

Epicyclic Gear Units - Often the Best Solution

BHS has been producing Epicyclic Gear Units using the Stoeckicht design since 1932, longer than any other gear manufacturer.

For many applications BHS Stoeckicht Epicyclic Gear Units have features which make them superior to other gear designs:

- Optimum utilization of space and minimum weight due to effective load distribution (Fig. 1).
- No bearings are required for the high speed shaft, eliminating bearing losses and substantially reducing oil requirements.
- Superior noise and vibration characteristics.
- Sun gear is lubricated from inside, resulting in effective heat dissipation with minimal lubrication.
- Gearbox is furnished with an integrated high speed coupling and coupling guard and requires no high speed shaft bearings, minimizing customer interfaces.
- Coupling available as a BHS TWINTORS® Diaphragm Coupling or a Gear Coupling.
- Patented Combi design (RTP...K) also available with integrated low speed coupling.
- E-PACK® Systems feature Epicyclic Gearboxes integrated with electric motors or generators into compact, cost effective systems. (Page 9). Please ask for our E-PACK® brochure!

For many applications, BHS Epicyclic Gear Units are the ideal solution with regard to gearbox performance and cost effectiveness.

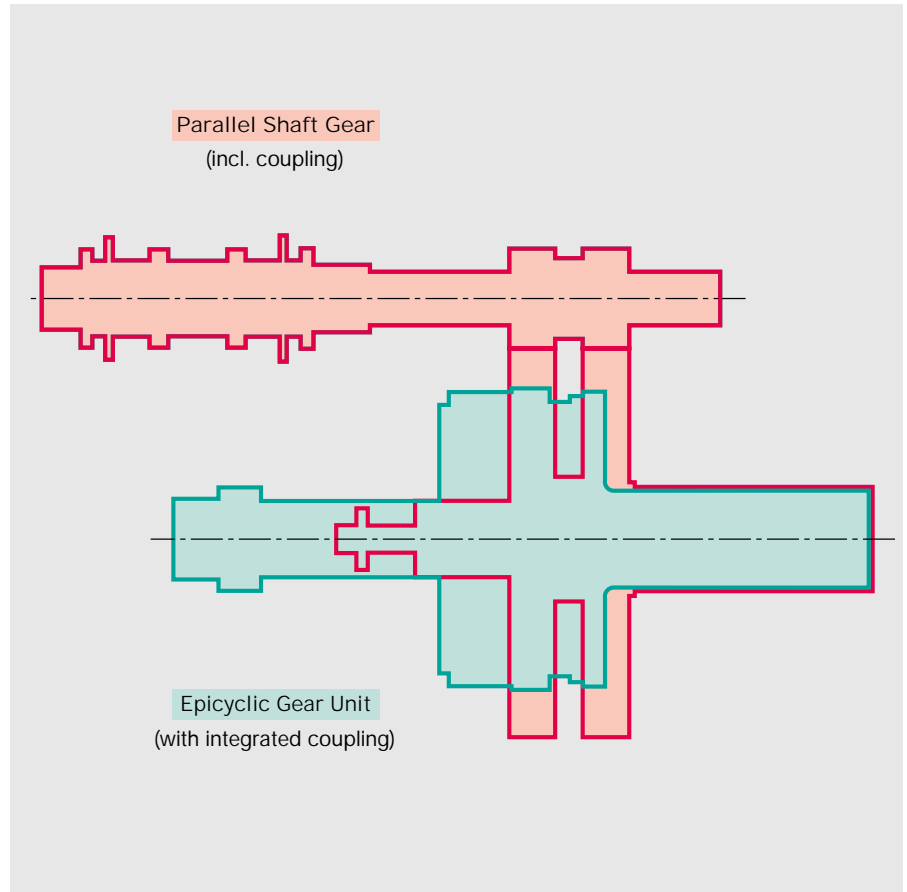


Fig. 1: Size comparison between a BHS Epicyclic Gear Unit (Type RTP 40) to that of a Parallel Shaft Gear Unit (Type FD 3), with identical input and output speeds.



Fig. 2: BHS Epicyclic Gear Unit, Type RTP...K, with base frame and torque meter shaft.

Designs and Principles

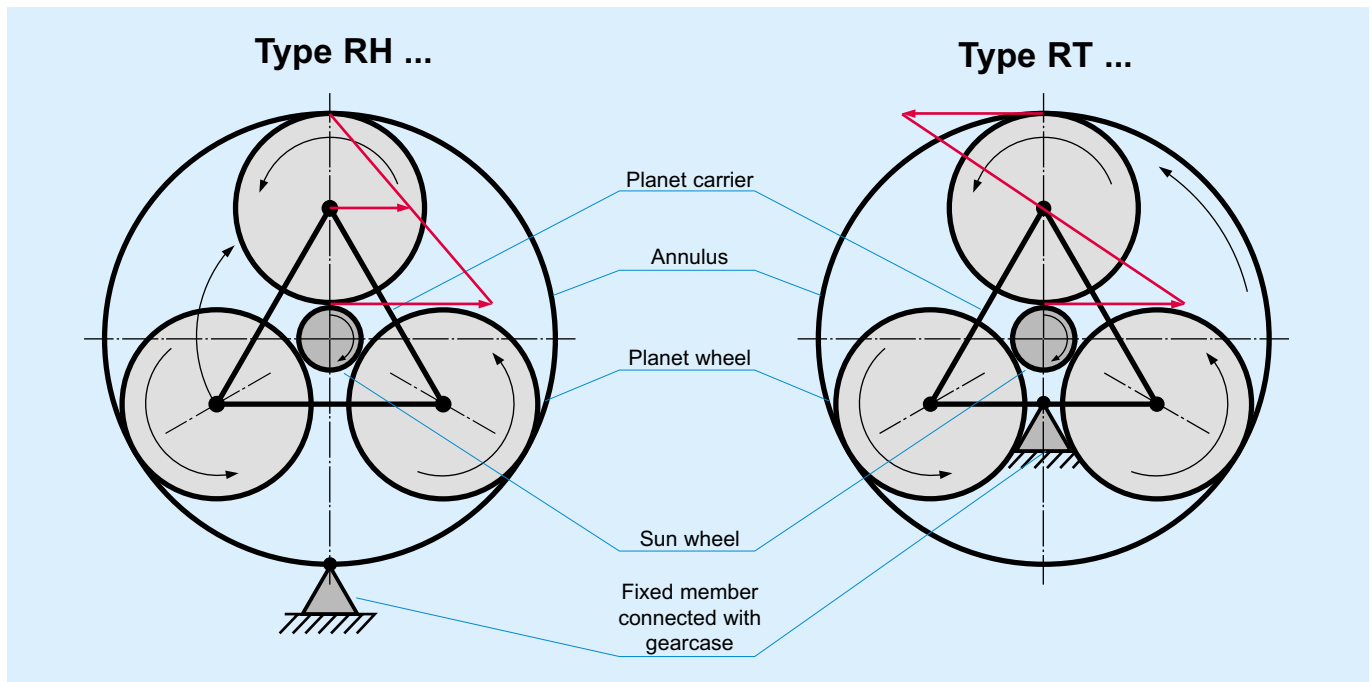


Fig. 3: Differences between two basic designs: Type RH... and RT...
(The red vectors show the circumferential velocity of the respective component.)

Type RH ...

- Annulus connected to the gearcase (stationary).
- Planet carrier connected to the low speed shaft.
- Sun wheel connected to the high speed shaft.
- Gear ratio of one stage ranging from 2.8 to 12.
- Identical direction of rotation of input and output shafts.

Type RT ...

- Planet carrier connected to the gearcase (stationary).
- Annulus connected to the low speed shaft.
- Sun wheel connected to the high speed shaft.
- Gear ratio of one stage ranging from 1.8 to 11.
- Opposite direction of rotation of input and output shafts.

Principle of Stoeckicht Load Equalization

- Free radial and axial* mobility of sun wheel and annulus results in best load equalization at the tooth contact points.
- The radially elastic design of the annulus compensates for manufacturing tolerances.

* In case of double helical gears.

Torque Distribution in Epicyclic Gear Units

The most significant advantage of Epicyclic Gears is that the input torque is distributed to all of the planets. BHS Stoeckicht Epicyclic Gear Units are particularly effective at balancing the torque equally between the planets. Depending on the gear ratio 3, 4, 5 or 6 planet wheels may be installed (in special designs up to 7). Each gear mesh then transmits only 1/3, 1/4, 1/5, 1/6 of the respective torque. The radial forces of each gear mesh offset each other. So with BHS Epicyclic Gear Units a compact design is achieved, combined with low strain on the components.



Fig. 4: BHS works premises.

Designs

Stoeckicht Epicyclic Gear Types RHP and RTP

BHS has built well over 10,000 Epicyclic Gear Units according to the Stoeckicht design. The rights to the Stoeckicht patent were acquired by BHS in 1970.

BHS Stoeckicht Epicyclic Gear Units ensure:

- Optimum load distribution to all gear components.
- Minimum influence of additional dynamic forces.
- Low influence of manufacturing tolerances.

All the geared components adjust themselves freely in radial and axial direction until their position is determined by an equilibrium of forces with all the other components. BHS Epicyclic Gears are thus especially suitable for high powers and speeds.

The design standardization and the machining processes especially developed for double helical Stoeckicht Epicyclic Gear Units allow:

- Optimum utilization of available space by shaping of the teeth, which allows minimization of the gap.
- Short delivery times due to "finish shaving" with subsequent nitriding of planet and sun wheel.
- High surface quality of annulus gearing possible with shaving of the internal gearing. (option)
- Smooth running and long service life due to fluid-film bearings.
- Rating possible according to API, DIN, AGMA and ISO.

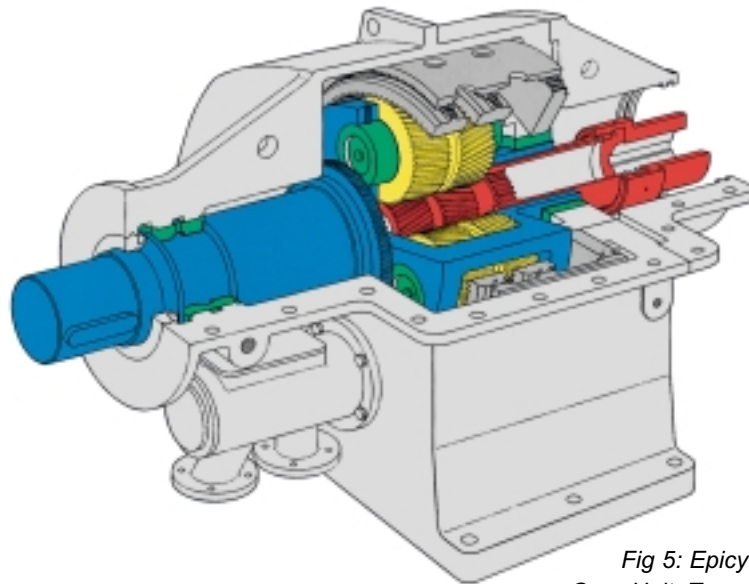


Fig 5: Epicyclic Gear Unit, Type RHP.

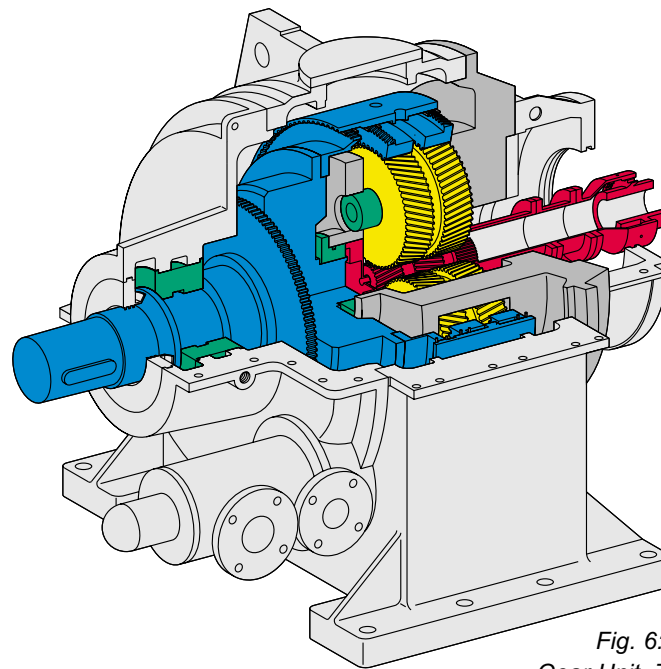


Fig. 6: Epicyclic Gear Unit, Type RTP.

- High bonding quality of the babbitt metal due to in-house manufacturing of the planet spindle sliding surfaces by the metal spraying method.
- High wear resistance of the gear teeth of the sun wheel and planets since the tooth flanks are not machined after nitriding.
- Applications up to 50 MW available, depending on type and operating speeds.
- Rating and dimensional tables. (Page 10 - 11)

BHS Epicyclic Gear Units drive machinery including generators, compressors, pumps, industrial blowers, and marine propellers.

Designs

Compact Epicyclic Gear Type RTG

For applications where small and medium powers must be transmitted, the well proven BHS compact Epicyclic Gear Unit is an economic alternative.

- A straight forward design with an attractive price-performance relationship with short delivery times.
- Quiet running due to planet wheels and gearing corrections.
- High bonding quality of the babbitt metal due to in-house manufacturing of the planet spindle sliding surfaces by the metal spraying method.
- High axial forces may be transmitted when RTG Units are equipped with thrust collars.
- By the patented „Double-Twin“ arrangement of the planet wheels a gear ratio up to 18 may be achieved in one stage.
- When equipped with a second set of planets, extreme gear ratios up to 25 may be achieved. This is called a Stage-Type Epicyclic Gear Unit, type RTG...CS (Fig. 8).
- Rating and dimensional tables. (Page 10 - 11)

Compact BHS Epicyclic Gear Units are used as Integral Gear Units in stationary and mobile generator or compressor plants, in free-standing as well as flange-mounted designs.

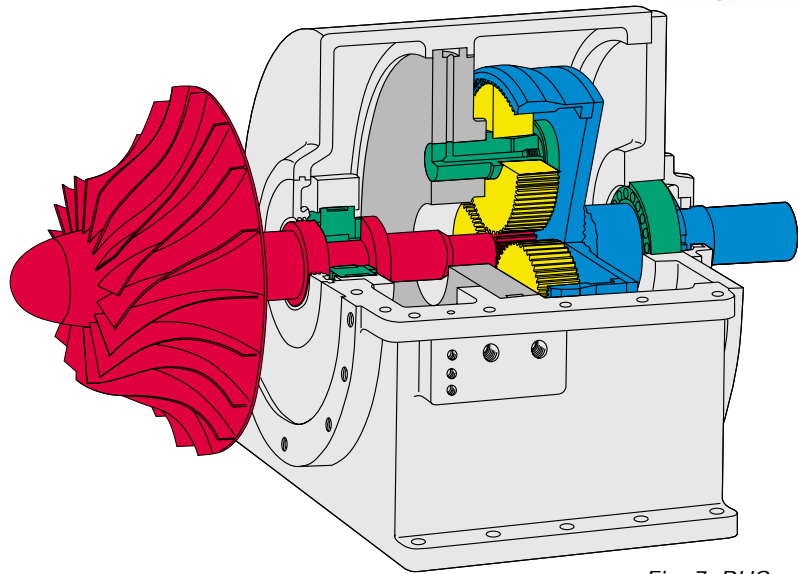


Fig. 7: BHS Integral Epicyclic Gear Unit, Type RTG.

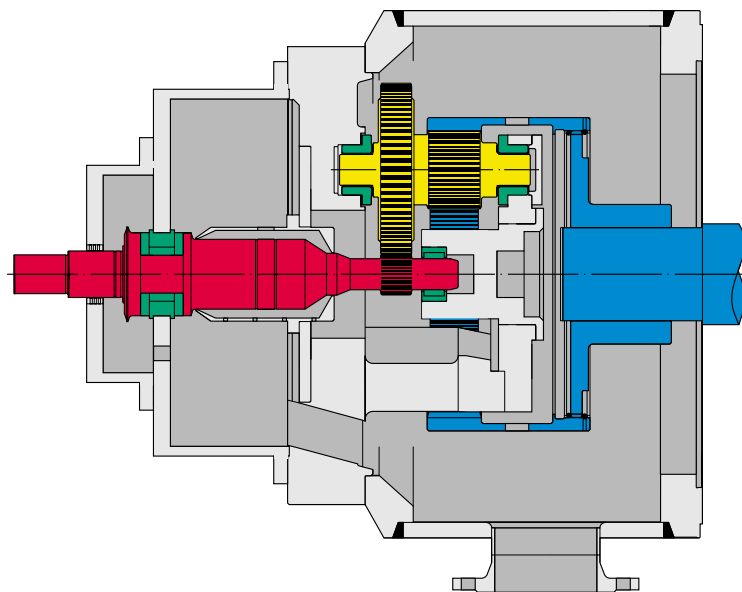
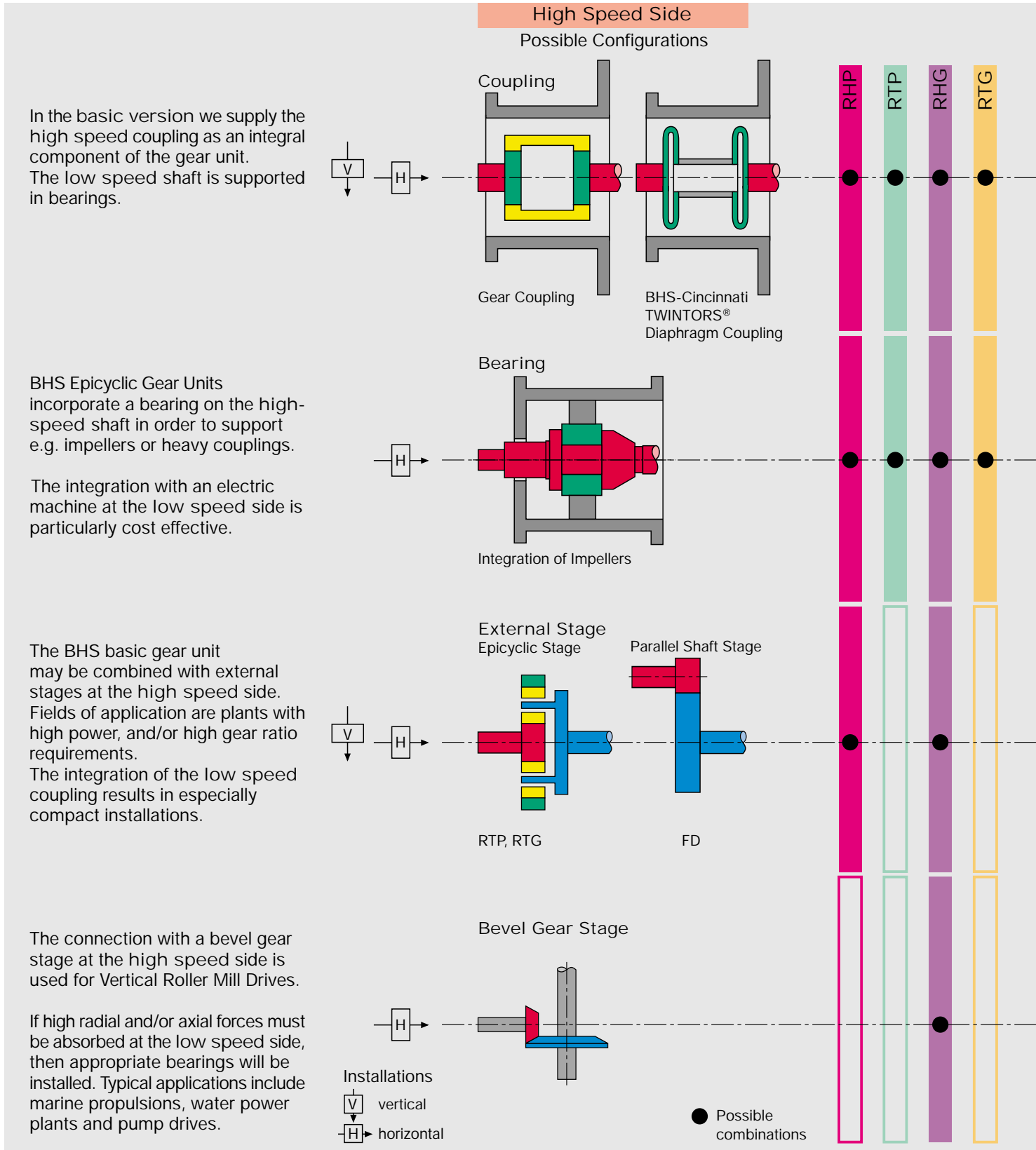


Fig. 8: BHS Stage-Type Epicyclic Gear Unit, Type RTG...CS.



Fig. 9: BHS set of gears for a RTG Epicyclic Gear Unit.

Gear Configurations for any Application



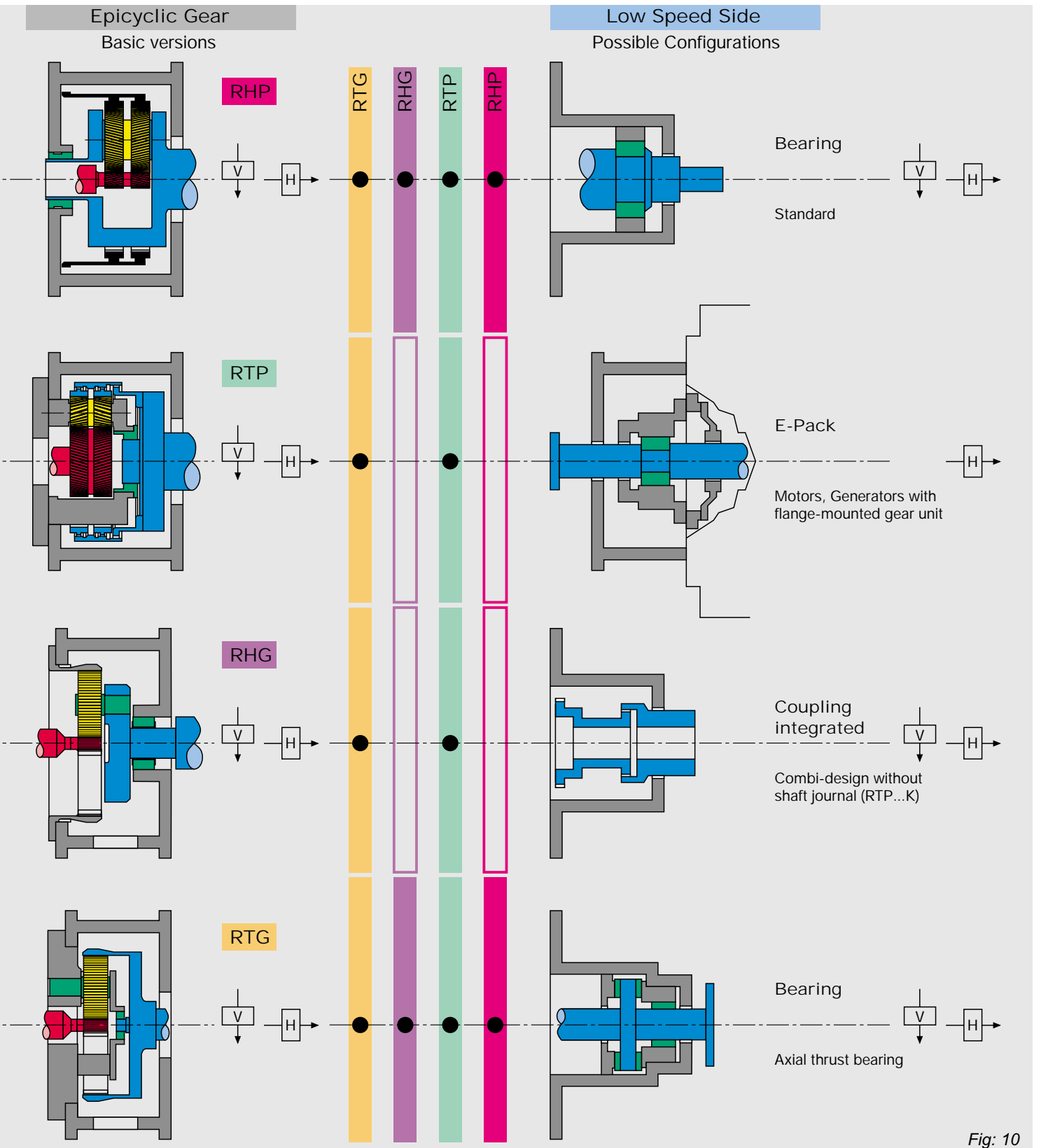


Fig: 10

Designs

Large-Scale Epicyclic Gear Type RHG

BHS Large-Scale Epicyclic Gear Units are significantly more compact than parallel shaft designs, particularly for high torque applications.

70 years of experience in the manufacturing of Large-Scale Epicyclic Gear Units ensure:

- Straight forward design with simple assembly and maintenance.
- Smooth running due to fluid-film bearings and gearing corrections.
- High bonding quality of the babbitt metal due to in-house manufacturing of the planet spindle sliding surfaces by the metal spraying method.
- A variety of design configurations are available. (Page 6 - 7)
- RHG Units may be integrated with other gearing stages (bevel, epicyclic or parallel shaft gear).
- Also available with rolling bearings for specific applications.
- Rating and dimensional tables. (Page 10 - 11)

Typical applications for RHG Units include water power plants, marine propulsions, pump stations, and steel mill plants.

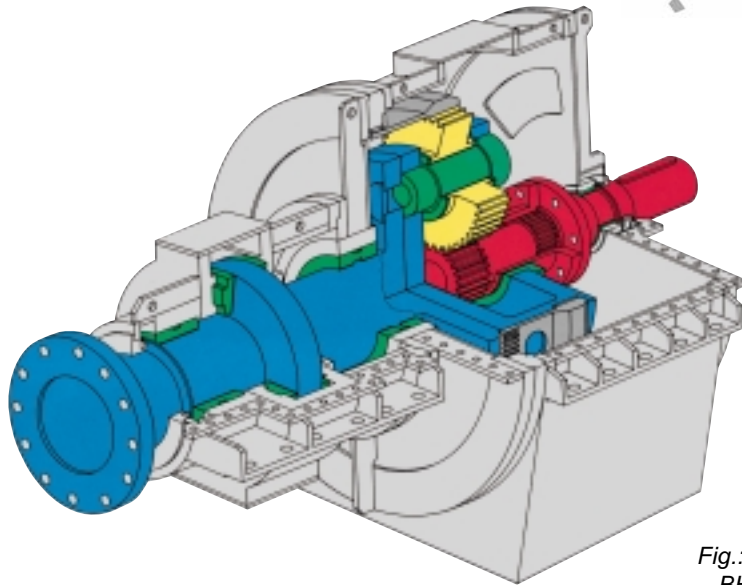


Fig.: 11:
BHS
Epicyclic Gear Unit, Type RHG,
with thrust bearing.



Fig. 12:
BHS
Vertical Epicyclic
Gear Unit,
for pump
and mill drives.



Fig. 13:
BHS-Cincinnati
Epicyclic Gear Unit for
a water power plant.

Application Examples

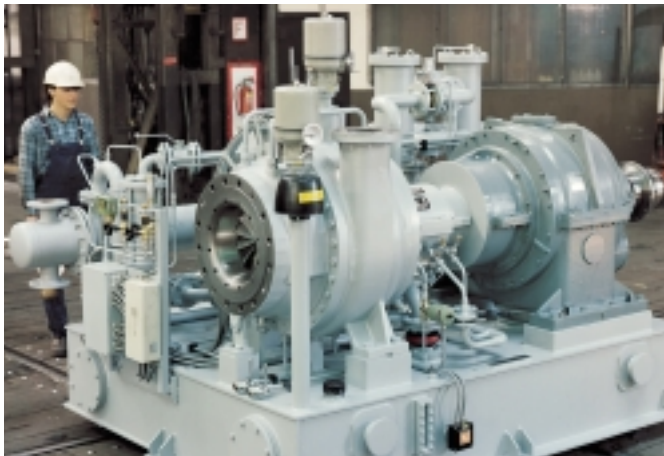


Fig. 14: BHS Epicyclic Gear Unit, Type RTP, in a compressor plant.

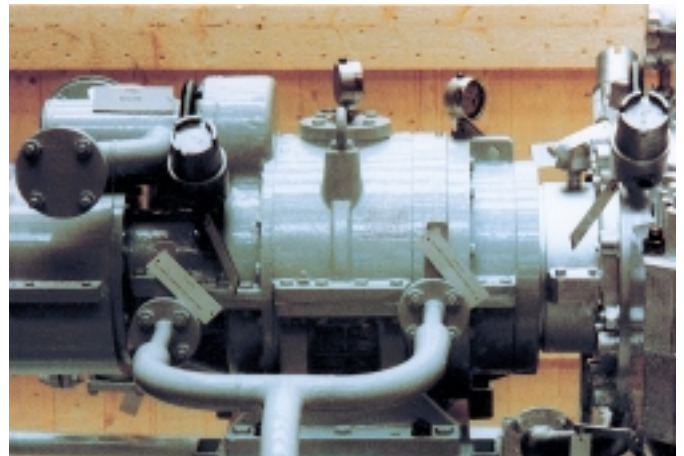


Fig. 15: BHS Epicyclic Gear Unit, Type RHP, between electric motor and compressor.

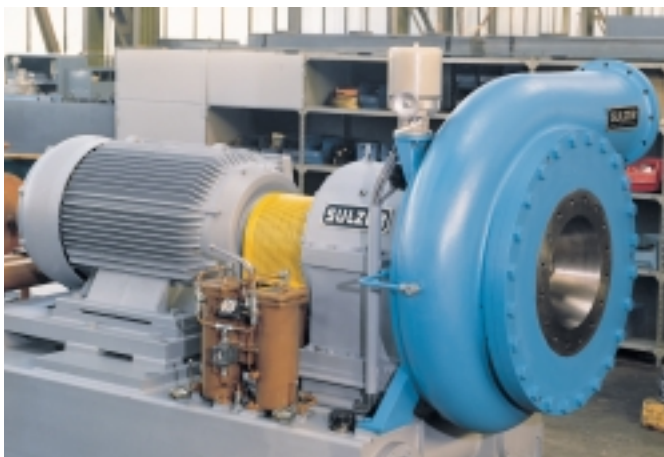


Fig. 16: BHS Epicyclic Gear Unit, Type RTG, for a blower drive.

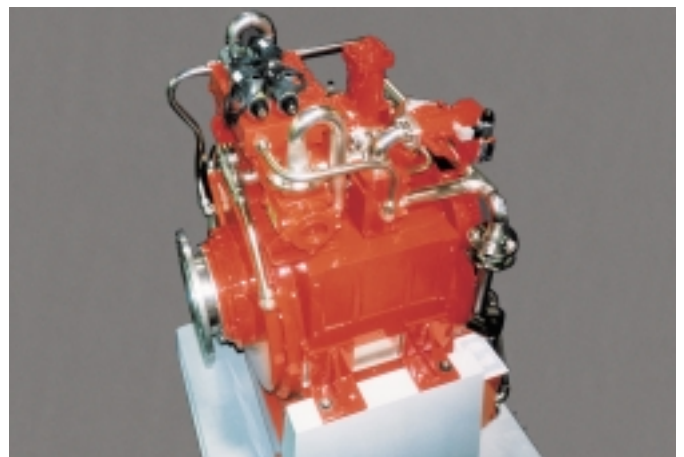


Fig. 17: BHS Epicyclic Marine Reversing Gear Unit, for a megayacht.

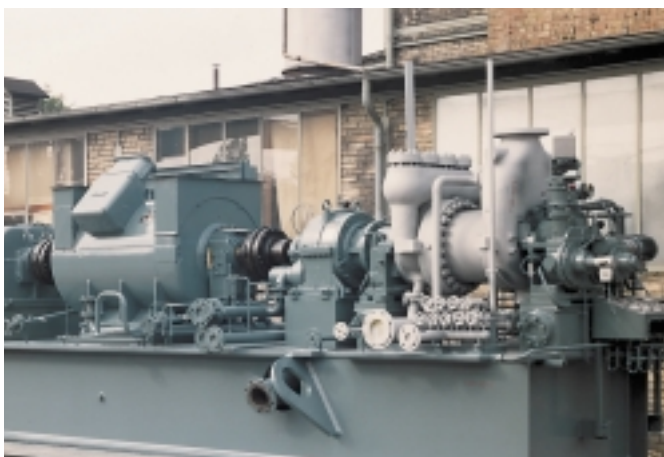
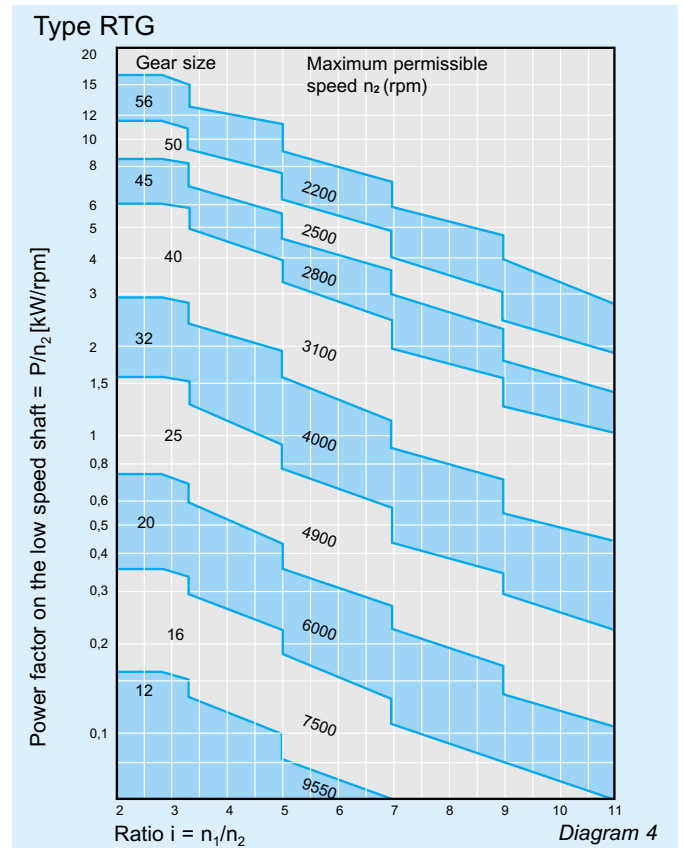
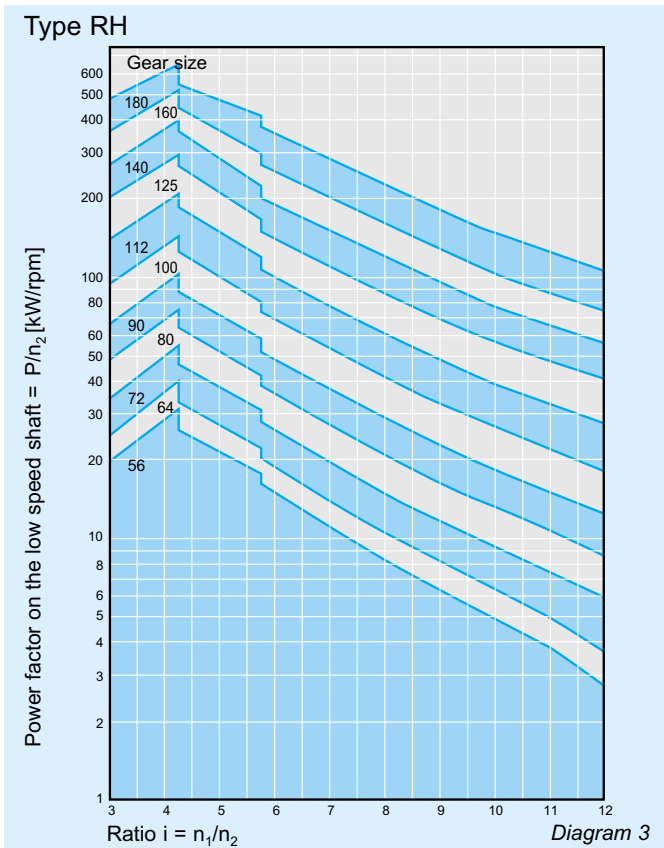
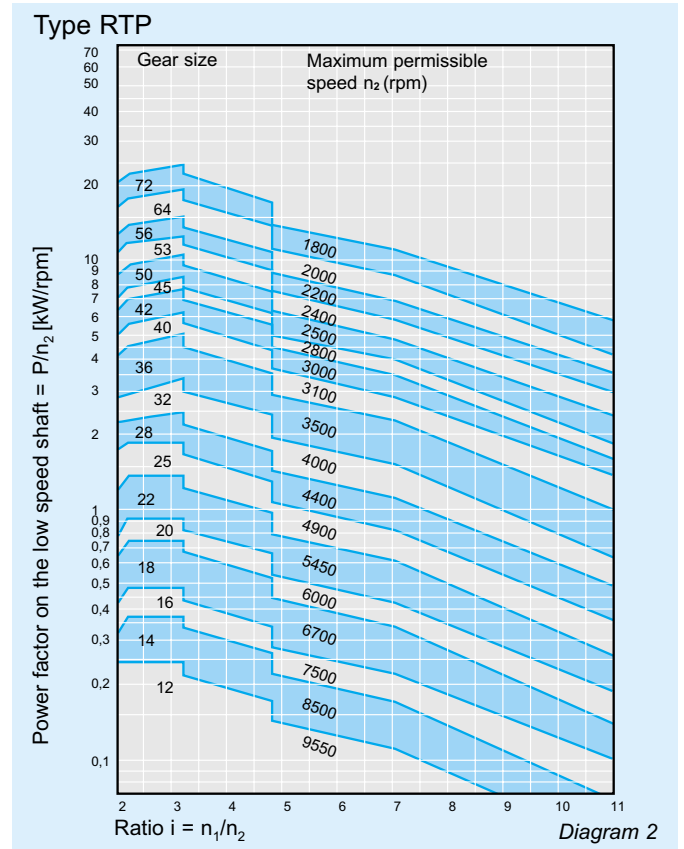
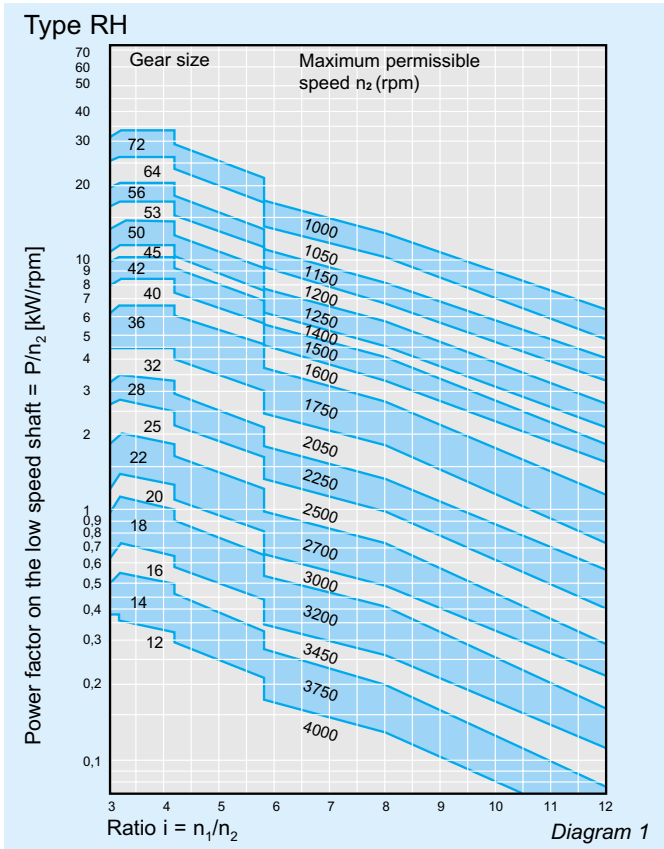


Fig. 18: BHS Epicyclic Gear Unit, Type RHP, for a steam turbine.



Fig. 19: BHS E-PACK® Epicyclic Gear Unit mounted on the generator, driven by a steam turbine.

Rating Diagrams



Calculation Examples

Rating per DIN 3990, ISO 6336 and AGMA 421.06

Given factors: $P_o = 2400 \text{ kW}$
 $n_1 = 16500 \text{ rpm}$
 $n_2 = 1500 \text{ rpm}$

Driving machine: turbine

Driven machine: generator
 $f = 1,1$ (from Table 3)

Rated power:
 $P = P_o \times f = 2400 \times 1,1 = 2640 \text{ kW}$

Power factor:
 $P/n_2 = 2640/1500 = 1,76 \text{ kW/rpm}$
 $i = n_1/n_2 = 16500/1500 = 11$

From the power diagram you will obtain a gear size RP 40, or RTP 45. For these two sizes, the max. admissible speed for the low speed shaft can be determined from the rating diagram.

$$n_{2 \text{ max.}} = 1600 \text{ rpm (RP)} \\ \text{or } 3000 \text{ rpm (RTP)}$$

Operating speed:
 $n_2 = 1500 \text{ rpm} < n_{2 \text{ max.}}$
 Thus permissible.

Important:

For each gear rating be sure that the operating speed of the determined gear type is below the max. admissible speed n_2 (Page 10).

In case of extreme shock loads, additional axial and radial loads, applications outside the specified limits, or deviating rating specifications we recommend that you contact the BHS project department.

Size Selection

The correct gear size is determined by the power diagram:

P_o [kW] Rated power of the gear unit

P [kW] $P_o \times f$

f Application factor depending upon the machines connected (Table 3)

n_1 [rpm] High speed shaft

n_2 [rpm] Low speed shaft

The typical start-up and short circuit shocks are taken into consideration when designing the BHS-Cincinnati Epicyclic Gear Units.

By means of the Power Factor P/n_2 (kW/rpm) and the ratio „ i “ the proper gear size and the admissible speed may be determined from the respective rating diagram.

Driven Machine	Driving Machine		
	E-Motor	Turbine	Piston Engine
Turbocompressor	1,4	1,6	1,7
Piston compressor 2 cyl.	2,0	2,0	2,3
Generators, base load and continuous operation	1,1	1,1	1,3
Generators, peak load operation	1,3	1,3	1,7
Pumps	1,7	2,0	2,0

Table 3: Application factor „ f “ according to API 613 specification recommended service factors (excerpt).

Main Dimensions

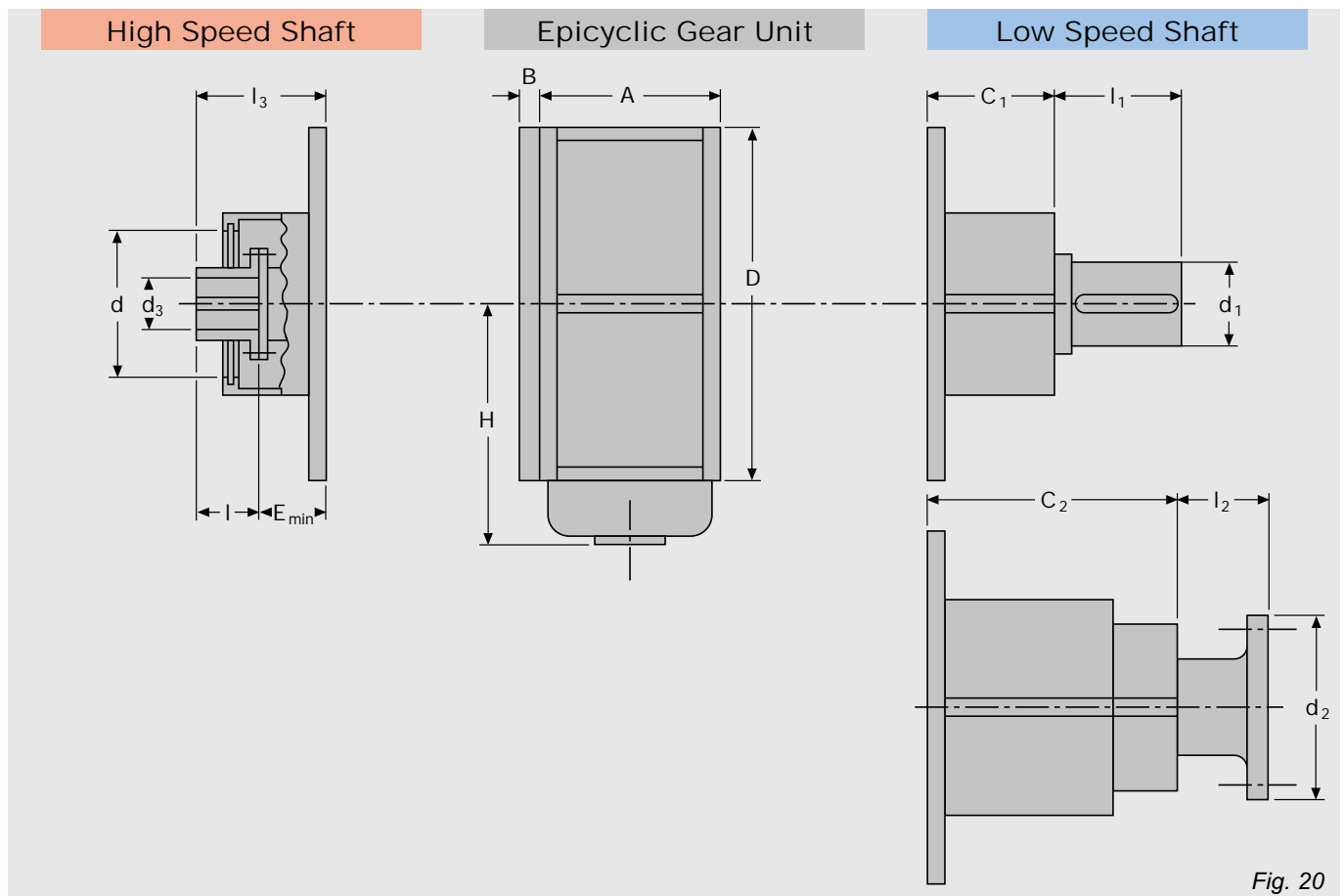


Fig. 20

Dimension Table RHP, RTP, RTG (Dimensions in mm) Table 1

Gear-size	D	A	B		C ₁	H	E _{min}	Weight (kg)
			RHP	RTP RTG				
12	400	200	50	60	220	225	75	230
14	400	200	50	60	220	225	75	250
16	400	200	50	60	220	225	75	270
18	490	250	50	60	240	300	95	380
20	490	250	50	60	240	300	95	420
22	550	290	50	80	255	315	110	630
25	550	290	50	80	255	315	110	670
28	670	370	60	100	315	420	140	1000
32	670	370	60	100	315	420	140	1100
36	840	460	60	110	340	520	170	1750
40	840	460	60	110	340	520	170	1900
45	940	500	60	125	360	585	190	2900
50	1040	530	70	125	370	650	200	3900
56	1300	600	70	125	400	800	225	5500
64	1570	686	70	125	654	975	260	6700
72	1570	686	70	125	654	975	260	7500

Dimension Table RHG (Dimensions in mm) Table 2

Gear-size	D	A	B	C ₁	C ₂	E _{min}
64	1250	625	76	445	890	235
72	1400	700	86	500	1000	260
80	1550	775	94	550	1100	290
90	1730	865	106	620	1200	325
100	1950	975	120	700	1400	365
112	2200	1100	134	790	1560	410
125	2500	1250	150	890	1780	470
140	2750	1375	166	980	1960	515
160	3000	1500	180	1070	2100	560
180	3400	1700	200	1200	2400	630

Applies to both tables:

C₁ without axial thrust bearing

C₂ with axial thrust bearing

Dimensions d , d_1 , d_2 , d_3 , l , l_1 , l_2 , l_3 to be agreed upon with customer.



**BHS
Getriebe GmbH**

Hausanschrift:
Hans-Böckler-Strasse 7
D-87527 Sonthofen
Germany

Postanschrift:
Postfach 1251
D-87516 Sonthofen
Germany

phone +49 83 21 802 - 0
fax +49 83 21 802 - 689

www.bhs-getriebe.de
info@bhs-getriebe.de

**BHS
Getriebe Inc.**

4357 Ferguson Drive
Suite 280
Cincinnati, Ohio 45245
U.S.A.

phone +1 513 797 - 8100
fax +1 513 797 - 8103

www.bhs-gears.com