ELECON

BEVEL PLANETARY GEAR UNITS

KPAV FOR VERTICAL ROLLER MILLS

ELECON
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Roller Mill Drives

Roller mills are directly driven by bevel-wheel planetary gears or bevel cylindrical gear units.

The gear unit represents an almost integral component of the mill. The output flange of the gear unit is rigidly connected with the Grinding table. In addition to transmitting the torque, the gear unit also has capability to take up the reaction forces from the grinding force of the mill's rollers.

Hydrodynamically or hydrostatically lubricated thrust bearings being mounted in the upper housing part of the gear unit absorb the grinding force which is then transferred through the housing into the mill's foundation.

The growing number of roller mills in operation as well as the increasing specific need and demand of gear transmission features such as:

- High power transmission capability of the mill
- Favourable efficiency
- Low-noise design
- Little space requirement
- Low weight
- High availability

led to the development of the bevel wheel-planetary gear drive of construction series KPAV.

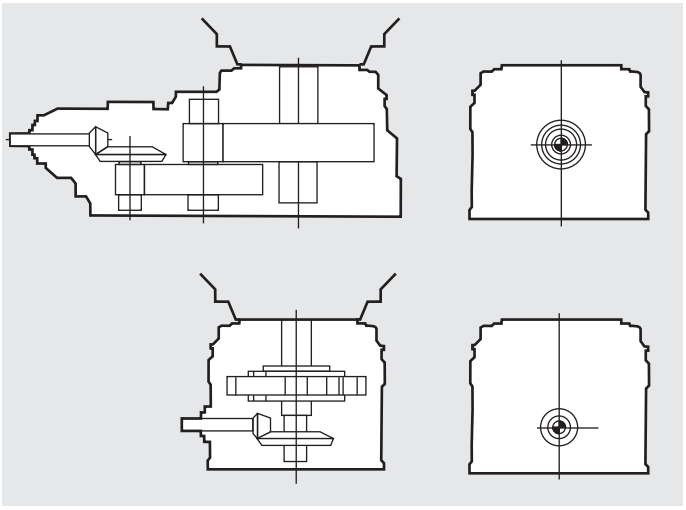
(Bevel-Planetary gear box casing under machining on CNC Horizontal machine center)

Contrary to the bevel cylindrical gearboxes used in the past, the bevel wheel-planetary gear units in particular stand out with the following advantages:

- Package-type, space saving design, thus lower weight by dividing power onto several planetary gears.
- More favorable efficiency as a portion of the power in the planetary stage is transmitted without losses as coupling power.
- Lower noise level, as only a part of the power in the planetary stage is transmitted by the gear teeth. More-over, the high-speed bevel gear stage is located centrally within the gear unit, a fact contributing to additional noise damping.
- Direct transmission of the grinding forces from the mill into the foundation over a circular symmetric housing with nearly the same stiffness.
- Arrangement of the axial bearing pads directly above the housing wall, so that partial deformation of the axial bearing due to axial forces coming from the mill are avoided.
- Higher precision of manufacturing quality owing to the circular symmetric shape of the housing.
- The compact design automatically necessitates a smaller, and thus more simpler foundation plate.

- Particularly easy to assemble and disassemble, not only because pressure plates and gears can easily be dis-mounted, but also because there is no need to seal the joint surfaces as is required for split housings.

Further developments and improvements following the extensive experience gained over the years with the operation of many gear units ensure the high reliability of bevel wheel- planetary gear units KPAV.



The comparison of the above sketches shows that the bevel wheel-planetary gear unit has much smaller dimensions, yet with the same power transmission capabilities.

Photo top right
Bevel Wheel-planetary gear unit KPAV 170
power P = 1350 kW
speeds n = 990/27.7 rpm

Construction of the Bevel Wheel-Planetary Gear Unit KPAV

Input Stage

Drive is accomplished over a bevel gear stage with horizontally arranged input shaft. The bevel pinion shaft (1) and the bevel gear shaft (2) are mounted on bevel and cylindrical roller bearings.

The paired bevel roller bearings take up the axial thrust coming from the bevel gear stage.

Planetary Stage

The torque is transmitted by a gear coupling (3) from the bevel gear shaft (2) to the central sun pinion (4) of the planetary stage. The uniform distribution of the torque on three planet gears (5) is ensured by the freely adjusting sun pinion (4) and by the planet gears (5) which are supported on spherical roller bearings.

As an additional degree of freedom the planet carrier (6) will not be supported by bearings in case of gearboxes from size KPAV 140 onwards. In this case, a gear coupling connects the planet carrier with the thrust plate (8) on the output side. For gearboxes up to the size KPAV 125 (Fig. 2) the planet carrier (6) is connected with the thrust plate (8) by the SKF-shrink fit procedure. Here, the planet carrier is radially guided over the upper cylindrical roller bearing. The central annulus (9) of the planetary stage is firmly held with the housing in both cases.

Output

The output of the gear unit is effected over a pressure plate (8) that is firmly connected with the grinding table by means of bolts. The vertically directed grinding forces induced from the mill are directly led over various slide bearing pads (10) and across the housing wall into the foundation. Additional radial forces out of the grinding process will be absorbed by slide bearings for gearboxes as of size 140, and by roller bearings for smaller gearboxes up to the size 125.

Fig. 1

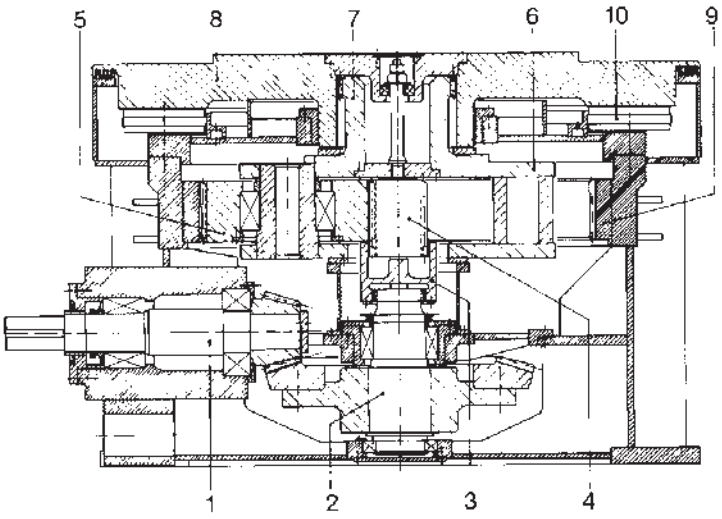
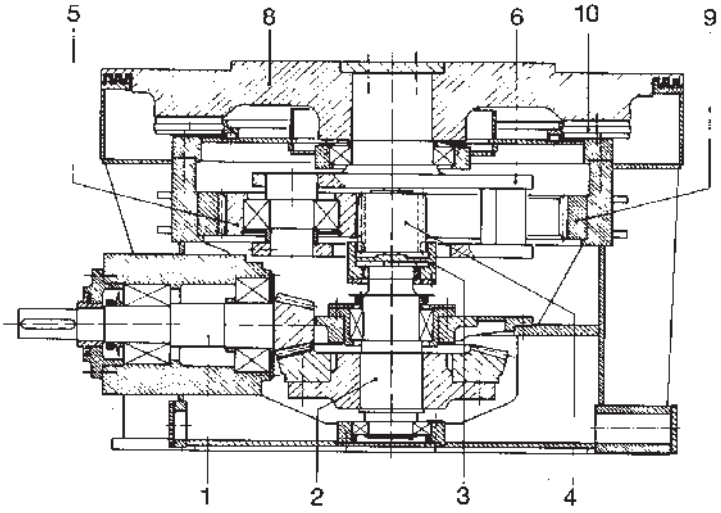


Fig. 2



Axial thrust bearing of gearbox unit KPAV 180

Axial Thrust Bearing

The optimum design and construction of the axial thrust bearing ensures high operational safety. Here, the circular symmetric slide bearing pads proved very great success.

The axial thrust bearing is rated on the basis of the required lubrication film and of sufficient security as a function of geometry of the circular pads, load, circumferential speed and oil viscosity.

The Hydrodynamically Lubricated Axial Thrust Bearing

Hydrodynamically lubricated thrust bearings are used for small and medium grinding forces, whereby the main motor will drive the mill with unloaded or raised grinding rolls to operating speed (Fig. 1).

Combination of Hydrodynamically and Hydrostatically Lubricated Axial Thrust Bearing

Thrust bearings continuously lubricated hydrodynamically and, in addition, hydrostatically, are used for medium up to high grinding forces, where the mill with unloads grinding rolls is slowly accelerated by an auxiliary drive.

The Fully Hydrostatically Lubricated Axial Thrust Bearing

Fully hydrostatically lubricated axial thrust bearings are used for mills with very high grinding forces and for nearly all starting conditions. (Fig. 2)

Fig. 1

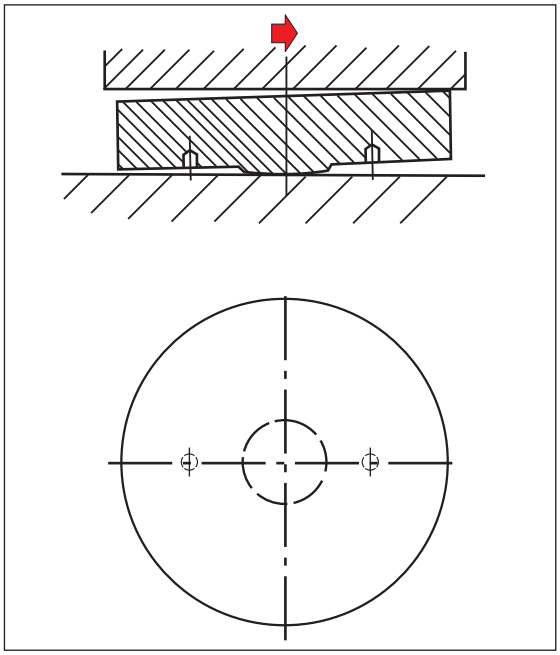
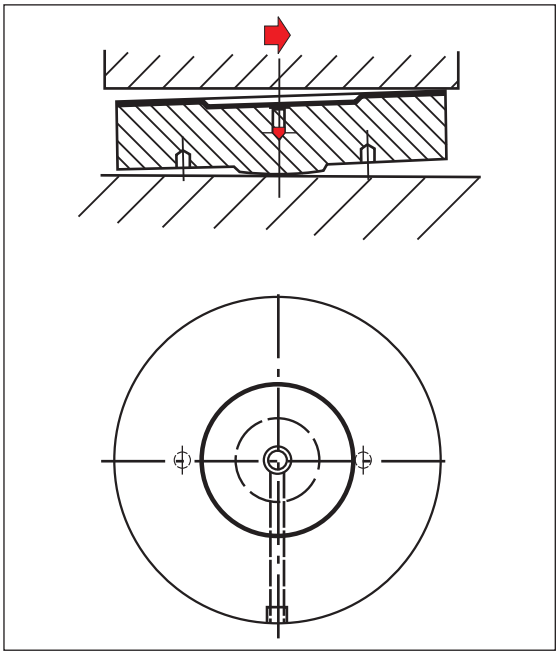


Fig. 2



Selection of Gearbox Sizes

The gear unit size is determined in accordance with the opposite diagram. The following values are needed:

Power factor $\frac{P_m}{n_1}$

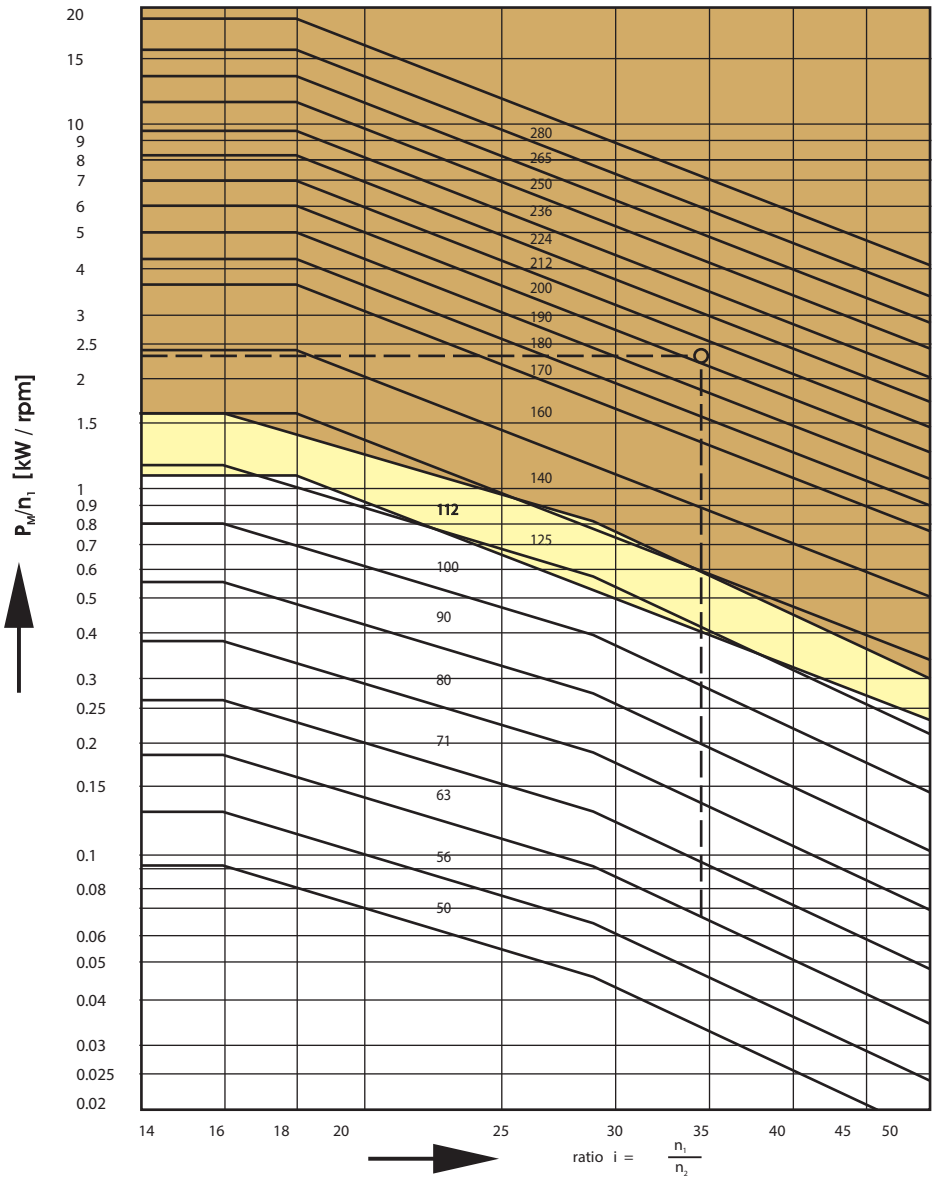
Speed ratio $\frac{n_1}{n_2}$

AGMA service factor, if required.

P_M = input power (kW)

n_1 = input speed (rpm)

n_2 = output speed (rpm)



Example

Given values:

P_M = 2300 kW

n1 = 990 rpm

n_2 = 28,7 rpm

AGMA service faktor 2,0

Solution

$$\frac{P_m}{n_1} = \frac{2300}{990} = 2{,}32$$

$$\frac{n}{n_2} = \frac{2300}{990} = 34{,}5$$

The diagram already includes the AGMA service factor 2.0. The result is the gearbox size KPAV 200.

Application :

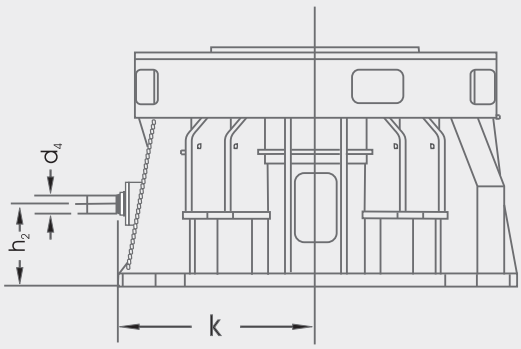
Grinding of Coal
Limit curves white area, KPAV 50-112
AGMA2.0 corresponds to the Elecon service factor 1.6

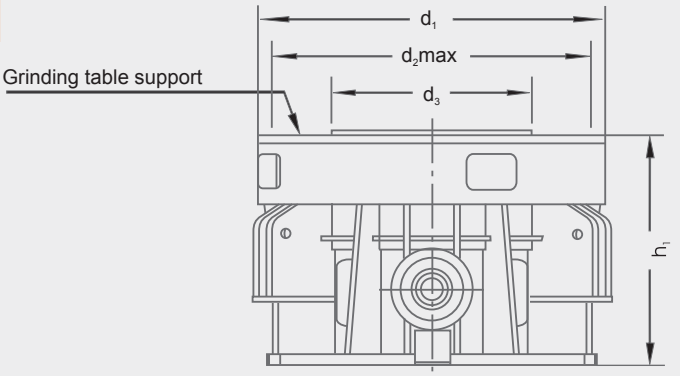
AGMA2.5 corresponds to the power factor $\frac{P_m}{n_1}$ x 1.34

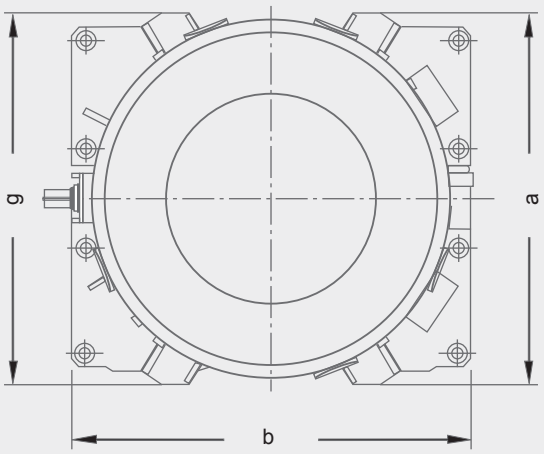
Grinding of Limestone
Limit curves shaded area, KPAV 125-280
AGMA 2.0 corresponds to the Elecon Service factor 1.8

AGMA2.5 corresponds to the power factor $\frac{P_m}{n_1}$ x 1.07

Gear Unit Dimensions







All dimensions are constructional minimum dimensions.

Keyway according to DIN 6885.

The weight is only valid for the connecting dimensions as stated in the table.

All values subject to change due to technical progress.

Gear Unit KPAV Size	Housing Dimensions					Connecting Dimensions					Weight
	a	b	g	h_1	h_1	d_1	$d_2$max	d_3	k	d_4	kg
50	950	930	-	785	260	1080	940	600	600	60	2.000
56	1020	1000	-	835	290	1090	1000	670	620	60	2.500
63	1040	1020	-	885	320	1185	1045	720	660	65	3.300
71	1180	1160	-	934	330	1325	1205	800	710	75	4.200
80	1320	1300	-	1090	385	1390	1270	850	760	85	5.400
90	1530	1510	-	1110	370	1625	1435	1000	850	90	7.000
100	1620	1600	-	1300	420	1740	1480	1000	1025	100	10.000
112	1820	1800	-	1300	420	1760	1630	1000	960	100	10.600
125	1950	2000	2140	1500	535	2230	2000	1320	1150	110	18.000
140	2280	2190	2460	1600	530	2430	2185	1450	1345	120	24.600
160	2440	2500	2860	1740	590	2790	2500	1750	1300	130	32.000
170	2630	3040	2850	1780	560	2850	2460	1675	1500	134	35.500
180	2720	2810	3000	2140	820	2900	2570	1750	1450	140	40.000
190	2870	2970	3100	2240	930	2950	2800	1900	1700	150	43.000
200	3040	3120	3260	2100	750	3080	2800	1900	1630	165	51.500
212	3210	3320	3680	2270	775	3550	3350	2250	2420	200	73.000
224	3390	3500	3660	2270	810	3600	3400	2250	2050	200	79.000
236	3590	3690	3830	2500	825	3740	3250	2250	2060	210	85.000
250	3480	3320	3755	2500	800	4010	3560	2600	2180	220	101.000
265	3670	3500	4050	2600	800	4070	3560	2600	2180	220	112.000
280	4190	4320	4500	2780	990	4200	3560	2600	2300	220	124.000

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