BEARING LOADS DUE TO BEVEL GEARS

The use of straight bevel gears produces thrust, as well as radial loads on bearings. The thrust loads applied at a distance from the shaft axis impose overturn loads on the bearings which also must be considered. The tangential force is obtained from the input horsepower as derived on page 247.

In Fig. I, below, the separating force is derived in terms of the tangential force. The pinion (Gear I) is mounted on the driving shaft A. The vertical component (S_V) of the separating force imposes a radial load on Shaft A. The reaction to S_V imposes a thrust load on the shaft of the mating (driven) gear.

Symbols and Abbreviations

Tang = Tangential Force
N = Normal Force
Sep = Separating Force
S_H = Horizontal Component of Sep
S_V = Vertical Component of Sep
θ = Tooth Pressure Angle
β = Bevel Angle

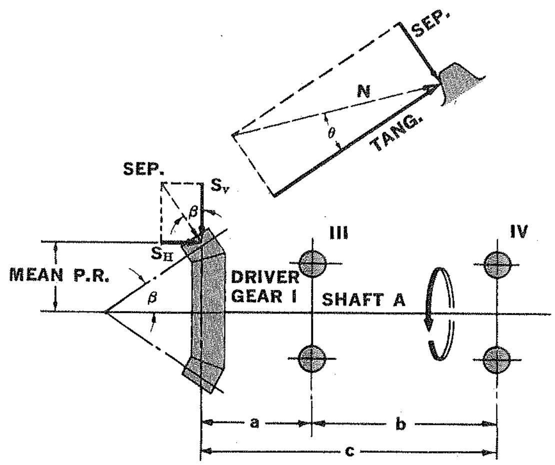


FIG. I

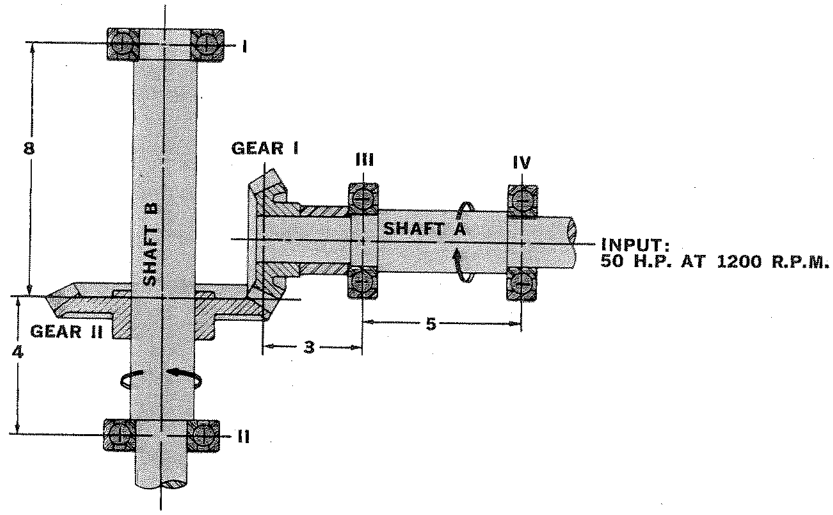
Derivation

(1) Tang = N cos θ
(2) Sep = N sin θ
Dividing (2) by (1)
$$\frac{\text{Sep}}{\text{Tang}} = \frac{N \sin\theta}{N\cos\theta} = \tan\theta$$
Sep = Tang tan θ
S_V = Sep cos β
(3) S_V = Tang tan θ cos β
S_H = Sep sin β
(4) S_H = Tang tan θ sin β

The table below shows the bearing loads based on Fig. I. These computations assume a right angle drive with the shaft of the driven gear vertical and in the plane of the paper.

FORCES	CALCULATIONS	DISTRIBUTION OF FORCES	
		BEARING III	BEARING IV
Tangential	Tang. = $\frac{\text{Torque on Shaft A}}{\text{Mean P.R. Gear I}}$	Tang. × $\frac{b}{c}$ ⊙	Tang. × $\frac{b}{c}$ ⊗
Separating	S_H = Tang. × $\tan\theta$ × $\sin\beta$	————	Thrust →
	S_V = Tang. × $\tan\theta$ × $\cos\beta$	$S_V \times \frac{b}{c}$ ↑	$S_V \times \frac{a}{b}$ ↓
Overturn Force	O.T. = $\frac{\text{Thrust} \times \text{Mean P.R.}}{b}$	Overturn ↓	Overturn ↑
Total Radial Force	Add According to Arrows	↑ or ↓ And ⊙ or ⊗	↑ or ↓ And ⊙ or ⊗
Radial Load	$\sqrt{\text{Sum of Squares}}$	$\sqrt{(\uparrow \text{ or } \downarrow)^2 + (\odot \text{ or } \otimes)^2}$	$\sqrt{(\uparrow \text{ or } \downarrow)^2 + (\odot \text{ or } \otimes)^2}$
Thrust Load	Add Thrust According to Arrows	————	Thrust

TYPICAL BEVEL GEAR CALCULATION



Gear	No. of Teeth	P.D.	Tooth Angle	Bevel Angle	Width of Face
I	28	4″	20°	33° 41′	1⅛″
II	42	6″	20°	56° 19′	1⅛″

$\tan(20° + 3°) = .424$
$\sin 33° 41' = .555$
$\cos 33° 41' = .832$
$\sin 56° 19' = .832$

GEAR I MEAN P.R. $= \frac{1}{2}(4 - 1.125 \times .555) = 1.688''$ **GEAR II MEAN P.R.** $= \frac{1}{2}(6 - 1.125 \times .832) = 2.532''$

SHAFT SPEED: SHAFT A = 1200 R.P.M. (GIVEN)

SHAFT B $= 1200 \times \frac{28}{42} = 800$ **R.P.M.**

FORCES	CALCULATIONS	DISTRIBUTION OF FORCES BEARING I	BEARING II	BEARING III	BEARING IV
Tangential	$\frac{63025 \times 50}{1200 \times 1.688} = 1556$	$\frac{1556 \times 4}{12} = 519 \odot$	$\frac{1556 \times 8}{12} = 1037 \odot$	$\frac{1556 \times 8}{5} = 2490 \otimes$	$\frac{1556 \times 3}{5} = 934 \odot$
Separating	$1556 \times .424 \times .555 = 366$	$\frac{366 \times 4}{12} = 122 \leftarrow$	$\frac{366 \times 8}{12} = 244 \leftarrow$	———	366 Thrust →
	$1556 \times .424 \times .832 = 549$	———	549 Thrust ↓	$\frac{549 \times 8}{5} = 878 \uparrow$	$\frac{549 \times 3}{5} = 329 \downarrow$
Overturn Force	$\frac{\text{Thrust} \times \text{Mean P.R.}}{\text{Brg. Spacing}}$	$\frac{549 \times 2.532}{12} = 116 \rightarrow$	$\frac{549 \times 2.532}{12} = 116 \leftarrow$	$\frac{366 \times 1.688}{5} = 124 \downarrow$	$\frac{366 \times 1.688}{5} = 124 \uparrow$
Total Radial Force	Summation	$519 \odot$ $6 \leftarrow$	$1037 \odot$ $360 \leftarrow$	$2490 \otimes$ $754 \uparrow$	$934 \odot$ $205 \downarrow$
Radial Load	$\sqrt{\text{Sum of Squares}}$	519 lbs.	1098 lbs.	2602 lbs.	956 lbs.
Thrust Load		———	549 lbs.	———	366 lbs.