The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J543

REV. NOV95

Issued 1917-08
Revised 1995-11

Superseding J543 JUN88

Submitted for recognition as an American National Standard

(R) STARTING MOTOR PINIONS AND RING GEARS

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

***1. Scope*—**The scope of this document is to provide uniform guidelines for the application of starter motor pinions and ring gears. SAE J543 contains guidelines for the use of diametral pitch gearing. The pinion data shown are based on the Fellows stub tooth system. Refer to ISO 8123, ISO 9457-1, and ISO 9457-2 for module gearing, and corresponding metric dimensions.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein.

2.1.1 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 8123—Diametral pitch starter motor pinions
ISO 9457-1—Road vehicles—Metric starter motor pinions—Part 1: Currently used pinions
ISO 9457-2—Road vehicles—Metric starter motor pinions—Part 2: Pinions with 20 degree pressure angle

SAENORM.COM : Click to view the full PDF of j543_199511

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

QUESTIONS REGARDING THIS DOCUMENT: (412) 772-8512 FAX: (412) 776-0243
TO PLACE A DOCUMENT ORDER; (412) 776-4970 FAX: (412) 776-0790
SAE WEB ADDRESS http://www.sae.org

Copyright 1995 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

3. Calculations for Spur Gears—Table 1 and Figures 1 to 3 are to be used as a guide in establishing starter motor pinions and ring gear designs. Consult the gear manufacturer for detail dimensions.

TABLE 1—SPUR GEAR DIMENSIONS

P1/P2[1]	P.A. (deg)	N1/N2	O.D. MAX. (in)	P.D. THEO. (in)	P.D. LAYOUT (in)	R.D. MAX.[2] (in)	HT (in)	C.T.T MAX.[3] (in)	W2 MAX. (in)
12/14	12	10.48/9	1.016	0.750	0.873	0.695	0.1607	0.161	0.416
10/12	20	10/9	1.167	0.900	1.000	0.789	0.1890	0.188	0.484
10/12	20	10/9	1.167	0.900	1.000	0.789	0.1890	0.187	0.485
10/12	20	12/11	1.367	1.100	1.200	0.989	0.1890	0.187	0.486
10/12	20	13/12	1.467	1.200	1.300	1.089	0.1890	0.187	0.488
8/10	20	10/9	1.450	1.125	1.250	1.000	0.2250	0.245	0.615
8/10	20	11/10	1.575	1.250	1.375	1.125	0.2250	0.245	0.617
8/10	20	12/11	1.700	1.375	1.500	1.250	0.2250	0.245	0.618
8/10	20	13/12	1.825	1.500	1.625	1.375	0.2250	0.245	0.619
8/10	20	14/13	1.950	1.625	1.750	1.525	0.2125	0.244	0.622
6/8	20	12/11	2.240	1.833	2.000	1.688	0.2760	0.317	0.814

1. The two diametral pitch gear data are based on Fellows stub tooth system.
2. If larger root diameter is desired, consult gear manufacturers.
3. Circular Tooth Thickness.

SAENORM.COM : Click to view the full PDF of j543_199511

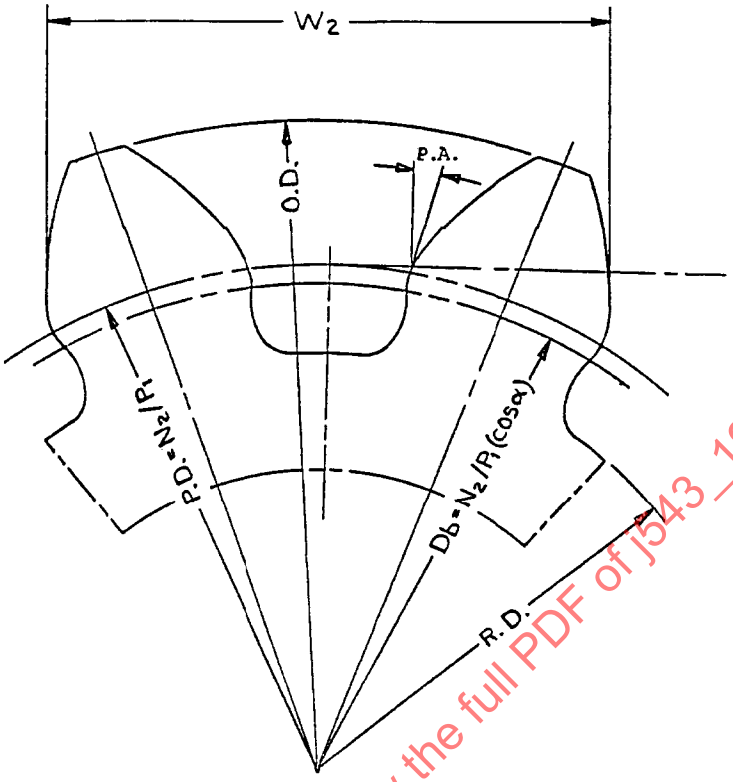


FIGURE 1—SPUR GEAR DETAIL

Outside Diameter (O.D.) = N1/P1 + 2/P2 (Eq. 1)

Theoretical Pitch Diameter (P.D.) = N2/P1 (Eq. 2)

Layout Pitch Diameter = N1/P1 (Eq. 3)

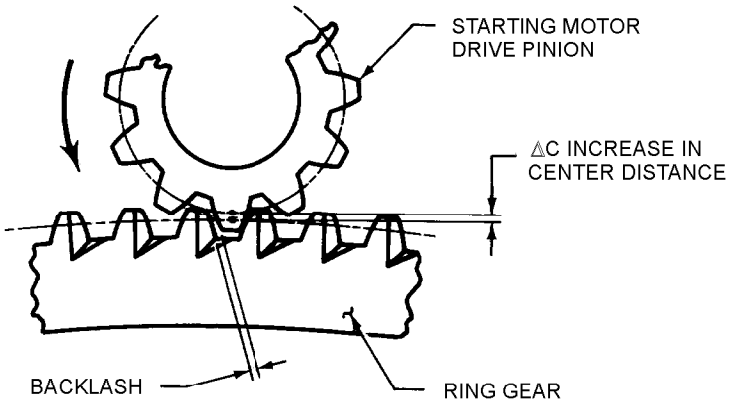
Base Circle Diameter (Db) = P.D. × cos P.A. (Eq. 4)

where:

N1 = Blank Size
N2 = Number of Teeth
P1/P2 = Diametral pitch for Fellows stub tooth. Use P1 to determine number of teeth, pitch diameter, and tooth thickness. Use P2 to determine addendum, dedendum, and tooth depth.
P.A. = Pressure Angle

4. ***Ring Gear and Pinion Installation***—Backlash is necessary for free meshing and running of the pinion with the ring gear. Backlash may be obtained by increasing the center distance as shown in Figure 2 or by reducing the tooth thickness.

SAENORM.COM : Click to view the full PDF of j543_199511



NOTE: BACKLASH OBTAINED BY INCREASING CENTER DISTANCE OR REDUCING TOOTH THICKNESS

FIGURE 2—PINION AND RING GEAR

5. Center Distance—The formula for calculating center distance (C.D.) is:

$$\text{C.D.} = \frac{\text{No. Ring Gear Teeth (Blank)}^{a} + \text{No. Pinion Teeth (Blank)}^{a}}{2 \times \text{Diametral Pitch}^{b}} + \Delta C^{c} \qquad \text{(Eq. 5)}$$

where:

a = The number of teeth is equal to the number used to determine blank size. A blank is a disk or cylinder of such size as to relate to a standard gear of standard addendum, dedendum and given number of teeth. To increase tooth strength and improve cranking ratio, many gears are cut on an oversize blank, i.e., 10 teeth cut on an 11 tooth blank. In this example, 11 would be used for the number of pinion teeth in calculating center distance.

b = For fractional diametral pitch (example: 8/10 pitch), use the numerator (8 in this example) for center distance calculation.

c = ΔC is the increase in center distance to obtain backlash Figure 2. If backlash is obtained by reducing tooth thickness, omit ΔC from the C.D. formula.

Center Distance for starter drives, for 12, 12/14 and finer pitch, is held to theoretical values, with a tolerance of 0.010 in. Backlash is designed into the ring gear by thinning the teeth and should be 0.010 to 0.030 in. Spread of centers for 10/12 and coarser pitch should be 0.020 to 0.040 in to produce backlash of 0.015 to 0.030 in, using the Equation 6:

$$\text{backlash} = 2 \times \Delta C \times \tan \text{P.A.} \qquad \text{(Eq. 6)}$$

where:

ΔC = spread of centers
P.A. = pressure angle

SAENORM.COM : Click to view the full PDF of j543_199511