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AMERICAN GEAR MANUFACTURERS ASSOCIATION

Basic Gear Geometry

AGMA 933- B03

AGMA INFORMATION SHEET

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American
Gear
Manufacturers
Association

Basic Gear Geometry
AGMA 933-B03

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ABSTRACT

This Information Sheet describes basic geometry relationships of gear pitch, plane and angles. It is the work of one man, Alan H. Candee, originally documented in his paper for American Machinist of July 4 and 11, 1929.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of AGMA Information Sheet 933-B03, *Basic Gear Geometry.*]

A paper entitled *Gear Geometry,* by Allan H. Candee, Mechanical Engineer, Gleason Works, was presented at the Annual Meeting of the American Gear Manufacturers Association in May, 1929. The paper was an extension of the author's ideas presented in ten blueprinted pages of diagrams, terms, and definitions to members of the AGMA Nomenclature Committee in April, 1928, under the title *Universal Gear Geometry.*

The paper of 1929 was reproduced in AMERICAN MACHINIST, July 4 and 11, 1929. Later, in April, 1936, it was adopted by AGMA as a Recommended Practice, and reprints were distributed to members. At that time, the letter symbols for angles were revised to conform to the standardization then under way in the Nomenclature Committee.

The 1959 publication of AGMA 115.01*, Basic Gear Geometry,* was essentially a reissue of the 1929 paper by Allan H. Candee. The original wording was found to conform without need of change to the terms and definitions in AGMA 112.03, *Gear Nomenclature.* Only minor editorial improvements were made, and a new term was introduced, *profile angle,* which is explained in the definitions.

This information serves as an introduction to and explanation of the geometrical relationships in gear teeth, but it does not in any way modify or affect standard gear nomenclature which is the outcome of conscientious efforts by the AGMA Nomenclature Committee which began more than seventy years ago.

The contents were reaffirmed by the AGMA Nomenclature Committee in 1988. It was then submitted to the American National Standards Institute (ANSI) as a proposed national standard. ANSI approved AGMA 115.01 as a national standard on September 7, 1989.

In 2000, the Technical Division Executive Committee voted to withdraw ANSI/AGMA 115.01 as a national standard and to return its contents back as an AGMA information sheet, duplicating Candee's original work. In a few instances, words have been deleted, ..., and added (italic), in an effort to make the meaning clear to today's reader.

The first draft of AGMA 933-B03 was made in May, 2000. It was approved by the AGMA Technical Division Executive Committee on October 20, 2002.

Suggestions for improvement of this document will be welcome. They should be sent to the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314.

PERSONNEL of the AGMA Nomenclature Committee, January 1959

Chairman: Granger Davenport . . . . Gould & Eberhardt Div., Norton Co.
Vice Chairman: Paul M. Dean, Jr. . . . . General Electric Co.

ACTIVE MEMBERS

A.H. Candee . . . . Honorary Member
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American Gear Manufacturers Association –

Basic Gear Geometry

0. Scope

A clear and accurate understanding of the elements involved is indispensable to all who deal with the design, dimensioning, cutting and measurement of gear teeth. The information here presented has been collected and arranged with the idea of making the important geometrical relationships as easy to see as possible with the intention of providing a sound basis for a thoroughly logical and comprehensive system of gear geometry.

The accurate exchange of ideas requires the exact definition and use of terms. Nowhere is this true to a greater degree than in the case of the present subject. Therefore, we will begin with a definition.

1. GEARS are machine elements provided with engaging teeth which are of such shape that motion is transmitted in the manner of smooth curves rolling together without slipping.

The rolling curves are called pitch curves because on them the pitch or spacing of the teeth is the same in both of two engaging gears. Here, as in some other branches of mechanics, pitch means interval between members of a series of equally spaced elements like the pitch of a row of rivets.

Usually, ... the motion transmitted is either rotation or straight line translation at a constant velocity ratio.

When two axes of rotation are in the same plane we have pitch surfaces corresponding to the pitch curves. The pitch surfaces, like the pitch curves, roll on each other and in addition are tangent along a straight-line element. Such surfaces may be cylinders, cones or planes.

These considerations lead up to a classification of the various types of gears, as outlined in table 1. Of course, there are also gears with axes not in the same plane. The special features of such gears will not be dealt with in this paper.

Most of the accompanying diagrams apply completely only to helical involute gears and especially to the corresponding oblique-tooth racks. The relationships between angles, however, are true for any type of gear.

In order to show how it is possible to develop a self-consistent system of gear terms, definitions, and relationships, it is best to start at the beginning and advance step by step. This will seem rather elementary at first, but it is the most satisfactory method to follow.

The original gear problem may be stated like this: Given two shafts, their relative position, and the speeds at which they are to rotate: to provide a pair of gears which will enable one shaft to drive the other at the required velocity ratio.

2. A PLANE OF ROTATION is any plane perpendicular to a gear axis. The complete geometry for a pair of spur gears can be confined to a single plane of rotation.

Table 1 – General classification of gears

Pitch surfaces	Relation of axes	Direction of teeth	Name of gear
Cylinders	Parallel	Parallel to axis Oblique to axis	Spur Helical or herringbone
Cones	Intersecting	Intersecting axis Offset from axis	Straight-tooth bevel Spiral bevel
Plane	(Rolling with cylinder)	Parallel to axis Oblique to axis	Spur rack Helical rack
Plane	(Rolling with cone)	Intersecting axis Offset from axis	Straight-tooth crown gear Spiral crown gear