

INVOLUTE SPLINE GAGES

Issued 6-1-45
Revised

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- I. **GENERAL:** Only with perfect splines can the theoretical tooth thickness, dimensions (over pins or otherwise), gages, and resultant fits be in complete agreement. In actual practice, the errors are relatively large and the discrepancies are troublesome. If tooth thickness on the shaft and space width in the hole are correct, then any errors of form or spacing will interfere unless the errors of both members match exactly which is improbable. An imperfectly splined shaft, if snug in a ring gage, is necessarily undersize at all except the few points of contact; likewise an internal spline that fits its plug gage must be oversize at most points; the two members then will almost certainly fit together looser than predicted by the gages. Note that, in general, the actual fit will be tighter than predicted by measurements (over pins, or by calipers), but looser than indicated by plug and ring gages; and the discrepancy will be of the same order as the errors. For these reasons, the plug gages shall be made undersize and the ring gages oversize in order to produce parts nearer to specified dimensions. Supplementary methods are required for checking individual spline elements.

II. **GAGE TOOTH NOMENCLATURE**

- A. Figure 1 shows a tooth diagram of a ring gage. The various elements of the tooth are illustrated and defined.
- B. Figure 2 shows a tooth diagram of a plug gage. The various elements of the tooth are illustrated and defined.

III. **BASIC GAGE TOOTH PROPORTIONS**

- A. Table 1 is a table of basic gage tooth proportions. The "Go" gage must check the part to the true involute form diameter of the part. If an involute clearance has been added (on an internal spline) or subtracted (on an external spline) the addendum of the "Go" gage must be increased by the same amount in order to check to the true involute form diameter of the part.
- B. Figure 3 shows the relationship of the ring gage to the external spline it is to check.
- C. Figure 4 shows the relationship of the plug gage to the internal spline it is to check.
- D. The true involute form diameter of the "Go" and "Not Go" ring gages is equal to the maximum outside diameter of the part to be checked.
- E. The true involute form diameter of the "Go" and "Not Go" plug gages is equal to the minimum inside diameter of the part.
- F. The inside diameter of the "Go" ring gage and the outside diameter of the "Go" plug gage are the same as the true involute form diameter of the part to be checked.

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- G. A "Not Go" gage, to be effective, can check but one element. A "Not Go" gage made to check the chordal tooth thickness or chordal space at the pitch diameter is usually sufficient for practical purposes. In order that the "Not Go" gage may check at the pitch diameter, it is necessary to have a short addendum so that the inside diameter of the "Not Go" ring gage is greater than the inside diameter of the "Go" ring gage and the outside diameter of the "Not Go" plug gage is less than the outside diameter of the "Go" plug gage. The addendum of the "Not Go" gages shall be approximately $\frac{2}{3}$ of the addendum of the part. (See Figures 3 and 4)

IV. TOLERANCES

- A. Table 2 shows the following tolerances for the plug gage:

1. Chordal tooth thickness tolerance.
2. Involute tolerance.
3. Spacing tolerance between any 2 adjacent or non-adjacent teeth.
4. Total of chordal thickness tolerance and spacing tolerance between any 2 adjacent or non-adjacent teeth.

- B. Table 3 shows the following tolerances for the ring gage:

1. Chordal space tolerance.
2. Involute tolerance.
3. Spacing tolerance between any 2 adjacent or non-adjacent teeth.
4. Total of chordal space tolerance and spacing tolerance between any 2 adjacent or non-adjacent teeth.

- C. 1. The chordal space or chordal tooth thickness tolerances shown in Tables 2 and 3 apply to the specified chordal thickness or chordal space.
2. The involute tolerance shown in Tables 2 and 3 is the amount that the profile may deviate from the true involute form. All errors in profile in the direction of the tooth shall be called minus and all errors in profile in the direction of the space shall be called plus.
3. Spacing tolerance between any two adjacent or non-adjacent teeth as shown in Tables 2 and 3 denotes the maximum cumulative tooth to tooth spacing error. The tooth to tooth spacing error is the amount any tooth varies from the theoretical spacing in relation to an adjacent tooth.
4. In Figure 9 is shown a graphical record of the spacing errors. In the example plotted, the spacing error between any two teeth is equal to .0003.

5. Figures 7 and 8 tend to show that spacing errors, whether plus or minus, will have the same effect on the part to be checked. Figures 7 and 8 are sketches of a perfect plug gage and part to match. In Figure 7, if one tooth of the gage has a minus error in spacing, the chordal space of the part will be increased by the amount of error in spacing as shown. All the chordal spaces of this part must be at least as large as the space mentioned above or the gage would fit in only one position. In Figure 8, one tooth of the gage has a plus error in spacing. If this plus error is equal to the minus error in Figure 7, it can easily be seen that a part checked by the gage in Figure 7 could also be checked by the gage in Figure 8.
6. The total of the chordal tooth thickness tolerance or chordal space tolerance and the spacing tolerance between any 2 adjacent or non-adjacent teeth as shown in Tables 2 and 3 is the maximum amount of error allowed by the accumulation of spacing tolerances and either the chordal space tolerance or the chordal tooth thickness tolerance. Column 5 of Tables 2 and 3 represent the maximum effect on chordal thickness due to probable accumulated errors.

V. DIMENSIONS FOR GAGES

A. The plug gages shall be undersize as follows:

The chordal tooth thickness of the "Go" plug gage shall be equal to the minimum chordal space of the part to be checked minus the sum of chordal tooth thickness tolerance and spacing errors. (See Tables 2 and 4) The chordal tooth thickness of the "Go" plug gage shall have a plus tolerance.

The chordal tooth thickness of the "Not Go" plug gage shall be equal to the maximum chordal space of the part to be checked minus the sum of chordal tooth thickness tolerance and spacing errors. (See Tables 2 and 4) The chordal tooth thickness of the "Not Go" plug gage shall have a plus tolerance.

B. The ring gages shall be oversize as follows:

The chordal space of the "Go" ring gage shall be equal to the maximum chordal tooth thickness of the part to be checked plus the sum of chordal space tolerance and spacing errors. (See Tables 3 and 5) The chordal space of the "Go" ring gage shall have a minus tolerance.

The chordal space of the "Not Go" ring gage shall be equal to the minimum chordal tooth thickness of the part to be checked plus the sum of chordal space tolerance and spacing errors. (See Tables 3 and 5) The chordal space of the "Not Go" ring gage shall have a minus tolerance.

C. Table 9 is an example showing gage dimensions with tolerances as calculated from the basic gage tooth dimensions Table 1.

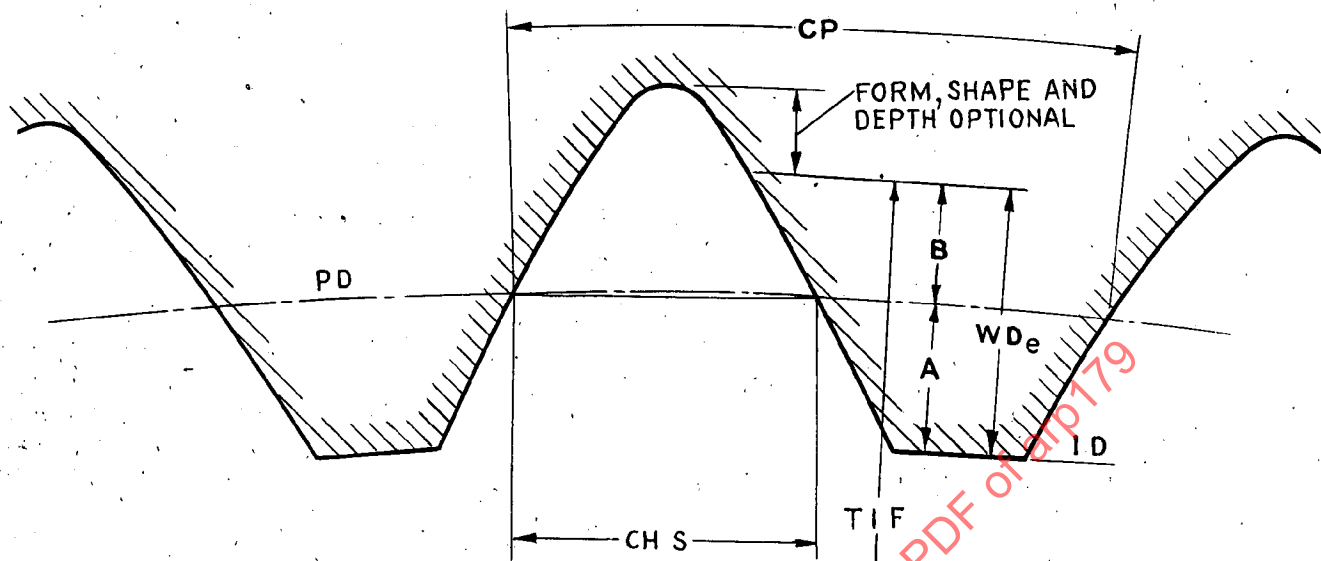


FIG 1
RING GAGE

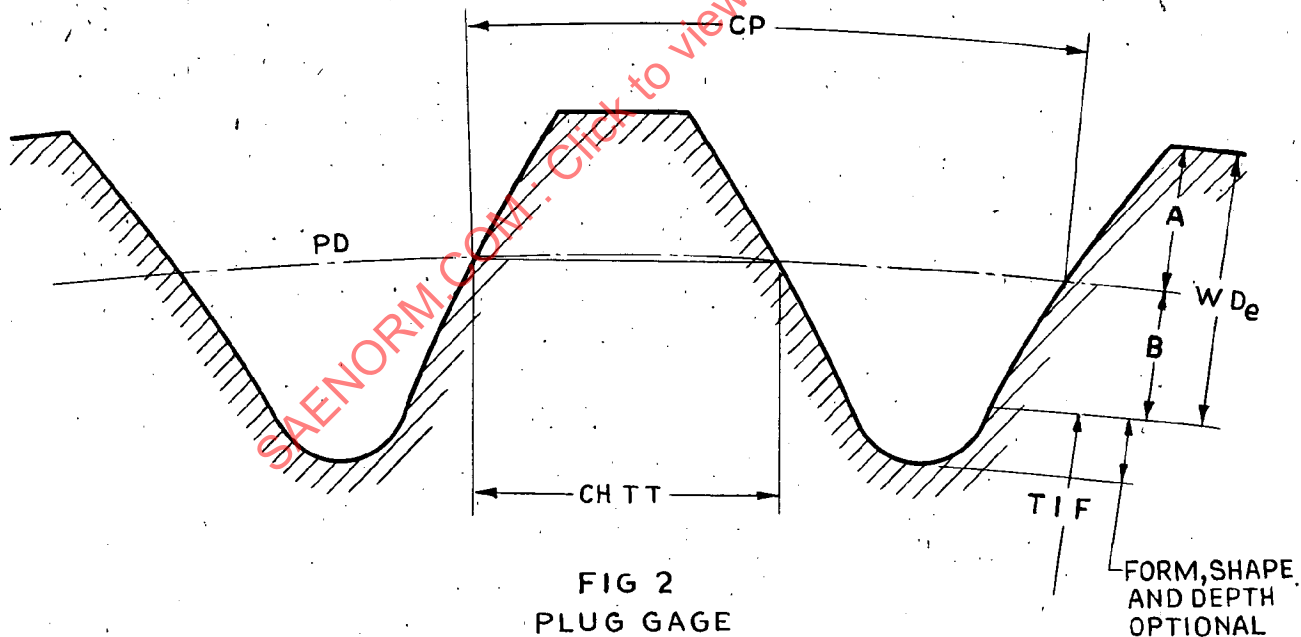


FIG 2
PLUG GAGE

A = ADDENDUM
B = ADDENDUM OF PART
CP = CIRCULAR PITCH
CH S = CHORDAL SPACE (RING)
CH TT = CHORDAL TOOTH THICKNESS (PLUG)
TIF = TRUE INVOLUTE FORM DIAMETER

WDe = WORKING DEPTH
O D = OUTSIDE DIAMETER
I D = INSIDE DIAMETER
P D = PITCH DIAMETER

GAGE NOMENCLATURE

TABLE I

DIAMETRAL PITCH	CIRCULAR PITCH	TYPE GAGE	*ADDENDUM	ADDENDUM OF PART	WORKING DEPTH
6/12	.5236	Go	.0833	.0833	.1666
		Not Go	.0555	.0833	.1388
8/16	.3927	Go	.0625	.0625	.1250
		Not Go	.0417	.0625	.1042
10/20	.3142	Go	.0500	.0500	.1000
		Not Go	.0333	.0500	.0833
12/24	.2618	Go	.0417	.0417	.0834
		Not Go	.0278	.0417	.0695
16/32	.1964	Go	.0313	.0313	.0626
		Not Go	.0209	.0313	.0522
20/40	.1571	Go	.0250	.0250	.0500
		Not Go	.0167	.0250	.0417
24/48	.1309	Go	.0208	.0208	.0416
		Not Go	.0139	.0208	.0347
32/64	.0982	Go	.0156	.0156	.0312
		Not Go	.0104	.0156	.0260
40/80	.0785	Go	.0125	.0125	.0250
		Not Go	.0083	.0125	.0208
48/96	.0655	Go	.0104	.0104	.0208
		Not Go	.0069	.0104	.0173

*The "Go" gage must check the part to the true involute form diameter of the part. The addendum of the "Go" gage may have to be increased in order to check the part to the true involute form diameter.

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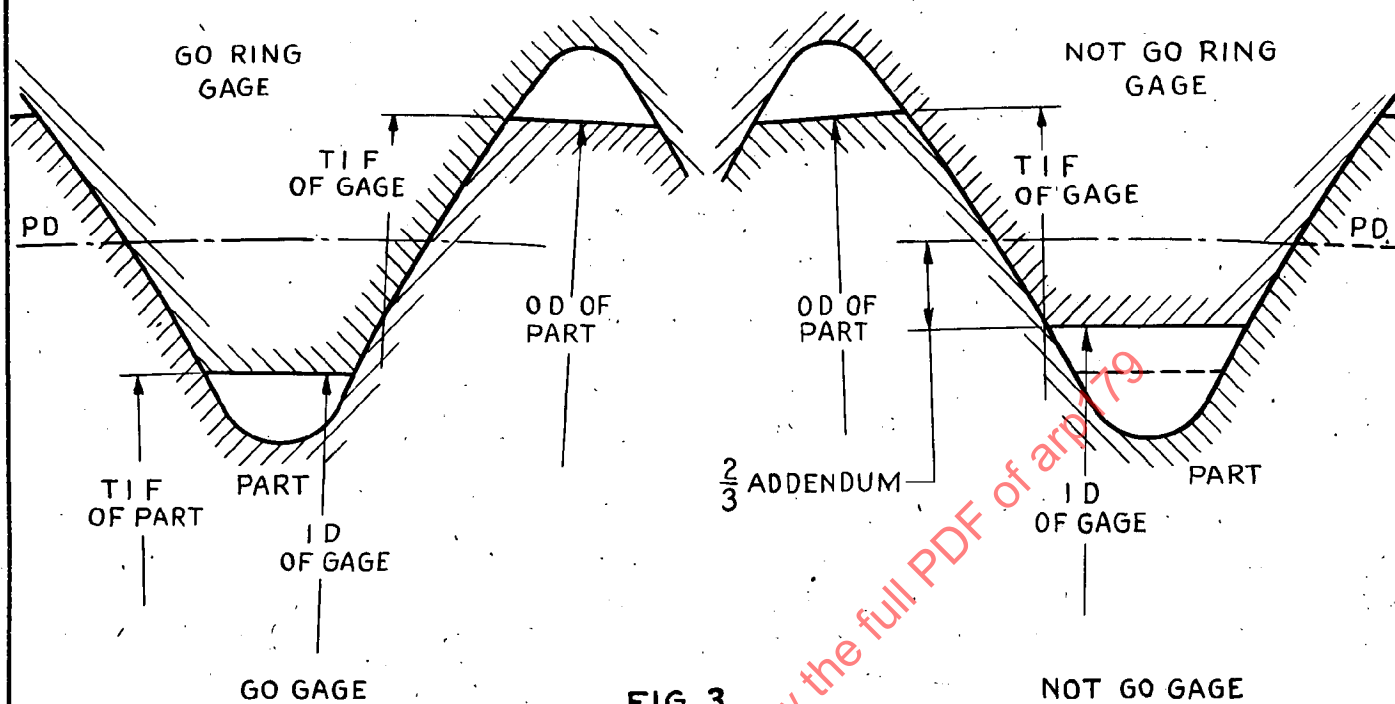


FIG 3
RING GAGE

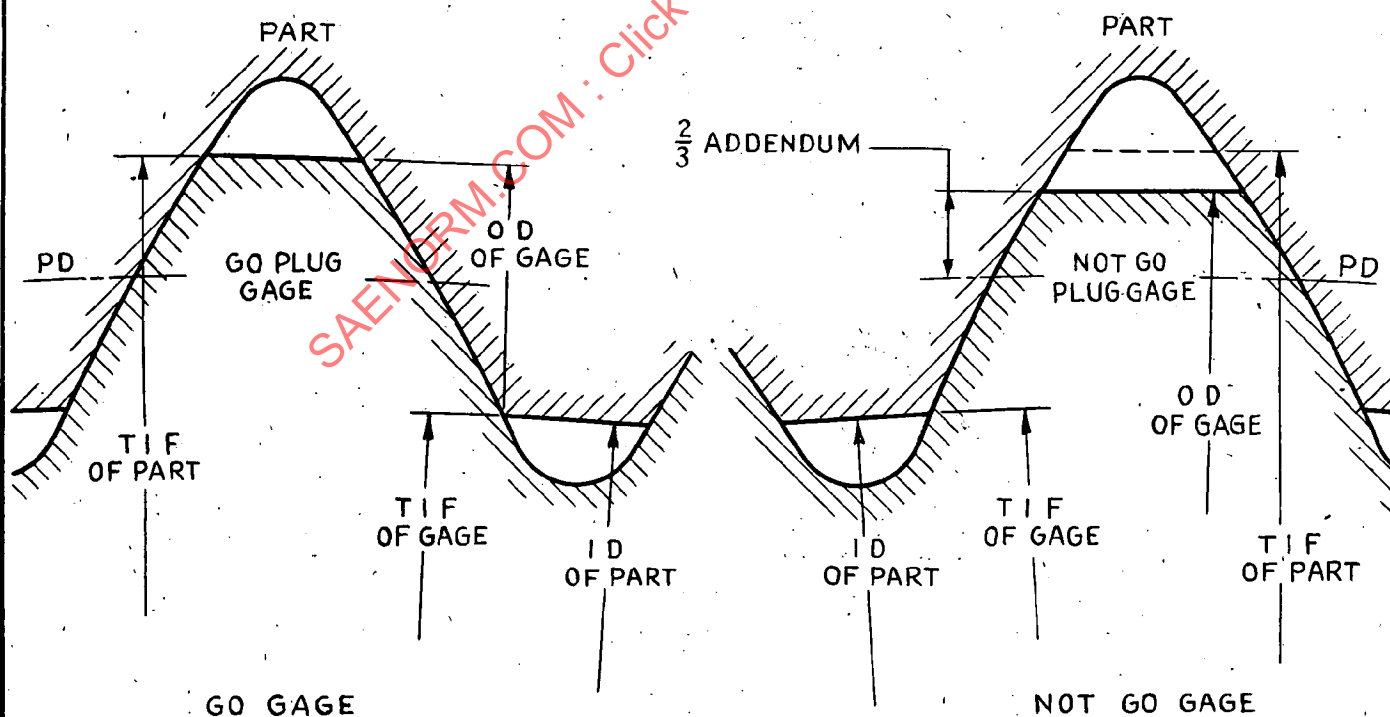


FIG 4
PLUG GAGE

TABLE 2
PLUG GAGE TOLERANCES

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PITCH DIAMETER	CHORDAL TOOTH THICKNESS TOLERANCE	INVOLUTE TOLERANCE FROM MEASURING CIRCLE ¹	SPACING TOLERANCE BETWEEN ANY 2 ADJACENT OR NON-ADJACENT TEETH	TOTAL OF COLUMNS 2 & 4
Up to 2	+ .0002	+ .0001 - .0002	.0002	.0004
2 to 4	+ .0002	+ .0001 - .0002	.0002	.0004
4 to 6	+ .0002	+ .0001 - .0002	.0003	.0005
6 to 8	+ .0002	+ .0001 - .0002	.0004	.0006
8 to 10	+ .0002	+ .0001 - .0002	.0005	.0007
10 to 12	+ .0002	+ .0001 - .0002	.0005	.0007

TABLE 3
RING GAGE TOLERANCES²

PITCH DIAMETER	CHORDAL SPACE TOLERANCE	INVOLUTE TOLERANCE FROM MEASURING CIRCLE ¹	SPACING TOLERANCE BETWEEN ANY 2 ADJACENT OR NON-ADJACENT TEETH	TOTAL OF COLUMNS 2 & 4
Up to 2	- .0002	+ .0001 - .0002	.0002	.0004
2 to 4	- .0002	+ .0001 - .0002	.0002	.0004
4 to 6	- .0002	+ .0001 - .0002	.0003	.0005
6 to 8	- .0002	+ .0001 - .0002	.0004	.0006
8 to 10	- .0002	+ .0001 - .0002	.0005	.0007
10 to 12	- .0002	+ .0001 - .0002	.0005	.0007

1 The measuring circle will be the P.D. in the basic standard. Where the spline deviates from the standard, this measuring circle will be the center of the working depth as measured radially.

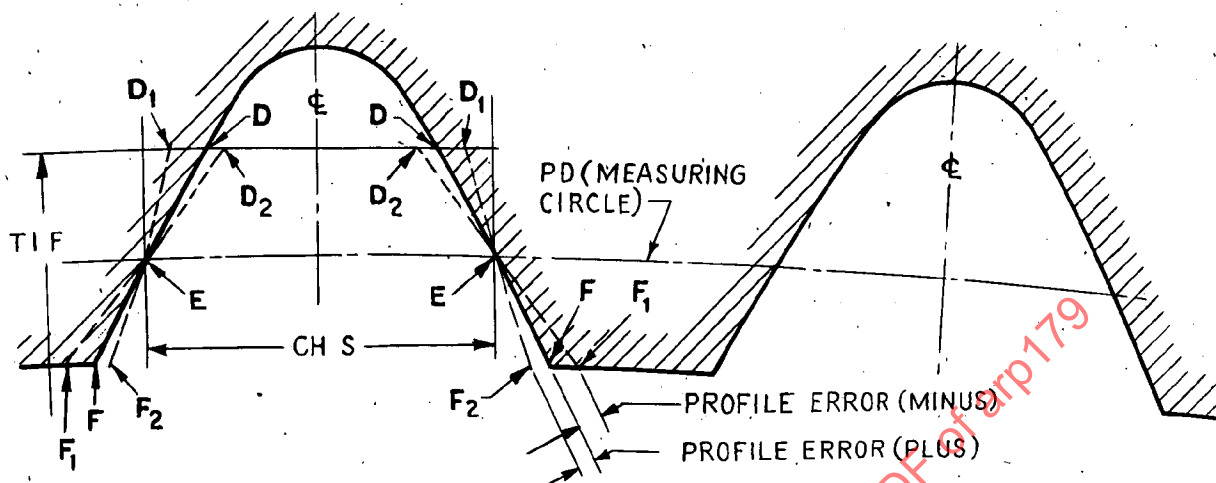
2 When a master spline plug^{gage} is used to check the ring, these tolerances also apply to the master plug gage.

TABLE 4
PLUG GAGE

PITCH DIAMETER	NOMINAL CHORDAL TOOTH THICKNESS OF "GO" PLUG GAGE	NOMINAL CHORDAL TOOTH THICKNESS OF "NOT GO" PLUG GAGE
Up to 2	Min. Ch. S. of Part -.0004	Max. Ch. S. of Part -.0004
2 to 4	Min. Ch. S. of Part -.0004	Max. Ch. S. of Part -.0004
4 to 6	Min. Ch. S. of Part -.0005	Max. Ch. S. of Part -.0005
6 to 8	Min. Ch. S. of Part -.0006	Max. Ch. S. of Part -.0006
8 to 10	Min. Ch. S. of Part -.0007	Max. Ch. S. of Part -.0007
10 to 12	Min. Ch. S. of Part -.0007	Max. Ch. S. of Part -.0007

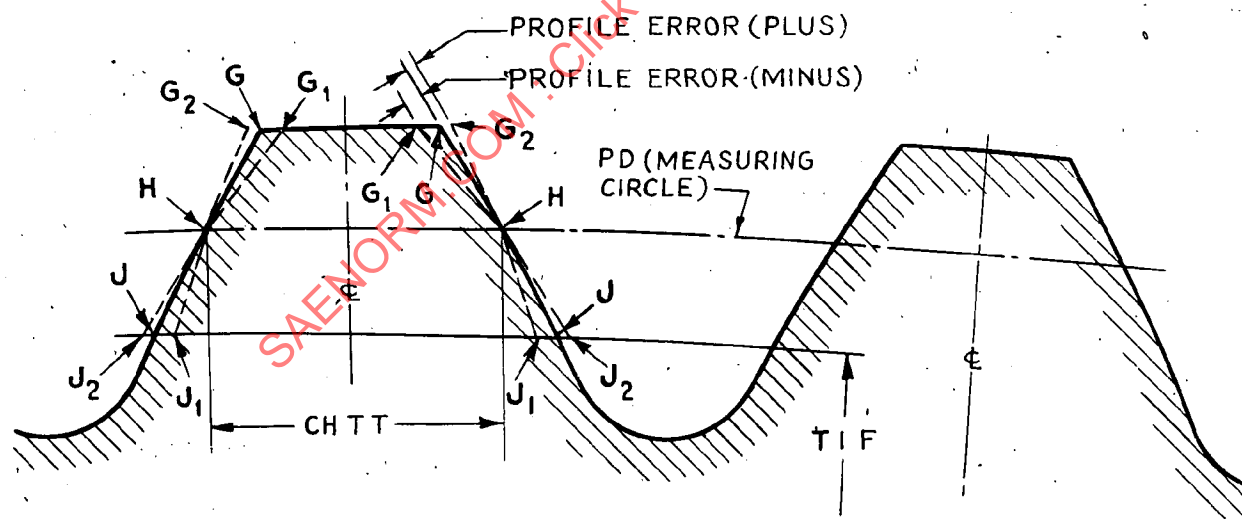
TABLE 5
RING GAGE²

PITCH DIAMETER	NOMINAL CHORDAL SPACE OF "GO" RING GAGE	NOMINAL CHORDAL SPACE OF "NOT GO" RING GAGE
Up to 2	Max. Ch. T. T. of Part +.0004	Min. Ch. T. T. of Part +.0004
2 to 4	Max. Ch. T. T. of Part +.0004	Min. Ch. T. T. of Part +.0004
4 to 6	Max. Ch. T. T. of Part +.0005	Min. Ch. T. T. of Part +.0005
6 to 8	Max. Ch. T. T. of Part +.0006	Min. Ch. T. T. of Part +.0006
8 to 10	Max. Ch. T. T. of Part +.0007	Min. Ch. T. T. of Part +.0007
10 to 12	Max. Ch. T. T. of Part +.0007	Min. Ch. T. T. of Part +.0007



DEF IS THE TRUE INVOLUTE FORM, DEF MAY VARY BETWEEN D_1EF_1 TO D_2EF_2

FIG 5
RING GAGE



GHJ IS THE TRUE INVOLUTE FORM, GHJ MAY VARY BETWEEN G_1HJ_1 TO G_2HJ_2

FIG 6
PLUG GAGE

PLUS PROFILE ERROR SHALL BE IN THE DIRECTION OF THE SPACE AND MINUS PROFILE ERROR SHALL BE IN THE DIRECTION OF THE TOOTH AS SHOWN IN FIG 5 AND 6