KPBV

Vertical Roller Mill Drives

Why planetary and three-stage?

Before the introduction of the planetary gear technology, the standard drive design of Vertical Roller Mills (VRMs) comprised gear units featuring a bevel stage and two helical gear stages.

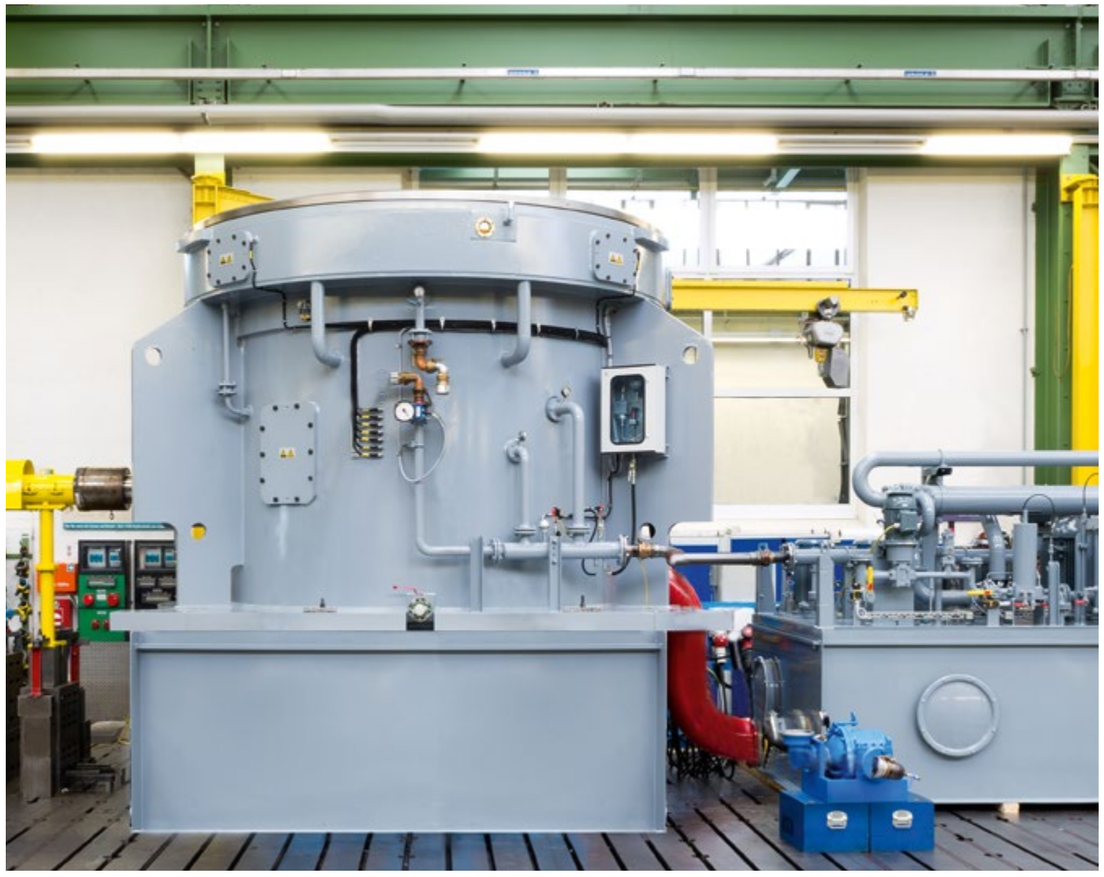
When RENK presented the first planetary gear unit for VRMs in 1979, its compact dimensions and the lower gear unit weight were a true innovation.

The new concept made it possible to design an almost cylindrical gear housing – except the bevel pinion module – with a housing centerline directly underneath the axial bearing for an optimum transmission of the grinding forces to the foundation.

For modern VRMs, especially for cement plants, the trend is towards higher output torques and higher gear ratios. These requirements are pushing the two-stage KPAV design to its limits. Larger mills are rotating more slowly and 6-pole motors have become the standard solution.

To meet the increasing performance requirements and provide scope for future developments, RENK developed the three-stage KPBV design in 1998. When the first unit – a KPBV 190 for a LOESCHE mill – was presented to the industry in December 1999, this was another innovation and since than it has been copied by many gear makers.

KPBV 150 gear



KPBV 180 with lube oil system on the test bed

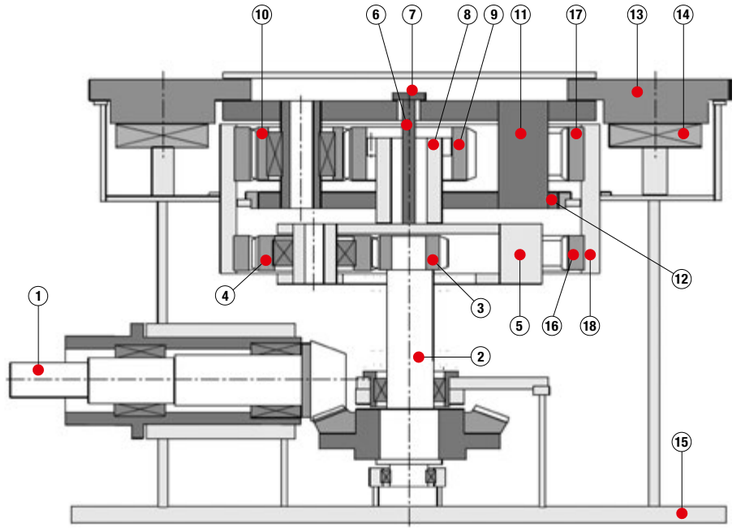
KPBV design features

Making mostly use of well-known and proven components, the KPBV consists of one bevel gear stage and two planetary gear stages. This design permits lower ratios in each individual stage but brings a significant increase in the overall gear ratio.

The output stage features 6 planet gears (instead of 3 in the KPAV) which not only makes for a very compact design of the output stage but at the same time also allows higher torques.

For instance, to transmit 2.5 million Nm of torque, a KPAV unit would require a ring gear with a pitch diameter of 3,000 mm (KPAV 300) and a bevel gear of 2,200 mm in diameter. Besides problems in manufacturing, heat treatment and handling, this would entail significant drawbacks in size, delivery time and – last but not least – the cost/weight ratio. On the other hand, a major advantage of the KPAV design, namely the straight-line transmission of the vertical load from the grinding table to the foundation plate, was also adopted for the KPBV concept.

Arrangement of KPBV gear units



1 Horizontal input shaft (1st stage)
2 Bevel gear shaft
3 Central sun pinion (2nd stage)
4 Planet gears (3 off)
5 Planet carrier
6 Rod
7 Axial spherical roller bearing
8 Curved tooth coupling
9 Central sun pinion
10 Planet gears (6 off, 3rd stage)
11 Planet carrier
12 Radial plain bearing
13 Thrust ring
14 Axial thrust pads
15 Cylindrical housing
16 Ring gear
17 Ring gear
18 Ring gear support

Input stage

The power of the electric motor is transmitted via a flexible coupling to the input-side bevel gear stage of the gear unit. For KPBV units up to size 180, the horizontal input shaft (1) is equipped with anti-friction bearings while for larger units, slide bearings are used. As the ratio of the planetary gear stages is identical for all KPBV units, the individual ratio is adapted to the VRM and motor requirements by the bevel gear stage.

Planetary gear stage 1

The torque is transmitted from the bevel gear shaft (2) to the central sun pinion (3) of the planetary gear stage 1. An even load distribution on all three planet gears (4) is achieved by the freely adjustable planet carrier (5). The weight of the planet carrier (5) is supported by a rod (6) which is suspended in an axial spherical roller bearing (7). The ratio of the planetary gear stage 1 is identical for all KPBV units. The torque is transferred to the next stage by a curved tooth coupling (8) which allows for a swiveling movement of the planet carrier (5) to achieve an even load distribution. The ring gear (16) is rigidly mounted to the ring gear support (18).

Planetary gear stage 2

The torque which is applied to the central sun pinion (9) is split and distributed among six planetary gears (10). These planet gears (10) are arranged in three groups of two. This design together with the freely adjustable sun pinion (9) has proved favorable for distributing the load among the individual planet gears (10).

The planet carrier (11) is radially borne by a radial plain bearing (12). As the planet carrier (11) is rigidly connected to the thrust ring (13), the radial plain bearing (12) also absorbs the radial forces from the grinding process. Also the ratio of the planetary gear stage 2 is identical for all KPBV units. The ring gear (17) is rigidly mounted to the ring gear support (18).

Output

The output torque is transmitted by the thrust ring (13) to the grinding bowl of the mill via threaded fasteners. The ring gear support (18) transmits the output torque to the housing (15).

Thrust support of the mill

The vertical load from the grinding process is supported by a set of axial thrust pads (14) located directly above the center of the cylindrical housing (15), providing for a straight-line transmission of the grinding forces to the foundation. The thrust bearing of the VRM is available in a hydrodynamic or a bullet proof hydrostatic design, depending on the mill table load.

Gear unit bearings

In response to the demand for more dependable drives and longer MTBO (main time between overhaul), RENK offers both an antifriction bearing (AB) solution for lower initial costs and a hydrodynamic sleeve bearing (SB) solution for lower total cost of ownership (TCO).

We turn experience into reliability

- Output torque up to 4 million Nm
- High gear ratios allow the use of low-cost 4-pole motors
- Highest reliability thanks to proven components and modules
- Quick assembly
- Disassembly of the bevel pinion under the mill
- Sophisticated lubrication system
- Optional CMS and long-term warranty
- Assured quality of materials from premier suppliers
- Short time of delivery
- Reduced weight/easy handling
- High gear accuracy for improved load capacity and noise behavior
- Selected spare parts available from stock
- Competitive pricing
- Adaptability to VRM dimensions and load requirements
- Comprehensive instrumentation

KPBV 130 after 15 years of trouble free operation.

KPBV 190 SB during shop assembly.

KPBV gear units

KPBV Size	Torque kNm	Approx. power kW
110	600	1500
120	750	2000
130	950	2700
150	1400	3600
160	1750	4500
170	2000	5000
180	2400	5600
190	2800	6300
200	3200	7000
210	3700	7800
225	4300	9000

The modular design of the KPBV gear units allows maximum component standardization and unit pre-engineering as well as adaptation to the most common mill designs.

Many spare parts of the individual modules are available from stock – please contact our service department.

The KPAV gear unit is still available for lower power and ratio requirements (max. 2 MW and max. ratio of 40).

KPBV features	Customer benefit
Adaptability to VRM dimensions and grinding forces independent of the torque rating	Cost optimization Standardization of parts
Standardized modules	Selected spares available from stock
No joint in casing	Easy disassembly
Bullet proof design of the mill thrust bearing	Maintenance free operation, no spares required
Sleeve bearings (SB) available as an option Brass spindle bearings for moderate bearing loads	Antifriction bearings (AB) for low investment cost, sleeve bearings for low total cost of ownership (TCO) available as an option
Fabricated casing	Light weight, high stiffness and toughness, wide supplier base, perfect support
Longest experience in the market with three-stage designs	Mature product from input to output: gears, bearings and structural parts proven during more than 100,000 service hours

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