Society of Automotive Engineers, Inc.
29 West 39th Street
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AERONAUTICAL STANDARD AS 84

SPLINES, INVOLUTE

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Revised

I. FUNDAMENTAL PRINCIPLES

The primary object of this standard is to provide efficient, durable and easily fabricated splines applicable to very nearly all conditions with a minimum of restrictions and limitations. In order to meet special requirements, a deviation from this standard may be necessary.

This is a shallow depth side bearing spline featuring a 30° pressure angle and a full radius at the root of the teeth to decrease the stress concentration at the root to a minimum.

This standard incorporates a stubbed tooth form. The numerator or basic pitches are eight in number ranging from 6 to 32, the depth, or denominator pitch being twice the basic pitch ranges from 12 to 64. The table of basic tooth proportions covers from 12 to an infinite number of teeth. The tables of dimensions cover from 12 to 50 teeth with pitch diameters from .375" to 8.333". To use a spline of less than 12 teeth it is suggested that the tooth form be laid out to check for possible tool interferences or interferences with the mating member and perhaps modifying the tooth to suit. For splines of more than 50 teeth use the same tooth proportions as for 50 teeth or as specified in Table I - Basic Tooth Dimensions.

II. SPLINE TOOTH NOMENCLATURE

Figure 1 shows a tooth diagram of splines in mesh. The various elements of the tooth are illustrated and defined.

III. METHOD OF DIMENSIONING SPLINES

Figure 2 contains the required data to be incorporated on the engineering drawing with an illustration to clarify the dimensions. The dimensions and tolerances may be taken from the tables entitled "Dimensions for Splines". The method of calculating the basic chordal space and basic chordal tooth thickness is indicated on Page 2.

This information given on the drawing will enable the tool and production engineers to design tools, gages and other equipment necessary for the manufacture of these splines.

IV. BASIC TOOTH PROPORTION

Table I is a table of basic tooth proportions. It is to be noted that the amount of land clearance of the teeth is considerably greater than on a gear of corresponding pitch, this being necessary to accommodate a full radius at the root of the teeth. The internal member does not require as much clearance as the external member; however, when the number of teeth of the internal becomes large enough to incorporate the same generating cutting tool as the external member, the depth of the internal tooth has been increased to equal that of the external, thereby eliminating one cutting tool. (See NOTE on P. 5)

IV. BASIC TOOTH PROPORTION (Continued)

The true involute form diameter for the external spline is given in the table as the maximum diameter and is the same as the basic I.D. of the internal spline. This diameter may be decreased to obtain the involute clearance desired. This also applies to the true involute form diameter for the internal spline which is given in the tables as the minimum diameter and is the O.D. of the external spline. In this case the diameter may be increased to give clearance if an exceptionally loose fit is used.

The fillet radius generated by a full radius tip tool is theoretically an epicycloid on the internal spline and a hypocycloid on the external spline, but for all practical purposes is an approximate radius tangent to adjacent involutes and root diameter.

V. DIMENSIONS FOR SPLINES

Tables II to IX inclusive show spline dimensions with tolerances as calculated from the basic tooth dimensions, Table I.

VI. FORMULAE

EXTERNAL & INTERNAL SPLINES

CIRCULAR PITCH = 3.1416/DIAMETRAL PITCH *
ADDENDUM = 1/DIAMETRAL PITCH **
DEDENDUM = ADDENDUM + CLEARANCE
CLEARANCE = DETERMINED BY LAYOUT
WORKING DEPTH = 2 x ADDENDUM
WHOLE DEPTH = ADDENDUM + DEDENDUM
INVOLUTE CLEARANCE & FULL RADIUS = DETERMINED BY LAYOUT
BASIC ARC SPACE & TOOTH THICKNESS = 1.5708/DIAMETRAL PITCH*
BASIC CH.T.T. } = P.D. x SIN $\frac{90°}{N}$
BASIC CH.S. }
PITCH DIAMETER = NO. OF TEETH/DIAMETRAL PITCH *

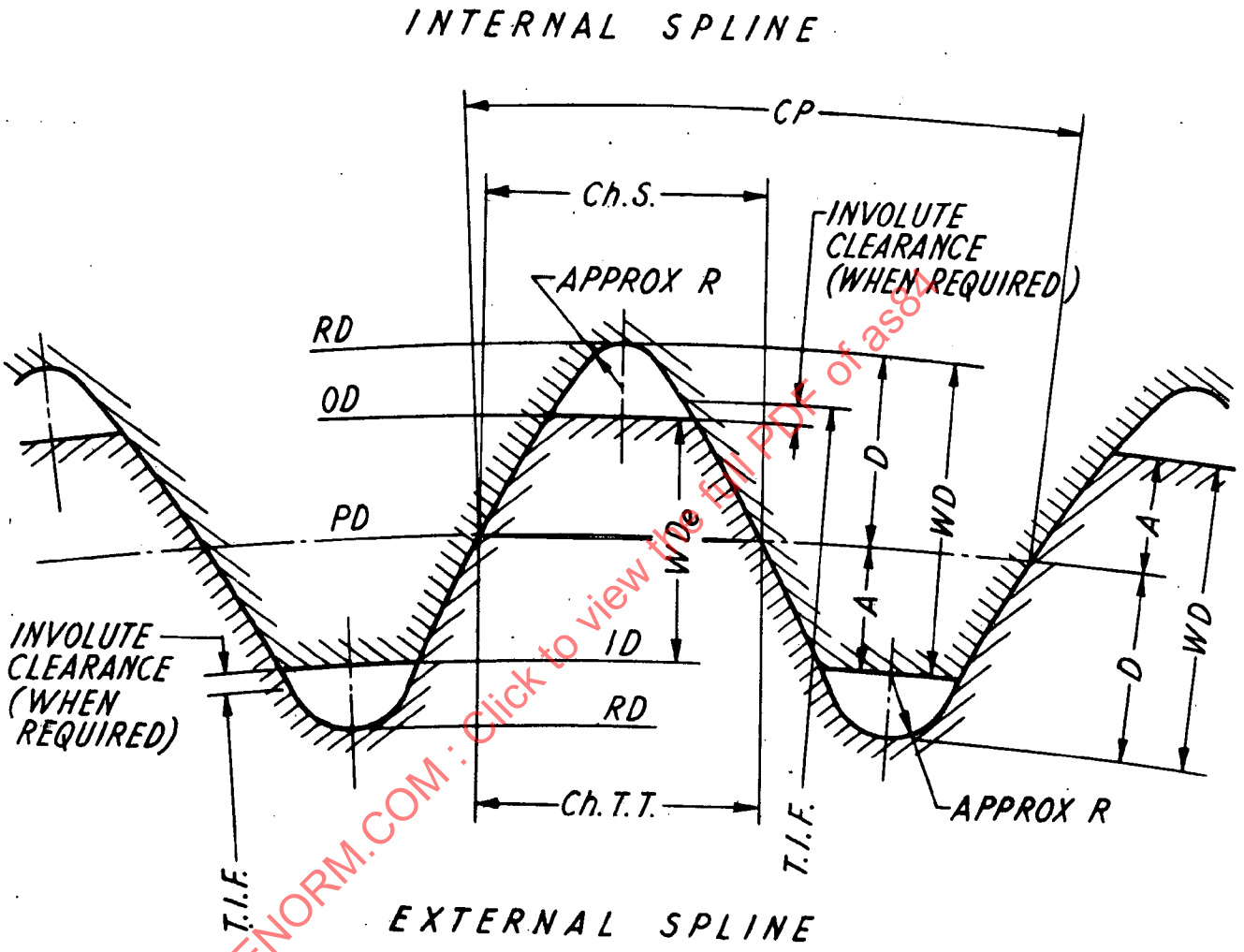
EXTERNAL SPLINES

OUTSIDE DIAMETER = PITCH DIAMETER + (2 x ADDENDUM)
ROOT DIAMETER = OUTSIDE DIAMETER - (2 x WHOLE DEPTH)
TRUE INVOLUTE FORM DIAMETER = INTERNAL INSIDE DIAMETER - (2 x INVOLUTE CLEARANCE, WHEN REQUIRED)

INTERNAL SPLINES

INSIDE DIAMETER = PITCH DIAMETER - (2 x ADDENDUM)
ROOT DIAMETER = INSIDE DIAMETER + (2 x WHOLE DEPTH)
TRUE INVOLUTE FORM DIAMETER = OUTSIDE DIAMETER + (2 x INVOLUTE CLEARANCE, WHEN REQUIRED)

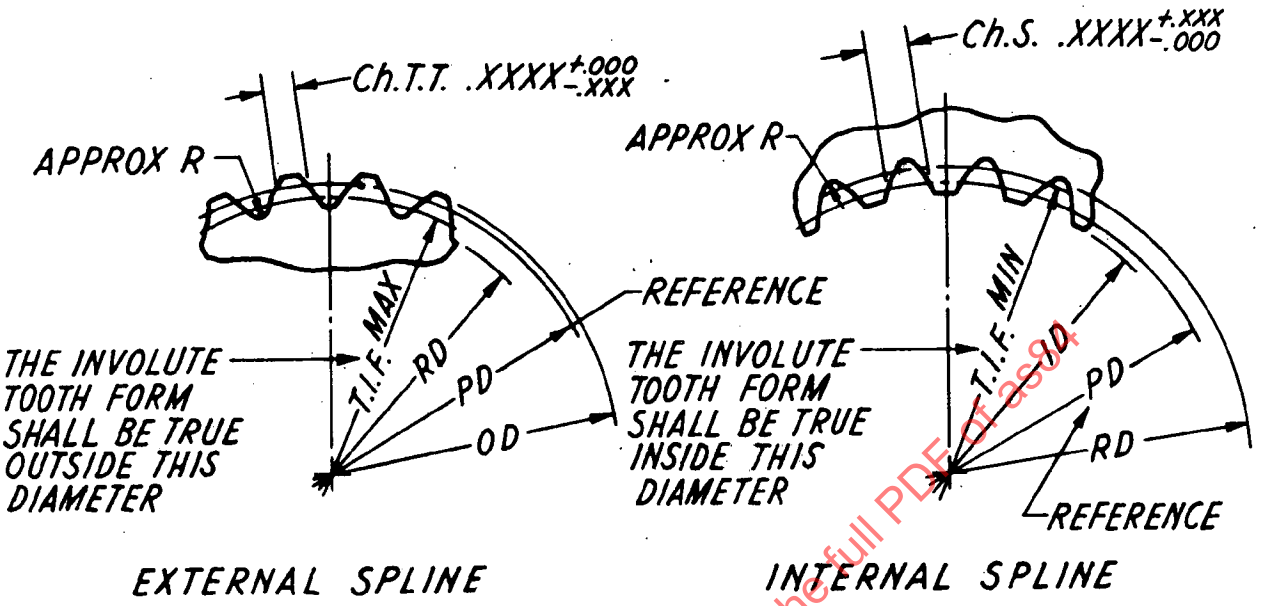
* Use numerator of the diametral pitch
** Use denominator of the diametral pitch



A = ADDENDUM
D = DEDENDUM
WD_e = WORKING DEPTH
WD = WHOLE DEPTH
R = FILLET RADIUS
CP = CIRCULAR PITCH
Ch.T.T. = CHORDAL TOOTH THICKNESS (EXTERNAL)
Ch.S. = CHORDAL SPACE (INTERNAL)

PD = PITCH DIAMETER
OD = OUTSIDE DIAMETER
RD = ROOT DIAMETER
ID = INSIDE DIAMETER
T.I.F. = TRUE INVOLUTE FORM DIAMETER

TOOTH NOMENCLATURE
FIG. 1



EXTERNAL SPLINE

INTERNAL SPLINE

NOTES:

(1) THE CHORDAL SPACE OF THE INTERNAL SPLINE (SEE TABLES) IS BASIC WITH A PLUS TOLERANCE

(2) THE CHORDAL TOOTH THICKNESS AND TOLERANCE OF THE EXTERNAL SPLINE SHOULD BE SELECTED TO OBTAIN THE DESIRED FIT

(3) SPLINE DATA:
30° STUB TOOTH FORM
XX TEETH XX/XX PITCH

METHOD OF DIMENSIONING
FIG. 2

TABLE I
BASIC TOOTH DIMENSIONS

DIA. PITCH	CIR. PITCH	TYPE	NO. OF TEETH	ADD.	DED.	WORKING DEPTH	WHOLE DEPTH	APPROX. FILLET RADIUS
6/12	.5236	EXT.	12 to Rack	.0833	.1506	.1666	.2339	.080
		INT.	12 to 29	.0833	.1370	.1666	.2203	.080
			30 to Rack	.0833	.1506	.1666	.2339	.070
*8/16	.3927	EXT.	12 to 16	.0625	.1127	.1250	.1752	.060
			17 to Rack	.0625	.1127	.1250	.1752	.060
		INT.	12 to 36	.0625	.1050	.1250	.1675	.060
			37 to Rack	.0625	.1127	.1250	.1752	.055
10/20	.3142	EXT.	12 to 19	.0500	.0901	.1000	.1401	.050
			20 to Rack	.0500	.0901	.1000	.1401	.045
		INT.	12 to 41	.0500	.0850	.1000	.1350	.045
			42 to Rack	.0500	.0901	.1000	.1401	.040
12/24	.2618	EXT.	12 to 20	.0417	.0749	.0834	.1166	.040
			21 to Rack	.0417	.0749	.0834	.1166	.035
		INT.	12 to 47	.0417	.0725	.0834	.1142	.035
			48 to Rack	.0417	.0749	.0834	.1166	.030
*16/32	.1964	EXT.	12 to Rack	.0313	.0625	.0626	.0938	.020
		INT.	12 to 59	.0313	.0555	.0626	.0868	.020
			60 to Rack	.0313	.0625	.0626	.0938	.015
20/40	.1571	EXT.	12 to Rack	.0250	.0500	.0500	.0750	.018
		INT.	12 to 71	.0250	.0425	.0500	.0675	.018
			72 to Rack	.0250	.0500	.0500	.0750	.018
24/48	.1309	EXT.	12 to Rack	.0208	.0417	.0416	.0625	.015
		INT.	12 to 83	.0208	.0355	.0416	.0563	.015
			84 to Rack	.0208	.0417	.0416	.0625	.010
*32/64	.0982	EXT.	12 to Rack	.0156	.0313	.0312	.0469	.010
		INT.	12 to 111	.0156	.0275	.0312	.0431	.010
			112 to Rack	.0156	.0313	.0312	.0469	.010

*Preferred

NOTE: The shallow depth given for the smaller internal splines may be used for the full range of the number of teeth, depending on the size of the cutter.

TABLE II

DIMENSIONS FOR SPLINES
6/12 DIAMETRAL PITCH - 30° PRESSURE ANGLE

No. Teeth	Pitch Dia.	External					Internal				
		O.D. +.000 -.005	R.D. +.000 -.020	T.I.F. Max.	Ch.T.T.	Approx. R	I.D. +.005 -.000	R.D. +.020 -.000	T.I.F. Min.	Ch.S. Min. (Basic)	Approx. R
12	2.0000	2.167	1.699	1.833		.080	1.833	2.274	2.167	.2611	.080
13	2.1667	2.333	1.866	2.000		"	2.000	2.441	2.333	.2612	"
14	2.3333	2.500	2.032	2.167		"	2.167	2.607	2.500	.2613	"
15	2.5000	2.667	2.199	2.333		"	2.333	2.774	2.667	"	"
16	2.6667	2.833	2.366	2.500		"	2.500	2.941	2.833	.2614	"
17	2.8333	3.000	2.532	2.667		"	2.667	3.107	3.000	"	"
18	3.0000	3.167	2.699	2.833		"	2.833	3.274	3.167	.2615	"
19	3.1667	3.333	2.866	3.000		"	3.000	3.441	3.333	"	"
20	3.3333	3.500	3.032	3.167		"	3.167	3.607	3.500	"	"
21	3.5000	3.667	3.199	3.333		.080	3.333	3.774	3.667	.2616	.080
22	3.6667	3.833	3.366	3.500		"	3.500	3.941	3.833	"	"
23	3.8333	4.000	3.532	3.667		"	3.667	4.107	4.000	"	"
24	4.0000	4.167	3.699	3.833		"	3.833	4.274	4.167	"	"
25	4.1667	4.333	3.866	4.000		"	4.000	4.441	4.333	"	"
26	4.3333	4.500	4.032	4.167		"	4.167	4.607	4.500	.2617	"
27	4.5000	4.667	4.199	4.333		"	4.333	4.774	4.667	"	"
28	4.6667	4.833	4.366	4.500		"	4.500	4.941	4.833	"	"
29	4.8333	5.000	4.532	4.667		"	4.667	5.107	5.000	"	"
30	5.0000	5.167	4.699	4.833		"	4.833	5.301	5.167	"	.070
31	5.1667	5.333	4.866	5.000		.080	5.000	5.468	5.333	.2617	.070
32	5.3333	5.500	5.032	5.167		"	5.167	5.635	5.500	"	"
33	5.5000	5.667	5.199	5.333		"	5.333	5.801	5.667	"	"
34	5.6667	5.833	5.366	5.500		"	5.500	5.968	5.833	"	"
35	5.8333	6.000	5.532	5.667		"	5.667	6.135	6.000	"	"
36	6.0000	6.167	5.699	5.833		"	5.833	6.301	6.167	"	"
37	6.1667	6.333	5.866	6.000		"	6.000	6.468	6.333	"	"
38	6.3333	6.500	6.032	6.167		"	6.167	6.635	6.500	"	"
39	6.5000	6.667	6.199	6.333		"	6.333	6.801	6.667	"	"
40	6.6667	6.833	6.366	6.500		"	6.500	6.968	6.833	"	"
41	6.8333	7.000	6.532	6.667		.080	6.667	7.135	7.000	.2617	.070
42	7.0000	7.167	6.699	6.833		"	6.833	7.301	7.167	"	"
43	7.1667	7.333	6.866	7.000		"	7.000	7.468	7.333	"	"
44	7.3333	7.500	7.032	7.167		"	7.167	7.635	7.500	"	"
45	7.5000	7.667	7.199	7.333		"	7.333	7.801	7.667	"	"
46	7.6667	7.833	7.366	7.500		"	7.500	7.968	7.833	"	"
47	7.8333	8.000	7.532	7.667		"	7.667	8.135	8.000	"	"
48	8.0000	8.167	7.699	7.833		"	7.833	8.301	8.167	"	"
49	8.1667	8.333	7.866	8.000		"	8.000	8.468	8.333	"	"
50	8.3333	8.500	8.032	8.167		"	8.167	8.635	8.500	"	"

SEE NOTE - Fig. 2

TABLE III
DIMENSIONS FOR SPLINES
8/16 DIAMETRAL PITCH - 30° PRESSURE ANGLE

No. Teeth	Pitch Dia.	External O.D. +.000 -.005	External R.D. +.000 -.020	External T.I.F. Max.	External Ch.T.T.	External Approx. R	Internal I.D. +.005 -.000	Internal R.D. +.020 -.000	Internal T.I.F. Min.	Internal Ch.S. Min. (Basic)	Internal Approx. R
12	1.5000	1.625	1.275	1.375		.060	1.375	1.710	1.625	.1958	.060
13	1.6250	1.750	1.400	1.500		"	1.500	1.835	1.750	.1959	"
14	1.7500	1.875	1.525	1.625		"	1.625	1.960	1.875	"	"
15	1.8750	2.000	1.650	1.750		"	1.750	2.085	2.000	.1960	"
16	2.0000	2.125	1.775	1.875		"	1.875	2.210	2.125	"	"
17	2.1250	2.250	1.900	2.000		"	2.000	2.335	2.250	.1961	"
18	2.2500	2.375	2.025	2.125		"	2.125	2.460	2.375	"	"
19	2.3750	2.500	2.150	2.250		"	2.250	2.585	2.500	"	"
20	2.5000	2.625	2.275	2.375		"	2.375	2.710	2.625	"	"
21	2.6250	2.750	2.400	2.500		.060	2.500	2.835	2.750	.1962	.060
22	2.7500	2.875	2.525	2.625		"	2.625	2.960	2.875	"	"
23	2.8750	3.000	2.650	2.750		"	2.750	3.085	3.000	"	"
24	3.0000	3.125	2.775	2.875		"	2.875	3.210	3.125	"	"
25	3.1250	3.250	2.900	3.000		"	3.000	3.335	3.250	"	"
26	3.2500	3.375	3.025	3.125		"	3.125	3.460	3.375	"	"
27	3.3750	3.500	3.150	3.250		"	3.250	3.585	3.500	"	"
28	3.5000	3.625	3.275	3.375		"	3.375	3.710	3.625	"	"
29	3.6250	3.750	3.400	3.500		"	3.500	3.835	3.750	"	"
30	3.7500	3.875	3.525	3.625	SEE NOTE - Fig. 2	"	3.625	3.960	3.875	.1963	"
31	3.8750	4.000	3.650	3.750		.060	3.750	4.085	4.000	.1963	.060
32	4.0000	4.125	3.775	3.875		"	3.875	4.210	4.125	"	"
33	4.1250	4.250	3.900	4.000		"	4.000	4.335	4.250	"	"
34	4.2500	4.375	4.025	4.125		"	4.125	4.460	4.375	"	"
35	4.3750	4.500	4.150	4.250		"	4.250	4.585	4.500	"	"
36	4.5000	4.625	4.275	4.375		"	4.375	4.710	4.625	"	"
37	4.6250	4.750	4.400	4.500		"	4.500	4.850	4.750	"	.055
38	4.7500	4.875	4.525	4.625		"	4.625	4.975	4.875	"	"
39	4.8750	5.000	4.650	4.750		"	4.750	5.100	5.000	"	"
40	5.0000	5.125	4.775	4.875		"	4.875	5.225	5.125	"	"
41	5.1250	5.250	4.900	5.000		.060	5.000	5.350	5.250	.1963	.055
42	5.2500	5.375	5.025	5.125		"	5.125	5.475	5.375	"	"
43	5.3750	5.500	5.150	5.250		"	5.250	5.600	5.500	"	"
44	5.5000	5.625	5.275	5.375		"	5.375	5.725	5.625	"	"
45	5.6250	5.750	5.400	5.500		"	5.500	5.850	5.750	"	"
46	5.7500	5.875	5.525	5.625		"	5.625	5.975	5.875	"	"
47	5.8750	6.000	5.650	5.750		"	5.750	6.100	6.000	"	"
48	6.0000	6.125	5.775	5.875		"	5.875	6.225	6.125	"	"
49	6.1250	6.250	5.900	6.000		"	6.000	6.350	6.250	"	"
50	6.2500	6.375	6.025	6.125		"	6.125	6.475	6.375	"	"

TABLE IV
DIMENSIONS FOR SPLINES
10/20 DIAMETRAL PITCH - 30° PRESSURE ANGLE

No. Teeth	Pitch Dia.	External O.D. +.000 -.005	External R.D. +.000 -.020	External T.I.F. Max.	External Ch.T.T.	External Approx. R	Internal I.D. +.005 -.000	Internal R.D. +.020 -.000	Internal T.I.F. Min.	Internal Ch.S. Min. (Basic)	Internal Approx. R
12	1.2000	1.300	1.020	1.100		.050	1.100	1.370	1.300	.1566	.045
13	1.3000	1.400	1.120	1.200		"	1.200	1.470	1.400	.1567	"
14	1.4000	1.500	1.220	1.300		"	1.300	1.570	1.500	.1568	"
15	1.5000	1.600	1.320	1.400		"	1.400	1.670	1.600	"	"
16	1.6000	1.700	1.420	1.500		"	1.500	1.770	1.700	"	"
17	1.7000	1.800	1.520	1.600		"	1.600	1.870	1.800	.1569	"
18	1.8000	1.900	1.620	1.700		"	1.700	1.970	1.900	"	"
19	1.9000	2.000	1.720	1.800		"	1.800	2.070	2.000	"	"
20	2.0000	2.100	1.820	1.900		.045	1.900	2.170	2.100	"	"
21	2.1000	2.200	1.920	2.000		.045	2.000	2.270	2.200	.1569	.045
22	2.2000	2.300	2.020	2.100		"	2.100	2.370	2.300	"	"
23	2.3000	2.400	2.120	2.200		"	2.200	2.470	2.400	.1570	"
24	2.4000	2.500	2.220	2.300		"	2.300	2.570	2.500	"	"
25	2.5000	2.600	2.320	2.400		"	2.400	2.670	2.600	"	"
26	2.6000	2.700	2.420	2.500		"	2.500	2.770	2.700	"	"
27	2.7000	2.800	2.520	2.600		"	2.600	2.870	2.800	"	"
28	2.8000	2.900	2.620	2.700		"	2.700	2.970	2.900	"	"
29	2.9000	3.000	2.720	2.800		"	2.800	3.070	3.000	"	"
30	3.0000	3.100	2.820	2.900		"	2.900	3.170	3.100	"	"
31	3.1000	3.200	2.920	3.000		.045	3.000	3.270	3.200	.1570	.045
32	3.2000	3.300	3.020	3.100		"	3.100	3.370	3.300	"	"
33	3.3000	3.400	3.120	3.200		"	3.200	3.470	3.400	"	"
34	3.4000	3.500	3.220	3.300		"	3.300	3.570	3.500	"	"
35	3.5000	3.600	3.320	3.400		"	3.400	3.670	3.600	"	"
36	3.6000	3.700	3.420	3.500		"	3.500	3.770	3.700	"	"
37	3.7000	3.800	3.520	3.600		"	3.600	3.870	3.800	"	"
38	3.8000	3.900	3.620	3.700		"	3.700	3.970	3.900	"	"
39	3.9000	4.000	3.720	3.800		"	3.800	4.070	4.000	"	"
40	4.0000	4.100	3.820	3.900		"	3.900	4.170	4.100	"	"
41	4.1000	4.200	3.920	4.000		.045	4.000	4.270	4.200	.1570	.045
42	4.2000	4.300	4.020	4.100		"	4.100	4.380	4.300	"	.040
43	4.3000	4.400	4.120	4.200		"	4.200	4.480	4.400	"	"
44	4.4000	4.500	4.220	4.300		"	4.300	4.580	4.500	"	"
45	4.5000	4.600	4.320	4.400		"	4.400	4.680	4.600	"	"
46	4.6000	4.700	4.420	4.500		"	4.500	4.780	4.700	"	"
47	4.7000	4.800	4.520	4.600		"	4.600	4.880	4.800	"	"
48	4.8000	4.900	4.620	4.700		"	4.700	4.980	4.900	"	"
49	4.9000	5.000	4.720	4.800		"	4.800	5.080	5.000	"	"
50	5.0000	5.100	4.820	4.900		"	4.900	5.180	5.100	"	"

SEE NOTE - Fig. 2

TABLE V
DIMENSIONS FOR SPLINES
12/24 DIAMETRAL PITCH - 30° PRESSURE ANGLE

		External					Internal				
No. Teeth	Pitch Dia.	O.D. +.000 -.005	R.D. +.000 -.020	T.I.F. Max.	Ch.T.T.	Approx. R	I.D. +.005 -.000	R.D. +.020 -.000	T.I.F. Min.	Ch.S. Min. (Basic)	Approx. R
12	1.0000	1.083	.850	.917		.040	.917	1.145	1.083	.1305	.035
13	1.0833	1.167	.934	1.000		"	1.000	1.228	1.167	.1306	"
14	1.1667	1.250	1.017	1.083		"	1.083	1.312	1.250	"	"
15	1.2500	1.333	1.100	1.167		"	1.167	1.395	1.333	.1307	"
16	1.3333	1.417	1.184	1.250		"	1.250	1.478	1.417	"	"
17	1.4167	1.500	1.267	1.333		"	1.333	1.562	1.500	"	"
18	1.5000	1.583	1.350	1.417		"	1.417	1.645	1.583	"	"
19	1.5833	1.667	1.434	1.500		"	1.500	1.728	1.667	.1308	"
20	1.6667	1.750	1.517	1.583		"	1.583	1.812	1.750	"	"
21	1.7500	1.833	1.600	1.667		.035	1.667	1.895	1.833	.1308	.035
22	1.8333	1.917	1.684	1.750		"	1.750	1.978	1.917	"	"
23	1.9167	2.000	1.767	1.833		"	1.833	2.062	2.000	"	"
24	2.0000	2.083	1.850	1.917		"	1.917	2.145	2.083	"	"
25	2.0833	2.167	1.934	2.000		"	2.000	2.228	2.167	"	"
26	2.1667	2.250	2.017	2.083		"	2.083	2.312	2.250	"	"
27	2.2500	2.333	2.100	2.167		"	2.167	2.395	2.333	"	"
28	2.3333	2.417	2.184	2.250		"	2.250	2.478	2.417	"	"
29	2.4167	2.500	2.267	2.333		"	2.333	2.562	2.500	"	"
30	2.5000	2.583	2.350	2.417		"	2.417	2.645	2.583	"	"
31	2.5833	2.667	2.434	2.500	SEE NOTE - Fig. 2	.035	2.500	2.728	2.667	.1308	.035
32	2.6667	2.750	2.517	2.583		"	2.583	2.812	2.750	"	"
33	2.7500	2.833	2.600	2.667		"	2.667	2.895	2.833	"	"
34	2.8333	2.917	2.684	2.750		"	2.750	2.978	2.917	"	"
35	2.9167	3.000	2.767	2.833		"	2.833	3.062	3.000	.1309	"
36	3.0000	3.083	2.850	2.917		"	2.917	3.145	3.083	"	"
37	3.0833	3.167	2.934	3.000		"	3.000	3.228	3.167	"	"
38	3.1667	3.250	3.017	3.083		"	3.083	3.312	3.250	"	"
39	3.2500	3.333	3.100	3.167		"	3.167	3.395	3.333	"	"
40	3.3333	3.417	3.184	3.250		"	3.250	3.478	3.417	"	"
41	3.4167	3.500	3.267	3.333		.035	3.333	3.562	3.500	.1309	.035
42	3.5000	3.583	3.350	3.417		"	3.417	3.645	3.583	"	"
43	3.5833	3.667	3.434	3.500		"	3.500	3.728	3.667	"	"
44	3.6667	3.750	3.517	3.583		"	3.583	3.812	3.750	"	"
45	3.7500	3.833	3.600	3.667		"	3.667	3.895	3.833	"	"
46	3.8333	3.917	3.684	3.750		"	3.750	3.978	3.917	"	"
47	3.9167	4.000	3.767	3.833		"	3.833	4.062	4.000	"	"
48	4.0000	4.083	3.850	3.917		"	3.917	4.150	4.083	"	.030
49	4.0833	4.167	3.934	4.000		"	4.000	4.233	4.167	"	"
50	4.1667	4.250	4.017	4.083		"	4.083	4.317	4.250	"	"

TABLE VI
DIMENSIONS FOR SPLINES
16/32 DIAMETRAL PITCH - 30° PRESSURE ANGLE

		External					Internal				
No. Teeth	Pitch Dia.	O.D. +.000 -.005	R.D. +.000 -.020	T.I.F. Max.	Ch.T.T.	Approx. R	I.D. +.005 -.000	R.D. +.020 -.000	T.I.F. Min.	Ch.S. Min. (Basic)	Approx. R
12	.7500	.813	.625	.688		.020	.688	.861	.813	.0979	.020
13	.8125	.875	.687	.750		"	.750	.924	.875	"	"
14	.8750	.938	.750	.813		"	.813	.986	.938	.0980	"
15	.9375	1.000	.812	.875		"	.875	1.049	1.000	"	"
16	1.0000	1.063	.875	.938		"	.938	1.111	1.063	"	"
17	1.0625	1.125	.937	1.000		"	1.000	1.174	1.125	"	"
18	1.1250	1.188	1.000	1.063		"	1.063	1.236	1.188	.0981	"
19	1.1875	1.250	1.062	1.125		"	1.125	1.299	1.250	"	"
20	1.2500	1.313	1.125	1.188		"	1.188	1.361	1.313	"	"
21	1.3125	1.375	1.187	1.250		.020	1.250	1.424	1.375	.0981	.020
22	1.3750	1.438	1.250	1.313		"	1.313	1.486	1.438	"	"
23	1.4375	1.500	1.312	1.375		"	1.375	1.549	1.500	"	"
24	1.5000	1.563	1.375	1.438		"	1.438	1.611	1.563	"	"
25	1.5625	1.625	1.437	1.500		"	1.500	1.674	1.625	"	"
26	1.6250	1.688	1.500	1.563		"	1.563	1.736	1.688	"	"
27	1.6875	1.750	1.562	1.625		"	1.625	1.799	1.750	"	"
28	1.7500	1.813	1.625	1.688		"	1.688	1.861	1.813	"	"
29	1.8125	1.875	1.687	1.750		"	1.750	1.924	1.875	"	"
30	1.8750	1.938	1.750	1.813		"	1.813	1.986	1.938	"	"
31	1.9375	2.000	1.812	1.875		.020	1.875	2.049	2.000	.0981	.020
32	2.0000	2.063	1.875	1.938		"	1.938	2.111	2.063	"	"
33	2.0625	2.125	1.937	2.000		"	2.000	2.174	2.125	"	"
34	2.1250	2.188	2.000	2.063		"	2.063	2.236	2.188	"	"
35	2.1875	2.250	2.062	2.125		"	2.125	2.299	2.250	"	"
36	2.2500	2.313	2.125	2.188		"	2.188	2.361	2.313	"	"
37	2.3125	2.375	2.187	2.250		"	2.250	2.424	2.375	"	"
38	2.3750	2.438	2.250	2.313		"	2.313	2.486	2.438	"	"
39	2.4375	2.500	2.312	2.375		"	2.375	2.549	2.500	.0982	"
40	2.5000	2.563	2.375	2.438		"	2.438	2.611	2.563	"	"
41	2.5625	2.625	2.437	2.500		.020	2.500	2.674	2.625	.0982	.020
42	2.6250	2.688	2.500	2.563		"	2.563	2.736	2.688	"	"
43	2.6875	2.750	2.562	2.625		"	2.625	2.799	2.750	"	"
44	2.7500	2.813	2.625	2.688		"	2.688	2.861	2.813	"	"
45	2.8125	2.875	2.687	2.750		"	2.750	2.924	2.875	"	"
46	2.8750	2.938	2.750	2.813		"	2.813	2.986	2.938	"	"
47	2.9375	3.000	2.812	2.875		"	2.875	3.049	3.000	"	"
48	3.0000	3.063	2.875	2.938		"	2.938	3.111	3.063	"	"
49	3.0625	3.125	2.937	3.000		"	3.000	3.174	3.125	"	"
50	3.1250	3.188	3.000	3.063		"	3.063	3.236	3.188	"	"

SEE NOTE - Fig. 2