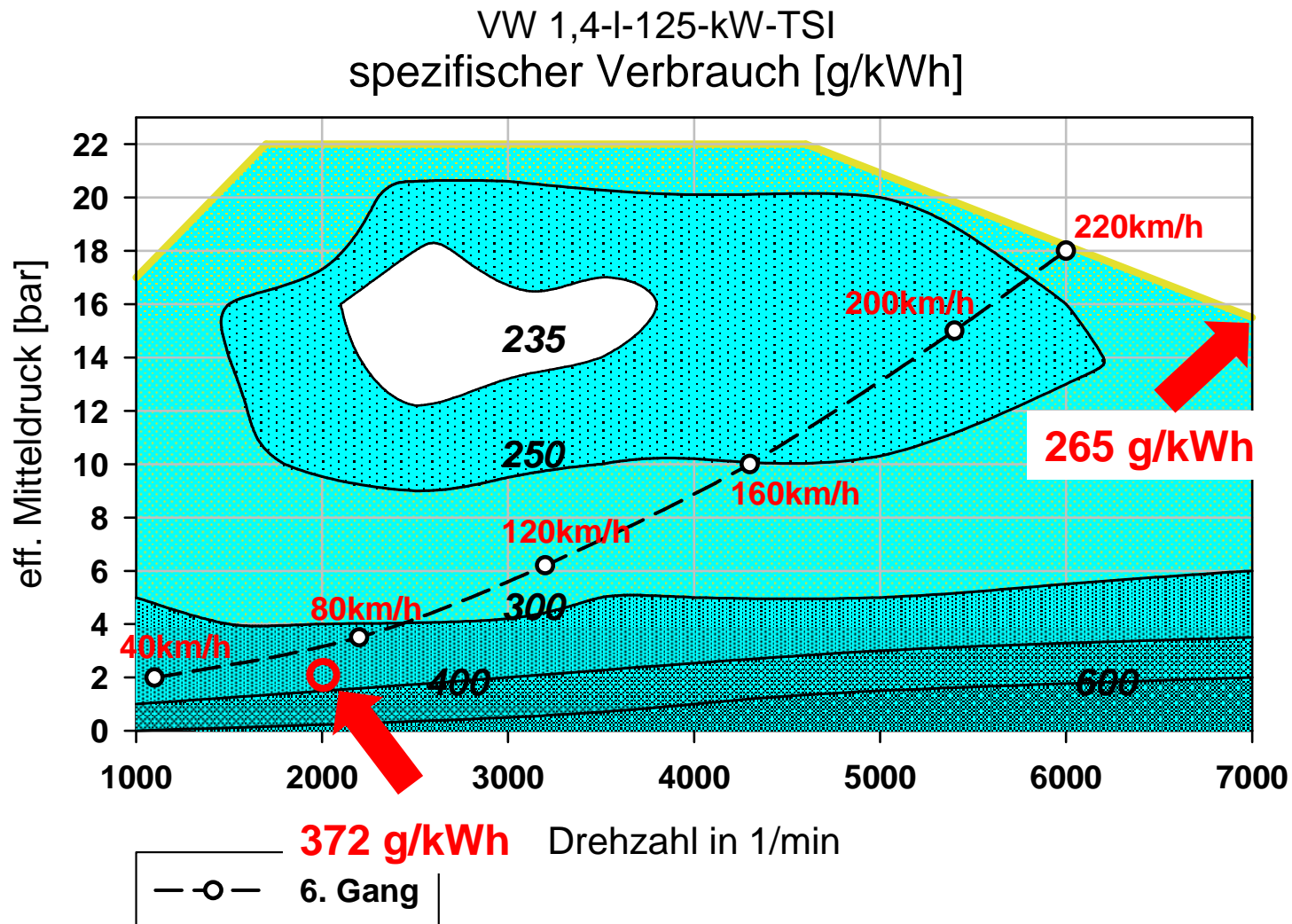
# High Eff. Gasoline Engine

## VW TSI 1.4

mech. power	125 kW @ 6600 rpm
number of cyl.	4
cyl. arrangm.	in line
bore	76.5 mm
stroke	75.6 mm
displacement	1.39 l
turbo charging	1 TC + mech. booster
BMEP	21.7 bar ←
max. torque	240 Nm @ 1750 rpm



# One Star of Fuel Economy VW 1.4 TSI





# Modern Wankel – Mazda RX-8



## Mazda twin-rotor Wankel engine

displacement 2\*654 ccm    fuel consumption  
(equivalent displ.: 2,616 ccm)

power output

gasoline 154 kW

torque 222 Nm@5000rpm

combined cycle

11.2 – 10.6 l/100 km

CO2 emissions

284 – 267 g/km

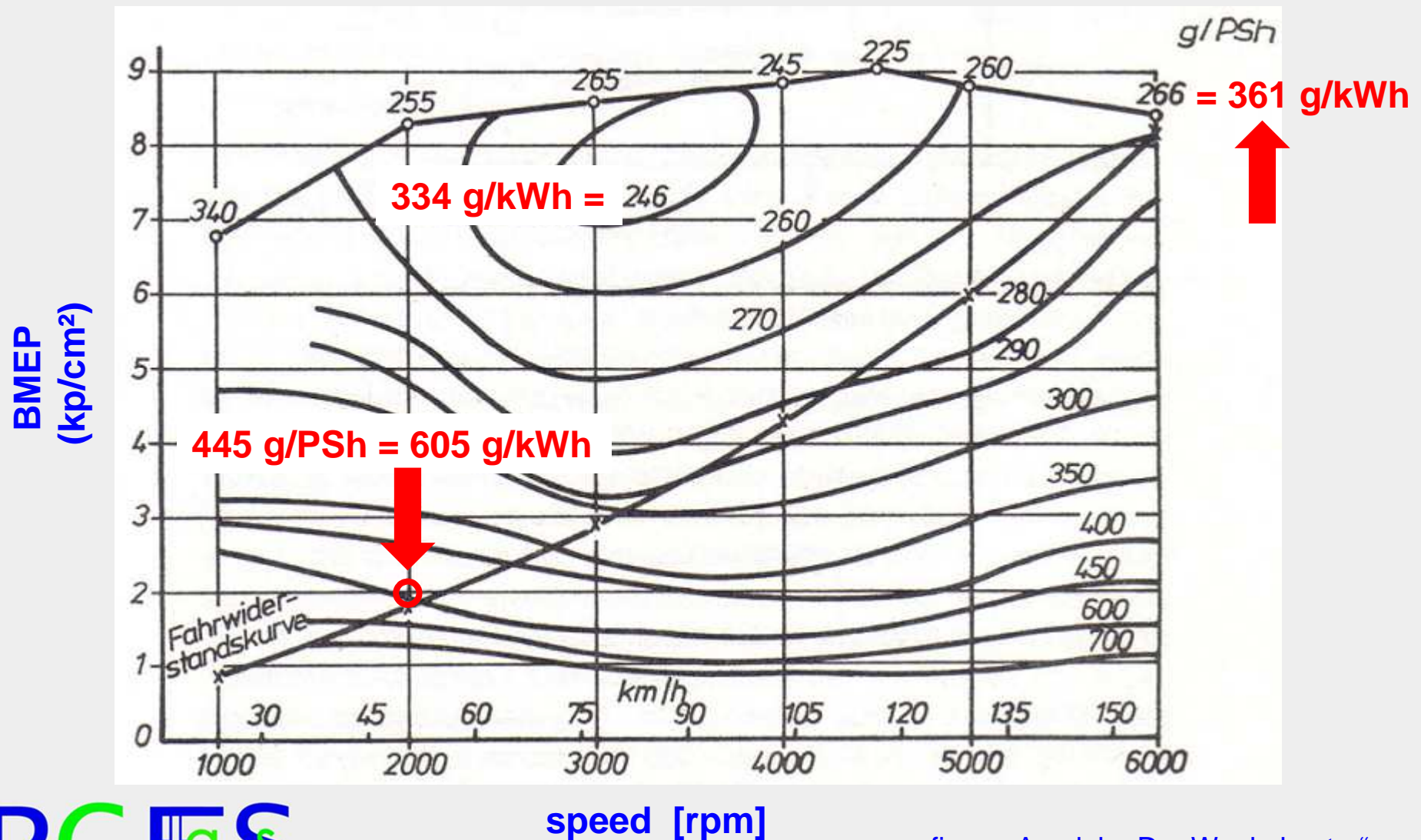
hydrogen 80 kW

torque 140 Nm@5000rpm



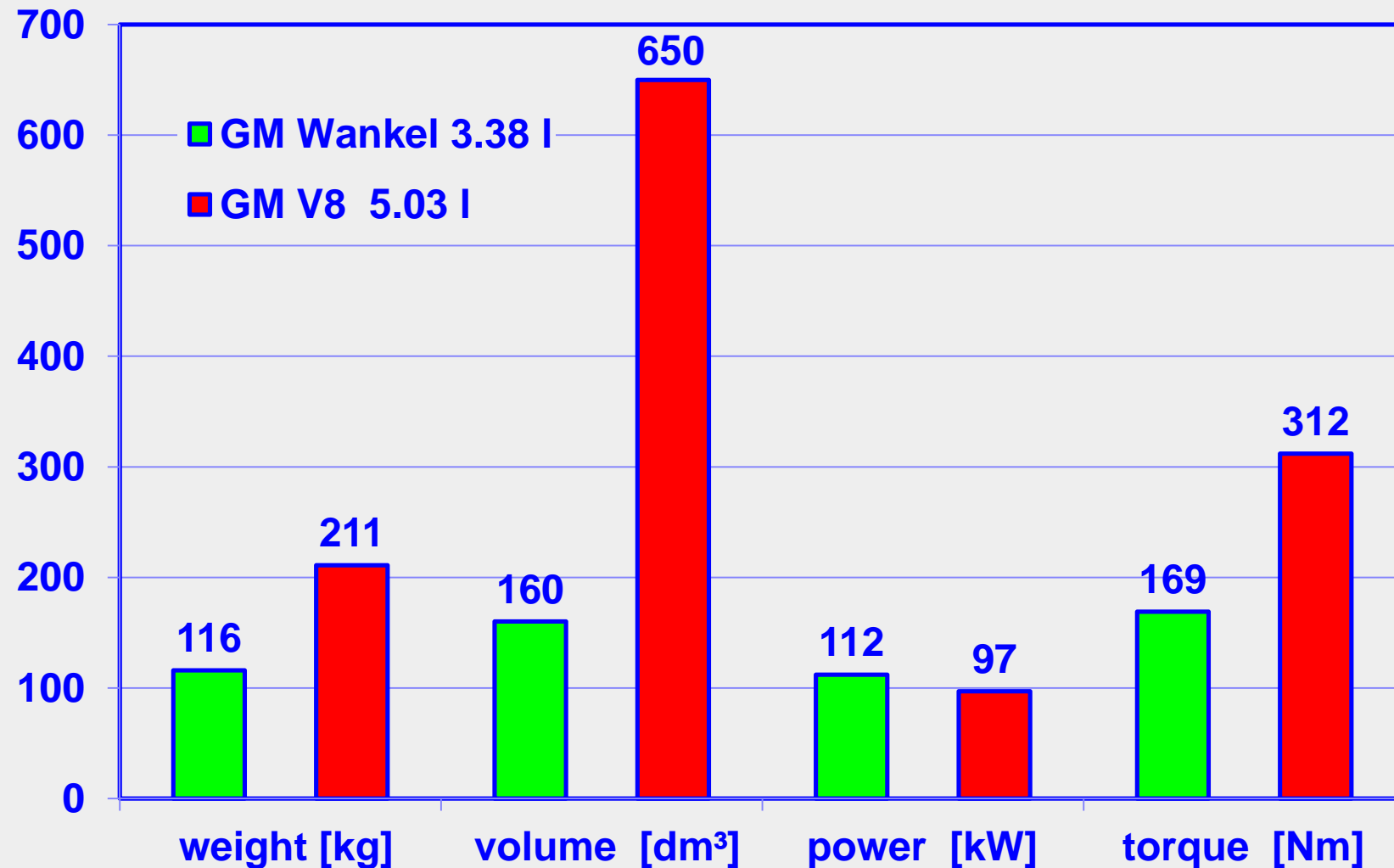
# The Rotary Piston Engine (Wankel) – less Fuel Eff.

spec. fuel consumption NSU-KKM 502 (with road load curve) => 54 hp@6000 rpm





# GM's Comparison Wankel vs. V8 Engine (1975)



# Smallest 4-Stroke engine

## Chevrolet 1/6th scale V8

max mech. Power	0.406 kW
number of cyl.	8
cyl. arrangement	V
bore	15.24 mm
stroke	12.37 mm
displacement	0.018 l
BMEP	6 bar
speed	4500 rpm



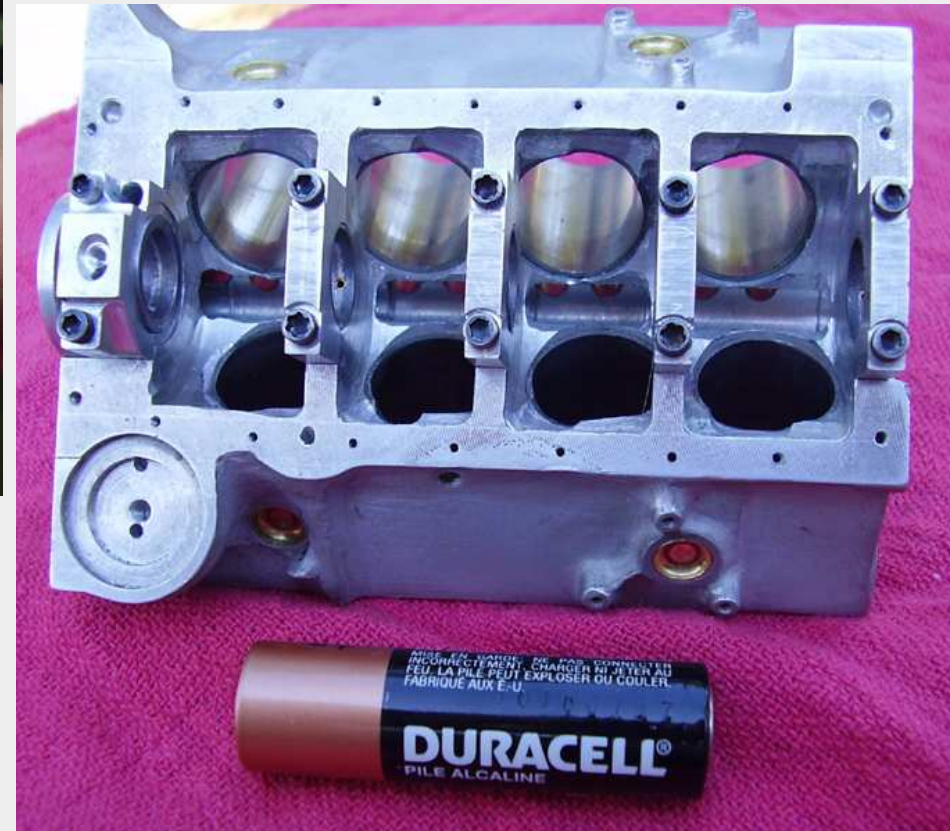
con rod bolt = ~ M1.3

# Some Engine Parts of the 1/6 Chevy



crank shaft

crank case





# Smallest Two Stroke Engine COX Babe Bee (Series Production)

**Babe Bee 049** (Manufactured Nov 1956-Jan 1996)

mech Power	42 W
number of cyl.	1
mech. efficiency	about 16%
bore	10.31 mm
stroke	9.8 mm
displacement	0.8189ccm
combustion	glow plug
BMEP	2.28 bar
speed	13500 rpm
dry weight	64 gram





# Engine with 56 Cylinder's

## JSC Zvezda M520

cyl. arrangem.	7*in line 8
mech. power	3.97 MW
bore	160 mm
stroke	170 mm
displacement	191.4 l
combustion	DI diesel
valves	224
BMEP	12.45 bar
speed	2000 rpm
dry weight	7.25 t

### engine dimensions

L\*W\*H [m]      4.4\*1.675\*1.675

Team: Kiepenkerl  
tractor puller with 4500 kW  
highly boosted

small brother M 503 (42 cyl.)

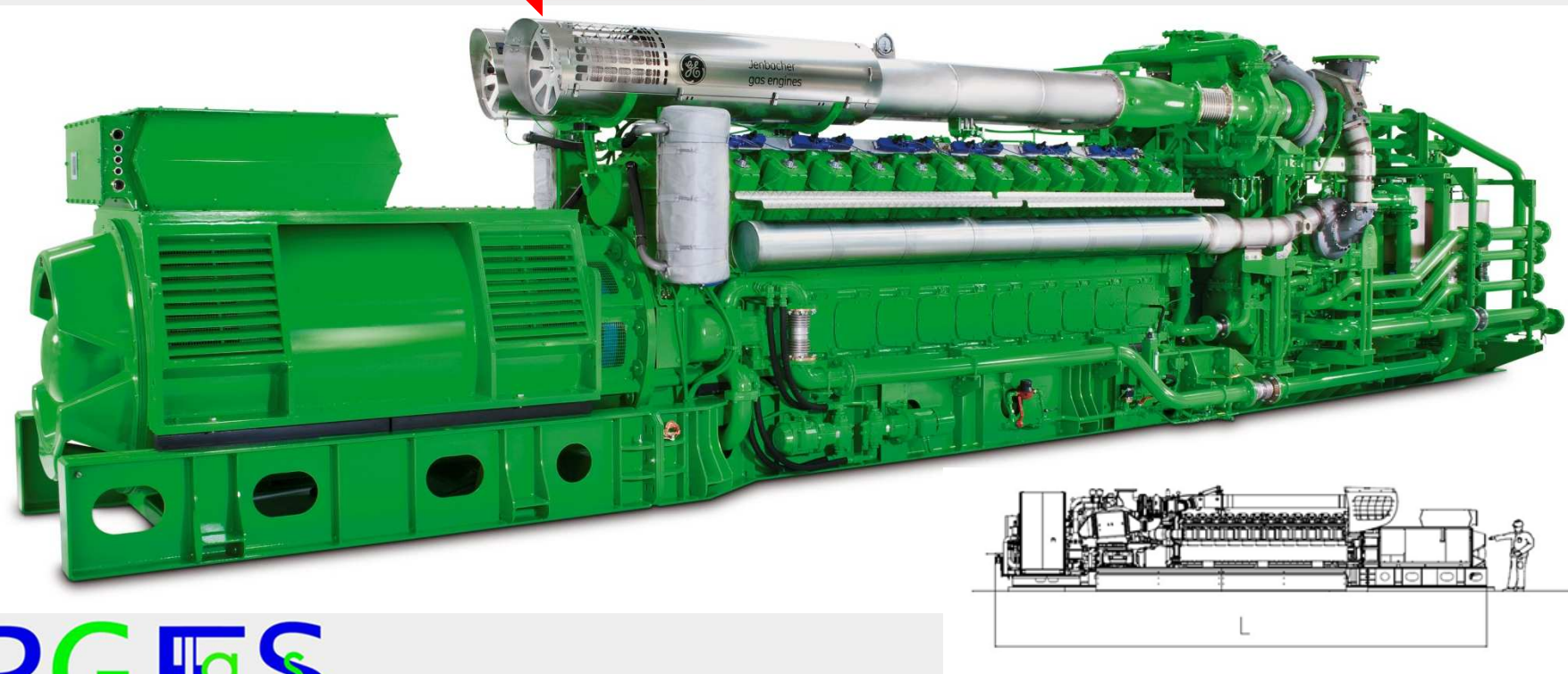


# Highest Power Density of a Gas Engine

## JMS 624 GS-N.L

el. power 4.401 MW  
el. efficiency 46.6 %  
bore 190 mm  
stroke 220 mm  
combustion ff pre chamber  
BMEP 24 bar

no. of cyl. 24  
speed 1500 rpm  
dry weight 18 t  
gen set dimensions  
L\*W\*H [m] 12.1\*2.2\*2.9





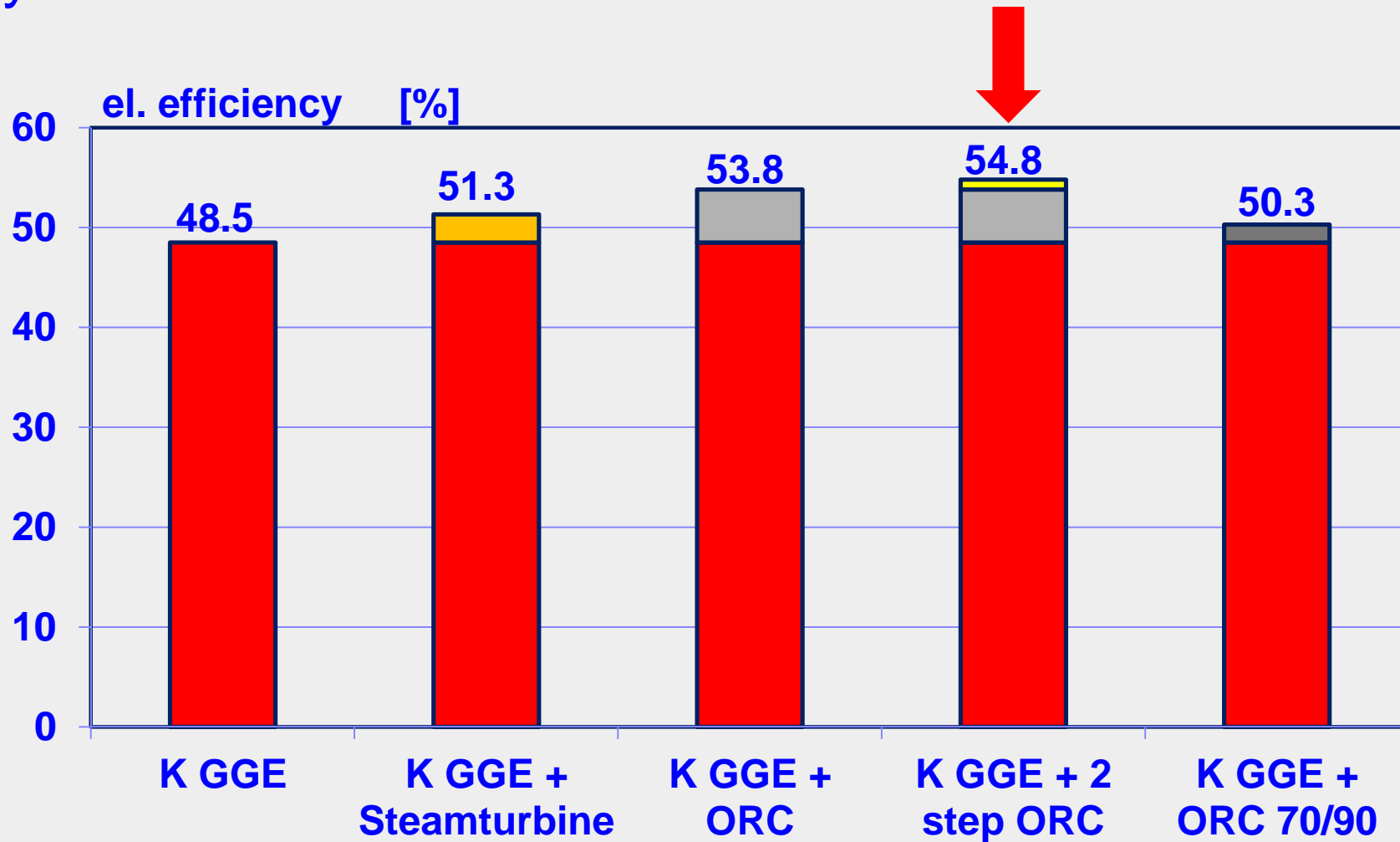
# Best in Class – Efficiency - Gas Engine KG 18

## Kawasaki KG 18

el. Power	7.8 MW
el. efficiency	48.5 %
bore	300 mm
stroke	480 mm
combustion	ff pre chamber
BMEP	21 bar
speed	750 rpm
dry weight	133 t
gen set dimensions	
L*W*H [m]	13.4*3.2*5.2



# Possible el. Efficiencies with the KHI KG 18 + Top Cycles





# Strongest Formula 1 Engine (1983)

## BMW M12/13

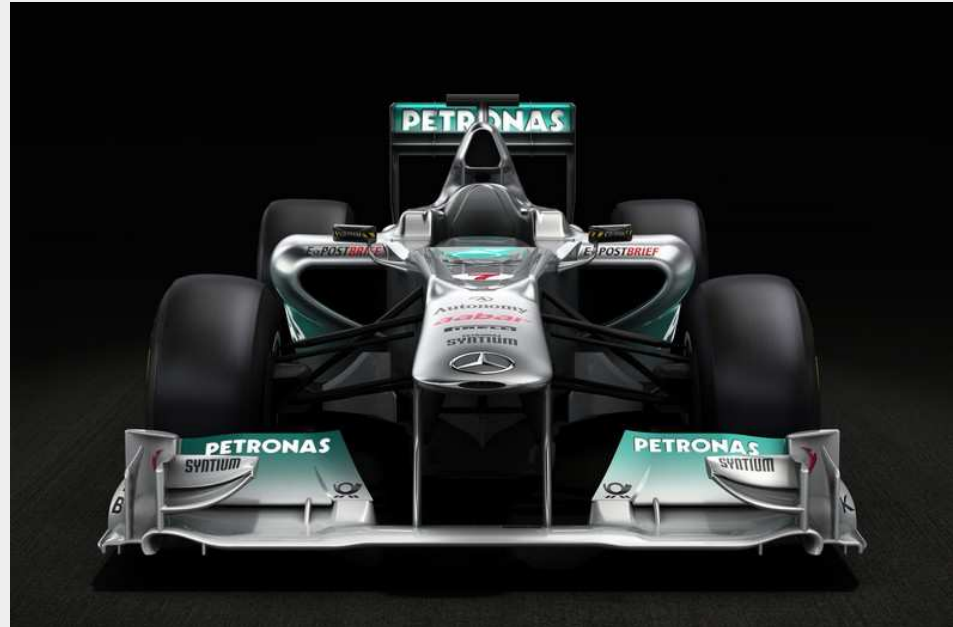
max mech. Power	1030 KW
number of cyl.	4
cyl. arrangement	in line
bore	89.2 mm
stroke	60 mm
displacement	1.5 l
BMEP	73.57 bar
speed	11200 rpm
length	620 mm
width	340 mm
height	54 mm



# Formula 1 Engine (2011)

## Mercedes-Benz FO 108Y

max mech. Power	ca. 558 KW
number of cyl.	8
cyl. arrangement	V
bore	ca. 98 mm
stroke	ca. 40 mm
displacement	2.4 l
BMEP	15.5 bar
speed	18000 rpm
weight	95kg



# Formula 1 Engine Parts

surface gap spark plug M 10  
assembly model



top ring height 1 mm





# Highest BMEP of NA Engine

## Engine GM 5.86 l V8

mech. power            576 kW @ 8000 rpm  
number of cyl.        8  
cyl. arrange.          V

bore                    105.5 mm  
stroke                 83.8 mm  
displ.                  5.86 l  
BMEP                  15.8 bar (Year 2000)  
max. torque         737 Nm @ 6800-7000 rpm

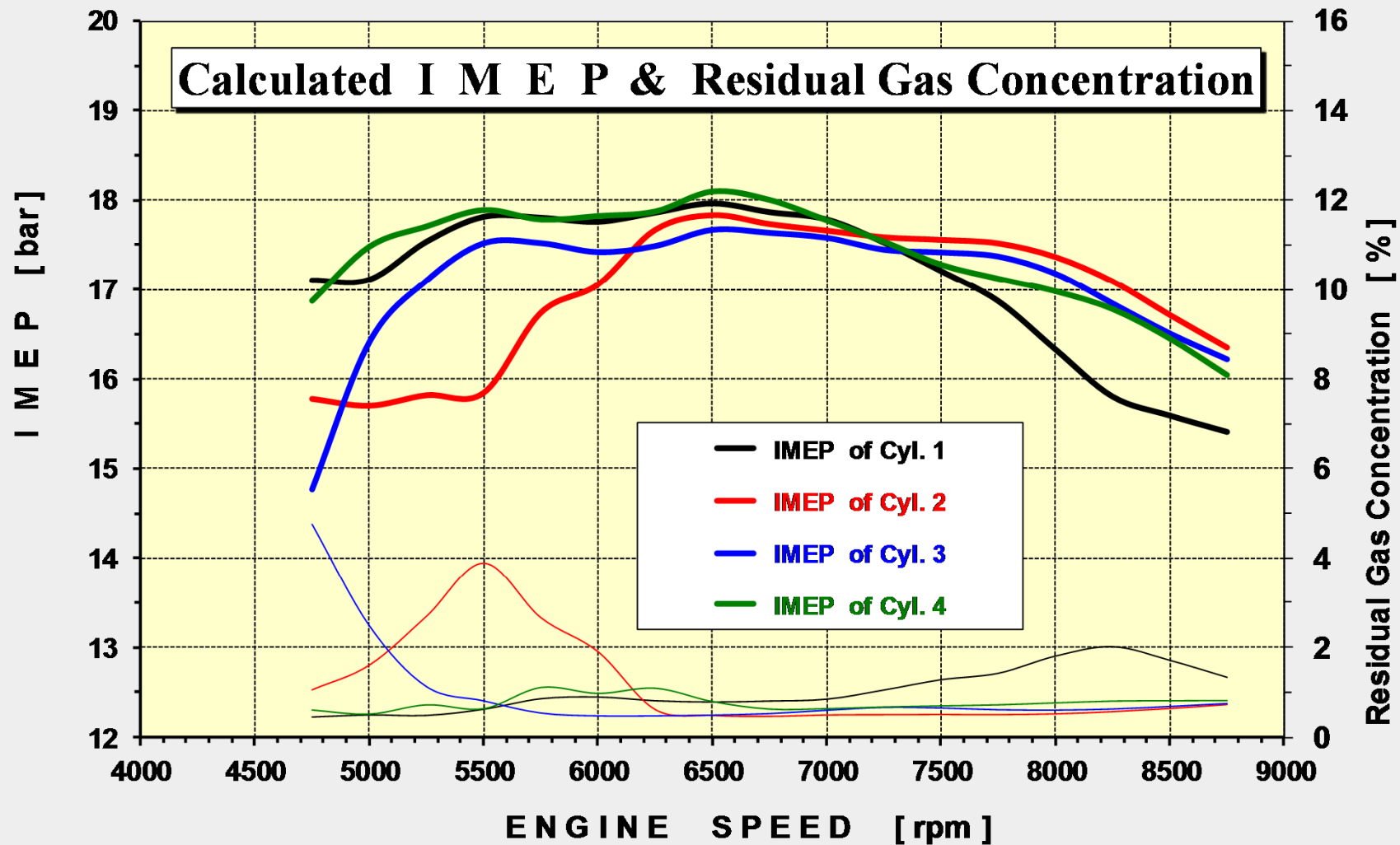
## Comparison

PORSCHE Carrera 911  
257 kW  
BMEP 12.1 bar @ 7400 rpm

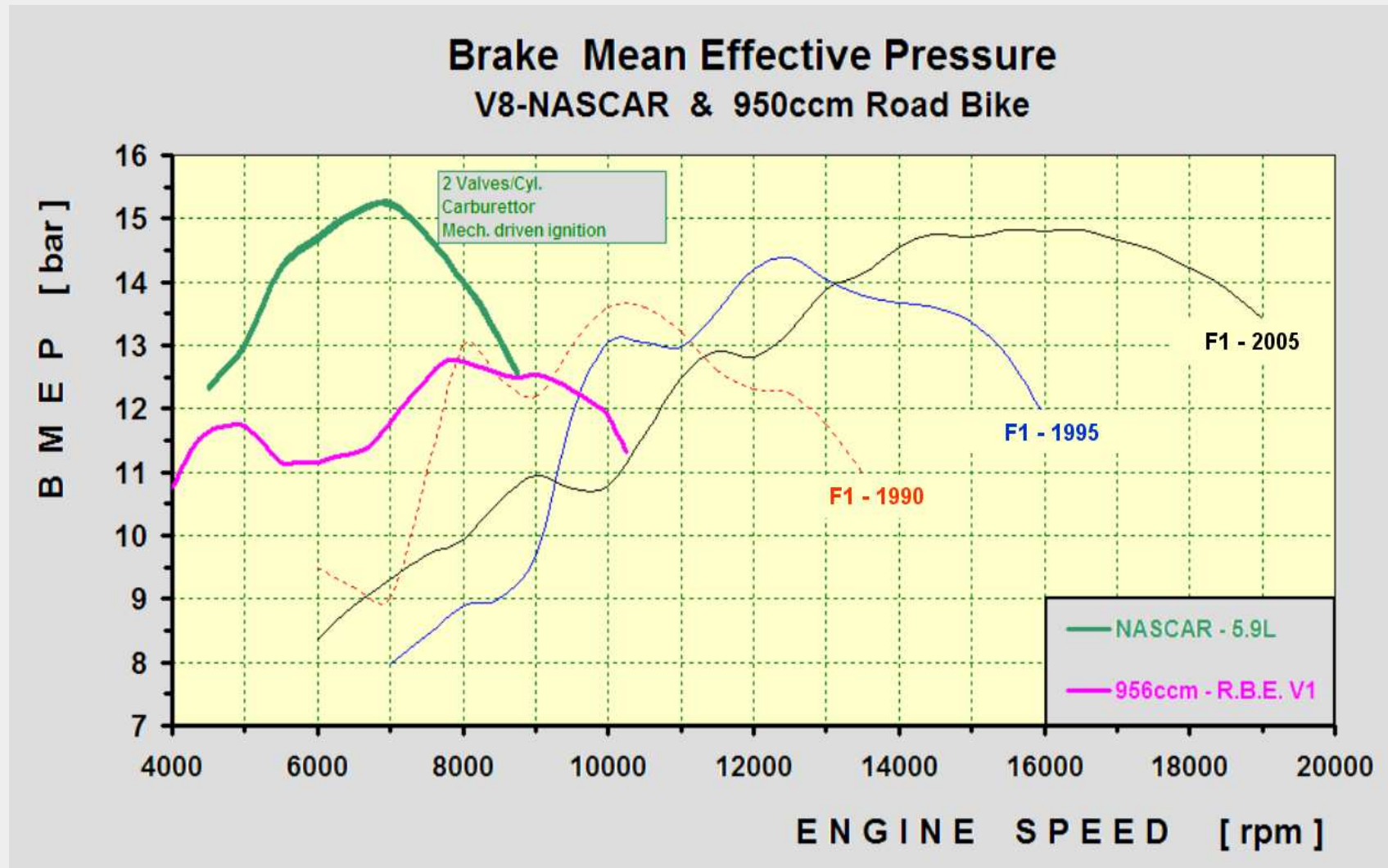




# Highest IMEP in a NA Engine – GM 5.86 V8



# Comparison BMEP Different Race Engines



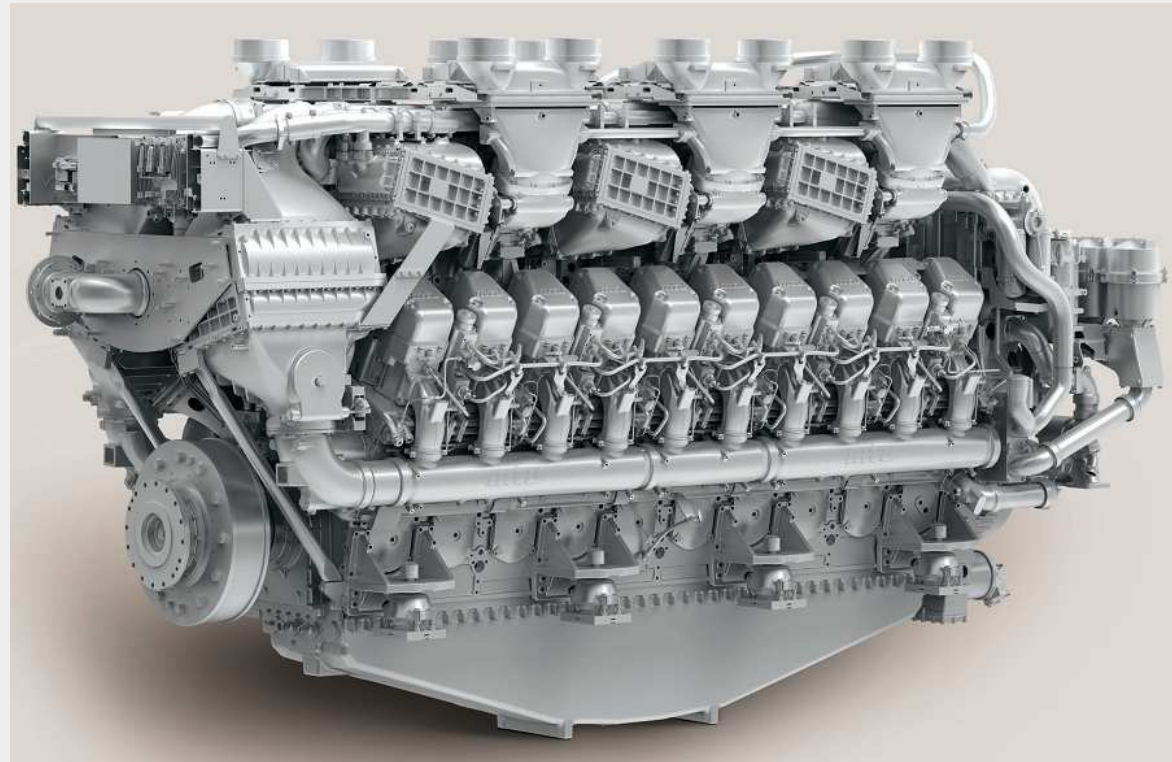
# MTU 1163 Highest Power Density Diesel Engine

## MTU 1163

mech. Power 7400 kW  
number of cyl. 20  
cyl. arrangm. V 60°  
bore 230 mm  
stroke 280 mm  
displacement 232.6 l

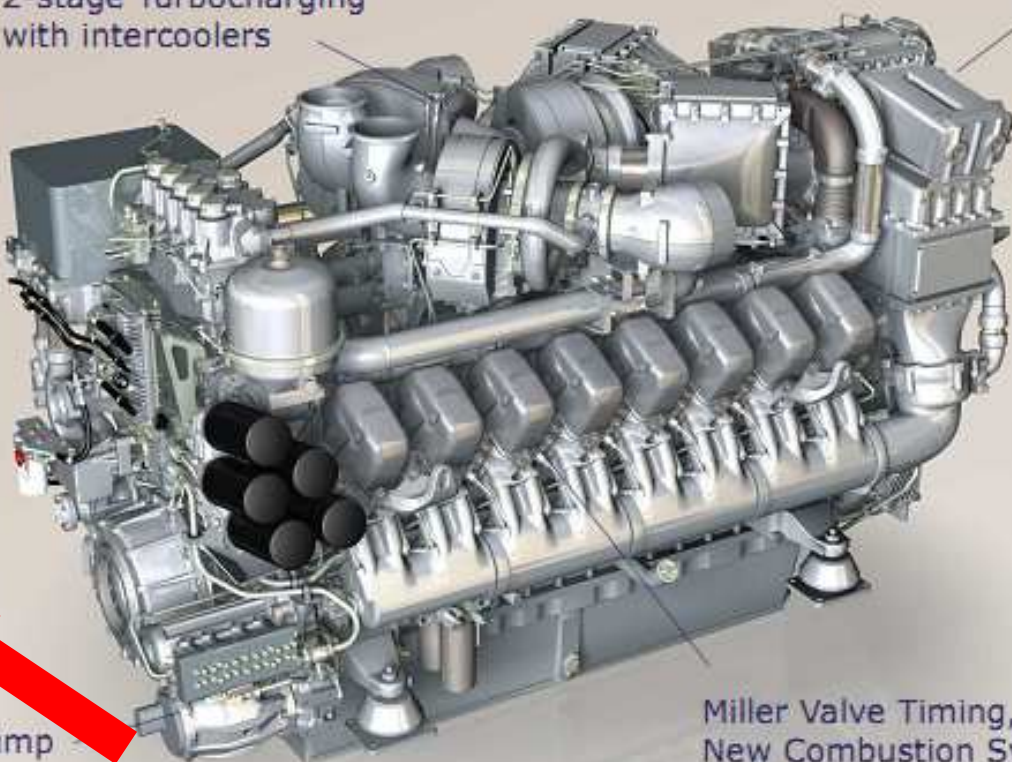
BMEP 29.35 bar  
speed 1300 rpm  
dry weight 24.5 t  
engine dimensions  
L\*W\*H [m] 5.62\*1.87\*2.925

power density  
> 200 kW/m<sup>3</sup> (20V)





# New MTU S4000 EUIIIIB Rail Engine



2-stage Turbocharging with intercoolers

EGR-Cooler

CR Injection pump

Miller Valve Timing, New Combustion System

Engine configuration	
cylinder numbers	8, 12, 16, 20V
displacement per cylinder	4,77 l
power range	1000-3000 kW
max. power per cylinder	150 kW
rated speed	1800 min <sup>-1</sup>
rated BMEP	21,0 bar

Engine operating data (at full load and rated speed)	
Boost pressure	4,8 bar
EGR rate	25%
Air to fuel ratio	25
fuel consumption	< 205 g/kWh
raw particulate emissions	< 0,1 g/kWh
NO <sub>x</sub> emissions	< 3,5 g/kWh

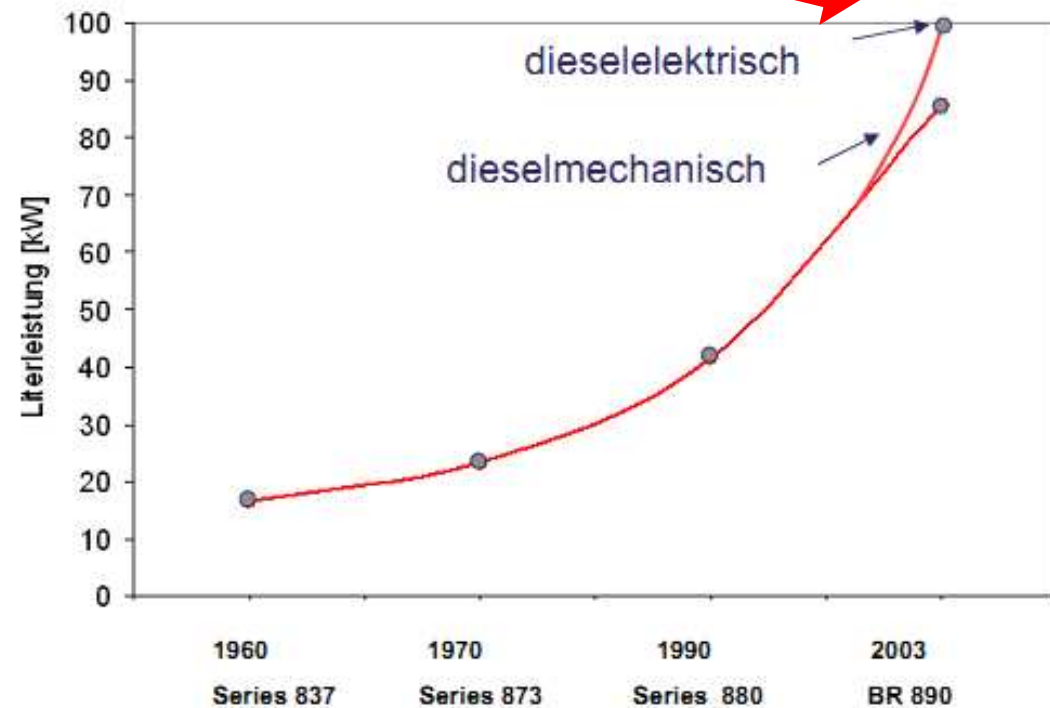
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# Extreme Downsizing MTU BR 890

## Entwicklung von Bauraum und Literleistung



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24.02.2012

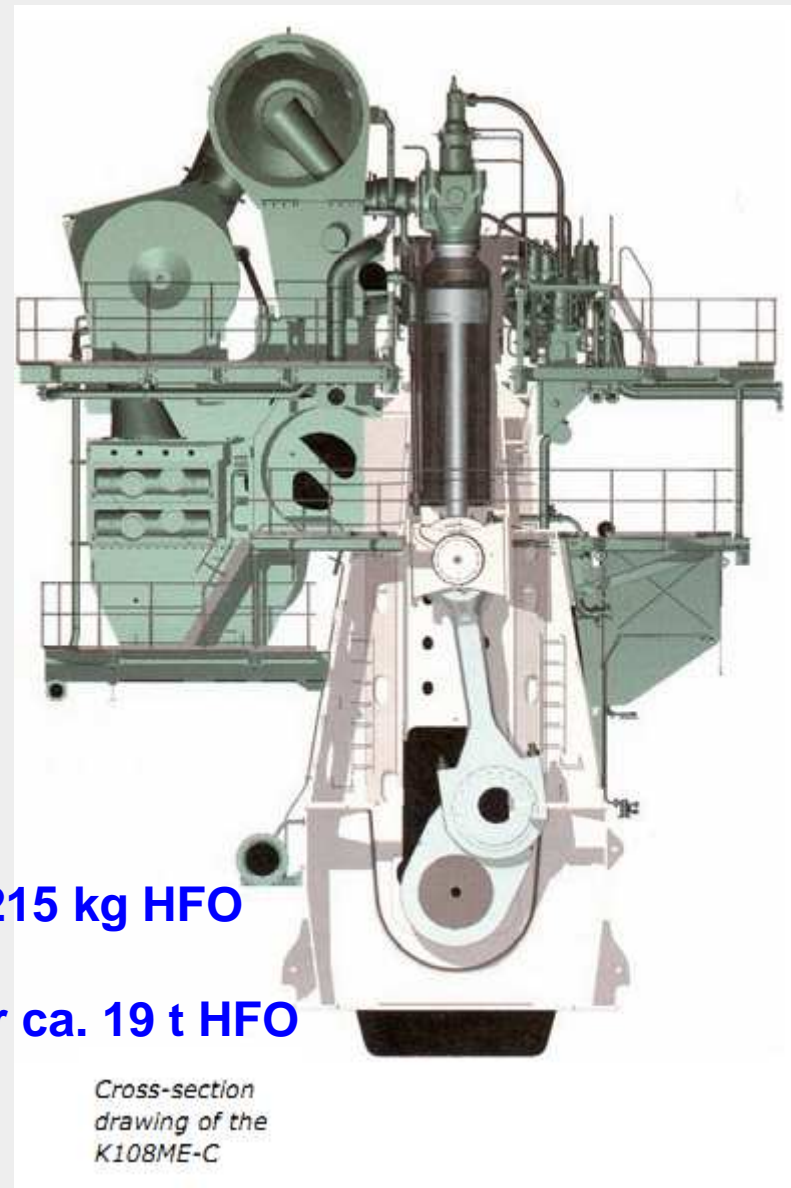
# Biggest 2-Stroke Diesel Engine (Series Preparation)

## MAN K 108 c/14 Zylinder (engine mainly based on K 98)

mech. Power	97.3 MW	←
number of cyl.	14	
cyl. arrangement	in line	
mech. efficiency	50.6%	
bore	1080 mm	
stroke	2660 mm	
displacement	34115 l	
BMEP	18.2 bar	
speed	94 rpm	
dry weight	appr. 2400 t	
L*W*H (m)	~28*4.64 (basem.)*13.58	



fuel injec. per stroke 0.215 kg HFO  
 $v = 0.238$  l/stroke  
fuel consumpt. per hour ca. 19 t HFO

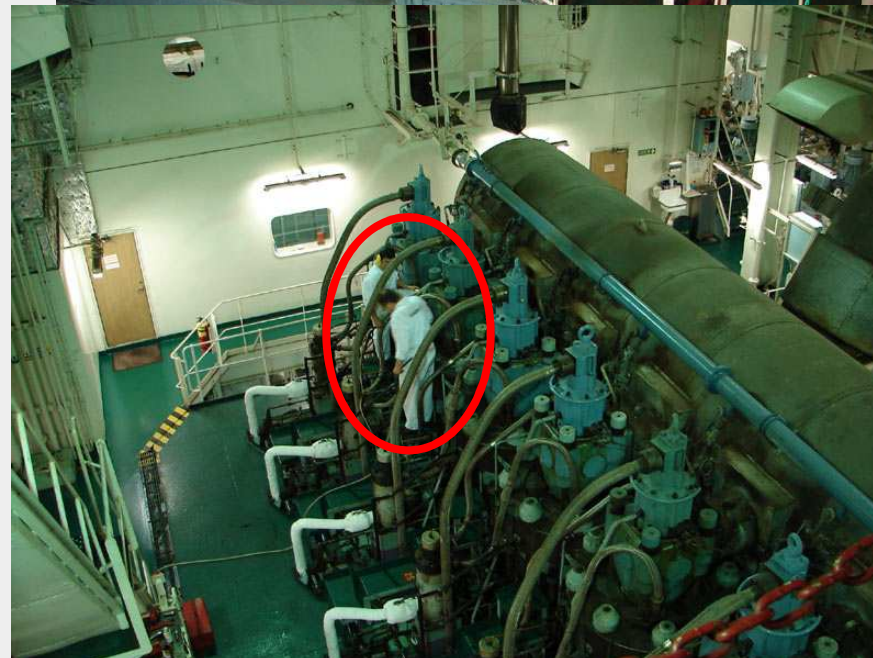


Cross-section  
drawing of the  
K108ME-C

# One of the Biggest 2-Stroke Diesel Engine

## Serie MAN K 98/14 Zylinder

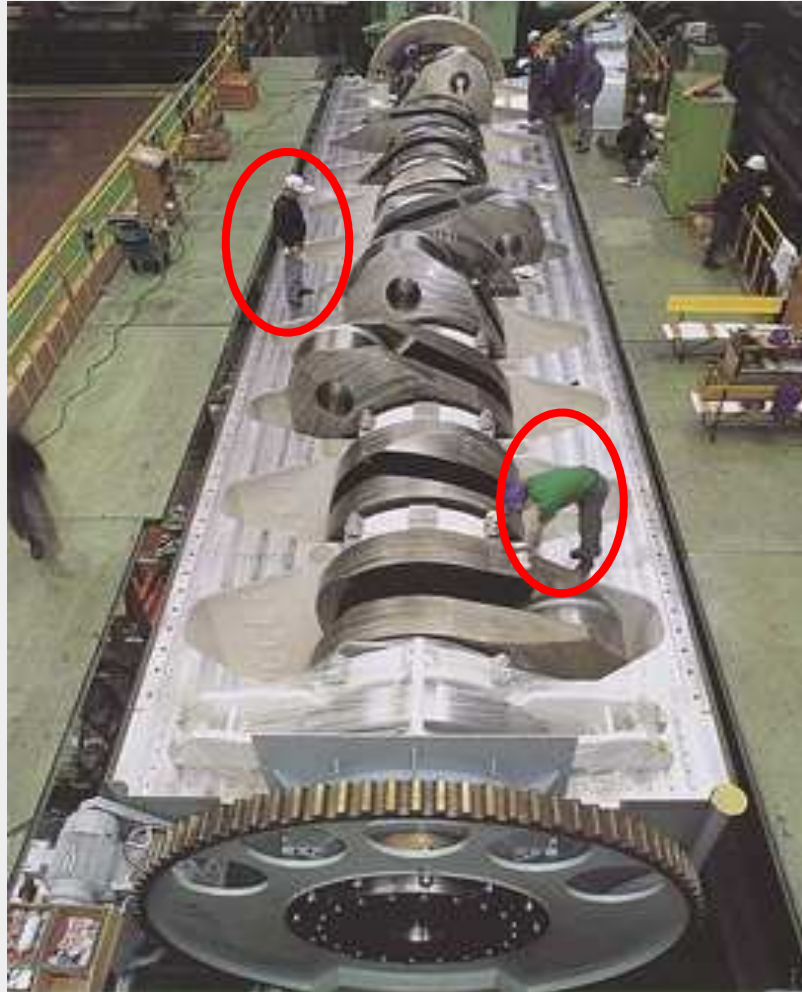
mech. Power	87.22 MW
number of cyl.	14
cyl. arrangement	in line
el. efficiency	50.4%
bore	980 mm
stroke	2660 mm
displacement	28090l
combustion	Diesel
BMEP	19.2 bar
speed	97rpm
dry weight	2200 t





# One of the Biggest 2-Stroke Diesel Engine for Oil Vessels

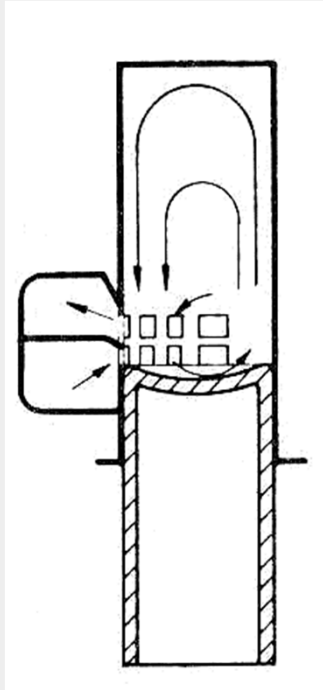
## Wärtsillä RTX 96



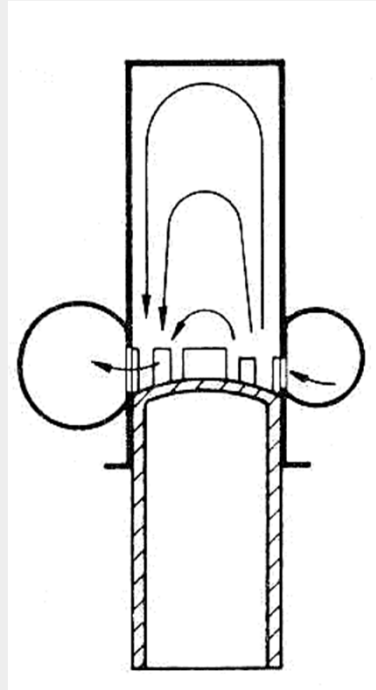
mech power	80,08 MW
number of cyl.	14
cyl. arrangement	in line
mech. efficiency	50.4%
bore	960 mm
stroke	2500 mm
displacement	25480l
BMEP	19.6bar
speed	92-102rpm
dry weight	2300 t



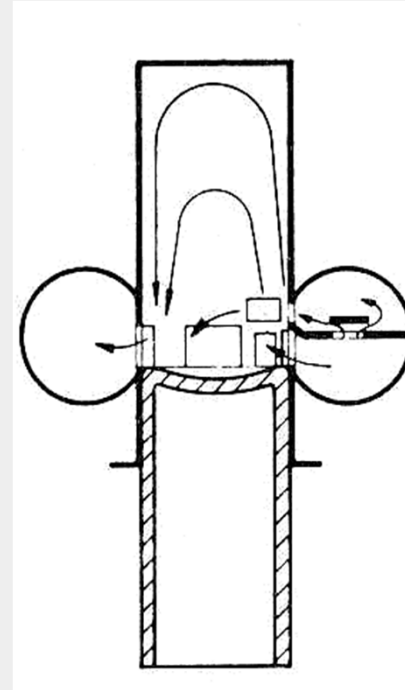
# Differences 2-Stroke Engines



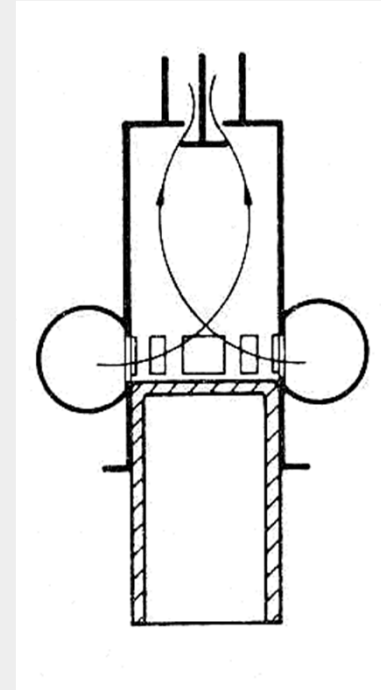
U-flow



cross flow



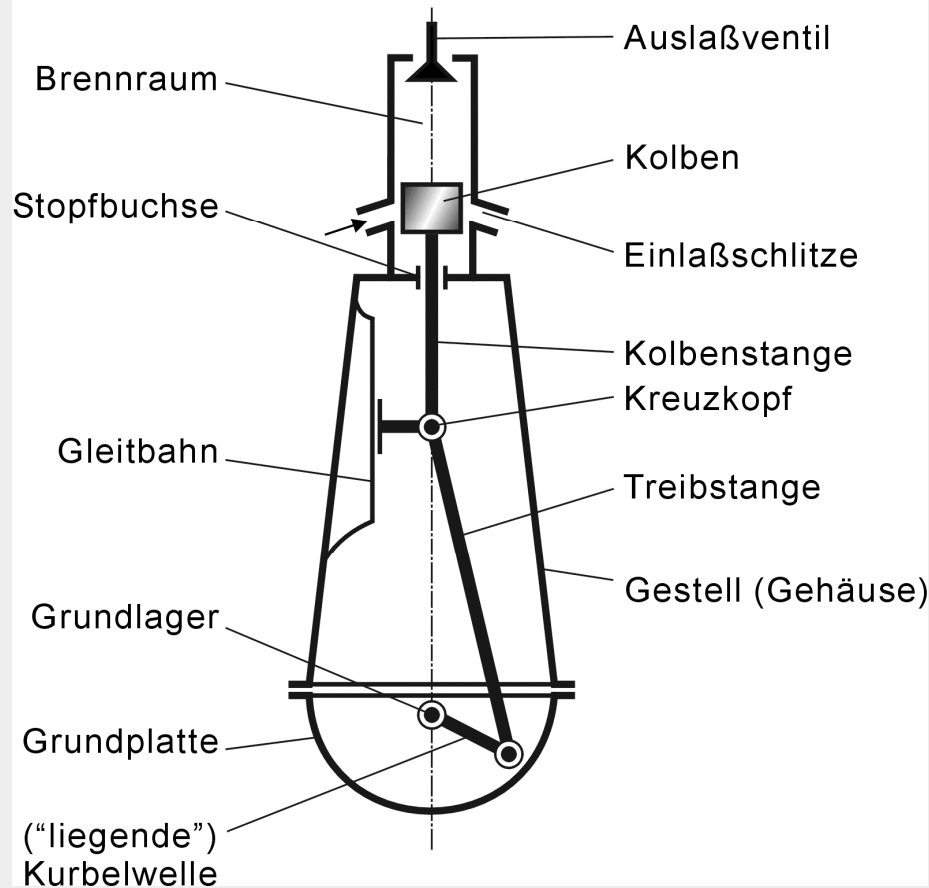
cross flow  
with add.  
boost



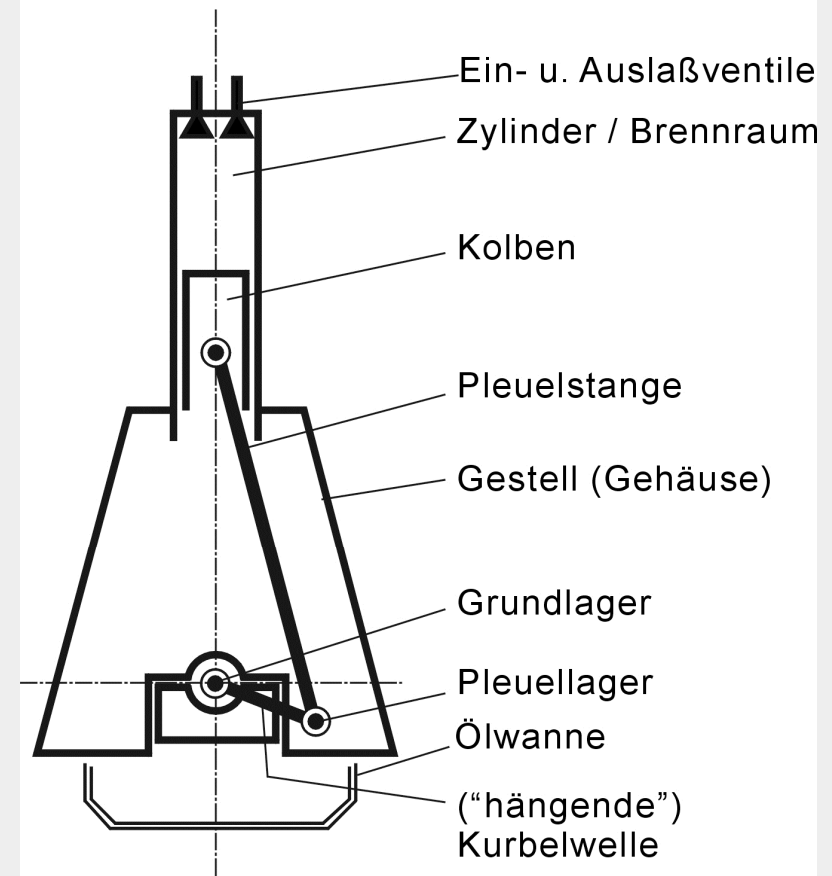
uniflow  
with exhaust  
valve

# Differences 2-Stroke Engines

**Kreuzkopfmotor**



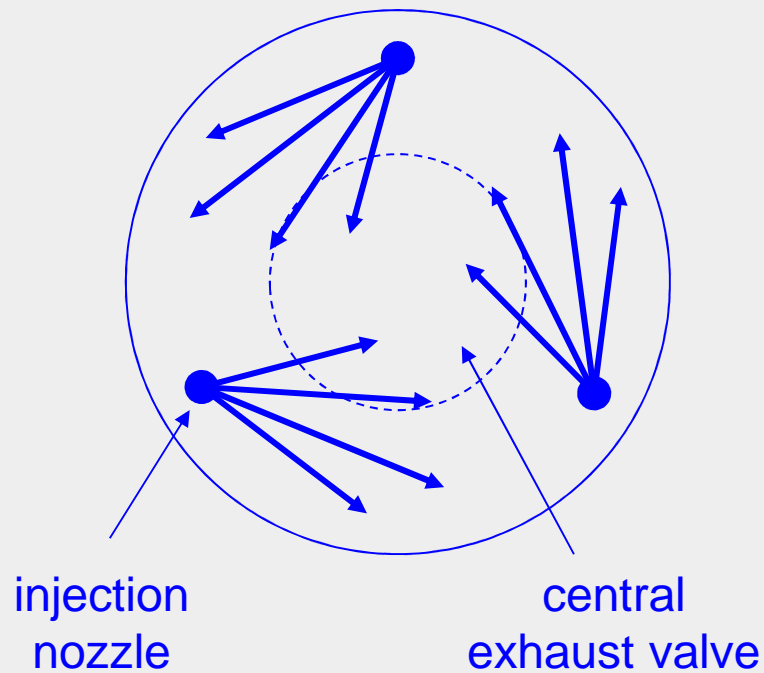
**Tauchkolbenmotor**



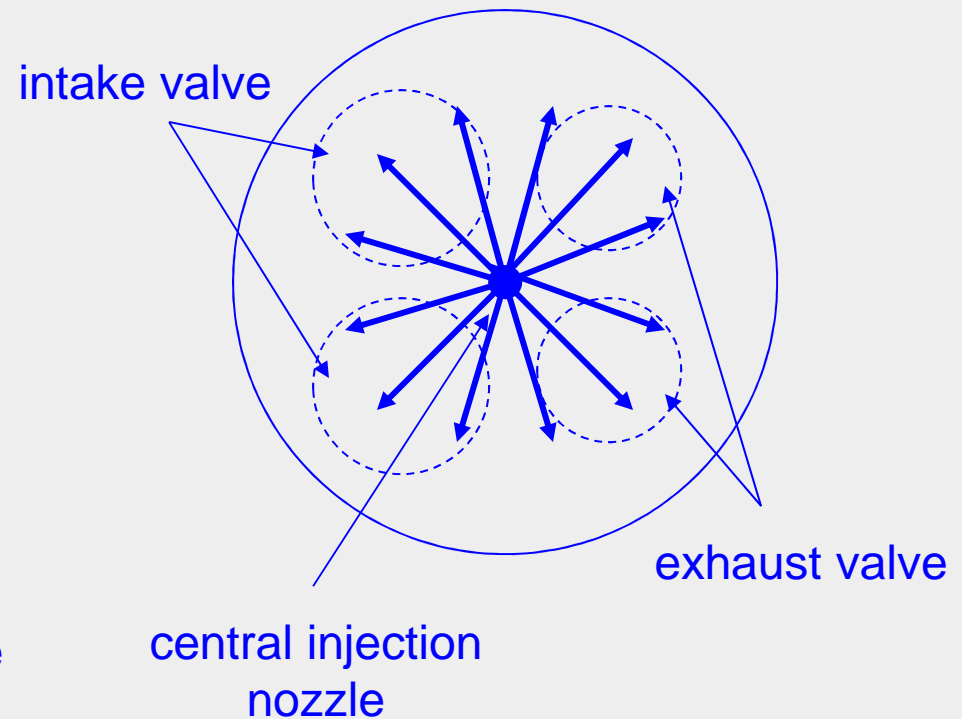


# Comparison 2-Stroke Uniflow vs. 4-Stroke

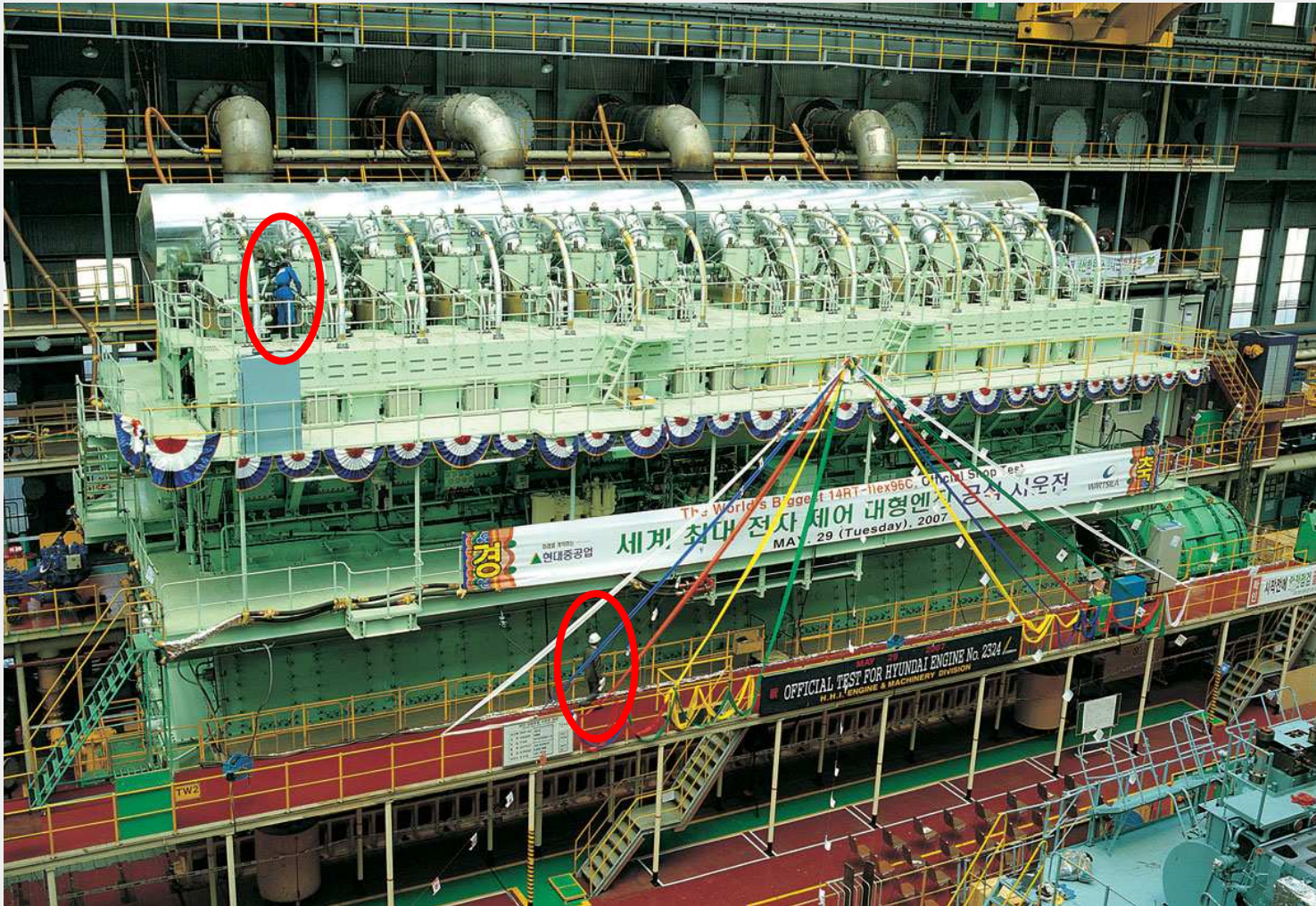
**2-stroke-engine with  
central exhaust valve**



**4-stroke-engine**



# Most Powerfull Engine 2007 – RTA 96 14 Cyl.





# Most Powerfull Engine 2004 MAN 12K98 ME





# Exhaust Valve Seat MC 90



weight (cooled) exhaust valve seat = 320 kg

# Exhaust Valve MC 90

system costs

approx. 40 000 €

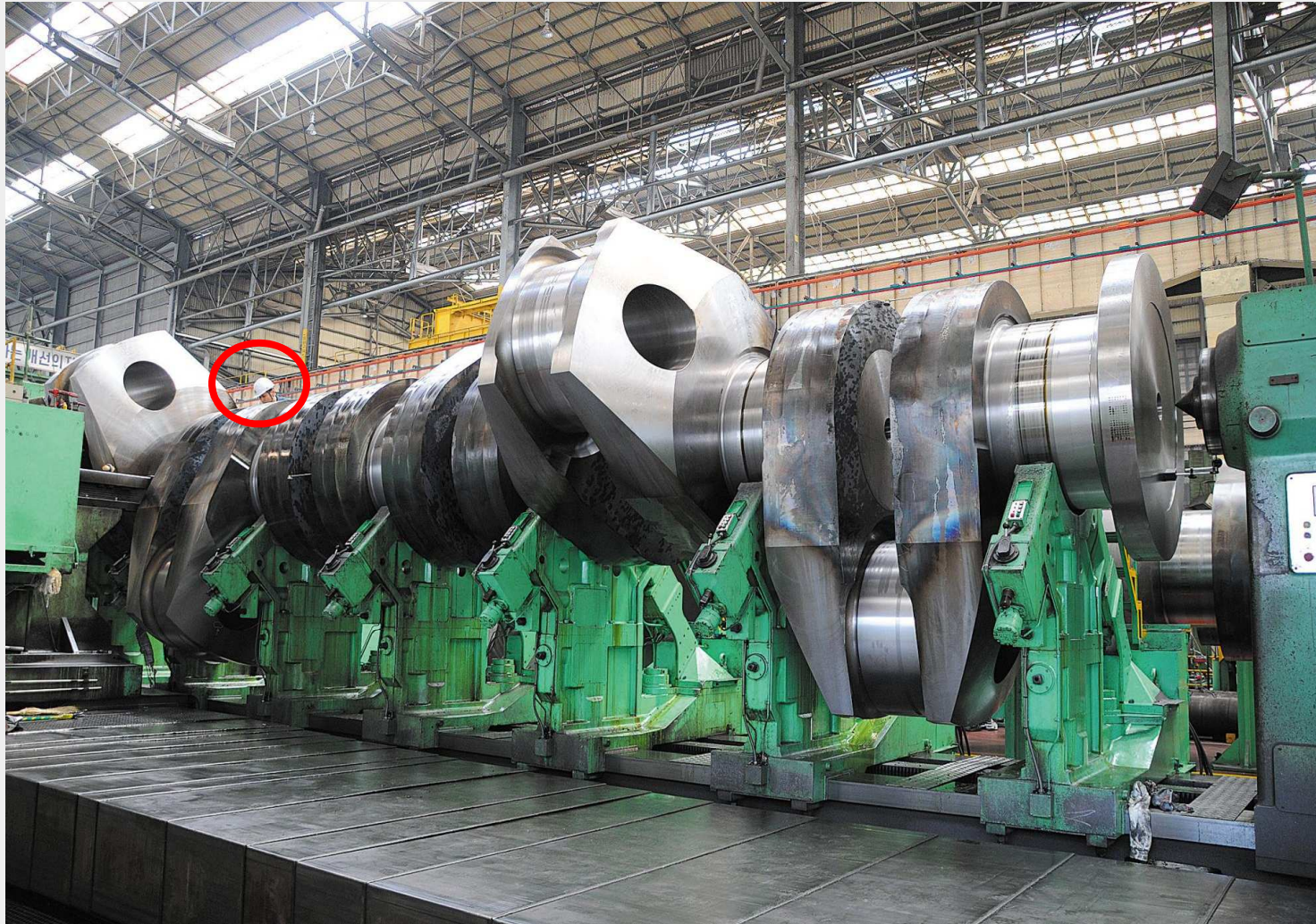
valve spindle costs

approx. 20 000€





# Production of an MAN K98 Crankshaft





# Liners Preparation for Assembly



# Highest Power Output 4-Stroke Diesel

## Wärtsilä 18V64

el. Power 34.92 MW

el. efficiency ~48 %

bore 640 mm

stroke 770 mm

combustion HF diesel

BMEP 22 bar

speed 428.6 rpm

dry weight 582 t

engine dimensions

L\*W\*H [m] 16.97 \* 7.5 \* 7.71

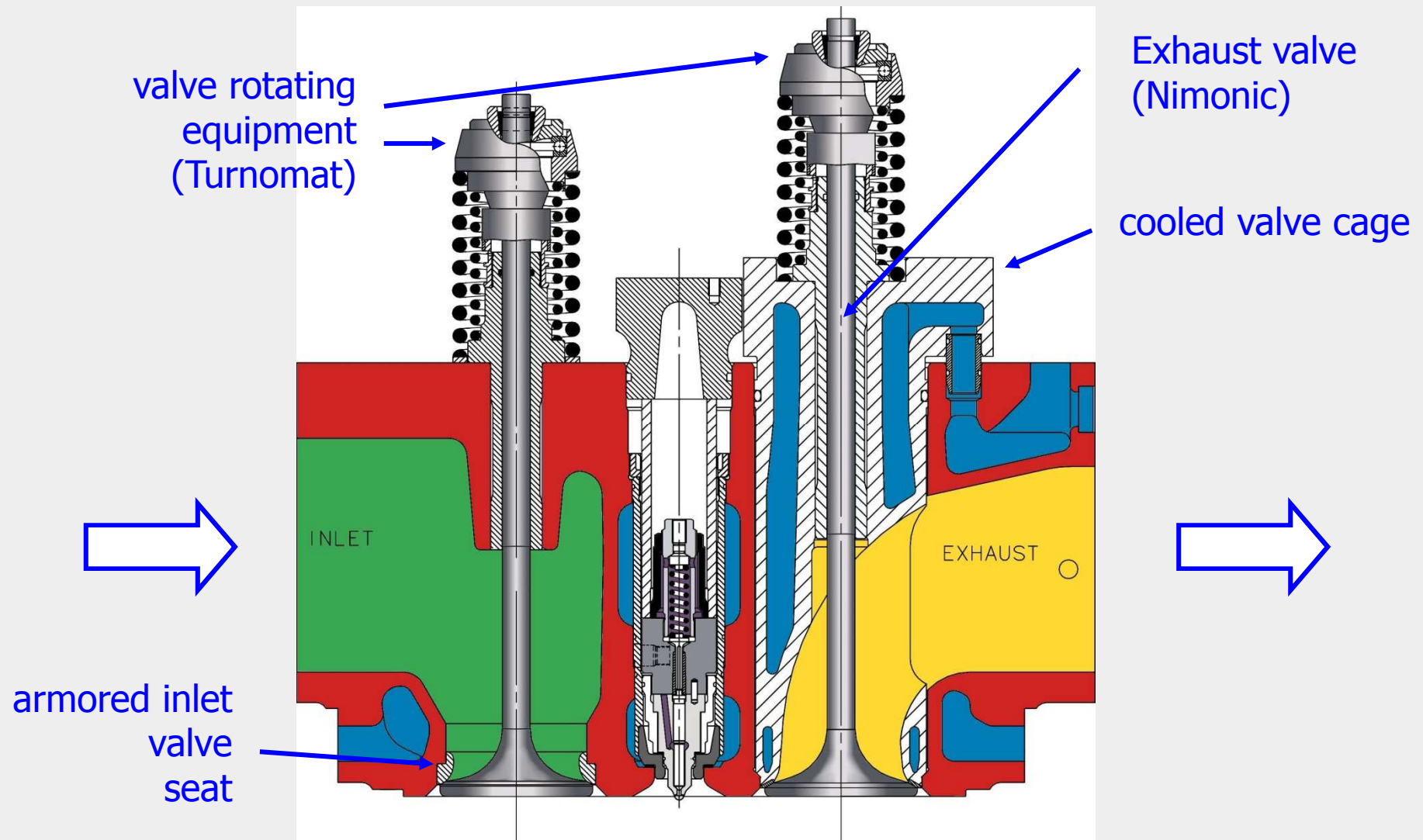
cyl. head

weight 3.5 t (compleat)





# Cylinder Head S.E.M.T. PC 2-6B

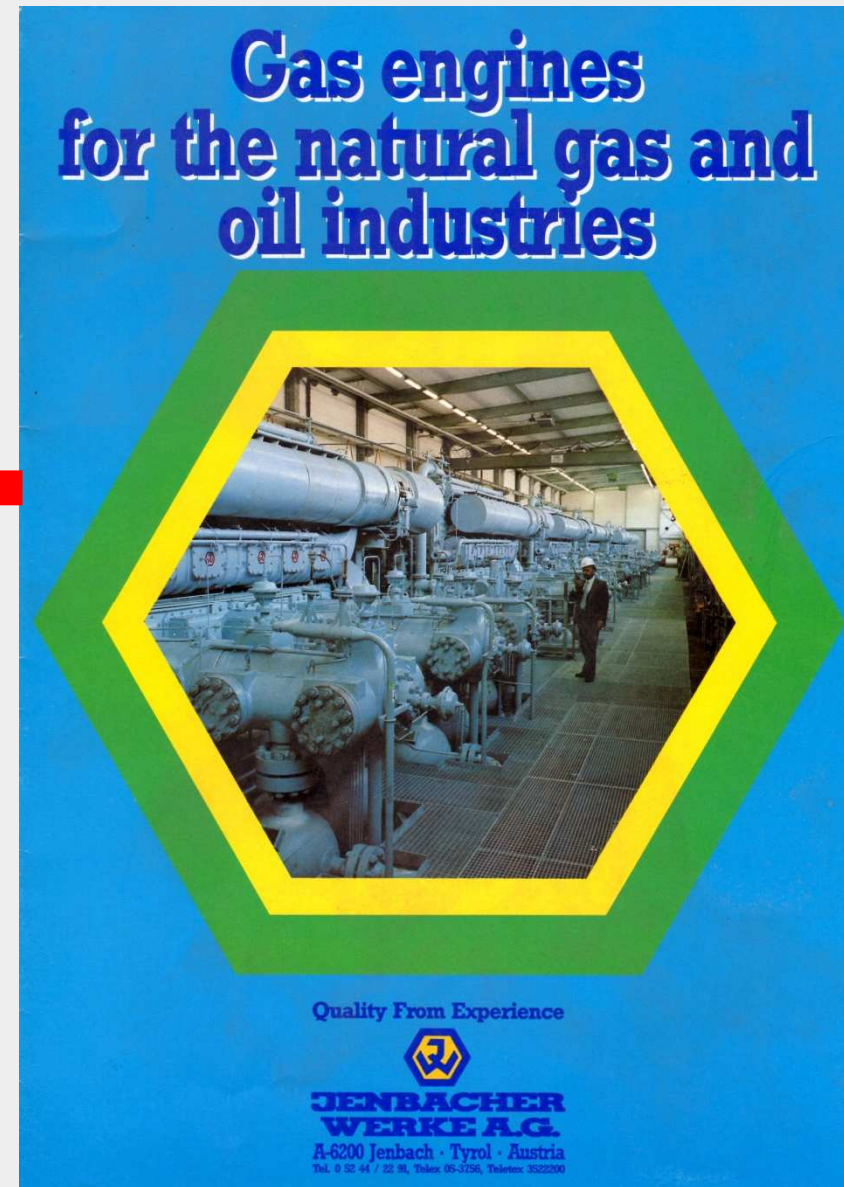




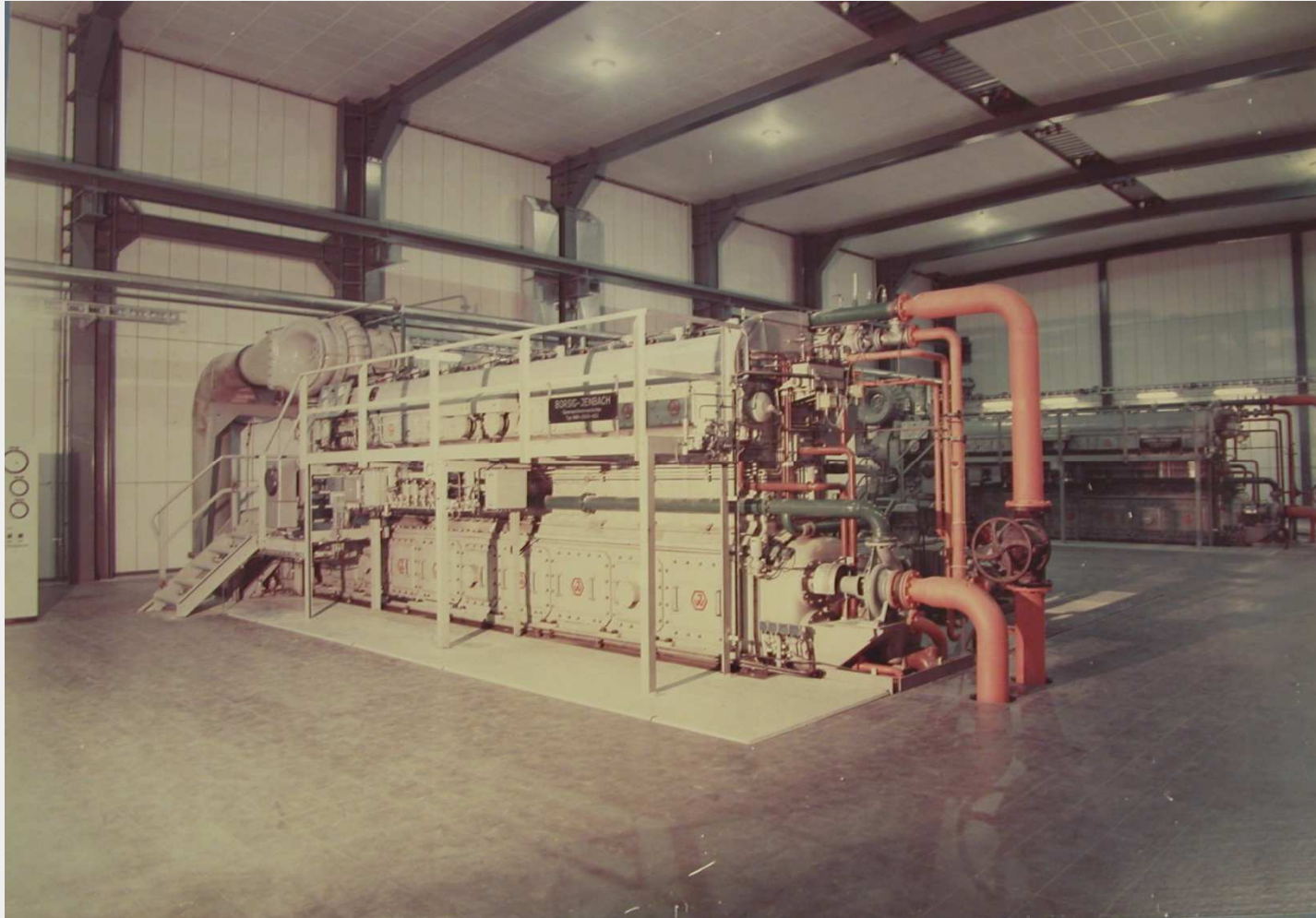
# The Biggest Manufactured 2 Stroke Gas Engine in Jenbach (1965)

Jenbacher Serie II M9-2500SGO  
VM9-2500SGO

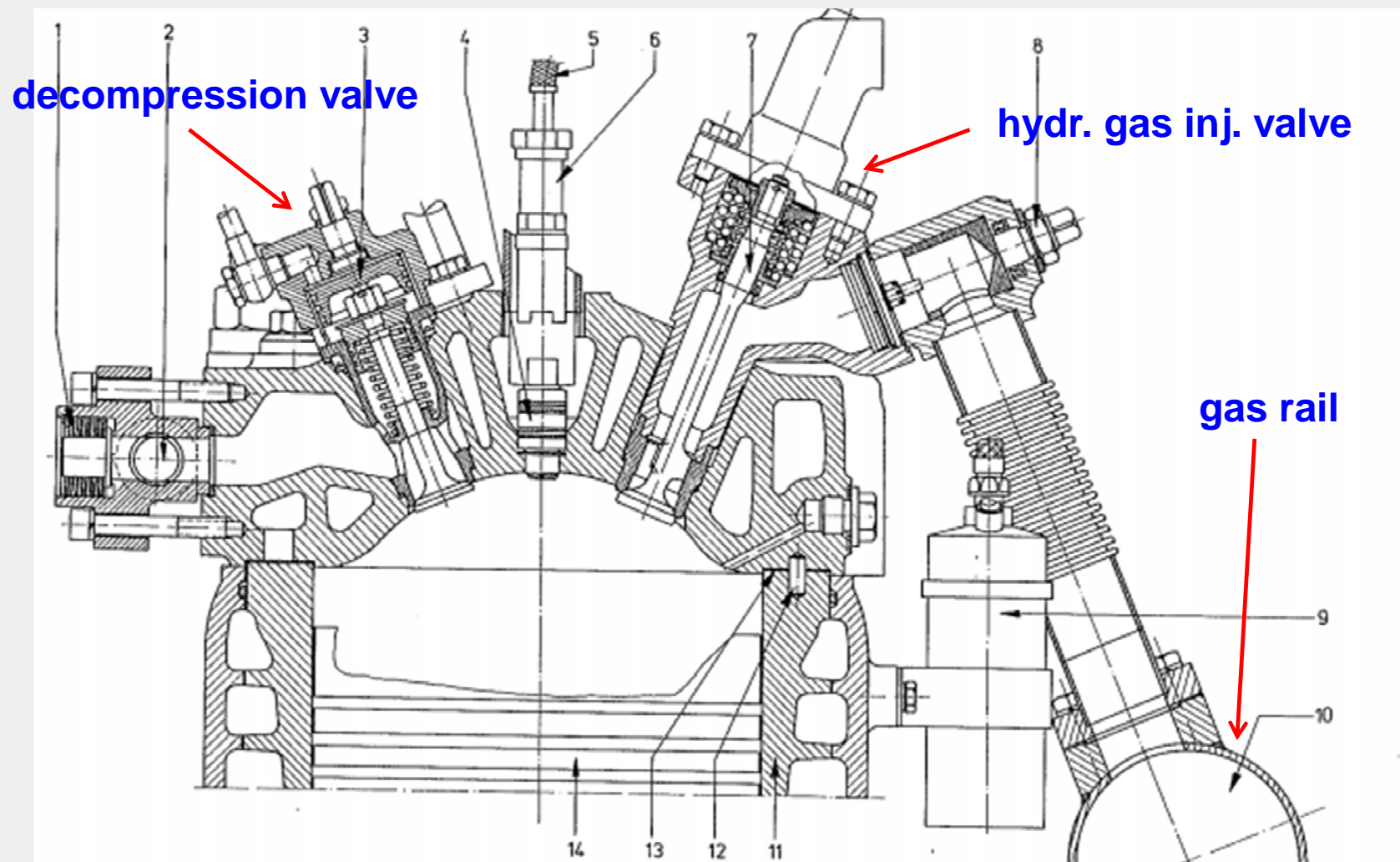
el. Power	2.48 MW
number of cyl.	9
cyl. arrangement	in line
el. efficiency	35.5 %
bore	420 mm
stroke	560 mm
displacement	623.45 l
combustion	spark plug
BMEP	7.46 bar
speed	333 rpm
dry weight	73 t



# Historical Photography of an Jenbacher Serie II M9-2500SGO (1967)

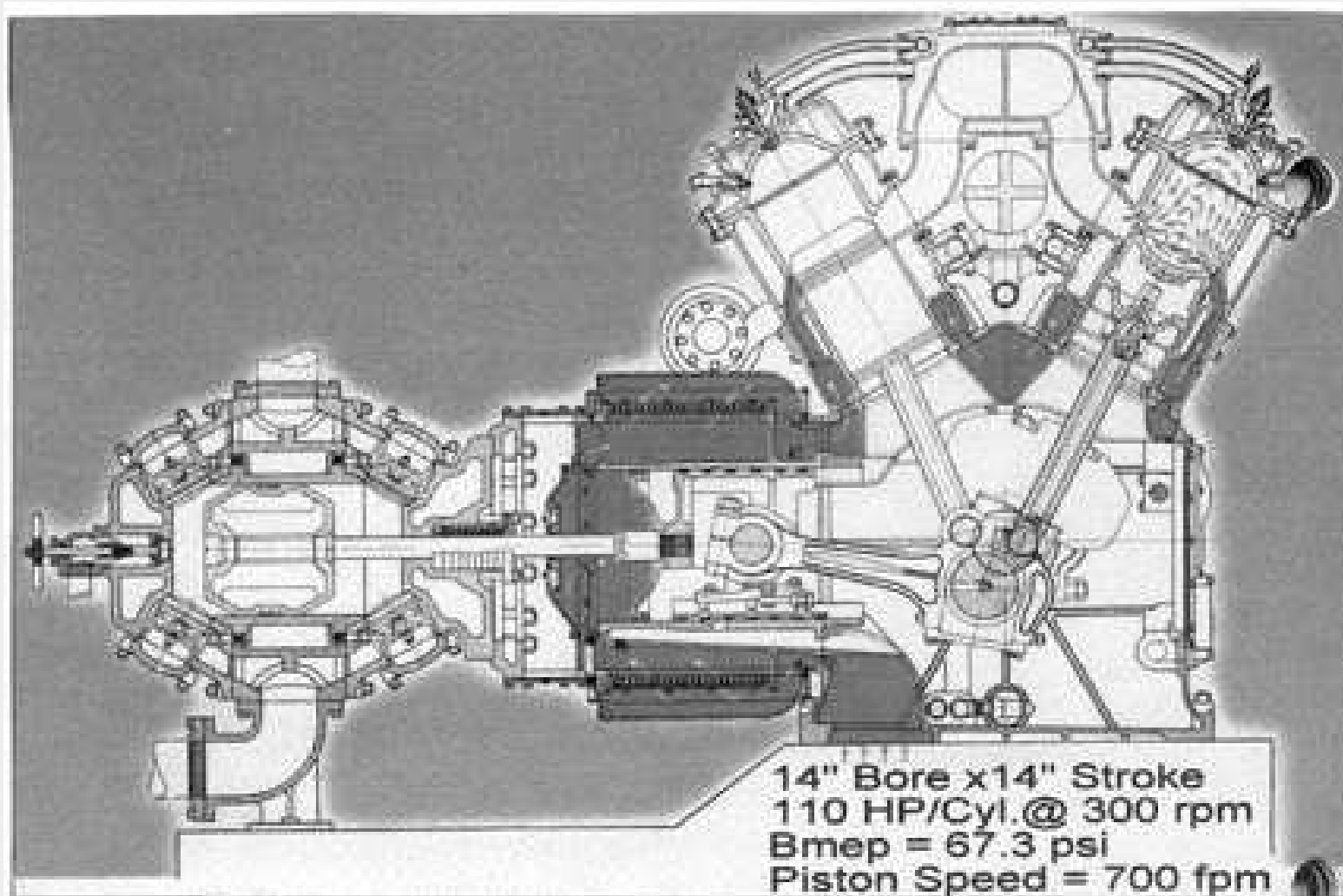


# Technology Mixture Formation





# Technology Integralcompressor (GMV Serie)

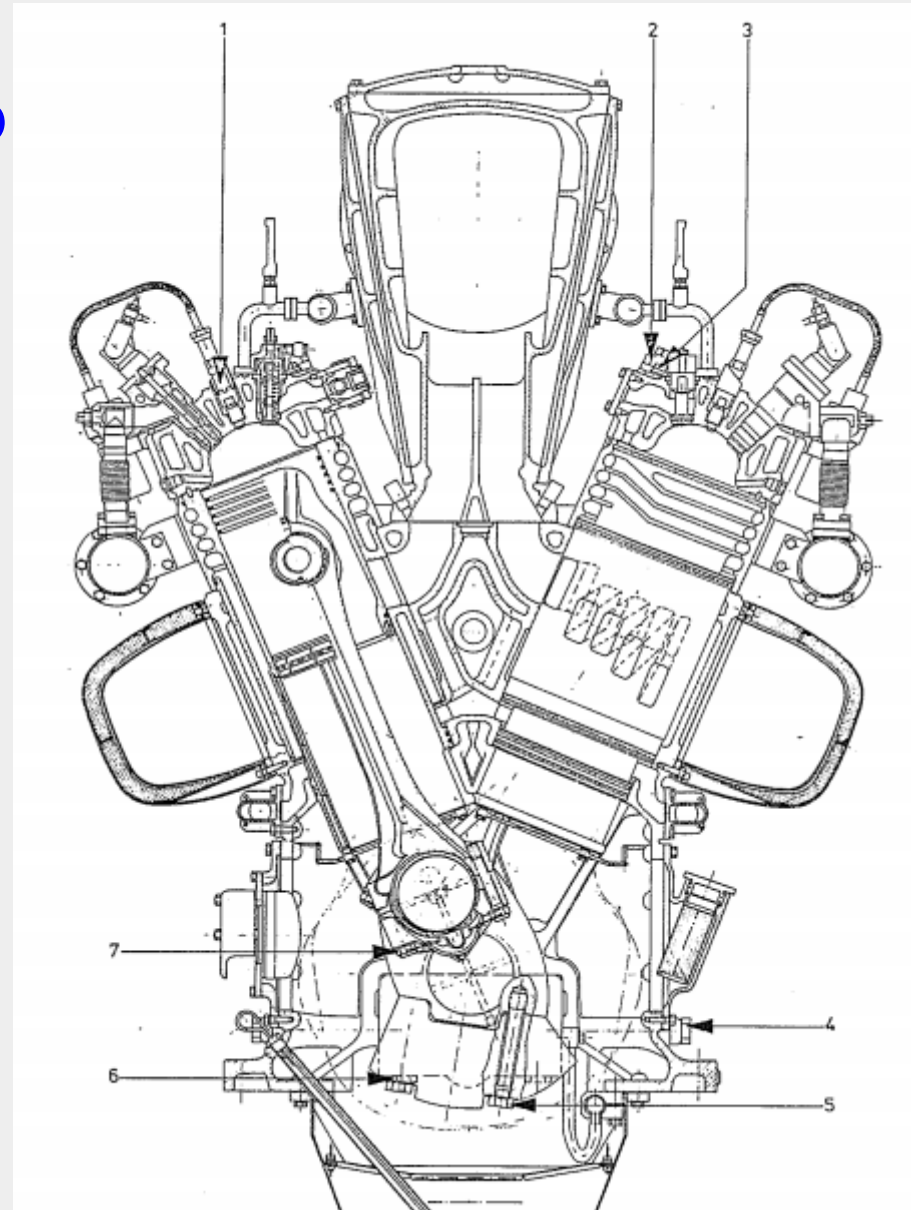


# Cross Section of a 2 Stroke Gasengine

## A 12-1200 GO

### Jenbacher Serie A1 A12-1200 GO

el. Power	883 kW
number of cyl.	12
cyl. arrangement	V 45°
el. efficiency	33.5 %
bore	230 mm
stroke	340 mm
displacement	169.5 l
combustion	spark plug
BMEP	5.42 bar
speed	600 rpm
dry weight	10.1 t



Thank you for attention

Questions?