Hardinge Dividing Head

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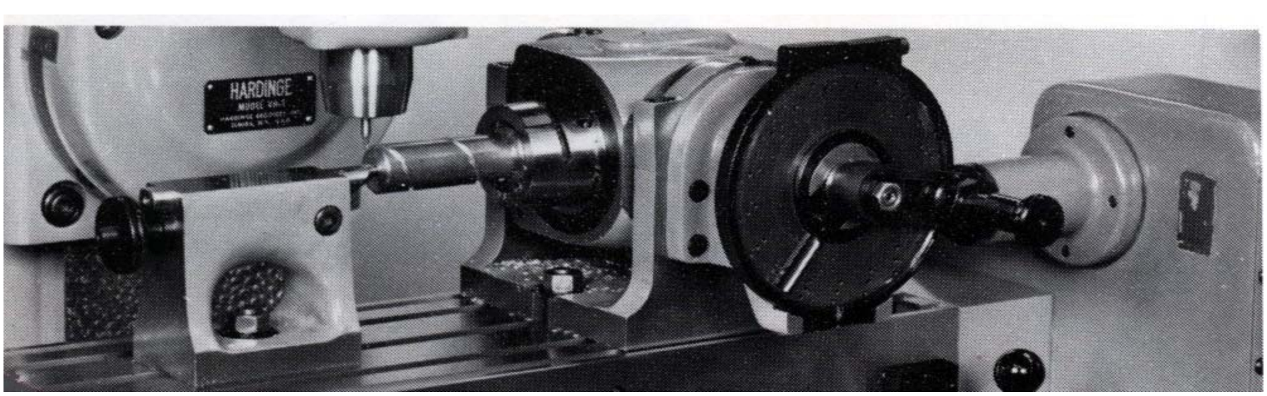
Universal Plain Dividing Head - TM

Universal Plain Dividing Head – TM – Hardinge Taper or Threaded Nose Spindle

This unique dividing head has a quick 4:1 ratio for rapid indexing. The spindle is a precision ground pre-loaded ball bearing spindle with a 5C collet seat and either a Hardinge taper or threaded spindle nose. The head can swing from 10° below horizontal to 20° beyond vertical. The two – piece draw spindle allows the draw bar to be removed without loosening the collet, allowing work to be easily accomplished in the vertical position. Seven index plates come with the unit. An adjustable stop plate is provided which can be locked in any position, speeding up work when doing repetitive angular milling. The dividing head also comes with a center / driver, tailstock, spanner wrench for the draw spindle, and the index table chart.

Narrative	**Fashion**	**Part Number**
TM Dividing Head Assembly	Taper Nose	PC – 0000055
TM Dividing Head Assembly	Threaded Nose	PC – 0000055 – D

Narrative (included in above assemblage)	**Part Number**
Center with Driver	U – 0009186
Tailstock	TM – 0000056
Spanner wrench	37B – 0000307
Index Plate with 17 Holes	PA – 0004138 – 17
Index Plate with 20 Holes	PA – 0004138 – 20
Index Plate with 27 Holes	PA – 0004138 – 27
Index Plate with 37 Holes	PA – 0004138 – 37
Index Plate with 43 Holes	PA – 0004138 – 43
Index Plate with 48 Holes	PA – 0004138 – 48
Index Plate with 75 Holes	PA – 0004138 – 75



Dividing Head

The Dividing Head or Spiral Milling Heads are used extensively in milling spiral and helical gears, constant velocity drum cams, etc. The manner of transmitting motion to the spindle in the head is the same for both types, but the construction of the main castings are entirely different. The Dividing Head is designed so that its spindle can be swiveled vertically, while the spindle of the Spiral Milling Head is rigidly fixed in a one – piece housing to provide an attachment suitable for heavy and continuous helical milling. The Spindle of the Dividing Head is housed in a swivel block, which can swing from 10° below horizontal to 20° beyond vertical. The two – piece draw spindle allows the draw bar to be removed without loosening the collet, allowing work to be done in the vertical position.

There are a few oil cups in the Dividing Head. Be sure to apply oil periodically throughout use.

Setting up the Dividing Head

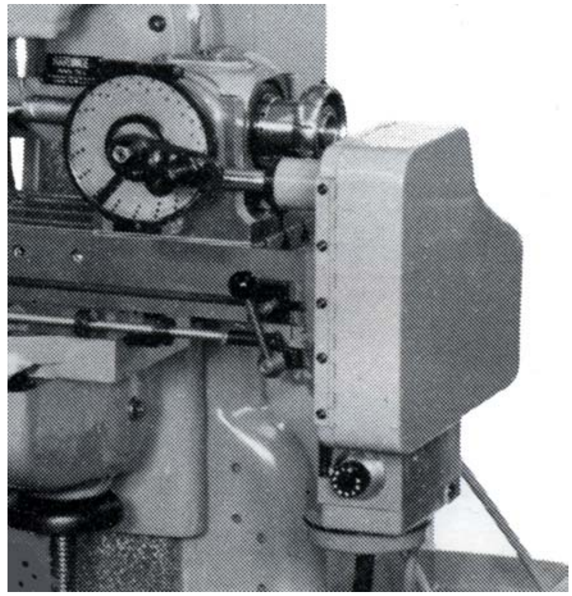
The instruction outlined for this set-up should be followed in the order in which they are listed.

1. Clean the table of the milling machine and the bottom of the Dividing Head and Tailstock.
2. Clamp the Dividing Head in the center slot of the table, in a suitable position for the length of the work.
3. Test the Dividing Head Spindle with a test bar and indicator to see that it is parallel with the table.
4. Clamp the Tailstock in the proper position, depending upon the length of the work.
5. Line up the Tailstock center with the Headstock center.
6. Line up the cutter centered with the Dividing Head or Tailstock center.
7. Lock the saddle in position.
8. Swing the Table to the correct angle (Universal Machine Only). If a Spiral Milling attachment is being used on a plain machine, swing it to the correct angle.
9. Lock the housing in position. (Universal Machine only).
10. Withdraw the index plate stop. The index plate must be free to revolve with the index pin. Note: The stop engaging the index plate should be engaged only when the Dividing Head is used without the Gear Box Assembly for index center.
11. Set up the change gears.
12. Set the index plate and sector for the proper spacing.
13. Oil the Dividing Head and change gears (if used) thoroughly.

Setting up the Enclosed Driving Mechanism

The Enclosed Driving Mechanism, may be used on the UM and with the Vertical Head Assembly.

When a new Driving Mechanism is set up on a used Plain or Universal Swivel Base UM the first time, run the table by hand to it's extreme left position after the Gear Box Assembly in it's place. Then set the trip dog to trip the feed just before the housing comes to the end of the table travel. Thereafter when setting up a job requiring the Driving Mechanism, set the stop dog to the left



List of Change Gears for Driving Mechanism

Part No.	No. Used	Part Name
6822	1	25 Teeth
6258	1	30 Teeth
6259	1	35 Teeth
6261	2	40 Teeth
6263	2	45 Teeth
6264	3	50 Teeth
6266	1	60 Teeth
70 – 4660	1	70 Teeth
6848	1	75 Teeth
6850	1	100 Teeth

Calculating the Change Gears

Many leads can be obtained with the Change Gears. Because the difference of ordinary requirements is so great only a handful are provided below.

$$\frac{\text{Lead}}{10} = \frac{\text{Driven}}{\text{Driven}} = \frac{A \times C}{B \times D}$$

Suppose you want a lead of 32”

$$\frac{32}{10} = 3.2 = \frac{40 \times 60}{30 \times 25}\ 3.2$$

Conversions for Short Leads

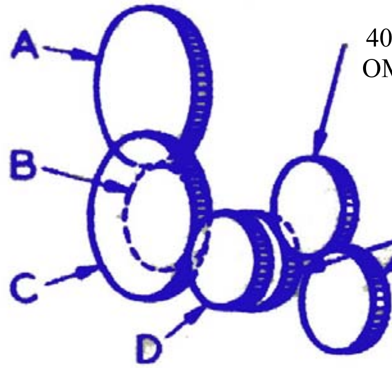
With the standard Driving Mechanism leads lower than those listed in the Tables can be obtained using hand feed only.

Index Table for Hardinge Universal Index Centers & Hardinge Universal Spiral Index Centers

Divisions	Circle	Turns	Holes	Divisions	Circle	Turns	Holes
2	Any	2	Ø	49	49	Ø	4
3	39	1	13	50	75	Ø	6
4	Any	1	Ø	52	39	Ø	3
5	20	Ø	16	54	27	Ø	2
6	18	Ø	12	56	70	Ø	5
7	49	Ø	28	58	29	Ø	2
8	20	Ø	10	60	15	Ø	1
9	27	Ø	12	62	31	Ø	2
10	20	Ø	8	64	16	Ø	1
11	33	Ø	12	66	33	Ø	2
12	39	Ø	13	68	17	Ø	1
13	39	Ø	12	70	70	Ø	4
14	49	Ø	14	72	18	Ø	1
15	15	Ø	4	74	37	Ø	2
16	16	Ø	4	75	75	Ø	4
17	17	Ø	4	76	19	Ø	1
18	18	Ø	4	78	39	Ø	2
19	19	Ø	4	80	20	Ø	1
20	20	Ø	4	82	41	Ø	2
21	21	Ø	4	84	21	Ø	1
22	33	Ø	6	86	43	Ø	2
23	23	Ø	4	88	66	Ø	3
24	18	Ø	3	90	90	Ø	4
25	75	Ø	12	92	23	Ø	1
26	39	Ø	6	94	47	Ø	2
27	27	Ø	4	96	48	Ø	2
28	49	Ø	7	98	49	Ø	2
29	29	Ø	4	100	75	Ø	3
30	15	Ø	2	108	27	Ø	1
31	31	Ø	4	116	29	Ø	1
32	16	Ø	2	120	90	Ø	3
33	33	Ø	4	124	31	Ø	1
34	17	Ø	2	132	33	Ø	1
35	70	Ø	8	140	70	Ø	2
36	18	Ø	2	148	37	Ø	1
37	37	Ø	4	150	75	Ø	2
38	19	Ø	2	156	39	Ø	1
39	39	Ø	4	164	41	Ø	1
40	20	Ø	2	172	43	Ø	1
41	41	Ø	4	180	90	Ø	2
42	21	Ø	2	188	47	Ø	1
43	43	Ø	4	192	48	Ø	1
44	33	Ø	3	196	49	Ø	1
45	90	Ø	8	280	70	Ø	1
46	23	Ø	2	300	75	Ø	1
47	47	Ø	4	360	90	Ø	1
48	48	Ø	4	Ø	Ø	Ø	Ø

Tables of Angles 4:1 Ratio

TABLES OF ANGLES & COMPOUND GEARING FOR CUTTING SPIRALS



					Diameter of Work in Inches															
Lead	**A**	**B**	**C**	**D**	**⅛**	**¼**	**⅜**	**½**	**⅝**	**¾**	**⅞**	**1**	**1¼**	**1½**	**1¾**	**2**	**2¼**	**2½**	**2¾**	**3**
.600	30	80	40	100	33.25															
.750	30	80	50	100	27.75															
.875	35	80	50	100	24.25	41.75														
.900	30	80	60	100	23.5	41														
1.066	40	75	50	100	20.25	36.5														
1.143	40	70	50	100	19	34.5														
1.333	40	60	50	100	16	30.25	41.5													
1.400	30	60	70	100	15.75	29.25	40													
1.440	30	50	60	100	14.75	28	38.5													
1.500	30	60	75	100	14.5	27.5	35.75													
1.680	30	50	70	100	12.75	25	34.75	43.25												
1.800	30	50	75	100	12.25	23.5	33.25	41												
2.100	35	50	60	80	10.25	20.5	29.5	37	43.25											
2.560	40	50	60	75	8.75	17	24.75	31.5	37.5	43.25										
2.740	40	50	60	70	8.25	16	23.25	29.75	35.5	40.75										
3.000	30	50	100	80	7.5	14.75	21.5	27.25	33.25	38.25	42.5									
3.200	30	50	100	75	6.75	13.25	19.75	25.75	31.25	36	40.5	44.25								
3.360	60	50	70	100	6.75	13	19.25	25	30.25	35	39.25	43								
3.420	30	50	100	70	6.5	13	19	24.75	29.75	34.5	38.75	42.5								
3.500	35	50	100	80	6.5	12.75	18.75	24.25	29.25	34	38.5	42								
3.600	60	50	75	100	6.25	12.25	18.25	23.5	28.5	33.25	37.25	41.25								
3.720	35	50	80	60	6	11.75	17.5	23	28	32.5	36.5	40.5								
4.000	60	30	50	100	5.5	11	16.5	21.5	26	30.5	34.5	38	44.5							
4.200	60	40	70	100	5.25	10.5	15.75	20.5	25.25	29.5	33.5	37	43.25							
4.285	50	35	75	100	5	10.25	15.5	20.25	24.5	28.75	32.75	36.25	42.5							
4.480	70	50	80	100	5	10	14.75	19.25	23.75	27.75	31.5	35	41.25							
4.500	60	40	75	100	4.75	9.75	14.75	19.25	23.75	27.75	31.5	35	41							
4.666	70	30	40	80	4.75	9.25	14	18.5	22.75	26.75	30.5	34	40.25							
4.800	75	50	80	100	4.5	9	13.5	17.75	22	25.75	29.5	33	39	44.25						
5.000	75	30	40	80	4.5	8.75	13.25	17.5	21.5	25.25	28.75	32.25	38	43.25						
5.240	60	40	70	80	4.25	8.25	12.5	16.75	20.5	24	27.75	31	37	42						
5.480	60	35	80	100	4.25	8.25	12.25	16.5	19.75	23.25	26.5	29.75	35.5	40.5						
5.600	70	40	80	100	4	8	12	15.75	19.25	22.75	26.25	29.25	35	40	44.25					
5.625	60	40	75	80	4	8	11.75	15.5	19.25	22.75	26	29.25	35	40	44.25					
5.830	70	30	50	80	3.75	7.75	11.5	15	18.5	22	25.25	28.25	34	39	43.25					
6.000	75	40	80	100	3.75	7.5	11	14.75	18	21.25	24.5	27.75	33.25	38.25	42.5					
6.250	75	30	50	80	3.5	7.25	10.75	14.25	17.5	20.75	23.75	26.75	32.25	37	41.25					
6.400	60	30	80	100	3.5	7	10.5	13.75	17	20.25	23.25	26.25	31.5	36.25	40.75	44.5				
6.720	70	25	60	100	3.25	6.5	10	13	16.25	19.25	22.25	25	30.25	35	39.25	43				

Note
The first column shows Leads. Second, third, fourth, & fifth columns show gearing, while the balance of the columns show angular setting of the table for the leads and diameters involved.

Tables of Angles 4:1 Ratio

					Diameter of Work in Inches															
Lead	A	B	C	D	⅛	¼	⅜	½	⅝	¾	⅞	1	1¼	1½	1¾	2	2¼	2½	2¾	3
7.200	75	25	60	100	3.25	6.25	9.25	12.25	15.25	18	21	23.5	28.5	33.25	37.25	41	44.5			
7.466	70	30	80	100	3	6	9	12	14.75	17.5	20.25	22.75	27.75	32.25	36.25	40	43.5			
7.680	80	25	60	100	3	5.75	8.75	11.5	14.25	17	19.75	22.25	27	31.5	35.5	39.25	42.5			
8.000	75	30	80	100	2.75	5.5	8.5	11	13.75	16.25	19	21.5	26.5	30.5	34.5	38.25	41.5	44.5		
8.400	70	40	60	50	2.75	5.25	8	10.5	13.25	15.75	18	20.5	25	29.25	33.25	36.75	40	43		
8.531	80	25	50	75	2.25	5.25	8	10.5	13	15.5	17.75	20.25	24.75	29	32.75	36.25	39.75	42.75		
9.000	75	40	60	50	2.5	5	7.5	10	12.5	14.75	17.5	19.25	24	28	31.75	35.25	38.5	41.25	43.75	
9.140	80	25	50	70	2.5	5	7.25	9.75	12.25	14.5	17	19	23.25	27.25	31	34.5	37.75	40.75	43.5	
9.333	70	40	80	60	2.5	4.75	7.25	9.5	11.75	14	16.5	18.5	23	27	30.5	34	37.25	40.25	43	
9.600	80	40	60	50	2.5	4.75	7.25	9.5	11.75	14	16	18.25	22.25	26.25	29.75	33.25	36.25	39.25	42	44.5
10.000	75	40	80	60	2.25	4.5	6.75	9	11	13.5	15.25	17.5	21.5	25.25	28.75	32.25	35.25	38.25	40.75	43.25
10.240	80	25	60	75	2.25	4.25	6.5	8.75	10.75	13	15	17	21	24.75	28.25	31.5	34.5	37.5	40.25	42.5
10.656	40	60	100	25	2	4	6.25	8.25	10.25	12.25	14.25	16.5	20.25	24	27.25	30.5	33.5	36.5	39	41.5
10.666	70	35	80	60	2	4	6.25	8.25	10.25	12.25	14.25	16.5	20.25	24	27.25	30.5	33.5	36.5	39	41.5
10.963	80	35	60	50	2	4	6	8.25	10	12	14	16	19.75	23.25	26.75	29.75	32.75	35.5	38.25	40.75
10.970	80	25	60	70	2	4	6	8.25	10	12	14	16	19.75	23.25	26.5	29.75	32.75	35.5	38.25	40.75
11.200	70	40	80	50	2	4	6	8	10	11.75	13.75	15.75	19.75	23	26.5	29.5	32.5	35.5	38	40.25
11.424	75	35	80	60	2	4	6	7.75	9.75	11.5	13.5	15.25	19	22.5	25.75	28.75	31.75	34.5	37	39.5
11.666	70	40	100	60	1.75	3.75	5.75	7.5	9.5	11.25	13.25	15.25	18.75	22	25.25	28.5	31.25	34	36.5	39
12.000	75	40	80	50	1.75	3.75	5.5	7.25	9.25	11	12.75	15	18.25	21.5	24.75	27.75	30.5	33.25	35.75	38
12.495	75	40	100	60	1.75	3.5	5.25	7	9	10.75	12.5	14	17.5	20.75	23.75	26.75	29.5	32.25	34.75	37
12.800	80	30	60	50	1.75	3.5	5.25	7	8.75	10.5	12	13.75	17	20.25	23.25	26.25	29	31.5	34	36.25
13.333	80	40	100	60	1.5	3.25	5	6.5	8.25	10	11.5	13.25	16.5	19.5	22.5	25.5	28	30.5	33	35.25
14.000	70	40	100	50	1.5	3.25	4.75	6.5	8	9.5	11.25	12.75	15.75	18.5	21.5	24.25	26.75	29.25	31.75	34
14.280	75	35	100	60	1.5	3.25	4.75	6.25	7.75	9.25	11	12.5	15.5	18.25	21	23.75	26.25	28.75	31.25	33.5
15.000	75	40	100	50	1.5	3	4.5	6	7.5	8.75	10.5	11.75	14.75	17.5	20.25	22.75	25.25	27.75	30	32.25
15.240	80	60	100	35	1.5	3	4.5	5.75	7.25	8.75	10.25	11.75	14.5	17.25	20	22.5	25	27.25	29.5	31.75
16.000	80	40	100	50	1.5	2.75	4.25	5.5	7	8.25	9.75	11.25	13.75	16.5	19	21.5	23.75	26.25	28.5	30.5
17.142	75	35	80	40	1.25	2.5	4	5.25	6.5	7.75	9	10.25	13	15.5	17.75	20.25	22.25	24.75	26.75	29
17.776	80	60	100	30	1.25	2.5	3.75	5	6.25	7.5	8.75	10	12.5	14.75	17.25	19.5	21.75	23.75	26	28
17.920	70	25	80	50	1.25	2.5	3.75	5	6.25	7.5	8.75	10	12.25	14.75	17	19.25	21.5	23.75	25.75	27.75
18.284	80	35	100	50	1.25	2.25	3.75	5	6	7.25	8.5	9.75	12	14.5	16.75	19	21.25	23.25	25.25	27.25
19.200	75	25	80	50	1	2.25	3.5	4.5	5.75	7	8	9.25	11.5	13.75	16	18.25	20.25	22.25	24	26
20.000	60	30	100	40	1	2.25	3.5	4.5	5.5	6.75	7.75	9	11.25	13.25	15.25	17.5	19.5	21.5	23.25	25.25
21.328	80	50	100	30	1	2.25	3.25	4.25	5.25	6.25	7.25	8.5	10.5	12.5	14.5	16.5	18.25	20.25	22	23.75
22.400	70	25	80	40	1	2	3	4	5	6	7	8	10	12	13.75	15.75	17.5	19.25	21	22.75
22.856	60	30	100	35	1	2	3	4	5	6	6.75	7.75	9.75	11.75	13.5	15.5	17.25	19	20.75	22.5
23.333	70	40	100	30	1	2	3	4	5	5.75	6.75	7.75	9.75	11.5	13.25	15.25	17	18.75	20.25	22
24.000	75	25	80	40	1	2	3	3.75	4.75	5.5	6.5	7.5	9.25	11.25	12.75	14.75	16.5	18.25	19.75	21.5
25.000	75	40	100	30	1	1.75	2.75	3.5	4.5	5.5	6.25	7.25	9	10.75	12.5	14.25	15.75	17.5	19	20.75
25.600	80	25	100	50	1	1.75	2.75	3.5	4.25	5.25	6.25	7	8.75	10.5	12.25	13.75	15.5	17	18.75	20.25
26.660	80	40	100	30	.75	1.75	2.5	3.25	4.25	5	6	6.75	8.5	10	11.75	13.25	14.75	16.5	18	19.5
28.000	75	40	100	25	.75	1.75	2.5	3.25	4	4.75	5.75	6.5	8	9.5	11.25	12.75	14.25	15.75	17.25	18.75
28.570	75	35	100	30	.75	1.5	2.5	3	4	4.75	5.5	6.25	7.75	9.5	11	12.5	14	15.25	16.75	18.25
30.000	75	40	100	25	.75	1.5	2.25	3	3.75	4.5	5.25	6	7.5	9.25	10.5	11.75	13.25	14.75	16	17.5
32.000	80	40	100	25	.75	1.5	2	2.75	3.5	4.25	5	5.5	7	8.5	9.75	11	12.5	13.75	15.25	16.5
34.284	75	35	100	25	.75	1.25	2	2.5	3.25	4	4.75	5.25	6.5	7.75	9	10.5	11.75	13	14.25	15.25
36.569	80	35	100	25	.5	1.25	1.75	2.5	3	3.75	4.25	5	6.25	7.25	8.5	9.75	11	12	13.25	14.5
37.333	70	30	100	25	.5	1.25	1.75	2.5	3	3.5	4.25	4.75	6	7.25	8.25	9.5	10.75	11.75	13	14.25
40.000	75	30	100	25	.5	1	1.75	2.25	2.75	3.25	4	4.5	5.5	6.75	7.75	9	10	11	12.25	13.25
42.656	80	30	100	25	.5	1	1.5	2.25	2.75	3.25	3.75	4.25	5.25	6.25	7.25	8.25	9.5	10.5	11.5	12.5

Table of Leads (2.500 to 3.800)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
2.500	27	45	20	48	2.923	19	39	27	45	3.385	22	39	27	45
2.507	22	39	20	45	2.927	19	51	33	42	3.389	22	42	33	51
2.510	24	45	24	51	2.930	20	39	24	42	3.394	21	33	24	45
2.513	19	36	20	42	2.941	24	51	30	48	3.399	39	45	20	51
2.516	21	36	22	51	2.946	22	42	27	48	3.409	27	33	20	48
2.521	20	42	27	51	2.956	21	30	19	45	3.415	33	36	19	51
2.530	17	42	30	48	2.966	22	51	33	48	3.422	24	33	24	51
2.534	21	39	24	51	2.976	20	48	30	42	3.429	24	42	27	45
2.540	20	42	24	45	2.986	22	39	27	51	3.437	27	36	22	48
2.546	22	36	20	48	2.991	20	36	21	39	3.440	22	27	19	45
2.552	22	39	19	42	2.995	21	33	24	51	3.451	24	30	22	51
2.561	19	51	33	48	3.000	21	55	33	42	3.457	21	27	20	45
2.567	24	33	18	51	3.009	22	45	24	39	3.462	27	39	24	48
2.574	21	48	30	51	3.017	20	51	30	39	3.472	30	36	20	48
2.579	19	39	27	51	3.025	24	42	27	51	3.480	30	39	19	42
2.588	22	51	27	45	3.029	21	39	27	48	3.486	24	27	20	51
2.593	21	36	20	45	3.039	18	55	39	42	3.492	30	42	22	45
2.598	24	39	19	45	3.048	24	42	24	45	3.500	36	45	21	48
2.608	21	30	19	51	3.056	22	45	30	48	3.505	39	48	22	51
2.614	20	51	30	45	3.068	27	33	18	48	3.516	24	39	24	42
2.619	22	42	24	48	3.077	20	39	27	45	3.526	30	39	22	48
2.625	21	45	27	48	3.081	22	51	30	42	3.535	21	33	20	36
2.632	21	39	22	45	3.088	21	51	36	48	3.543	24	33	19	39
2.639	19	45	30	48	3.096	22	30	19	45	3.556	24	36	24	45
2.647	24	48	27	51	3.105	30	36	19	51	3.565	30	33	20	51
2.655	22	39	24	51	3.111	24	36	21	45	3.571	30	42	24	48
2.661	19	51	30	42	3.117	24	33	18	42	3.580	27	33	21	48
2.667	24	45	24	48	3.125	21	42	30	48	3.590	42	39	17	51
2.674	21	36	22	48	3.134	20	36	22	39	3.595	30	36	22	51
2.679	20	42	27	48	3.143	22	42	27	45	3.603	21	48	42	51
2.689	24	42	24	51	3.152	19	51	33	39	3.611	39	36	17	51
2.696	22	51	30	48	3.163	22	45	33	51	3.620	30	39	24	51
2.707	20	36	19	39	3.173	27	39	22	48	3.626	27	39	22	42
2.715	20	39	27	51	3.182	24	33	21	48	3.636	24	33	24	48
2.727	21	33	18	42	3.189	19	55	36	39	3.641	39	42	20	51
2.735	24	39	20	45	3.199	20	33	19	36	3.650	33	39	22	51
2.745	24	36	21	51	3.205	20	39	30	48	3.660	24	27	21	51
2.750	22	45	27	48	3.214	24	48	27	42	3.667	24	30	22	48
2.764	19	55	36	45	3.223	22	39	24	42	3.676	39	42	19	48
2.773	22	42	27	51	3.231	27	39	21	45	3.686	22	27	19	42
2.778	20	45	30	48	3.239	27	33	19	48	3.692	27	39	24	45
2.784	24	39	19	42	3.248	19	45	30	39	3.697	33	42	24	51
2.794	22	42	24	45	3.258	27	39	24	51	3.702	33	39	21	48
2.801	20	42	30	51	3.263	21	33	20	39	3.706	27	30	21	51
2.812	21	42	27	48	3.268	30	36	20	51	3.714	39	42	18	45
2.820	22	39	24	48	3.274	22	48	30	42	3.720	19	55	42	39
2.824	24	51	27	45	3.282	24	39	24	45	3.730	24	33	20	39
2.831	21	51	33	48	3.284	21	27	19	45	3.739	22	51	39	45
2.842	19	36	21	39	3.291	21	39	22	36	3.743	30	33	21	51
2.851	21	39	27	51	3.297	20	39	27	42	3.750	18	45	..	48
2.857	24	42	24	48	3.309	27	48	30	51	3.753	24	27	19	45
2.866	19	39	30	51	3.318	22	51	30	39	3.761	30	39	22	45
2.876	22	51	30	45	3.329	17	55	42	39	3.765	24	30	24	51
2.879	24	33	19	48	3.333	21	42	30	45	3.770	30	36	19	42
2.885	20	39	27	48	3.346	21	51	39	48	3.775	33	36	21	51
2.896	24	39	24	51	3.353	27	30	19	51	3.782	30	42	27	51
2.903	19	45	33	48	3.361	22	45	33	48	3.788	30	33	20	48
2.910	20	36	22	42	3.369	27	33	21	51	3.792	39	45	21	48
2.917	21	45	30	48	3.377	20	55	39	42	3.800	27	30	19	45

Table of Leads (3.810 to 5.025)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
3.810	30	42	24	45	4.202	45	42	20	51	4.606	36	33	19	45
3.818	27	33	21	45	4.215	17	55	45	33	4.615	18	42	..	39
3.824	39	42	21	51	4.222	19	42	..	45	4.622	33	42	30	51
3.828	33	39	19	42	4.231	33	39	24	48	4.628	20	55	42	33
3.834	24	27	22	51	4.235	27	30	24	51	4.635	39	33	20	51
3.838	30	33	19	45	4.242	30	33	21	45	4.643	39	42	24	48
3.843	21	51	42	45	4.248	39	36	20	51	4.646	42	39	22	51
3.850	27	33	24	51	4.256	39	42	22	48	4.656	24	27	22	42
3.860	21	51	45	48	4.263	42	39	19	48	4.662	30	33	20	39
3.869	39	42	20	48	4.267	24	30	24	45	4.667	21	39	..	45
3.878	33	39	22	48	4.274	30	36	20	39	4.673	39	36	22	51
3.882	27	30	22	51	4.278	33	36	21	45	4.678	39	33	19	48
3.889	30	36	21	45	4.286	18	45	..	42	4.687	30	36	27	48
3.897	36	39	19	45	4.293	30	33	17	36	4.691	30	27	19	45
3.911	24	30	22	45	4.299	45	39	19	51	4.701	30	36	22	39
3.916	24	33	21	39	4.308	36	39	21	45	4.706	24	36	..	51
3.922	20	48	..	51	4.314	22	45	..	51	4.711	19	55	45	33
3.929	33	42	24	48	4.318	36	33	19	48	4.714	33	42	27	45
3.937	27	30	21	48	4.327	30	39	27	48	4.722	17	42	..	36
3.949	33	39	21	45	4.333	39	45	24	48	4.727	39	33	18	45
3.954	33	36	22	51	4.344	36	39	24	51	4.740	39	36	21	48
3.958	19	45	..	48	4.354	33	30	19	48	4.745	33	30	22	51
3.963	30	33	17	39	4.364	27	33	24	45	4.751	21	51	45	39
3.968	30	36	20	42	4.370	24	42	39	51	4.762	20	39	..	42
3.972	39	45	22	48	4.375	21	45	..	48	4.773	36	33	21	48
3.977	30	33	21	48	4.387	22	27	21	39	4.777	17	55	51	33
3.982	33	39	24	51	4.392	24	45	42	51	4.786	42	39	20	45
3.986	27	33	19	39	4.396	30	39	24	42	4.793	30	27	22	51
3.992	45	42	19	51	4.400	27	30	22	45	4.800	27	30	24	45
4.000	27	36	24	45	4.406	27	33	21	39	4.807	19	48	51	42
4.006	39	42	22	51	4.412	30	36	27	51	4.813	30	33	27	51
4.011	33	36	21	48	4.420	33	42	27	48	4.821	36	42	27	48
4.018	30	42	27	48	4.429	30	33	19	39	4.827	48	39	20	51
4.021	24	27	19	42	4.434	42	39	21	51	4.835	33	39	24	42
4.029	30	39	22	42	4.444	20	42	..	45	4.843	39	30	19	51
4.034	36	42	24	51	4.453	27	24	19	48	4.848	30	33	24	45
4.040	30	33	20	45	4.461	39	36	21	51	4.853	33	36	27	51
4.048	17	39	..	42	4.466	33	36	19	39	4.858	27	22	19	48
4.060	30	36	19	39	4.471	36	30	19	51	4.866	39	33	21	51
4.064	36	33	19	51	4.476	24	33	24	39	4.875	39	30	18	48
4.072	30	39	27	51	4.480	33	39	27	51	4.887	36	39	27	51
4.078	24	45	39	51	4.486	19	48	51	45	4.895	30	33	21	39
4.083	21	48	42	45	4.492	36	33	21	51	4.902	45	36	20	51
4.091	27	33	21	42	4.500	27	30	24	48	4.911	33	42	30	48
4.098	33	30	19	51	4.508	42	33	17	48	4.916	27	42	39	51
4.103	30	39	24	45	4.514	39	36	20	48	4.922	27	24	21	48
4.113	30	33	19	42	4.524	19	45	..	42	4.926	42	36	19	45
4.118	21	48	..	51	4.529	33	30	21	51	4.935	36	33	19	42
4.125	33	45	27	48	4.533	36	30	17	45	4.941	36	30	21	51
4.136	21	55	39	36	4.540	39	42	22	45	4.945	30	39	27	42
4.147	33	36	19	42	4.547	42	39	19	45	4.948	45	36	19	48
4.156	24	33	24	42	4.553	33	27	19	51	4.952	39	42	24	45
4.160	33	42	27	51	4.558	24	27	20	39	4.959	20	55	45	33
4.167	20	39	..	48	4.567	45	39	19	48	4.967	48	36	19	51
4.171	39	33	18	51	4.571	36	42	24	45	4.977	33	39	30	51
4.176	36	39	19	42	4.575	42	36	20	51	4.990	39	33	19	45
4.183	20	51	48	45	4.583	22	39	..	48	5.000	24	36	..	48
4.190	33	42	24	45	4.588	39	30	18	51	5.014	24	27	22	39
4.196	27	33	20	39	4.602	27	22	18	48	5.025	19	55	48	33

Table of Leads (5.033 to 6.291)

Lead of Spiral Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
5.033	42	36	22	51	5.440	33	39	27	42	5.882	30	36	..	51
5.038	42	33	19	48	5.444	42	36	21	45	5.887	48	33	17	42
5.042	33	30	22	48	5.455	36	33	24	48	5.893	33	36	27	42
5.048	45	39	21	48	5.469	45	36	21	48	5.903	55	33	17	48
5.056	39	36	21	45	5.481	27	24	19	39	5.911	42	30	19	45
5.065	39	33	18	42	5.489	39	30	19	45	5.921	30	19	18	48
5.068	21	51	48	39	5.495	45	39	20	42	5.926	24	27	24	36
5.077	33	39	27	45	5.500	33	36	27	45	5.934	36	39	27	42
5.080	45	33	19	51	5.510	27	21	18	42	5.939	42	33	21	45
5.085	42	36	17	39	5.515	39	33	21	45	5.948	39	27	21	51
5.091	36	33	21	45	5.527	19	55	48	30	5.954	33	27	19	39
5.098	39	36	24	51	5.538	36	39	27	45	5.961	48	30	19	51
5.104	42	36	21	48	5.546	33	21	18	51	5.966	45	33	21	48
5.114	30	33	27	48	5.552	27	22	19	42	5.975	33	27	22	45
5.123	33	24	19	51	5.556	20	39	..	36	5.983	42	36	20	39
5.128	20	42	..	39	5.561	39	33	24	51	5.989	42	33	24	51
5.135	20	51	55	42	5.568	42	33	21	48	5.994	51	39	22	48
5.143	36	42	27	45	5.573	30	19	18	51	6.000	27	39	..	45
5.147	45	36	21	51	5.581	39	33	17	36	6.010	42	33	17	36
5.152	17	45	..	33	5.587	22	45	48	42	6.019	39	27	20	48
5.156	33	36	27	48	5.594	30	33	24	39	6.027	27	42	45	48
5.160	33	27	19	45	5.600	36	30	21	45	6.032	48	36	19	42
5.170	39	33	21	48	5.608	39	30	22	51	6.039	42	30	22	51
5.176	51	39	19	48	5.615	45	33	21	51	6.044	33	39	30	42
5.185	42	36	20	45	5.625	27	36	..	48	6.050	36	21	18	51
5.192	36	39	27	48	5.630	48	36	19	45	6.054	39	24	19	51
5.195	30	33	24	42	5.641	22	42	..	39	6.058	27	24	21	39
5.200	39	30	18	45	5.647	36	30	24	51	6.061	20	42	..	33
5.208	45	36	20	48	5.657	42	33	20	45	6.067	39	30	21	45
5.216	42	30	19	51	5.664	39	27	20	51	6.071	45	30	17	42
5.223	27	48	39	42	5.675	39	36	22	42	6.090	45	36	19	39
5.229	48	36	20	51	5.682	45	33	20	48	6.095	24	45	48	42
5.238	22	45	..	42	5.687	39	30	21	48	6.100	42	27	20	51
5.241	42	33	21	51	5.692	55	36	19	51	6.107	27	20	19	42
5.250	27	30	21	36	5.698	30	27	20	39	6.111	22	42	..	36
5.255	17	55	51	30	5.704	42	36	22	45	6.118	39	30	24	51
5.260	27	22	18	42	5.714	24	39	..	42	6.125	42	30	21	48
5.265	42	39	22	45	5.718	39	27	19	48	6.130	33	19	18	51
5.272	33	27	22	51	5.727	27	22	21	45	6.136	36	33	27	48
5.278	19	42	..	36	5.735	39	24	18	51	6.141	48	33	19	45
5.288	33	39	30	48	5.744	42	39	24	45	6.154	24	42	..	39
5.294	27	36	..	51	5.752	33	27	24	51	6.162	33	21	20	51
5.303	42	33	20	48	5.758	19	42	..	33	6.169	45	33	19	42
5.312	51	36	18	48	5.762	33	30	22	42	6.176	36	24	21	51
5.322	30	21	19	51	5.769	36	39	30	48	6.182	51	33	18	45
5.333	24	39	..	45	5.775	36	33	27	51	6.190	39	36	24	42
5.339	19	55	51	33	5.782	30	21	17	42	6.198	51	36	21	48
5.347	42	36	22	48	5.789	33	19	17	51	6.205	33	30	22	39
5.353	39	30	21	51	5.795	51	33	18	48	6.209	45	27	19	51
5.359	33	30	19	39	5.804	30	42	39	48	6.222	42	36	24	45
5.369	27	22	21	48	5.807	21	51	55	39	6.231	39	27	22	51
5.378	33	30	22	45	5.816	27	21	19	42	6.237	39	33	19	36
5.385	21	42	..	39	5.820	30	27	22	42	6.250	30	36	..	48
5.392	45	36	22	51	5.824	33	30	27	51	6.257	39	33	27	51
5.398	45	33	19	48	5.833	21	39	..	36	6.268	30	27	22	39
5.413	30	27	19	39	5.844	30	33	27	42	6.275	48	33	22	51
5.419	48	33	19	51	5.854	33	21	19	51	6.282	42	36	21	39
5.429	36	30	19	42	5.864	30	27	19	36	6.286	33	21	18	45
5.432	30	27	22	45	5.874	36	33	21	39	6.291	21	51	55	36

Table of Leads (6.296 to 7.483)

ead of Spiral Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
6.296	17	45	..	27	6.699	33	24	19	39	7.059	45	30	24	51
6.303	39	33	24	45	6.710	42	27	22	51	7.062	39	27	22	45
6.316	36	19	17	51	6.713	36	33	24	39	7.071	33	30	27	44
6.319	39	27	21	48	6.717	42	33	19	36	7.083	17	45	..	22
6.333	19	42	..	30	6.722	33	24	22	45	7.086	48	33	19	39
6.340	48	33	17	39	6.729	51	30	19	48	7.091	39	33	27	45
6.346	33	36	27	39	6.734	30	27	20	33	7.105	36	19	18	48
6.349	48	36	20	42	6.738	42	33	27	51	7.112	42	22	19	51
6.353	36	30	27	51	6.741	39	27	21	45	7.125	36	20	19	48
6.356	39	30	22	45	6.746	55	33	17	42	7.130	42	27	22	48
6.364	21	42	..	33	6.750	36	30	27	48	7.136	51	27	17	45
6.375	51	30	18	48	6.756	48	30	19	45	7.143	30	39	..	42
6.387	36	21	19	51	6.761	51	33	21	48	7.152	33	19	21	51
6.393	22	45	51	39	6.769	33	30	24	39	7.159	42	33	27	48
6.400	36	30	24	45	6.774	60	33	19	51	7.175	39	22	17	42
6.405	42	27	21	51	6.779	33	21	22	51	7.179	42	36	24	39
6.410	45	36	20	39	6.786	45	30	19	42	7.190	33	27	30	51
6.417	36	33	30	51	6.790	30	27	22	36	7.200	36	30	27	45
6.420	39	27	20	45	6.797	39	27	24	51	7.206	42	24	21	51
6.429	27	39	..	42	6.806	42	27	21	48	7.212	51	33	21	45
6.439	45	33	17	36	6.810	39	30	22	42	7.222	39	27	24	48
6.447	22	42	48	39	6.818	36	33	30	48	7.232	33	17	19	51
6.451	33	27	19	36	6.821	42	30	19	39	7.240	30	39	48	51
6.462	42	39	27	45	6.830	55	30	19	51	7.245	39	19	18	51
6.465	48	33	20	45	6.838	48	36	20	39	7.253	36	39	33	42
6.471	33	36	..	51	6.845	24	51	48	33	7.259	42	27	21	45
6.477	36	22	19	48	6.853	42	33	21	39	7.265	45	27	17	39
6.481	42	27	20	48	6.857	36	30	24	42	7.273	24	42	..	33
6.490	27	39	45	48	6.863	45	27	21	51	7.279	33	24	27	51
6.494	45	33	20	42	6.869	48	33	17	36	7.283	39	21	20	51
6.500	39	30	24	48	6.875	33	30	..	48	7.286	51	30	18	42
6.513	33	19	18	48	6.878	39	27	20	42	7.292	45	27	21	48
6.519	33	27	24	45	6.882	39	30	27	51	7.299	39	22	21	51
6.525	51	33	19	45	6.894	39	33	21	36	7.308	45	30	19	39
6.531	33	20	19	48	6.902	48	30	22	51	7.313	39	20	18	48
6.536	45	27	20	51	6.908	30	19	21	48	7.320	42	27	24	51
6.545	36	33	27	45	6.914	42	27	20	45	7.326	30	21	20	39
6.555	39	21	18	51	6.919	39	21	19	51	7.333	33	36	..	45
6.563	36	24	21	48	6.923	27	42	..	39	7.341	19	55	51	24
6.568	42	27	19	45	6.926	48	33	20	42	7.347	27	21	24	42
6.577	39	21	17	48	6.933	39	30	24	45	7.353	45	24	20	51
6.581	42	36	22	39	6.939	36	21	17	42	7.368	30	19	21	45
6.588	42	30	24	51	6.944	45	27	20	48	7.385	36	30	24	39
6.593	45	39	24	42	6.947	33	19	18	45	7.389	42	24	19	45
6.600	33	30	27	45	6.952	39	33	30	51	7.395	33	21	24	51
6.608	27	22	21	39	6.955	18	55	51	24	7.403	36	22	19	42
6.611	42	24	17	45	6.960	30	21	19	39	7.407	20	45	..	27
6.618	30	24	27	51	6.964	39	36	27	42	7.412	42	30	27	51
6.623	51	33	18	42	6.968	33	39	42	51	7.418	45	39	27	42
6.632	27	19	21	45	6.972	48	27	20	51	7.424	42	33	21	36
6.635	33	21	19	45	6.984	48	36	22	42	7.429	39	30	24	42
6.643	45	33	19	39	6.993	45	33	20	39	7.438	51	30	21	48
6.648	39	33	27	48	7.000	21	42	..	30	7.444	33	19	18	42
6.667	30	36	..	45	7.010	39	24	22	51	7.451	42	21	19	51
6.679	33	20	17	42	7.013	36	33	27	42	7.459	48	33	20	39
6.684	55	36	21	48	7.018	30	19	20	45	7.464	33	20	19	42
6.687	36	19	18	51	7.030	33	19	17	42	7.469	33	27	22	36
6.691	39	24	21	51	7.037	19	45	..	27	7.474	36	17	18	51
6.696	30	42	45	48	7.051	30	24	22	39	7.483	30	21	22	42

Table of Leads (7.487 to 8.766)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
7.487	42	33	30	51	7.889	36	17	19	51	8.319	33	21	27	51
7.492	33	19	22	51	7.897	42	30	22	39	8.322	51	33	21	39
7.500	36	33	..	48	7.901	48	27	20	45	8.333	30	39	..	36
7.506	48	27	19	45	7.908	33	18	22	51	8.342	39	22	24	51
7.517	39	21	17	42	7.912	48	39	27	42	8.352	42	22	21	48
7.521	48	36	22	39	7.917	19	42	..	24	8.357	39	30	27	42
7.529	51	33	19	39	7.933	51	30	21	45	8.366	48	27	24	51
7.538	42	30	21	39	7.944	39	36	33	45	8.374	33	17	22	51
7.549	42	24	22	51	7.955	42	33	30	48	8.381	48	30	22	42
7.552	36	33	27	39	7.964	33	39	48	51	8.388	55	27	21	51
7.557	42	22	19	48	7.972	36	22	19	39	8.392	36	33	30	39
7.563	33	20	22	48	7.977	42	27	20	39	8.400	42	30	27	45
7.566	39	27	22	42	7.983	45	21	19	51	8.403	45	21	20	51
7.571	33	19	17	39	7.988	55	27	20	51	8.412	39	30	33	51
7.576	60	33	20	48	7.993	33	17	21	51	8.422	45	22	21	51
7.583	39	30	21	36	8.000	36	33	..	45	8.426	39	27	21	36
7.589	55	27	19	51	8.011	39	21	22	51	8.438	36	24	27	48
7.597	39	33	27	42	8.016	33	19	18	39	8.444	48	24	19	45
7.600	36	20	19	45	8.021	42	24	22	48	8.452	39	19	21	51
7.605	42	27	22	45	8.028	51	24	17	45	8.462	33	36	..	39
7.612	33	17	20	51	8.036	45	36	27	42	8.471	36	17	18	45
7.615	33	30	27	39	8.042	48	27	19	42	8.482	45	24	19	42
7.619	48	30	20	42	8.050	39	19	20	51	8.488	55	27	20	48
7.623	39	27	19	36	8.059	30	21	22	39	8.493	33	17	21	48
7.628	42	24	17	39	8.063	55	27	19	48	8.497	39	27	30	51
7.636	36	22	21	45	8.067	36	21	24	51	8.502	30	19	21	39
7.639	33	27	30	48	8.072	39	18	19	51	8.512	39	24	22	42
7.646	51	27	17	42	8.077	45	30	21	39	8.515	48	21	19	51
7.656	42	24	21	48	8.081	60	33	20	45	8.523	45	22	20	48
7.669	48	27	22	51	8.088	33	24	30	51	8.531	39	20	21	48
7.677	36	27	19	33	8.095	17	45	..	21	8.538	55	24	19	51
7.684	33	17	19	48	8.105	33	19	21	45	8.545	51	27	19	42
7.692	30	36	..	39	8.114	21	55	51	24	8.553	39	19	20	48
7.697	39	19	18	48	8.120	55	33	19	39	8.556	42	30	22	36
7.700	33	20	21	45	8.128	48	22	19	51	8.571	36	33	..	42
7.704	39	27	24	45	8.143	36	20	19	42	8.576	39	24	19	36
7.714	36	30	27	42	8.148	22	42	..	27	8.594	33	24	30	48
7.721	45	24	21	51	8.157	51	33	19	36	8.603	39	24	27	51
7.727	17	45	..	22	8.163	30	21	24	42	8.615	42	30	24	39
7.734	33	24	27	48	8.167	42	24	21	45	8.627	42	21	22	51
7.738	39	36	30	42	8.173	45	24	17	39	8.636	19	45	..	22
7.741	55	30	19	45	8.182	27	39	..	33	8.643	33	20	22	42
7.749	48	27	17	39	8.196	33	17	19	45	8.654	45	36	27	39
7.758	48	33	24	45	8.205	48	36	24	39	8.661	48	27	19	39
7.765	36	30	33	51	8.211	39	19	18	45	8.667	39	33	..	45
7.778	21	42	..	27	8.231	33	21	22	42	8.673	45	21	17	42
7.792	51	30	22	48	8.235	48	24	21	51	8.684	33	19	24	48
7.800	39	30	27	45	8.242	51	33	24	45	8.693	51	22	18	48
7.813	45	24	20	48	8.250	33	20	24	48	8.708	33	20	19	36
7.822	48	30	22	45	8.254	39	27	24	42	8.715	60	27	20	51
7.829	42	19	17	48	8.259	36	19	17	39	8.720	36	17	21	51
7.832	42	33	24	39	8.264	51	27	21	48	8.727	36	30	24	33
7.841	39	21	19	45	8.273	39	30	21	33	8.730	33	27	30	42
7.846	51	30	18	39	8.282	51	30	19	39	8.739	39	21	24	51
7.857	33	36	..	42	8.289	36	19	21	48	8.745	27	19	24	39
7.861	42	22	21	51	8.296	42	27	24	45	8.750	21	45	..	24
7.870	45	27	17	36	8.305	36	17	20	51	8.754	39	27	20	33
7.875	42	30	27	48	8.308	36	30	27	39	8.758	51	22	17	45
7.879	39	33	30	45	8.312	48	33	24	42	8.766	45	33	27	42

Table of Leads (8.769 to 10.094)

Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D	Lead of Spiral in Inches	A	B	C	D
8.769	36	20	19	39	9.184	30	21	27	42	9.630	39	27	24	36
8.775	42	27	22	39	9.192	39	27	21	33	9.636	42	19	17	39
8.782	33	17	19	42	9.202	51	27	19	39	9.643	36	24	27	42
8.787	55	27	22	51	9.205	36	22	27	48	9.651	48	21	19	45
8.791	30	21	24	39	9.211	42	19	20	48	9.659	39	19	24	51
8.796	60	27	19	48	9.215	55	27	19	42	9.670	33	21	24	39
8.800	33	20	24	45	9.231	36	33	..	39	9.676	55	24	19	45
8.811	42	33	27	39	9.236	42	24	19	36	9.686	39	17	19	45
8.815	51	27	21	45	9.244	45	21	22	51	9.692	42	30	27	39
8.821	39	20	19	42	9.253	45	22	19	42	9.700	55	27	20	42
8.827	39	27	22	36	9.259	60	27	20	48	9.706	36	24	33	51
8.831	48	22	17	42	9.273	51	33	27	45	9.714	51	21	18	45
8.839	33	24	27	42	9.281	33	20	27	48	9.722	45	27	21	36
8.844	39	21	20	42	9.288	45	19	20	51	9.728	39	21	22	42
8.854	55	22	17	48	9.297	51	24	21	48	9.740	45	33	30	42
8.864	39	33	36	48	9.301	42	22	19	39	9.744	48	24	19	39
8.867	42	20	19	45	9.308	33	20	22	39	9.750	39	30	27	36
8.882	45	19	18	48	9.314	60	24	19	51	9.757	55	21	19	51
8.889	24	42	..	27	9.333	42	30	24	36	9.770	33	19	27	48
8.897	33	17	22	48	9.341	45	21	17	39	9.778	55	30	24	45
8.905	51	30	22	42	9.346	39	27	33	51	9.788	51	30	19	33
8.909	42	22	21	45	9.351	48	33	27	42	9.796	36	21	24	42
8.916	36	19	24	51	9.356	39	24	19	33	9.800	42	20	21	45
8.922	39	18	21	51	9.375	36	24	30	48	9.808	51	24	18	39
8.929	45	24	20	42	9.385	39	22	27	51	9.818	36	20	18	33
8.932	55	30	19	39	9.402	33	27	30	39	9.825	42	19	20	45
8.938	39	20	22	48	9.408	39	19	22	48	9.832	39	21	27	51
8.941	36	17	19	45	9.412	42	21	24	51	9.844	42	24	27	48
8.947	17	45	..	19	9.421	36	22	19	33	9.852	42	18	19	45
8.951	48	33	24	39	9.429	33	21	27	45	9.860	48	21	22	51
8.956	42	27	19	33	9.436	55	24	21	51	9.868	45	19	20	48
8.964	48	21	20	51	9.441	45	33	27	39	9.872	55	30	21	39
8.972	51	24	19	45	9.446	39	17	21	51	9.877	48	27	20	36
8.980	39	19	21	48	9.455	39	30	24	33	9.882	36	17	21	45
8.990	33	39	51	48	9.474	18	45	..	19	9.886	55	24	22	51
9.000	27	42	..	30	9.481	48	27	24	45	9.890	30	21	27	39
9.015	42	22	17	36	9.490	33	17	22	45	9.894	51	27	22	42
9.023	30	19	24	42	9.500	19	45	..	20	9.900	33	20	27	45
9.031	51	20	17	48	9.506	55	27	21	45	9.907	48	19	20	51
9.048	19	45	..	21	9.510	51	33	24	39	9.917	30	22	24	33
9.053	55	27	20	45	9.519	33	24	27	39	9.926	45	24	27	51
9.059	42	30	33	51	9.524	20	45	..	21	9.931	39	24	22	36
9.066	27	42	55	39	9.533	39	20	22	45	9.935	51	33	27	42
9.071	55	24	19	48	9.536	42	19	22	51	9.955	33	17	20	39
9.076	36	21	27	51	9.545	21	45	..	22	9.959	55	27	22	45
9.081	39	17	19	48	9.549	55	24	20	48	9.965	36	17	24	51
9.091	30	36	..	33	9.559	39	24	30	51	9.969	51	27	19	36
9.098	33	19	22	42	9.563	51	20	18	48	9.972	39	22	27	48
9.102	42	19	21	51	9.573	42	27	24	39	9.989	55	24	17	39
9.107	51	36	27	42	9.579	39	19	21	45	10.000	24	45	..	24
9.117	48	27	20	39	9.586	45	19	17	42	10.026	55	24	21	48
9.123	39	19	20	45	9.590	51	30	22	39	10.031	36	19	27	51
9.135	45	24	19	39	9.596	45	27	19	33	10.037	39	17	21	48
9.141	39	24	27	48	9.600	48	30	27	45	10.053	60	27	19	42
9.148	39	18	19	45	9.603	55	30	22	42	10.065	42	27	33	51
9.150	42	27	30	51	9.608	42	18	21	51	10.070	36	22	24	39
9.154	51	30	21	39	9.613	51	24	19	42	10.076	42	22	19	36
9.167	33	39	..	36	9.619	55	27	17	36	10.084	45	21	24	51
9.176	39	30	36	51	9.625	42	20	22	48	10.094	51	20	19	48

How to Calculate Indexing with Side Plate

I case particular circle of holes on the index plate becomes worn through constant use; you may be able to use some other circle of holes & get the same result. The following set of rules & example illustrate the procedure to follow in obtaining the maximum number of settings for any condition of indexing.

1. Divide 40 by the number of divisions required. The result gives the number of turns or fraction of a turn of the index pointer.

2. If a fraction of a turn is required, the denominator represents the circle to use, while the numerator represents the number of spaces in the circle over which the index pin must pass.

3. Reduce the fraction to its lowest terms, and multiply both parts of the fraction by the same number until the denominator equals the number of holes in any circle.

   a. ***Standard Dividing Head Plate*** Number of hole for indexing: 24, 25, 28, 30, 34, 37,38, 39, 41, 42, & 43 (on one side;) 46, 47, 49, 51, 53, 54, 57, 58, 59, 62, & 66 (on the other)

Example

Suppose you want to calculate all the indexing circles for 3 divisions

$$\frac{40}{3} = 13\ \frac{1}{3}\ \text{Turns of the index pointer}$$

- **Note**: use pitch diameter in calculating helical angle for helical and spiral gears, worms, etc

One-third of a turn could be obtained by rotating the index pin over one space in a 3-division circle (rule 2). Since we do not have a 3-hole circle, we must use one into which 3 can evenly divide the number of holes. For instance 8 spaces in the 24-hole circle (8/24 = 1/3), 10 spaces in a 30-hole circle (10/30 = 1/3), etc. One-third of a turn can be obtained in any of the following circles:

$$\frac{1 \times 8}{3 \times 8} = \frac{8}{24}$$ Or 8 spaces in the 24 hole circle

$$\frac{1 \times 10}{3 \times 10} = \frac{10}{30}$$ Or 10 spaces in the 30 hole circle

$$\frac{1 \times 13}{3 \times 13} = \frac{13}{39}$$ Or 13 spaces in the 39 hole circle

$$\frac{1 \times 14}{3 \times 14} = \frac{14}{42}$$ Or 14 spaces in the 42 hole circle

$$\frac{1 \times 17}{3 \times 17} = \frac{17}{51}$$ Or 17 spaces in the 51 hole circle

$$\frac{1 \times 18}{3 \times 18} = \frac{18}{54}$$ Or 18 spaces in the 54 hole circle

$$\frac{1 \times 19}{3 \times 19} = \frac{19}{57}$$ Or 19 spaces in the 57 hole circle

$$\frac{1 \times 22}{3 \times 22} = \frac{22}{66}$$ Or 22 spaces in the 66 hole circle

Suppose you want to calculate all the indexing circles for 56 divisions

$$\frac{40}{56} = \frac{5}{7}$$ Of a turn of the index crank

$$\frac{5 \times 4}{7 \times 4} = \frac{20}{28}$$ Or 20 spaces in the 28 hole circle

$$\frac{5 \times 6}{7 \times 6} = \frac{30}{42}$$ Or 30 spaces in the 42 hole circle

$$\frac{5 \times 7}{7 \times 7} = \frac{35}{49}$$ Or 35 spaces in the 49 hole circle

How to Mill Cams

Rise and fall cams having a relatively narrow face may be machined using the type of set up (indicated in fig…) The cutter may be supported in any type of swivel head, such as a Universal Spiral Milling Attachment or Vertical Attachment. Almost any cam lead can be machined, and by trying different machine leads, the angle to which the dividing head must be set can be changed to suit conditions. All you need in addition to these instructions is a table of sine functions.

$$\text{Formula: } \frac{\text{Lead of Cam}}{\text{Lead of Table}} = \text{Sine of Angle “D”}$$

Examples:

1. Suppose you want to mill a cam having a .500” lead. Assume change gears are set up for 2.5” table lead.

$$\frac{\text{Lead of Cam}}{\text{Lead of Table}} = \frac{.5}{2.5}$$ =.200; Sine of Angle “D”
“D” = 11 Degrees, 33 min.

2. Suppose you want to mill a lead of 6.005”.
   a. Assume change gears are set up for 8” table lead

   $$\frac{\text{Lead of Cam}}{\text{Lead of Table}} = \frac{6.005}{8}$$ =.7506; Angle “D” = 48 degrees, 39 min

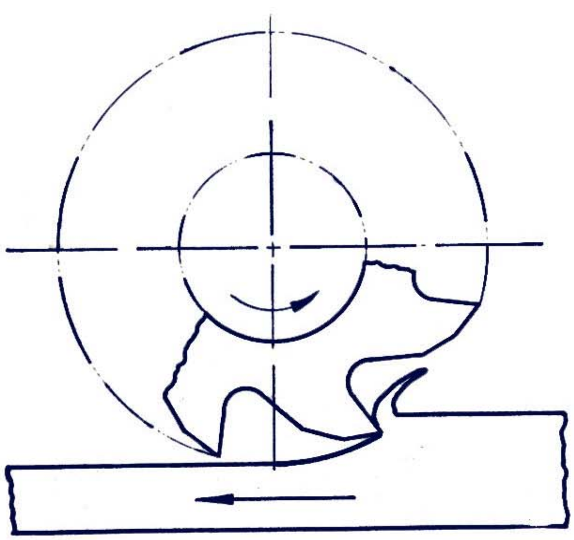
   b. Assume change gears are set up for 9.935” table lead, instead of 8”, as in *example 2a,* then

   $$\frac{6.005}{9.935}$$ =.6044; Angle “D” = 37 degrees, 11 min

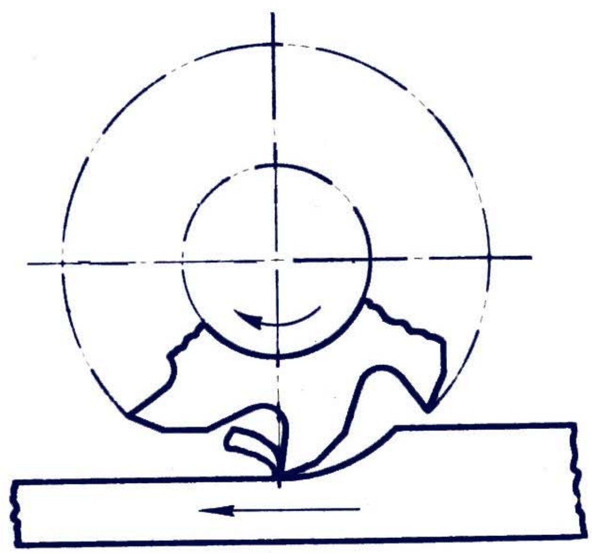
Cam Rolls & Roll Studs

It is important that the cam roll & roll stud be ground all over after hardening. The end of the roller should be cut back or recessed 1/64" (or thereabouts) on the sides for some distance, beginning at the periphery, so as to avoid undue friction against the collar of the stud or the part in which it is mounted. On account of the warping that takes place in hardening, rolls that are not ground on both inside & on the outside often will stop under heavy load, until ,in time, flat spots are worn on the face. Then the working surface of the cam will begin to wear or is roughed up. Roll studs that are out of parallel with the working surface of the cam, even to a very small degree, also cause trouble. The same difficulty is met with on cylinder or barrel cams if the milling cutter is set below or above the center of the cam when cutting it. The roll will then bear at one end only at the most important time – when the throw takes place.

There is a great deal of end pressure on the conical roll used in barrel cams, & this must be taken care of by thrust collars on the stud on which the rolls are mounted, or, better still, by a ball race scored in the collar & the large end of the roll, so as to provide for a ball thrust bearing. The end pressure on the conical roll, however, reduces the side pressure on the stud to a considerable extent, so that the stud may be made shorter or smaller in diameter than when a roll with parallel sides is used.



Conventional, or Up-Milling



Climb, or Down-Milling

Mathmatical Tables

Tables of Trigonometric Functions. -The numerical values for the natural or trigonometric functions for some degrees and minutes are given in the tables, pages 17 to 19 inclusive. The chart below shows how to find the functions of angles between 0 and 180^{o} degrees.

How to Enter Table Of Natural Trigonometric Functions

For Angles From	Enter Table for Degrees and Function	Minutes	For Angles From	Enter Table for Degrees and Function	Minutes
0^0 to 45^0	At top	At left	90^0 to 135^0	At bottom	At left
45^0 to 90^0	At bottom	135^0 to 180^0	135^0 to 180^0	At top	At right

Examples: The sine of 26^0 is 0.43837; of 46^0 0.71934; of 126^0, 0.80902; and of 146^0, 0.55919.

Exception: To obtain the inversed sine of any angle from 90 to 180^0, enter the table in column for cosine of required angle and add ii to value shown.

Example: Find versed sine 102^0. Versed sine = 1 - cos of angle. Between 90^0 and 180^0, values of cosine are negative; hence,

$$1 - \text{COS } 102^0\ 10 = 1 - (-0.21076) = 1 + 1.21076\ 0.21076$$

The sine is positive for all angles up to 180^0 degrees. The cosine, tangent and cotangent for angles between 90^0 and 180^0 degrees, while they have the same numerical values as for angles from 0 to 90^0 degrees, are negative. These should be preceded by a minus sign; thus tan 123^0 degrees 20 minutes - -1-5204.

Changes in Value and Sign of Trigonometric Functions

Function	Between 0 and 90^0	Between 90^0 and 180^0	Between 180^0 and 270^0	Between 270^0 and 360^0
Sine	Positive From 0 to 1	Positive From 1 to 0	Negative From 0 to- 1	Negative From - 1 to 0
Cosine	Positive From 1 to 0	Negative From 0 to - 1	Negative From - 1 to 0	Positive From 0 to 1
Tangent	Positive From 0 to 00	Negative From 00 to 0	Positive From 0 to 00	Negative From 00 to 0
Cotangent	Positive From 00 to 0	Negative From 0 to 00	Positive From 00 to 0	Negative From 0 to 00
Secant	Positive From 1 to 00	Negative From 00 to 1	Negative From - 1 to 00	Positive From 00 to 1
Cosecant	Positive From 00 to 1	Positive From 1 to 00	Negative From 00 to 1	Negative From 1 to 00

0° **179°**

M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Vrs. Sin.	Vrs. Cos.	M
0	0.00000	1.0000	0.00000	Infinite	1.0000	Infinite	0.00000	1.00000	60
1	.00029	.0000	.00029	3437.7	.0000	3437.7	.00000	0.99971	59
2	.00058	.0000	.00058	1718.9	.0000	1718.9	.00000	.99942	58
3	.00087	.0000	.00087	1145.9	.0000	1145.9	.00000	.99913	57
4	.00116	.0000	.00116	859.44	.0000	859.44	.00000	.99884	56
5	0.00145	1.0000	0.00145	687.55	1.0000	687.55	0.00000	0.99854	55
6	.00174	.0000	.00174	572.96	.0000	572.96	.00000	.99825	54
7	.00204	.0000	.00204	491.11	.0000	491.11	.00000	.99796	53
8	.00233	.0000	.00233	429.72	.0000	429.72	.00000	.99767	52
9	.00262	.0000	.00262	381.97	.0000	381.97	.00000	.99738	51
10	0.00291	0.99999	0.00291	343.77	1.0000	343.77	0.00000	0.99709	50
11	.00320	.99999	.00320	312.52	.0000	312.52	.00000	.99680	49
12	.00349	.99999	.00349	286.48	.0000	286.48	.00001	.99651	48
13	.00378	.99999	.00378	264.44	.0000	264.44	.00001	.99622	47
14	.00407	.99999	.00407	245.55	.0000	245.55	.00001	.99593	46
15	0.00436	0.99999	0.00436	229.18	1.0000	229.18	0.00001	0.99564	45
16	.00465	.99999	.00465	214.86	.0000	214.86	.00001	.99534	44
17	.00494	.99999	.00494	202.22	.0000	202.22	.00001	.99505	43
18	.00524	.99999	.00524	190.98	.0000	190.99	.00001	.99476	42
19	.00553	.99998	.00553	180.93	.0000	180.93	.00001	.99447	41
20	0.00582	0.99998	0.00582	171.88	1.0000	171.89	0.00002	0.99418	40
21	.00611	.99998	.00611	163.70	.0000	163.70	.00002	.99389	39
22	.00640	.99998	.00640	156.26	.0000	156.26	.00002	.99360	38
23	.00669	.99998	.00669	149.46	.0000	149.47	.00002	.99331	37
24	.00698	.99997	.00698	143.24	.0000	143.24	.00002	.99302	36
25	0.00727	0.99997	0.00727	137.51	1.0000	137.51	0.00003	0.99273	35
26	.00756	.99997	.00756	132.22	.0000	132.22	.00003	.99244	34
27	.00785	.99997	.00785	127.32	.0000	127.32	.00003	.99215	33
28	.00814	.99997	.00814	122.77	.0000	122.78	.00003	.99185	32
29	.00843	.99996	.00844	118.54	.0000	118.54	.00003	.99156	31
30	0.00873	0.99996	0.00873	114.59	1.0000	114.59	0.00004	0.99127	30
31	.00902	.99996	.00902	110.89	.0000	110.90	.00004	.99098	29
32	.00931	.99996	.00931	107.43	.0000	107.43	.00004	.99069	28
33	.00960	.99995	.00960	104.17	.0000	104.17	.00005	.99040	27
34	.00989	.99995	.00989	101.11	.0000	101.11	.00005	.99011	26
35	0.01018	0.99995	0.01018	98.218	1.0000	98.223	0.00005	0.98982	25
36	.01047	.99994	.01047	95.489	.0000	95.495	.00005	.98953	24
37	.01076	.99994	.01076	92.908	.0000	92.914	.00006	.98924	23
38	.01105	.99994	.01105	90.463	.0001	90.469	.00006	.98895	22
39	.01134	.99993	.01134	88.143	.0001	88.149	.00006	.98865	21
40	0.01163	0.99993	0.01164	85.940	1.0001	85.946	0.00007	0.98836	20
41	.01193	.99993	.01193	83.843	.0001	83.849	.00007	.98807	19
42	.01222	.99992	.01222	81.847	.0001	81.853	.00007	.98778	18
43	.01251	.99992	.01251	79.943	.0001	79.950	.00008	.98749	17
44	.01280	.99992	.01280	78.126	.0001	78.133	.00008	.98720	16
45	0.01309	0.99991	0.01309	76.390	1.0001	76.396	0.00008	0.98691	15
46	.01338	.99991	.01338	74.729	.0001	74.736	.00009	.98662	14
47	.01367	.99991	.01367	73.139	.0001	73.146	.00009	.98633	13
48	.01396	.99990	.01396	71.615	.0001	71.622	.00010	.98604	12
49	.01425	.99990	.01425	70.153	.0001	70.160	.00010	.98575	11
50	0.01454	0.99989	0.01454	68.750	1.0001	68.757	0.00010	0.98546	10
51	.01483	.99989	.01484	67.402	.0001	67.409	.00011	.98516	9
52	.01512	.99988	.01513	66.105	.0001	66.113	.00011	.98487	8
53	.01542	.99988	.01542	64.858	.0001	64.866	.00012	.98458	7
54	.01571	.99988	.01571	63.657	.0001	63.664	.00012	.98429	6
55	0.01600	0.99987	0.01600	62.499	1.0001	62.507	0.00013	0.98400	5
56	.01629	.99987	.01629	61.383	.0001	61.391	.00013	.98371	4
57	.01658	.99987	.01658	60.306	.0001	60.314	.00014	.98342	3
58	.01687	.99986	.01687	59.266	.0001	59.274	.00014	.98313	2
59	.01716	.99985	.01716	58.261	.0001	58.270	.00015	.98284	1
60	0.01745	0.99985	0.01745	57.290	1.0001	57.299	0.00015	0.98255	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Vrs. Cos.	Vrs. Sin.	M

Mathematical Tables
Natural Trigonometric Function

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M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Vrs. Sin.	Vrs. Cos.	M
0	0.01745	0.99985	0.01745	57.290	1.0001	57.299	0.00015	0.98255	60
1	.01774	.99984	.01775	56.350	.0001	56.359	.00016	.98226	59
2	.01803	.99984	.01804	55.441	.0001	55.450	.00016	.98196	58
3	.01832	.99983	.01833	54.561	.0002	54.570	.00017	.98167	57
4	.01861	.99983	.01862	53.708	.0002	53.718	.00017	.98138	56
5	0.01891	0.99982	0.01891	52.882	1.0002	52.891	0.00018	0.98109	55
6	.01920	.99981	.01920	52.081	.0002	52.090	.00018	.98080	54
7	.01949	.99981	.01949	51.303	.0002	51.313	.00019	.98051	53
8	.01978	.99980	.01978	50.548	.0002	50.558	.00019	.98022	52
9	.02007	.99980	.02007	49.816	.0002	49.826	.00020	.97993	51
10	0.02036	0.99979	0.02036	49.104	1.0002	49.114	0.00021	0.97964	50
11	.02065	.99979	.02066	48.412	.0002	48.422	.00021	.97935	49
12	.02094	.99978	.02095	47.739	.0002	47.750	.00022	.97906	48
13	.02123	.99977	.02124	47.085	.0002	47.096	.00022	.97877	47
14	.02152	.99977	.02153	46.449	.0002	46.460	.00023	.97847	46
15	0.02181	0.99976	0.02182	45.829	1.0002	45.840	0.00024	0.97818	45
16	.02210	.99975	.02211	45.226	.0002	45.237	.00024	.97789	44
17	.02240	.99975	.02240	44.638	.0002	44.650	.00025	.97760	43
18	.02269	.99974	.02269	44.066	.0002	44.077	.00026	.97731	42
19	.02298	.99974	.02298	43.508	.0003	43.520	.00026	.97702	41
20	0.02326	0.99973	0.02327	42.964	1.0003	42.976	0.00027	0.97673	40
21	.02356	.99972	.02357	42.433	.0003	42.445	.00028	.97644	39
22	.02385	.99971	.02386	41.916	.0003	41.928	.00028	.97615	38
23	.02414	.99971	.02415	41.410	.0003	41.423	.00029	.97586	37
24	.02443	.99970	.02444	40.917	.0003	40.930	.00030	.97557	36
25	0.02472	0.99969	0.02473	40.436	1.0003	40.448	0.00030	0.97528	35
26	.02501	.99969	.02502	39.965	.0003	39.978	.00031	.97499	34
27	.02530	.99968	.02531	39.506	.0003	39.518	.00032	.97469	33
28	.02559	.99967	.02560	39.057	.0003	39.069	.00033	.97440	32
29	.02589	.99966	.02589	38.618	.0003	38.631	.00033	.97411	31
30	0.02618	0.99966	0.02618	38.188	1.0003	38.201	0.00034	0.97382	30
31	.02647	.99965	.02648	37.769	.0003	37.782	.00035	.97353	29
32	.02676	.99964	.02677	37.358	.0003	37.371	.00036	.97324	28
33	.02705	.99963	.02706	36.956	.0004	36.969	.00036	.97295	27
34	.02734	.99963	.02735	36.563	.0004	36.576	.00037	.97266	26
35	0.02763	0.99962	0.02764	36.177	1.0004	36.191	0.00038	0.97237	25
36	.02792	.99961	.02793	35.800	.0004	35.814	.00039	.97208	24
37	.02821	.99960	.02822	35.431	.0004	35.445	.00040	.97179	23
38	.02850	.99959	.02851	35.069	.0004	35.084	.00041	.97150	22
39	.02879	.99958	.02881	34.715	.0004	34.729	.00041	.97121	21
40	0.02908	0.99958	0.02910	34.368	1.0004	34.382	0.00042	0.97091	20
41	.02937	.99957	.02939	34.027	.0004	34.042	.00043	.97062	19
42	.02967	.99956	.02968	33.693	.0004	33.708	.00044	.97033	18
43	.02996	.99955	.02997	33.366	.0004	33.381	.00045	.97004	17
44	.03025	.99954	.03026	33.045	.0004	33.060	.00046	.96975	16
45	0.03054	0.99953	0.03055	32.730	1.0005	32.745	0.00046	0.96946	15
46	.03083	.99952	.03084	32.421	.0005	32.437	.00047	.96917	14
47	.03112	.99951	.03113	32.118	.0005	32.134	.00048	.96888	13
48	.03141	.99951	.03143	31.820	.0005	31.836	.00049	.96859	12
49	.03170	.99950	.03172	31.528	.0005	31.544	.00050	.96830	11
50	0.03199	0.99949	0.03201	31.241	1.0005	31.257	0.00051	0.96801	10
51	.03228	.99948	.03230	30.960	.0005	30.976	.00052	.96772	9
52	.03257	.99947	.03259	30.683	.0005	30.699	.00053	.96743	8
53	.03286	.99946	.03288	30.411	.0005	30.428	.00054	.96713	7
54	.03315	.99945	.03317	30.145	.0005	30.161	.00055	.96684	6
55	0.03344	0.99944	0.03346	29.882	1.0005	29.899	0.00056	0.96655	5
56	.03374	.99943	.03375	29.624	.0006	29.641	.00057	.96626	4
57	.03403	.99942	.03405	29.371	.0006	29.388	.00058	.96597	3
58	.03432	.99941	.03434	29.122	.0006	29.139	.00059	.96568	2
59	.03461	.99940	.03463	28.877	.0006	28.894	.00060	.96539	1
60	0.03490	0.99939	0.03492	28.636	1.0006	28.654	0.00061	0.96510	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Vrs. Cos.	Vrs. Sin.	M

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M	Sine	Cosine	Tan.	Cotan.	Secant	Cosec.	Vrs. Sin.	Vrs. Cos.	M
0	0.03490	0.99939	0.03492	28.636	1.0006	28.654	0.00061	0.96510	60
1	.03519	.99938	.03521	28.399	.0006	28.417	.00062	.96481	59
2	.03548	.99937	.03550	28.166	.0006	28.184	.00063	.96452	58
3	.03577	.99936	.03579	27.937	.0006	27.955	.00064	.96423	57
4	.03606	.99935	.03608	27.712	.0006	27.730	.00065	.96394	56
5	0.03635	0.99934	0.03638	27.490	1.0007	27.508	0.00066	0.96365	55
6	.03664	.99933	.03667	27.271	.0007	27.290	.00067	.96336	54
7	.03693	.99932	.03696	27.056	.0007	27.075	.00068	.96306	53
8	.03722	.99931	.03725	26.845	.0007	26.864	.00069	.96277	52
9	.03751	.99930	.03754	26.637	.0007	26.655	.00070	.96248	51
10	0.03781	0.99928	0.03783	26.432	1.0007	26.450	0.00071	0.96219	50
11	.03810	.99927	.03812	26.230	.0007	26.249	.00073	.96190	49
12	.03839	.99926	.03842	26.031	.0007	26.050	.00074	.96161	48
13	.03868	.99925	.03871	25.835	.0007	25.854	.00075	.96132	47
14	.03897	.99924	.03900	25.642	.0008	25.661	.00076	.96103	46
15	0.03926	0.99923	0.03929	25.452	1.0008	25.471	0.00077	0.96074	45
16	.03955	.99922	.03958	25.264	.0008	25.284	.00078	.96045	44
17	.03984	.99921	.03987	25.080	.0008	25.100	.00079	.96016	43
18	.04013	.99919	.04016	24.898	.0008	24.918	.00080	.95987	42
19	.04042	.99918	.04045	24.718	.0008	24.739	.00082	.95958	41
20	0.04071	0.99917	0.04075	24.542	1.0008	24.562	0.00083	0.95929	40
21	.04100	.99916	.04104	24.367	.0008	24.388	.00084	.95900	39
22	.04129	.99915	.04133	24.196	.0008	24.216	.00085	.95870	38
23	.04158	.99913	.04162	24.026	.0009	24.047	.00086	.95841	37
24	.04187	.99912	.04191	23.859	.0009	23.880	.00088	.95812	36
25	0.04217	0.99911	0.04220	23.694	1.0009	23.716	0.00089	0.95783	35
26	.04246	.99910	.04249	23.532	.0009	23.553	.00090	.95754	34
27	.04275	.99908	.04279	23.372	.0009	23.393	.00091	.95725	33
28	.04304	.99907	.04308	23.214	.0009	23.235	.00093	.95696	32
29	.04333	.99906	.04337	23.058	.0009	23.079	.00094	.95667	31
30	0.04362	0.99905	0.04366	22.904	1.0009	22.925	0.00095	0.95638	30
31	.04391	.99903	.04395	22.752	.0010	22.774	.00096	.95609	29
32	.04420	.99902	.04424	22.602	.0010	22.624	.00098	.95580	28
33	.04449	.99901	.04453	22.454	.0010	22.476	.00099	.95551	27
34	.04478	.99900	.04483	22.308	.0010	22.330	.00100	.95522	26
35	0.04507	0.99898	0.04512	22.164	1.0010	22.186	0.00102	0.95493	25
36	.04536	.99897	.04541	22.022	.0010	22.044	.00103	.95464	24
37	.04565	.99896	.04570	21.881	.0010	21.904	.00104	.95435	23
38	.04594	.99894	.04599	21.742	.0010	21.765	.00106	.95405	22
39	.04623	.99893	.04628	21.606	.0011	21.629	.00107	.95376	21
40	0.04652	0.99892	0.04657	21.470	1.0011	21.494	0.00108	0.95347	20
41	.04681	.99890	.04687	21.337	.0011	21.360	.00110	.95318	19
42	.04711	.99889	.04716	21.205	.0011	21.228	.00111	.95289	18
43	.04740	.99888	.04745	21.075	.0011	21.098	.00112	.95260	17
44	.04769	.99886	.04774	20.946	.0011	20.970	.00114	.95231	16
45	0.04798	0.99885	0.04803	20.819	1.0011	20.843	0.00115	0.95202	15
46	.04827	.99883	.04832	20.693	.0012	20.717	.00116	.95173	14
47	.04856	.99882	.04862	20.569	.0012	20.593	.00118	.95144	13
48	.04885	.99881	.04891	20.446	.0012	20.471	.00119	.95115	12
49	.04914	.99879	.04920	20.325	.0012	20.350	.00121	.95086	11
50	0.04943	0.99878	0.04949	20.205	1.0012	20.230	0.00122	0.95057	10
51	.04972	.99876	.04978	20.087	.0012	20.112	.00124	.95028	9
52	.05001	.99875	.05007	19.970	.0012	19.995	.00125	.94999	8
53	.05030	.99873	.05037	19.854	.0013	19.880	.00127	.94970	7
54	.05059	.99872	.05066	19.740	.0013	19.766	.00128	.94941	6
55	0.05088	0.99870	0.05095	19.627	1.0013	19.653	0.00129	0.94912	5
56	.05117	.99869	.05124	19.515	.0013	19.541	.00131	.94883	4
57	.05146	.99867	.05153	19.405	.0013	19.431	.00132	.94853	3
58	.05175	.99866	.05182	19.296	.0013	19.322	.00134	.94824	2
59	05204	.99864	.05212	19.188	.0013	19.214	.00135	.94795	1
60	0.05234	0.99863	0.05241	19.081	1.0014	19.107	0.00137	0.94766	0
M	Cosine	Sine	Cotan.	Tan.	Cosec.	Secant	Vrs. Cos.	Vrs. Sin.	M

Cam Milling Plate Cams

Plate cams having a constant rise, such as are used on automatic screw machines, can be cut in a universal milling machine, with the Spiral Head either in a vertical position or set at an angle †, as shown by the illustration. When the Spiral Head is set vertical, the "Lead" of the cam (or its rise for one complete revolution) is the same as the lead for which the machine is geared; but when the Spiral Head and cutter are inclined, any lead or rise of the cam can be obtained provided it is less than the lead for which the machine is geared, that is, less than the forward feed of the table for one turn of the spiral Head spindle. The cam lead, then, can be varied within certain limits by simply changing the inclination † of the Spiral Head and cutter. In the following formulas for determining this angle of inclination, for a given rise of cam & with the machine geared for a certain lead, let.

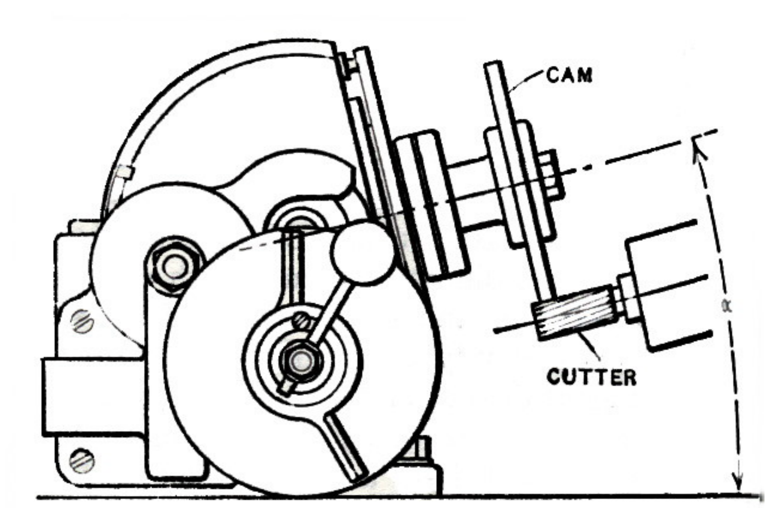
† = Angle which index head and milling attachment are set;
r = Rise of cam in given part of circumference;
R ="Lead" of cam or rise if latter were continued at given rate for one complete revolution;
L = Spiral lead for which milling machine is geared;
N = Part of circumference in which rise is required, expressed as a decimal in hundredths of cam circumference.

$$\text{Sin } \dagger = \frac{R}{L} \quad \text{And } R = \frac{R}{N} \quad \text{Hence, sin } \dagger = \frac{r}{N \times L}$$

For example suppose a cam is to be milled having a rise of 0.125" in 300^0 or in 0.83 of the circumference, and that the machine is geared for the smallest possible lead or 0.67" then:

$$\text{Sin } \dagger = \frac{r}{N \times L} = \frac{0.125}{0.83 \times 0.67} = 0.2247$$

Which is approximately the sine of 13^0 Therefore, to secure a rise of 0.125 with the machine geared for 0.67 lead the spiral head is elevated to an angle of 13^0 and the vertical Milling attachment is also swiveled around to locate the cutter in line with the spiral – head spindle so that the edge of the finished cam will be parallel to its axis of rotation.



When there are several lobes on a cam having different leads the machine can be geared for a lead somewhat in excess of the greatest lead on the cam, and then all the lobs can be milled without changing the spiral head gearing, by simply varying the angle of the spiral head & cutter to suit the different leads. Whenever possible it is advisable to mill on the underside of the cam, as there is less interference from chips; more-over it is easier to see any lines that may be laid out on the cam face. To set the cam for a new cut it is first turned back by operating the handle of the table feed screw after which the index crank is disengaged from the plate and turned the required amount.

The accompanying tables give the combinations of change gears and the angular setting required for cutting a cam of any lead likely to be met within practice. The figures in the column headed “ lead of cam,” represent the rise for one complete revolution. Set the vertical attachment to the angle given in the table. For the dividing head, subtract the angle in the table from 90^0; the difference is the angle to which the spindle must be raised from the horizontal position.

> ***Example***: if the angle is 39.5^0 , set the spindle of the vertical attachment 39.5^0 from the vertical. Set the dividing head 50.5^0 from the horizontal position (90 – 39.5 = 50.5).

Change Gears & Angles for Cam Milling table 1

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
0.600	24	86	24	100	26½	0.650	24	86	24	100	14	0.700	24	72	24	100	29
0.601	24	86	24	100	26	0.651	24	86	28	100	33½	0.701	24	72	24	86	41
0.602	24	86	24	100	26	0.652	24	86	24	100	13½	0.702	24	86	28	100	26
0.603	24	86	28	100	39½	0.653	24	86	32	100	43	0.703	24	72	24	100	28½
0.604	24	72	24	100	41	0.654	24	86	24	100	12½	0.704	24	86	32	100	38
0.605	24	86	24	100	25½	0.655	24	86	24	100	12	0.705	24	86	28	100	25½
0.606	24	86	28	100	39	0.656	24	86	24	100	11½	0.706	24	72	24	100	28
0.607	24	86	24	100	25	0.657	24	86	24	100	11	0.707	24	72	24	86	40½
0.608	24	72	24	100	40½	0.658	24	86	32	100	42½	0.708	24	86	28	100	25
0.609	24	86	24	100	24½	0.659	24	72	24	100	34½	0.709	24	72	28	100	40½
0.610	24	86	24	100	24½	0.660	24	86	24	100	10	0.710	24	72	24	100	27½
0.611	24	86	28	100	38½	0.661	24	86	28	100	32	0.711	24	86	28	100	24½
0.612	24	86	24	100	24	0.662	24	86	28	100	32	0.712	24	72	24	86	40
0.613	24	72	24	100	40	0.663	24	72	24	100	34	0.713	24	72	24	100	27
0.614	24	86	24	100	23½	0.664	24	86	32	100	42	0.714	24	64	24	100	37½
0.615	24	86	28	100	38	0.665	24	72	28	100	44½	0.715	24	72	28	100	40
0.616	24	86	24	100	23	0.666	24	86	28	100	31½	0.716	24	86	28	100	23½
0.617	24	72	24	100	39½	0.667	24	72	24	100	33½	0.717	24	72	24	86	39½
0.618	24	72	24	100	39½	0.668	24	64	24	100	42	0.718	24	86	32	100	36½
0.619	24	86	24	100	22½	0.669	24	72	24	86	44	0.719	24	86	28	100	23
0.620	24	86	28	100	37½	0.670	24	86	28	100	31	0.720	24	72	28	100	39½
0.621	24	86	24	100	22	0.671	24	72	24	100	33	0.721	24	86	28	100	22½
0.622	24	72	24	100	39	0.672	24	86	28	100	30½	0.722	24	72	24	100	25½
0.623	24	86	24	100	21½	0.673	24	86	28	100	30½	0.723	24	64	24	100	36½
0.624	24	86	28	100	37	0.674	24	64	24	100	41½	0.724	24	86	28	100	22
0.625	24	86	24	100	21	0.675	24	72	24	100	32½	0.725	24	72	24	100	25
0.626	24	86	32	100	45½	0.676	24	86	28	100	30	0.726	24	86	28	100	21½
0.627	24	86	24	100	20½	0.677	24	72	28	100	43½	0.727	24	86	32	100	35½
0.628	24	86	28	100	36½	0.678	24	72	24	100	32	0.728	24	72	24	100	24½
0.629	24	86	24	100	20	0.679	24	86	32	100	40½	0.729	24	86	28	100	21
0.630	24	72	24	100	38	0.680	24	72	24	86	43	0.730	24	72	28	100	38½
0.631	24	86	32	100	45	0.681	24	72	24	100	31½	0.731	24	72	24	100	24
0.632	24	86	28	100	36	0.682	24	72	28	100	43	0.732	24	86	28	100	20½
0.633	24	86	24	100	19	0.683	24	86	28	100	29	0.733	24	72	24	86	38
0.634	24	72	24	100	37½	0.684	24	86	32	100	40	0.734	24	86	28	100	20
0.635	24	86	24	100	18½	0.685	24	72	24	86	42½	0.735	24	72	28	100	38
0.636	24	86	28	100	35½	0.686	24	86	28	100	28½	0.736	24	86	28	100	19½
0.637	24	86	32	100	44½	0.687	24	72	28	100	42½	0.737	24	64	24	100	35
0.638	24	72	24	100	37	0.688	24	72	28	100	42½	0.738	24	72	24	86	37½
0.639	24	86	24	100	17½	0.689	24	86	32	100	39½	0.739	24	72	24	100	22½
0.640	24	86	28	100	35	0.690	24	86	28	100	28	0.740	24	72	28	100	37½
0.641	24	86	24	100	17	0.691	24	72	24	86	42	0.741	24	86	28	100	18½
0.642	24	86	32	100	44	0.692	24	86	28	100	27½	0.742	24	72	24	100	22
0.643	24	86	28	100	34½	0.693	24	72	28	100	42	0.743	24	86	28	100	18
0.644	24	86	24	100	16	0.694	24	86	32	100	39	0.744	24	72	24	100	21½
0.645	24	86	24	100	15½	0.695	24	64	24	100	39½	0.745	24	72	28	100	37
0.646	24	86	24	100	15½	0.696	24	86	28	100	27	0.746	24	64	24	100	34
0.647	24	86	24	100	15	0.697	24	72	24	86	41½	0.747	24	86	28	100	17
0.648	24	86	32	100	43½	0.698	24	72	28	100	41½	0.748	24	72	24	86	36½
0.649	24	86	24	100	14½	0.699	24	86	32	100	38½	0.749	24	86	28	100	16½

Change Gears & Angles for Cam Milling table 2

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
0.750	24	72	28	100	36½
0.751	24	86	28	100	16
0.752	24	72	24	100	20
0.753	24	86	32	100	32½
0.754	24	72	24	100	19½
0.755	24	72	28	100	36
0.756	24	86	28	100	14½
0.757	24	72	24	86	35½
0.758	24	86	28	100	14
0.759	24	64	24	100	32½
0.760	24	72	28	100	35½
0.761	24	86	28	100	13
0.762	24	72	24	86	35
0.763	24	72	24	100	17½
0.764	24	86	28	100	12
0.765	24	72	24	100	17
0.766	24	72	24	86	34½
0.767	24	72	24	100	16½
0.768	24	86	28	100	10½
0.769	24	86	28	100	10
0.770	24	86	32	100	30½
0.771	24	72	24	86	34
0.772	24	72	24	100	15
0.773	24	86	32	100	30
0.774	24	72	24	100	14½
0.775	24	64	24	100	30½
0.776	24	72	24	100	14
0.777	24	86	32	100	29½
0.778	24	72	28	100	33½
0.779	24	72	24	100	13
0.780	24	72	24	86	33
0.781	24	72	24	100	12½
0.782	24	72	28	100	33
0.783	24	64	24	100	29½
0.784	24	72	24	100	11½
0.785	24	86	32	100	28½
0.786	28	86	32	100	41
0.787	24	64	24	100	29
0.788	24	72	24	100	10
0.789	24	72	24	86	32
0.790	24	64	24	86	41
0.791	24	64	24	100	28½
0.792	24	86	32	100	27½
0.793	24	72	24	86	31½
0.794	24	72	28	86	43
0.795	24	72	28	100	31½
0.796	24	64	24	86	40½
0.797	24	72	24	86	31
0.798	28	86	32	100	40
0.799	24	72	32	100	41½

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
0.800	24	72	28	100	31
0.801	24	72	24	86	30½
0.802	24	64	24	86	40
0.803	24	86	32	100	26
0.804	28	86	32	100	39½
0.805	24	72	32	100	41
0.806	24	86	32	100	25½
0.807	24	64	24	86	39½
0.808	24	72	28	100	30
0.809	24	64	24	100	26
0.810	28	86	32	100	39
0.811	24	72	32	100	40½
0.812	24	72	28	100	29½
0.813	24	72	24	86	29
0.814	24	64	24	86	39
0.815	28	86	32	100	38½
0.816	24	72	28	100	29
0.817	24	72	24	86	28½
0.818	24	72	28	86	41
0.819	24	86	32	100	23½
0.820	24	72	28	100	28½
0.821	24	72	24	86	28
0.822	24	86	32	100	23
0.823	24	72	32	100	39½
0.824	24	72	28	100	28
0.825	24	72	24	86	27½
0.826	28	86	32	100	37½
0.827	24	72	28	100	27½
0.828	24	86	32	100	22
0.829	24	86	40	100	42
0.830	24	64	24	86	37½
0.831	24.	72	28	86	40
0.832	24	72	24	86	26½
0.833	24	56	24	100	36
0.834	24	86	32	100	21
0.835	24	72	32	100	38½
0.836	24	72	24	86	26
0.837	24	72	28	86	39½
0.838	24	56	24	100	35½
0.839	24	86	32	100	20
0.840	24	64	24	100	21
0.841	24	72	32	100	38
0.842	24	86	32	100	19½
0.843	24	72	28	86	39
0.844	24	86	32	100	19
0.845	24	72	28	100	25
0.846	24	64	24	100	20
0.847	24	86	32	100	18½
0.848	24	64	24	100	19½
0.849	24	86	32	100	18

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
0.850	24	72	24	86	24
0.851	24	64	24	100	19
0.852	24	72	28	100	24
0.853	24	72	24	86	23½
0.854	24	86	32	100	17
0.855	24	64	28	100	35½
0.856	24	86	32	100	16½
0.857	24	64	24	86	35
0.858	24	64	24	100	17½
0.859	24	72	24	86	22½
0.860	24	64	28	100	35
0.861	24	72	28	86	37½
0.862	24	72	28	100	22½
0.863	24	64	24	100	16½
0.864	28	86	32	100	34
0.865	24	64	24	100	16
0.866	24	86	32	100	14
0.867	24	64	24	100	15½
0.868	24	72	28	100	21½
0.869	24	64	24	100	15
0.870	24	86	32	100	13
0.871	24	64	24	100	14½
0.872	24	86	32	100	12½
0.873	24	64	24	100	14
0.874	24	72	24	86	20
0.875	24	86	32	100	11½
0.876	24	64	28	100	33½
0.877	24	64	24	100	13
0.878	24	86	32	100	10½
0.879	24	64	24	100	12½
0.880	24	64	24	100	12
0.881	24	64	28	100	33
0.882	24	64	24	100	11½
0.883	24	64	24	86	32½
0.884	28	86	32	100	32
0.885	24	64	24	100	10½
0.886	24	64	24	100	10
0.887	24	72	24	86	17½
0.888	24	64	24	86	32
0.889	24	72	24	86	17
0.890	24	72	28	100	17½
0.891	24	56	24	100	30
0.892	24	72	24	86	16½
0.893	28	86	32	100	31
0.894	24	72	24	86	16
0.895	24	64	28	100	31½
0.896	24	72	24	86	15½
0.897	24	72	28	100	16
0.898	24	72	24	86	15
0.899	24	72	28	100	15½

Change Gears & Angles for Cam Milling table 3

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
0.900	24	56	24	100	29	0.950	24	72	32	86	40	1.000	24	86	44	100	35½
0.901	24	72	28	100	15	0.951	24	56	24	100	22½	1.001	24	56	24	100	13½
0.902	24	72	24	86	14	0.952	28	86	32	100	24	1.002	28	86	32	100	16
0.903	24	72	28	100	14½	0.953	24	64	24	86	24½	1.003	24	56	24	100	13
0.904	24	72	24	86	13½	0.954	24	56	24	100	22	1.004	28	86	32	100	15½
0.905	24	72	28	100	14	0.955	24	72	32	100	26½	1.005	24	56	24	100	12½
0.906	24	72	24	86	13	0.956	24	64	28	86	38½	1.006	24	56	24	100	12
0.907	24	72	28	100	13½	0.957	24	56	24	100	21½	1.007	24	64	24	86	16
0.908	24	72	24	86	12½	0.958	24	72	28	86	28	1.008	24	56	24	100	11½
0.909	24	72	28	100	13	0.959	24	72	32	100	26	1.009	28	86	32	100	14½
0.910	24	72	32	100	31½	0.960	24	64	24	86	23½	1.010	24	56	24	100	11
0.911	24	72	28	100	12½	0.961	24	86	44	100	38½	1.011	28	86	32	100	14
0.912	24	72	28	100	12	0.962	24	72	28	86	27½	1.012	24	56	24	100	10½
0.913	24	72	24	86	11	0.963	28	86	32	100	22½	1.013	24	56	24	100	10
0.914	24	72	28	100	11½	0.964	24	56	24	100	20½	1.014	24	64	24	86	14½
0.915	24	72	32	100	31	0.965	24	64	32	100	36½	1.015	28	86	32	100	13
0.916	24	72	24	86	10	0.966	28	86	32	100	22	1.016	24	64	24	86	14
0.917	24	72	28	100	10½	0.967	24	56	24	100	20	1.017	28	86	32	100	12½
0.918	24	64	28	100	29	0.968	24	56	24	86	36	1.018	24	64	24	86	13½
0.919	24	72	28	100	10	0.969	24	64	28	86	37½	1.019	28	86	32	100	12
0.920	28	86	32	100	28	0.970	24	56	24	100	19½	1.020	24	64	24	86	13
0.921	24	56	24	100	26½	0.971	24	72	28	86	26½	1.021	28	86	32	100	11½
0.922	24	64	28	86	41	0.972	86	44	32	64	6	1.022	24	64	24	86	12½
0.923	24	64	28	100	28½	0.973	24	56	24	100	19	1.023	28	86	32	100	11
0.924	28	86	32	100	27½	0.974	24	64	24	86	21½	1.024	24	64	24	86	12
0.925	24	56	24	100	26	0.975	24	72	32	100	24	1.025	24	64	28	100	12½
0.926	24	64	32	100	39½	0.976	28	86	32	100	20½	1.026	24	64	24	86	11½
0.927	24	64	28	100	28	0.977	24	64	28	100	21½	1.027	24	64	28	100	12
0.928	24	64	28	86	40½	0.978	24	56	24	100	18	1.028	24	64	24	86	11
0.929	24	56	24	100	25½	0.979	28	86	32	100	20	1.029	24	64	28	100	11½
0.930	24	72	28	86	31	0.980	24	64	28	100	21	1.030	24	64	24	86	10½
0.931	24	64	28	100	27½	0.981	24	64	24	86	20½	1.031	24	64	28	100	11
0.932	28	72	32	100	41½	0.982	28	86	32	100	19½	1.032	24	64	28	100	10½
0.933	24	64	24	86	27	0.983	24	72	28	86	25	1.033	24	72	32	100	14½
0.934	24	86	44	100	40½	0.984	24	56	24	100	17	1.034	24	64	28	100	10
0.935	24	72	28	86	30½	0.985	28	86	32	100	19	1.035	24	72	32	100	14
0.936	24	56	24	100	24½	0.986	24	72	32	100	22½	1.036	24	56	24	86	30
0.937	24	64	24	86	26½	0.987	24	64	24	86	19½	1.037	24	72	32	100	13½
0.938	24	72	32	100	28½	0.988	28	86	32	100	18½	1.038	24	72	28	86	17
0.939	24	64	32	100	38½	0.989	24	56	24	100	16	1.039	24	64	32	100	30
0.940	24	56	24	100	24	0.990	24	64	24	86	19	1.040	24	72	32	100	13
0.941	24	64	24	86	26	0.991	28	86	32	100	18	1.041	24	56	24	86	29½
0.942	24	72	32	100	28	0.992	24	56	24	100	15½	1.042	24	72	32	100	12½
0.943	24	72	32	86	40½	0.993	24	64	24	86	18½	1.043	24	72	28	86	16
0.944	24	56	24	100	23½	0.994	24	56	24	100	15	1.044	24	72	32	100	12
0.945	24	64	24	86	25½	0.995	24	72	28	86	23½	1.045	24	86	40	100	20½
0.946	24	72	32	100	27½	0.996	24	56	24	100	14½	1.046	24	72	32	100	11½
0.947	24	56	24	100	23	0.997	24	56	24	86	33½	1.047	24	72	32	100	11
0.948	28	86	32	100	24½	0.998	24	56	24	100	14	1.048	24	72	28	86	15
0.949	24	64	24	86	25	0.999	28	86	32	100	16½	1.049	24	72	32	100	10½

Change Gears & Angles for Cam Milling table 4

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.050	24	72	28	86	14½	1.100	28	72	32	86	40½	1.150	24	56	24	86	16
1.051	24	72	32	100	10	1.101	24	56	24	86	23	1.151	24	64	32	100	16½
1.052	24	86	40	100	19½	1.102	24	64	28	86	25½	1.152	28	86	44	100	36½
1.053	24	72	28	86	14	1.103	28	72	32	100	27½	1.153	24	56	24	86	15½
1.054	24	72	28	86	14	1.104	24	86	44	100	26	1.154	24	64	28	86	19
1.055	24	72	28	86	13½	1.105	24	56	24	86	22½	1.155	24	56	24	86	15
1.056	24	56	24	86	28	1.106	40	64	24	100	42½	1.156	24	64	32	100	15½
1.057	24	72	28	86	13	1.107	24	64	28	86	25	1.157	28	72	32	100	21½
1.058	24	86	40	100	18½	1.108	24	86	44	100	25½	1.158	24	56	24	86	14½
1.059	24	72	28	86	12½	1.109	24	56	24	86	22	1.159	24	64	32	100	15
1.060	28	86	40	100	35½	1.110	24	72	32	86	26½	1.160	24	56	24	86	14
1.061	24	72	28	86	12	1.111	24	64	28	86	24½	1.161	24	64	28	86	18
1.062	24	72	28	86	12	1.112	24	72	40	100	33½	1.162	24	64	32	100	14½
1.063	24	72	28	86	11½	1.113	24	56	24	86	21½	1.163	24	56	24	86	13½
1.064	24	86	40	100	17½	1.114	24	64	32	86	37	1.164	24	64	32	100	14
1.065	24	72	28	86	11	1.115	24	64	28	86	24	1.165	24	56	24	86	13
1.066	24	56	24	86	27	1.116	24	56	24	86	21	1.166	24	72	40	100	29
1.067	24	72	28	86	10½	1.117	24	86	44	100	24½	1.167	24	64	32	100	13½
1.068	24	64	28	86	29	1.118	28	72	32	100	26	1.168	24	56	24	86	12½
1.069	24	72	28	86	10	1.119	24	72	32	86	25½	1.169	24	64	32	100	13
1.070	24	86	40	100	16½	1.120	24	56	24	86	20½	1.170	24	56	24	86	12
1.071	32	56	24	100	38½	1.121	24	64	32	86	36½	1.171	24	64	28	86	16½
1.072	28	72	32	100	30½	1.122	24	86	44	100	24	1.172	24	56	24	86	11½
1.073	24	86	40	100	16	1.123	28	72	32	100	25½	1.173	28	72	32	100	19½
1.074	24	64	32	100	26½	1.124	24	56	24	86	20	1.174	24	56	24	86	11
1.075	24	86	40	100	15½	1.125	28	64	32	100	36½	1.175	28	86	40	100	25½
1.076	24	64	32	86	39½	1.126	24	86	44	100	23½	1.176	24	56	24	86	10½
1.077	28	72	32	100	30	1.127	24	56	24	86	19½	1.177	24	64	28	86	15½
1.078	24	86	40	100	15	1.128	24	64	32	100	20	1.178	24	56	24	86	10
1.079	24	56	24	86	25½	1.129	24	64	32	86	36	1.179	24	64	28	86	15
1.080	24	86	40	100	14½	1.130	24	72	40	100	32	1.180	24	64	32	100	10½
1.081	28	64	32	100	39½	1.131	24	56	24	86	19	1.181	32	56	24	100	30½
1.082	28	86	44	100	41	1.132	24	64	28	86	22	1.182	24	64	32	100	10
1.083	24	86	40	100	14	1.133	24	72	32	86	24	1.183	24	86	44	100	15½
1.084	24	56	24	86	25	1.134	24	56	24	86	18½	1.184	24	64	32	100	9½
1.085	24	86	40	100	13½	1.135	24	64	32	100	19	1.185	24	64	28	86	14
1.086	28	86	40	100	33½	1.136	24	64	28	86	21½	1.186	24	86	44	100	15
1.087	24	86	40	100	13	1.137	24	56	24	86	18	1.187	24	64	28	86	13½
1.088	24	56	24	86	24½	1.138	24	64	32	100	18½	1.188	24	72	40	100	27
1.089	24	86	40	100	12½	1.139	28	86	40	100	29	1.189	24	86	44	100	14½
1.090	24	72	32	86	28½	1.140	24	64	28	86	21	1.190	24	64	28	86	13
1.091	24	86	48	100	35½	1.141	24	56	24	86	17½	1.191	24	86	44	100	14
1.092	24	86	40	100	12	1.142	24	64	32	86	35	1.192	24	64	28	86	12½
1.093	24	56	24	86	24	1.143	24	86	44	100	21½	1.193	28	72	32	100	16½
1.094	24	86	40	100	11½	1.144	24	56	24	86	17	1.194	24	64	28	86	12
1.095	24	72	32	86	28	1.145	28	72	32	100	23	1.195	24	72	32	86	15½
1.096	24	86	40	100	11	1.146	24	86	44	100	21	1.196	28	72	32	100	16
1.097	24	86	40	100	10½	1.147	24	56	24	86	16½	1.197	24	64	28	86	11½
1.098	28	72	32	100	28	1.148	24	64	32	100	17	1.198	24	72	32	86	15
1.099	24	86	40	100	10	1.149	28	72	32	100	22½	1.199	24	64	28	86	11

Change Gears & Angles for Cam Milling table 5

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.200	24	72	32	86	14½	1.250	24	64	28	72	31	1.300	24	86	48	100	14
1.201	24	64	28	86	10½	1.251	24	86	48	100	21	1.301	24	72	40	100	12½
1.202	24	64	28	86	10	1.252	28	86	40	100	16	1.302	24	64	32	86	21
1.203	24	86	44	100	11½	1.253	24	72	40	100	20	1.303	24	86	48	100	13½
1.204	28	72	32	100	14½	1.254	24	64	32	86	26	1.304	24	72	40	100	12
1.205	24	86	44	100	11	1.255	28	86	40	100	15½	1.305	24	64	28	72	26½
1.206	24	72	32	86	13½	1.256	24	64	28	72	30½	1.306	24	72	40	100	11½
1.207	24	86	44	100	10½	1.257	24	72	40	100	19½	1.307	32	56	24	100	17½
1.208	24	72	32	86	13	1.258	28	86	40	100	15	1.308	24	72	40	100	11
1.209	24	86	44	100	10	1.259	24	86	48	100	20	1.309	28	86	44	100	24
1.210	28	72	32	100	13½	1.260	28	86	40	100	14½	1.310	24	64	28	72	26
1.211	24	72	32	86	12½	1.261	28	86	40	100	14½	1.311	24	72	40	100	10½
1.212	28	72	32	100	13	1.262	32	56	24	100	23	1.312	40	64	24	100	29
1.213	24	72	32	86	12	1.263	28	86	40	100	14	1.313	24	72	40	100	10
1.214	24	86	48	100	25	1.264	24	72	40	100	18½	1.314	28	86	44	100	23½
1.215	24	72	32	86	11½	1.265	28	86	44	100	28	1.315	24	86	48	100	11
1.216	32	56	24	100	27½	1.266	28	86	40	100	13½	1.316	28	64	32	100	20
1.217	24	72	32	86	11	1.267	24	86	48	100	19	1.317	28	72	32	86	24½
1.218	24	72	40	100	24	1.268	24	72	40	100	18	1.318	24	86	48	100	10½
1.219	24	72	32	86	10½	1.269	28	86	40	100	13	1.319	24	64	32	86	19
1.220	28	86	40	100	20½	1.270	24	72	44	100	30	1.320	24	86	48	100	10
1.221	24	72	32	86	10	1.271	28	86	40	100	12½	1.321	32	56	24	100	15½
1.222	24	72	40	100	23½	1.272	28	72	32	86	28½	1.322	28	72	32	86	24
1.223	28	72	32	100	10½	1.273	28	86	40	100	12	1.323	24	64	32	86	18½
1.224	28	86	40	100	20	1.274	28	86	40	100	12	1.324	32	56	24	100	15
1.225	28	72	32	100	10	1.275	24	72	40	100	17	1.325	28	86	48	100	32
1.226	24	72	48	100	40	1.276	28	86	40	100	11½	1.326	32	86	40	100	27
1.227	28	86	40	100	19½	1.277	28	86	44	100	27	1.327	32	56	24	100	14½
1.228	28	86	44	100	31	1.278	28	86	40	100	11	1.328	28	64	32	100	18½
1.229	24	86	48	100	23½	1.279	24	64	32	86	23½	1.329	28	86	44	100	22
1.230	28	64	32	100	28½	1.280	28	86	40	100	10½	1.330	32	56	24	100	14
1.231	28	86	40	100	19	1.281	24	72	40	100	16	1.331	28	64	32	100	18
1.232	24	72	40	100	22½	1.282	28	86	40	100	10	1.332	28	64	32	100	18
1.233	32	86	40	100	34	1.283	28	72	32	86	27½	1.333	32	56	24	100	13½
1.234	24	86	48	100	23	1.284	24	72	40	100	15½	1.334	24	64	32	86	17
1.235	28	86	40	100	18½	1.285	24	72	40	100	15½	1.335	28	64	32	100	17½
1.236	24	72	40	100	22	1.286	40	64	24	100	31	1.336	32	56	24	100	13
1.237	32	56	24	100	25½	1.287	24	72	40	100	15	1.337	28	72	32	86	22½
1.238	28	86	40	100	18	1.288	24	72	40	100	15	1.338	32	56	24	100	12½
1.239	24	64	32	72	42	1.289	24	64	32	86	22½	1.339	32	56	24	100	12½
1.240	24	72	40	100	21½	1.290	24	72	40	100	14½	1.340	24	72	44	100	24
1.241	28	86	44	100	30	1.291	24	72	40	100	14½	1.341	32	56	24	100	12
1.242	28	86	40	100	17½	1.292	32	56	24	100	19½	1.342	28	64	32	100	16½
1.243	32	56	24	100	25	1.293	24	72	40	100	14	1.343	32	56	24	100	11½
1.244	24	72	40	100	21	1.294	24	86	48	100	15	1.344	24	64	32	86	15½
1.245	28	86	40	100	17	1.295	28	72	32	86	26½	1.345	24	72	44	100	23½
1.246	32	72	40	100	45½	1.296	24	72	40	100	13½	1.346	32	56	24	100	11
1.247	24	86	48	100	21½	1.297	24	86	48	100	14½	1.347	24	64	32	86	15
1.248	28	86	40	100	16½	1.298	24	64	32	86	21½	1.348	32	56	24	100	10½
1.249	24	72	40	100	20½	1.299	24	72	40	100	13	1.349	28	64	32	100	15½

Change Gears & Angles for Cam Milling table 6

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.350	32	56	24	100	10	1.400	40	64	24	100	21	1.450	32	86	40	100	13
1.351	24	64	32	86	14½	1.401	28	72	32	86	14½	1.451	28	64	32	86	27
1.352	28	64	32	100	15	1.402	28	86	44	100	12	1.452	40	64	24	100	14½
1.353	24	72	44	86	37½	1.403	24	72	44	100	17	1.453	32	86	40	100	12½
1.354	24	64	32	86	14	1.404	28	72	32	86	14	1.454	28	86	48	100	21½
1.355	28	64	32	100	14½	1.405	24	64	28	72	15½	1.455	32	86	40	100	12
1.356	24	64	32	86	13½	1.406	28	86	44	100	11	1.456	24	72	40	86	20
1.357	24	64	28	72	21½	1.407	28	72	32	86	13½	1.457	24	72	40	86	20
1.358	28	64	32	100	14	1.408	24	64	28	72	15	1.458	32	86	40	100	11½
1.359	24	64	32	86	13	1.409	28	86	44	100	10½	1.459	40	64	24	100	13½
1.360	28	72	32	86	20	1.410	28	72	32	86	13	1.460	24	44	32	86	44
1.361	28	64	32	100	13½	1.411	28	86	48	100	25½	1.461	32	86	40	100	11
1.362	24	64	32	86	12½	1.412	24	64	28	72	14½	1.462	40	64	24	100	13
1.363	28	86	44	100	18	1.413	28	72	32	86	12½	1.463	32	86	40	100	10½
1.364	24	64	32	86	12	1.414	24	72	44	100	15½	1.464	40	64	24	100	12½
1.365	24	64	32	86	12	1.415	28	72	32	86	12	1.465	32	86	40	100	10
1.366	24	64	28	72	20½	1.416	24	64	44	86	42½	1.466	24	72	40	86	19
1.367	24	64	32	86	11½	1.417	24	72	44	100	15	1.467	40	64	24	100	12
1.368	28	72	32	86	19	1.418	28	72	32	86	11½	1.468	28	64	40	100	33
1.369	24	64	32	86	11	1.419	32	86	40	100	17½	1.469	28	86	48	100	20
1.370	28	86	44	100	17	1.420	28	72	32	86	11	1.470	40	64	24	100	11½
1.371	24	64	32	86	10½	1.421	24	64	28	72	13	1.471	28	72	40	100	19
1.372	24	64	32	86	10½	1.422	40	64	24	100	18½	1.472	40	64	24	100	11
1.373	28	64	44	100	44½	1.423	28	72	32	86	10½	1.473	40	64	24	100	11
1.374	24	64	32	86	10	1.424	28	64	32	86	29	1.474	24	72	40	86	18
1.375	32	86	40	100	22½	1.425	28	72	32	86	10	1.475	40	64	24	100	10½
1.376	28	72	32	86	18	1.426	24	64	28	72	12	1.476	28	72	40	100	18½
1.377	28	64	32	100	10½	1.427	32	86	40	100	16½	1.477	40	64	24	100	10
1.378	28	86	44	100	16	1.428	28	86	48	100	24	1.478	24	72	40	86	17½
1.379	28	64	32	100	10	1.429	24	64	28	72	11½	1.479	24	64	32	72	27½
1.380	28	72	32	86	17½	1.430	32	86	40	100	16	1.480	28	72	40	100	18
1.381	28	86	44	100	15½	1.431	24	64	28	72	11	1.481	28	64	32	86	24½
1.382	24	64	32	72	34	1.432	24	72	44	100	12½	1.482	24	72	40	86	17
1.383	24	64	28	72	18½	1.433	28	86	48	100	23½	1.483	44	64	24	100	26
1.384	28	86	44	100	15	1.434	24	64	28	72	10½	1.484	28	72	40	100	17½
1.385	28	64	44	100	44	1.435	24	72	44	100	12	1.485	24	64	32	72	27
1.386	40	64	24	100	22½	1.436	24	64	28	72	10	1.486	24	72	40	86	16½
1.387	28	86	44	100	14½	1.437	32	86	40	100	15	1.487	28	86	48	100	18
1.388	28	64	32	86	31½	1.438	24	72	44	100	11½	1.488	28	72	40	100	17
1.389	32	86	40	100	21	1.439	28	86	48	100	23	1.489	24	72	48	100	21½
1.390	28	86	44	100	14	1.440	24	72	44	100	11	1.490	24	72	40	86	16
1.391	28	72	32	86	16	1.441	32	86	40	100	14½	1.491	28	86	48	100	17½
1.392	44	64	24	100	32½	1.442	24	72	44	100	10½	1.492	28	72	40	100	16½
1.393	28	86	44	100	13½	1.443	24	72	44	100	10½	1.493	28	64	32	86	23½
1.394	28	72	32	86	15½	1.444	32	86	40	100	14	1.494	24	72	40	86	15½
1.395	24	72	44	100	18	1.445	24	72	44	100	10	1.495	28	86	48	100	17
1.396	28	86	44	100	13	1.446	24	72	44	86	32	1.496	28	72	40	100	16
1.397	24	72	44	86	35	1.447	32	56	40	100	13½	1.497	24	72	40	86	15
1.398	28	72	32	86	15	1.448	28	72	40	100	21½	1.498	32	64	40	100	41½
1.399	28	86	44	100	12½	1.449	40	64	24	100	15	1.499	28	72	40	100	15½

Change Gears & Angles for Cam Milling table 7

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw*	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.500	28	64	40	100	31	1.550	44	64	24	100	20	1.600	44	56	24	100	21
1.501	32	86	44	100	23½	1.551	44	64	24	100	20	1.601	28	64	32	86	10½
1.502	28	86	48	100	16	1.552	24	72	48	100	14	1.602	24	64	32	72	16
1.503	28	72	40	100	15	1.553	28	64	32	72	37	1.603	28	64	32	86	10
1.504	24	72	40	86	14	1.554	24	64	40	86	27	1.604	32	86	44	100	11½
1.505	24	64	32	72	25½	1.555	44	64	24	100	19½	1.605	40	56	24	100	20½
1.506	28	72	40	100	14½	1.556	24	64	32	72	21	1.606	24	64	32	72	15½
1.507	24	72	40	86	13½	1.557	28	64	32	86	17	1.607	32	86	44	100	11
1.508	24	72	48	100	19½	1.558	24	72	44	86	24	1.608	44	64	24	100	13
1.509	28	64	32	86	22	1.559	24	72	48	100	13	1.609	28	72	48	100	30½
1.510	24	72	40	86	13	1.560	44	64	24	100	19	1.610	32	86	44	100	10½
1.511	24	64	32	72	25	1.561	28	64	32	86	16½	1.611	44	64	24	100	12½
1.512	24	64	44	86	38	1.562	24	72	48	100	12½	1.612	32	86	44	100	10
1.513	24	72	40	86	12½	1.563	28	72	44	100	24	1.613	28	72	44	100	19½
1.514	24	72	48	86	35½	1.564	24	72	44	86	23½	1.614	44	64	24	100	12
1.515	28	64	32	86	21½	1.565	24	72	48	100	12	1.615	24	64	48	86	39½
1.516	24	72	40	86	12	1.566	32	86	44	100	17	1.616	40	56	24	100	19½
1.517	24	72	48	100	18½	1.567	28	64	44	100	35½	1.617	44	64	24	100	11½
1.518	32	86	44	100	22	1.568	24	72	48	100	11½	1.618	24	64	32	72	14
1.519	24	72	40	86	11½	1.569	28	64	32	86	15½	1.619	32	86	48	100	25
1.520	28	86	48	100	13½	1.570	32	72	40	100	28	1.620	44	64	24	100	11
1.521	24	72	40	86	11	1.571	24	72	48	100	11	1.621	24	64	32	72	13½
1.522	24	72	40	86	11	1.572	28	64	32	86	15	1.622	44	64	24	100	10½
1.523	28	86	48	100	13	1.573	24	72	48	100	10½	1.623	28	72	44	100	18½
1.524	24	72	40	86	10½	1.574	32	86	44	100	16	1.624	24	64	32	72	13
1.525	28	72	40	100	11½	1.575	24	72	44	86	22½	1.625	44	64	24	100	10
1.526	24	72	40	86	10	1.576	24	72	48	100	10	1.626	24	72	44	86	17½
1.527	28	72	40	100	11	1.577	32	86	44	100	15½	1.627	24	64	32	72	12½
1.528	32	86	44	100	21	1.578	44	64	24	100	17	1.628	24	64	32	72	12½
1.529	28	86	48	100	12	1.579	28	100	56	86	30	1.629	32	72	40	86	38
1.530	28	72	40	100	10½	1.580	28	64	32	86	14	1.630	24	64	32	72	12
1.531	28	72	44	100	26½	1.581	32	86	44	100	15	1.631	24	64	32	72	12
1.532	28	72	40	100	10	1.582	44	64	24	100	16½	1.632	28	72	44	100	17½
1.533	32	86	44	100	20½	1.583	28	64	32	86	13½	1.633	28	72	40	86	25½
1.534	28	86	48	100	11	1.584	40	56	24	100	22½	1.634	24	64	32	72	11½
1.535	28	64	32	86	19½	1.585	32	86	44	100	14½	1.635	24	72	44	86	16½
1.536	32	72	40	86	42	1.586	28	64	32	86	13	1.636	24	64	32	72	11
1.537	28	86	48	100	10½	1.587	24	64	40	86	24½	1.637	32	72	40	100	23
1.538	24	72	48	100	16	1.588	32	86	44	100	14	1.638	32	86	48	100	23½
1.539	28	86	48	100	10	1.589	28	64	32	86	12½	1.639	24	64	32	72	10½
1.540	28	100	56	72	45	1.590	44	64	24	100	15½	1.640	28	72	40	86	25
1.541	40	56	24	100	26	1.591	32	72	40	100	26½	1.641	28	72	44	100	16½
1.542	24	72	48	100	15½	1.592	28	64	32	86	12	1.642	24	64	32	72	10
1.543	32	86	44	100	19½	1.593	24	64	40	86	24	1.643	24	72	44	86	15½
1.544	28	64	32	86	18½	1.594	44	64	24	100	15	1.644	24	64	40	86	19½
1.545	24	72	48	100	15	1.595	28	64	32	86	11½	1.645	28	72	44	100	16
1.546	24	72	48	100	15	1.596	28	64	44	100	34	1.646	28	72	40	86	24½
1.547	40	56	24	100	25½	1.597	44	64	24	100	14½	1.647	24	72	44	86	15
1.548	28	64	32	86	18	1.598	28	64	32	86	11	1.648	40	56	24	100	16
1.549	24	72	48	100	14½	1.599	24	64	40	86	23½	1.649	28	72	44	100	15½

Change Gears & Angles for Cam Milling table 8

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.650	28	64	40	100	19½	1.700	32	72	40	100	17	1.750	32	86	48	100	11½
1.651	24	72	44	86	14½	1.701	32	64	40	86	43	1.751	32	72	40	100	10
1.652	40	56	24	100	15½	1.702	28	64	40	100	13½	1.752	28	100	56	86	16
1.653	28	72	44	100	15	1.703	24	64	40	86	12½	1.753	32	86	48	100	11
1.654	24	72	44	86	14	1.704	28	64	40	72	45½	1.754	28	72	48	100	20
1.655	28	64	40	100	19	1.705	28	64	40	100	13	1.755	28	72	40	86	14
1.656	28	72	44	100	14½	1.706	24	64	40	86	12	1.756	32	86	48	100	10½
1.657	28	72	44	100	14½	1.707	40	86	44	100	33½	1.757	28	100	56	86	15½
1.658	24	72	44	86	13½	1.708	28	64	40	100	12½	1.758	32	72	44	100	26
1.659	24	64	40	86	18	1.709	24	64	40	86	11½	1.759	32	86	48	100	10
1.660	28	72	44	100	14	1.710	28	72	40	86	19	1.760	28	72	48	100	19½
1.661	24	72	44	86	13	1.711	32	72	44	100	29	1.761	28	100	56	86	15
1.662	32	86	48	100	21½	1.712	24	64	40	86	11	1.762	28	64	32	72	25
1.663	40	56	24	100	14	1.713	32	72	40	100	15½	1.763	28	72	40	86	13
1.664	28	72	44	100	13½	1.714	32	64	40	100	31	1.764	24	72	48	86	18½
1.665	24	72	44	86	12½	1.715	24	64	40	86	10½	1.765	28	100	56	86	14½
1.666	28	64	32	72	31	1.716	28	72	40	86	18½	1.766	28	72	40	86	12½
1.667	28	72	44	100	13	1.717	32	72	40	100	15	1.767	44	56	24	100	20½
1.668	24	72	44	86	12	1.718	24	64	40	86	10	1.768	32	72	48	100	34
1.669	28	64	40	100	17½	1.719	28	72	48	100	23	1.769	28	72	40	86	12
1.670	28	72	44	100	12½	1.720	28	72	40	86	18	1.770	28	72	48	100	18½
1.671	24	72	44	86	11½	1.721	28	64	40	100	10½	1.771	28	72	48	100	18½
1.672	24	64	40	86	16½	1.722	24	44	32	86	32	1.772	44	56	24	100	20
1.673	40	56	24	100	12½	1.723	28	64	40	100	10	1.773	28	72	40	86	11½
1.674	24	72	44	86	11	1.724	28	100	56	86	19	1.774	24	72	48	86	17½
1.675	28	64	44	100	29½	1.725	32	72	40	100	14	1.775	24	44	32	86	29
1.676	24	72	44	86	10½	1.726	24	56	40	86	30	1.776	28	72	40	86	11
1.677	28	72	44	100	11½	1.727	32	72	44	100	28	1.777	32	56	40	100	39
1.678	28	64	40	100	16½	1.728	32	72	40	100	13½	1.778	44	56	24	100	19½
1.679	24	72	44	86	10	1.729	32	72	40	100	13½	1.779	28	72	40	86	10½
1.680	28	72	44	100	11	1.730	28	72	40	86	17	1.780	28	100	56	86	12½
1.681	24	64	40	86	15½	1.731	24	72	48	86	21½	1.781	28	72	40	86	10
1.682	28	72	44	100	10½	1.732	32	72	40	100	13	1.782	32	64	40	100	27
1.683	40	56	24	100	11	1.733	32	86	48	100	14	1.783	28	100	56	86	12
1.684	32	86	48	100	19½	1.734	28	72	40	86	16½	1.784	24	56	40	86	26½
1.685	28	72	44	100	10	1.735	28	72	40	86	16½	1.785	28	72	48	100	17
1.686	28	64	40	100	15½	1.736	32	72	40	100	12½	1.786	28	100	56	86	11½
1.687	32	64	40	100	32½	1.737	32	86	48	100	13½	1.787	32	72	44	100	24
1.688	40	56	24	100	10	1.738	32	56	40	100	40½	1.788	24	72	48	86	16
1.689	32	86	48	100	19	1.739	32	72	40	100	12	1.789	28	100	56	86	11
1.690	28	64	40	100	15	1.740	32	86	48	100	13	1.790	28	100	56	86	11
1.691	32	72	40	100	18	1.741	28	72	44	86	29	1.791	24	64	44	86	21
1.692	24	64	40	86	14	1.742	32	72	40	100	11½	1.792	28	100	56	86	10½
1.693	24	72	48	86	24½	1.743	28	72	40	86	15½	1.793	28	100	56	86	10½
1.694	32	72	44	100	30	1.744	32	86	48	100	12½	1.794	44	56	24	100	18
1.695	44	56	24	100	26	1.745	32	72	40	100	11	1.795	28	100	56	86	10
1.696	24	64	40	86	13½	1.746	24	64	44	86	24½	1.796	28	64	32	72	22½
1.697	28	72	44	86	31½	1.747	32	86	48	100	12	1.797	24	72	48	86	15
1.698	28	64	40	100	14	1.748	32	72	40	100	10½	1.798	24	64	44	86	20½
1.699	24	64	40	86	13	1.749	28	72	48	100	20½	1.799	28	72	48	100	15½

Change Gears & Angles for Cam Milling table 9

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.800	32	72	44	100	23	1.850	28	64	44	100	16	1.900	28	64	40	86	21
1.801	24	72	48	86	14½	1.851	44	56	24	100	11	1.901	28	64	32	72	12
1.802	28	64	32	72	22	1.852	28	72	44	86	21½	1.902	28	64	32	72	12
1.803	28	72	48	100	15	1.853	28	56	32	72	33½	1.903	28	72	44	86	17
1.804	32	72	44	86	37½	1.854	44	56	24	100	10½	1.904	24	64	48	86	24½
1.805	24	72	48	86	14	1.855	28	64	44	100	15½	1.905	28	64	32	72	11½
1.806	24	56	40	86	25	1.856	24	64	40	72	27	1.906	32	72	44	100	13
1.807	28	72	48	100	14½	1.857	44	56	24	100	10	1.907	32	64	40	100	17½
1.808	28	72	48	100	14½	1.858	24	64	44	86	14½	1.908	28	64	32	72	11
1.809	24	72	48	86	13½	1.859	28	64	44	100	15	1.909	32	72	48	100	26½
1.810	28	72	48	86	33½	1.860	32	72	44	100	18	1.910	32	72	44	100	12½
1.811	28	72	48	100	14	1.861	24	56	40	86	21	1.911	24	56	40	86	16½
1.812	24	72	48	86	13	1.862	24	64	44	86	14	1.912	28	64	32	72	10½
1.813	44	56	24	100	16	1.863	24	56	40	86	20½	1.913	32	72	44	100	12
1.814	24	64	44	86	19	1.864	28	64	44	100	14½	1.914	28	64	32	72	10
1.815	28	72	48	100	13½	1.865	32	72	44	100	17½	1.915	28	64	32	72	10
1.816	24	72	48	86	12½	1.866	24	64	44	86	13½	1.916	24	56	40	86	16
1.817	44	56	24	100	15½	1.867	32	64	40	100	21	1.917	32	72	44	100	11½
1.818	28	72	44	86	24	1.868	28	64	44	100	14	1.918	28	72	44	86	15½
1.819	24	72	48	86	12	1.869	28	64	32	72	16	1.919	24	44	32	86	19
1.820	24	64	44	86	18½	1.870	24	64	44	86	13	1.920	32	72	44	100	11
1.821	28	64	32	72	20½	1.871	32	72	44	100	17	1.921	24	56	40	86	15½
1.822	44	56	24	100	15	1.872	28	64	44	100	13½	1.922	28	72	44	86	15
1.823	24	72	48	86	11½	1.873	24	64	44	86	12½	1.923	32	72	44	100	10½
1.824	40	86	44	100	27	1.874	24	64	44	86	12½	1.924	28	64	40	86	19
1.825	24	64	44	86	18	1.875	32	72	44	100	16½	1.925	24	56	40	86	15
1.826	24	72	48	86	11	1.876	28	64	44	100	13	1.926	32	72	44	100	10
1.827	28	64	32	72	20	1.877	24	64	44	86	12	1.927	28	72	44	86	14½
1.828	24	56	40	86	23½	1.878	28	64	32	72	15	1.928	28	64	44	86	30½
1.829	24	72	48	86	10½	1.879	28	64	44	100	12½	1.929	24	56	40	86	14½
1.830	28	72	48	100	11½	1.880	24	64	44	86	11½	1.930	24	56	40	86	14½
1.831	28	64	44	100	18	1.881	32	72	40	86	24½	1.931	28	72	44	86	14
1.832	24	72	48	86	10	1.882	28	64	32	72	14½	1.932	32	64	40	100	15
1.833	28	72	48	100	11	1.883	28	64	44	100	12	1.933	48	56	24	100	20
1.834	44	56	24	100	13½	1.884	24	64	44	86	11	1.934	24	56	40	86	14
1.835	24	64	44	86	17	1.885	32	72	44	100	15½	1.935	28	72	44	86	13½
1.836	28	72	48	100	10½	1.886	28	64	44	100	11½	1.936	32	64	40	100	14½
1.837	28	64	40	86	25½	1.887	24	64	44	86	10½	1.937	28	64	48	86	37½
1.838	44	56	24	100	13	1.888	28	72	44	86	18½	1.938	24	56	40	86	13½
1.839	28	72	48	100	10	1.889	32	72	44	100	15	1.939	28	72	44	86	13
1.840	24	64	44	86	16½	1.890	24	64	44	86	10	1.940	28	64	48	100	22½
1.841	44	56	24	100	12½	1.891	32	64	40	100	19	1.941	32	64	40	100	14
1.842	32	72	40	86	27	1.892	32	72	48	100	27½	1.942	24	56	40	86	13
1.843	28	64	48	86	41	1.893	28	64	44	100	10½	1.943	28	72	44	86	12½
1.844	28	64	32	72	18½	1.894	28	64	32	72	13	1.944	32	56	40	86	43
1.845	44	56	24	100	12	1.895	24	56	40	86	18	1.945	48	56	24	100	19
1.846	28	64	44	100	16½	1.896	28	64	44	100	10	1.946	28	72	44	86	12
1.847	24	44	32	86	24½	1.897	32	64	40	100	18½	1.947	28	72	44	86	12
1.848	44	56	24	100	11½	1.898	28	64	32	72	12½	1.948	32	72	40	86	19½
1.849	24	64	44	86	15½	1.899	28	72	48	86	29	1.949	24	56	40	86	12

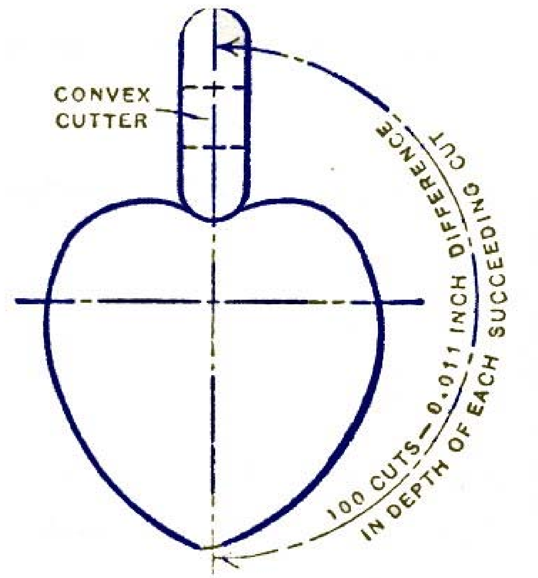
Change Gears & Angles for Cam Milling table 10

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
1.950	28	72	44	86	11½	2.200	24	56	40	72	22½	2.450	24	64	48	72	11½
1.955	32	72	48	86	38	2.205	48	56	32	100	36½	2.455	40	72	48	100	23
1.960	28	72	44	86	10	2.210	48	100	56	86	45	2.460	28	64	48	72	32½
1.965	24	44	32	86	14½	2.215	24	56	40	72	21½	2.465	32	64	44	86	15½
1.970	32	64	40	100	10	2.220	32	72	44	86	12½	2.470	28	40	32	86	18½
1.975	28	64	40	86	14	2.225	28	44	32	86	20	2.475	32	64	40	72	27
1.980	28	64	48	100	19½	2.230	32	64	40	86	16½	2.480	44	48	28	100	15
1.985	24	64	48	86	18½	2.235	44	86	48	100	24½	2.485	28	72	56	86	11
1.990	28	64	40	86	12	2.240	32	56	40	100	11½	2.490	28	72	56	86	10½
1.995	40	86	44	100	13	2.245	28	64	56	86	38	2.495	24	44	40	86	10½
2.000	48	56	24	100	13½	2.250	24	64	44	72	11	2.500	28	64	48	72	31
2.005	28	100	56	72	23	2.255	32	64	48	100	20	2.505	24	56	44	72	17
2.010	32	72	40	86	13½	2.260	44	56	32	100	26	2.510	28	40	44	86	45½
2.015	40	86	48	100	25½	2.265	28	44	32	86	17	2.515	32	64	44	86	10½
2.020	28	72	48	86	21½	2.270	28	44	32	86	16½	2.520	44	48	28	100	11
2.025	32	72	40	86	11½	2.275	32	64	40	86	12	2.525	48	56	32	100	23
2.030	24	64	40	72	13	2.280	28	64	44	72	31½	2.530	24	56	44	72	15
2.035	24	64	48	86	13½	2.285	44	86	48	100	21½	2.535	32	56	40	86	17½
2.040	32	72	48	100	17	2.290	24	44	40	86	25½	2.540	32	64	48	86	24½
2.045	24	64	40	72	11	2.295	32	64	48	100	17	2.545	32	56	44	86	29½
2.050	28	64	48	100	12½	2.300	24	56	40	72	15	2.550	28	64	44	72	17½
2.055	24	64	48	86	11	2.305	24	56	40	72	14½	2.555	32	56	40	86	16
2.060	32	72	48	100	15	2.310	24	56	40	72	14	2.560	32	64	48	86	23½
2.065	28	64	48	100	10½	2.315	24	56	40	72	13½	2.565	28	40	32	86	10
2.070	32	72	48	100	14	2.320	28	44	32	86	11½	2.570	44	48	40	100	45½
2.075	40	44	24	100	18	2.325	28	44	32	86	11	2.575	24	56	44	72	10½
2.080	32	64	44	100	19	2.330	40	100	56	72	41½	2.580	40	72	56	86	44½
2.085	24	64	48	72	33½	2.335	28	64	48	86	17	2.585	32	56	40	86	13½
2.090	32	72	48	100	11½	2.340	24	56	48	72	35	2.590	32	56	40	86	13
2.095	28	56	32	72	19½	2.345	24	56	40	72	10	2.595	44	40	32	100	42½
2.100	28	44	32	86	27½	2.350	28	64	44	72	28½	2.600	32	56	40	86	12
2.105	40	86	48	100	19½	2.355	44	86	48	100	16½	2.605	32	56	40	86	11½
2.110	28	64	44	86	19½	2.360	32	64	48	100	10½	2.610	32	64	40	72	20
2.115	28	72	48	86	13	2.365	24	56	48	86	8½	2.615	44	48	40	100	44½
2.120	28	72	48	86	12½	2.370	44	56	32	100	19½	2.620	28	64	44	72	11½
2.125	32	64	44	100	15	2.375	28	64	48	86	13½	2.625	44	56	24	64	27
2.130	28	100	56	72	12	2.380	32	100	56	72	17	2.630	48	56	32	100	16½
2.135	28	72	48	86	10½	2.385	32	72	56	86	34½	2.635	40	72	44	86	22
2.140	24	56	40	72	26	2.390	28	64	40	72	10½	2.640	48	100	56	72	45
2.145	28	100	56	72	10	2.395	40	72	44	100	11½	2.645	24	40	44	86	30½
2.150	32	72	44	86	19	2.400	56	64	32	100	31	2.650	40	56	44	86	43½
2.155	44	56	32	100	31	2.405	28	64	48	86	10	2.655	56	64	32	100	18½
2.160	32	64	44	100	11	2.410	32	100	56	72	14½	2.660	44	48	40	100	43½
2.165	28	56	32	72	13	2.415	44	86	48	100	10½	2.665	28	64	48	72	24
2 170	32	72	48	86	29	2.420	32	100	56	72	13½	2.670	28	48	44	72	41½
2.175	32	72	44	86	17	2.425	32	100	56	72	13	2.675	48	64	28	56	44½
2.180	40	86	48	100	12½	2.430	32	100	56	72	12½	2.680	28	44	48	86	41
2.185	28	56	32	72	10½	2.435	32	72	48	86	11	2.685	48	100	56	72	44
2.190	32	56	40	86	34½	2.440	32	72	48	86	10½	2.690	40	64	44	100	12
2.195	28	64	48	86	26	2.445	44	56	32	100	13½	2.695	40	64	44	100	11½

Change Gears & Angles for Cam Milling table 11

Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle	Lead of Cam	Gear on Worm	First Intermediate	Second Intermediate	Gear on Screw	Angle
2.700	28	44	48	86	40½	2.950	40	64	48	100	10½	3.200	48	100	56	72	31
2.705	56	64	32	100	15	2.955	48	64	28	56	38	3.205	28	40	44	86	26½
2.710	40	72	56	86	41½	2.960	24	44	48	72	35½	3.210	24	44	48	72	28
2.715	40	56	44	86	42	2.965	32	64	44	72	14	3.215	40	64	48	72	39½
2.720	48	64	28	56	43½	2.970	32	64	48	72	27	3.220	56	44	28	86	39
2.725	44	48	40	100	42	2.975	40	56	44	86	35½	3.225	24	44	48	72	27½
2.730	48	100	56	72	43	2.980	48	40	28	100	27½	3.230	48	40	28	100	16
2.735	44	40	32	100	39	2.985	44	48	40	100	35½	3.235	32	72	64	86	12
2.740	28	44	48	86	39½	2.990	28	48	44	72	33	3.240	24	44	48	72	27
2.745	40	72	44	86	15	2.995	48	64	28	56	37	3.245	28	40	44	86	25
2.750	28	64	48	72	19½	3.000	40	100	56	64	31	3.250	44	64	48	100	10
2.755	44	40	32	100	38½	3.005	40	64	48	86	30½	3.255	32	48	40	72	28½
2.760	28	44	48	86	39	3.010	28	56	64	86	36	3.260	32	56	44	72	21
2.765	48	64	28	56	42½	3.015	48	64	28	56	36½	3.265	48	100	56	72	29
2.770	28	48	44	72	39	3.020	48	100	56	72	36	3.270	40	56	44	86	26½
2.775	40	72	44	86	12½	3.025	40	100	56	72	13½	3.275	44	40	32	100	21½
2.780	40	72	44	86	12	3.030	40	64	44	72	37½	3.280	48	64	28	56	29
2.785	24	44	48	72	40	3.035	24	40	48	86	25	3.285	32	48	40	72	27½
2.790	28	48	44	72	38½	3.040	44	48	40	100	34	3.290	32	44	40	86	13½
2.795	32	48	40	72	41	3.045	32	64	48	72	24	3.295	24	44	48	72	25
2.800	24	56	48	72	11½	3.050	40	56	44	100	14	3.300	32	48	40	72	27
2.805	24	56	48	72	11	3.055	56	44	28	86	42½	3.305	40	72	56	86	24
2.810	44	56	24	64	17½	3.060	28	44	48	86	30½	3.310	44	48	40	100	25½
2.815	28	44	40	86	18	3.065	40	56	44	86	33	3.315	32	48	4c	72	26½
2.820	40	56	44	86	39½	3.070	28	40	44	86	31	3.320	28	40	44	86	22
2.825	32	56	44	72	36	3.075	44	48	40	100	33	3.325	40	56	44	86	24½
2.830	48	64	28	56	41	3.080	40	64	48	86	28	3.330	28	56	64	86	26½
2.835	28	48	40	72	29	3.085	28	56	64	86	34	3.335	28	64	56	72	11½
2.840	40	56	44	86	39	3.090	48	64	28	56	34½	3.340	40	64	44	72	29
2.845	28	44	40	86	16	3.095	48	100	56	72	34	3.345	32	44	48	86	34½
2.850	28	56	64	86	40	3.100	24	44	48	72	31½	3.350	44	48	40	100	24
2.855	28	44	48	86	36½	3.105	40	100	56	64	27½	3.355	48	100	56	72	26
2.860	40	56	44	86	38½	3.110	44	48	40	100	32	3.360	40	56	48	100	11½
2.865	24	44	48	72	38	3.115	28	48	40	72	16	3.365	28	40	44	86	20
2.870	44	48	40	100	38½	3.120	44	64	48	100	19	3.370	48	64	28	56	26
2.875	40	64	48	86	34½	3.125	32	56	44	72	26½	3.375	44	48	40	100	23
2.880	48	100	56	72	39½	3.130	32	56	48	86	11	3.380	32	56	48	72	27½
2.885	24	44	48	72	37½	3.135	28	44	48	86	28	3.385	48	64	28	56	25½
2.890	44	48	40	100	38	3.140	32	56	48	86	10	3.390	48	40	32	100	28
2.895	32	56	44	72	34	3.145	48	64	28	56	33	3.395	32	56	44	72	13½
2.900	28	44	40	86	11½	3.150	28	44	48	86	27½	3.400	40	56	44	86	21½
2.905	40	72	48	86	20½	3.155	28	64	56	72	22	3.405	28	44	48	86	16½
2.910	28	44	40	86	10½	3.160	44	48	40	100	30½	3.410	32	48	40	72	23
2.915	28	40	44	86	35½	3.165	24	44	48	72	29½	3.415	28	40	44	86	17½
2.920	28	48	44	72	35	3.170	28	48	40	72	12	3.420	32	40	48	86	40
2.925	40	64	48	86	33	3.175	32	48	40	72	31	3.425	28	56	64	86	23
2.930	32	64	44	72	16½	3.180	40	56	44	86	29½	3.430	28	44	48	86	15
2.935	48	64	28	56	38½	3.185	40	100	56	64	24½	3.435	44	48	40	100	20½
2.940	40	64	48	100	11½	3.190	28	56	64	86	31	3.440	48	100	56	64	35
2.945	40	72	56	86	35½	3.195	44	72	48	86	20½	3.445	28	44	48	86	14

Simple Method for Cutting Uniform Motion Cams



Cams are generally laid out with dividers, machined and filled to a line; but for a cam that must advance a certain number of thousandths per revolution of the spindle this is not accurate.

Cams are easily & precisely cut in the following manner.

The illustration shows a heart-shaped cam, with the throw of 1.1" Now by setting the index on the milling machine to cut 200 teeth and the dividing 1.1" by 100, we find that we have 0.011" to recede from or advance toward the cam center for each cut across the cam.

Place the cam securely on an arbor, and the latter between centers of the milling machine. Use a convex cutter set the proper difference from the center of the arbor and make the first cut across the cam. Then by lowering the milling machine knee 0.011" and turning the index pin to the proper number of holes on the index plate, take the next cut and so on, and so on.

Each cut should be marked on paper so that there will be no cause for error in number of cuts taken. (In fact the whole design should be drawn on paper first. My father always taught me to build everything twice, first on paper, and then move on to your project.) When 100 cuts have been completed the knee must be raised to complete the opposing side of the cam.

This same method can also be used to advantage for milling uniform motion cam lobes extending only over a portion of the cam circumference. After the cam has been completed refer to Cam Roll & Roll Studs for hardening & grinding.

Simple, Compound, Differential & Block Indexing

Simple Indexing: **-** A general rule for determining the number of turns the crank of a dividing head must make to obtain a given number of divisions is as follows: Divide the number of turns required for one revolution of the dividing-head spindle by the number of divisions into which the periphery of the work is to be divided.

Example: -If 40 turns of the index crank are required for one revolution of the spindle, and 12 divisions are required, the number of turns of the index crank for each indexing would equal 40 / 12 = 3 ⅓ turns.

Compound Indexing: - This method is sometimes used to obtain divisions, which are beyond the range of those secured by the simple method. The crank is first turned a definite amount in the regular way then the index plate is also turned either in the same or opposite direction in order to locate the index crank in the proper position. Thus, there are two separate movements which are, in reality, two simple indexing operations. The following rule is for determining what circles of holes can be used for indexing by the compound method.

Rule: Resolve into its factors the number of divisions required. Then choose at random two circles of holes, subtract one from the other, and factor the difference. Place the two sets of factors thus obtained above a horizontal line. Next, factor the number of turns of the crank required for one revolution of the spindle, and also the number of holes in each of the chosen circles. Place the three sets of factors thus obtained below the horizontal line. If all the factors above the line can be canceled by those below, the two circles chosen will give the required number of divisions. If not, other circles must be chosen and another trial made.

Example: - Assume that 69 divisions are required, and that circles having 33 and 23 holes are chosen for the first trial. Then, by applying the foregoing rule, it is found that all the factors above the line cancel:

$$\frac{3 \times 23 \times 2 \times 5}{2 \times 2 \times 2 \times 5 \times 3 \times 11 \times 23} = \frac{1}{2 \times 2 \times 11}$$

Milling Machine Indexing

No. of Divisions	Indexing Movements	No. of Times Around	No. of Divisions	Indexing Movements	No. of Times Around	No. of Divisions	Indexing Movements	No. of Times Around
51	$8\frac{41}{47}-\frac{12}{49}$	11	133	$3\frac{23}{29}-\frac{16}{33}$	11	198*	$\frac{3}{27}+\frac{3}{33}$	...
53	$6\frac{43}{47}-\frac{6}{49}$	9	134	$3\frac{27}{47}+\frac{15}{49}$	13	199	$2\frac{12}{41}-\frac{4}{49}$	11
57	$4\frac{40}{47}+\frac{3}{49}$	7	137	$3\frac{17}{43}-\frac{9}{49}$	11	201	$2\frac{18}{47}+\frac{10}{49}$	13
59	$7\frac{10}{47}+\frac{12}{49}$	11	138*	$\frac{11}{33}-\frac{1}{23}$	...	202	$3\frac{10}{41}+\frac{6}{49}$	17
61	$3\frac{42}{47}+\frac{2}{49}$	6	139	$2\frac{25}{37}+\frac{24}{49}$	11	203	$1\frac{23}{39}+\frac{9}{49}$	9
63	$4\frac{19}{29}+\frac{14}{33}$	8	141	$1\frac{32}{39}+\frac{22}{49}$	8	204	$2\frac{20}{41}+\frac{3}{49}$	13
67	$2\frac{27}{41}+\frac{16}{49}$	5	142	$4\frac{1}{47}+\frac{10}{49}$	15	206	$2\frac{34}{39}+\frac{2}{49}$	15
69*	$2\frac{1}{23}-\frac{11}{33}$	...	143	$1\frac{36}{47}-\frac{18}{49}$	5	207	$3\frac{8}{41}-\frac{24}{49}$	14
71	$3\frac{34}{41}-\frac{22}{49}$	6	146	$2\frac{3}{37}-\frac{8}{49}$	7	208	$1\frac{19}{47}+\frac{16}{49}$	9
73	$6\frac{28}{47}-\frac{1}{49}$	12	147*	$\frac{13}{39}-\frac{3}{49}$	...	209	$\frac{8}{49}+\frac{9}{41}$	2
77*	$\frac{9}{21}+\frac{3}{33}$	...	149	$3\frac{5}{43}-\frac{8}{49}$	11	211	$1\frac{28}{39}+\frac{18}{49}$	11
79	$2\frac{42}{43}+\frac{3}{49}$	6	151	$1\frac{42}{43}-\frac{6}{49}$	7	212	$3\frac{4}{47}+\frac{6}{49}$	17
81	$5\frac{5}{41}-\frac{9}{49}$	10	153	$2\frac{45}{47}-\frac{4}{49}$	11	213	$1\frac{18}{39}+\frac{2}{49}$	8
83	$3\frac{45}{47}-\frac{5}{49}$	8	154*	$\frac{8}{21}-\frac{4}{33}$	...	214	$3\frac{9}{47}-\frac{19}{49}$	15
87*	$2\frac{3}{29}-\frac{11}{33}$	...	157	$2\frac{23}{31}+\frac{2}{33}$	11	217	$2\frac{3}{43}+\frac{16}{49}$	13
89	$3\frac{28}{39}-\frac{6}{49}$	8	158	$5\frac{5}{43}-\frac{15}{49}$	19	218	$1\frac{22}{47}-\frac{9}{49}$	7
91*	$\frac{6}{39}+\frac{14}{49}$	...	159	$2\frac{7}{37}+\frac{16}{49}$	10	219	$3\frac{29}{43}-\frac{10}{49}$	19
93*	$\frac{3}{31}+\frac{11}{33}$	...	161	$2\frac{10}{39}-\frac{1}{49}$	9	221	$1\frac{5}{47}-\frac{1}{49}$	6
96*	$\frac{3}{18}+\frac{5}{20}$	...	162	$1\frac{30}{39}-\frac{2}{49}$	7	222	$2\frac{8}{43}-\frac{10}{49}$	11
97	$4\frac{27}{41}-\frac{6}{49}$	11	163	$3\frac{7}{37}-\frac{24}{49}$	11	223	$2\frac{26}{43}+\frac{13}{49}$	16
99*	$1\frac{5}{27}-\frac{5}{33}$	...	166	$1\frac{19}{43}+\frac{12}{49}$	7	224	$2\frac{6}{23}+\frac{2}{33}$	13
101	$4\frac{32}{43}-\frac{19}{49}$	11	167	$2\frac{1}{29}+\frac{4}{33}$	9	225*	$\frac{5}{18}-\frac{2}{20}$	...
102	$4\frac{17}{43}-\frac{4}{49}$	11	169	$1\frac{32}{37}+\frac{13}{49}$	9	226	$1\frac{38}{39}+\frac{16}{49}$	13
103	$1\frac{8}{43}+\frac{18}{49}$	4	171	$1\frac{29}{47}+\frac{1}{49}$	7	227	$3\frac{3}{43}+\frac{5}{49}$	18
106	$2\frac{38}{41}+\frac{23}{49}$	9	173	$1\frac{7}{43}+\frac{11}{49}$	6	228	$2\frac{8}{41}-\frac{13}{49}$	11
107	$2\frac{21}{31}-\frac{2}{33}$	7	174*	$\frac{11}{33}-\frac{3}{29}$	...	229	$2\frac{19}{41}-\frac{18}{49}$	12
109	$2\frac{19}{39}+\frac{4}{49}$	7	175	$1\frac{4}{31}+\frac{8}{33}$	6	231*	$\frac{3}{21}+\frac{1}{33}$	...
111	$3\frac{29}{47}+\frac{17}{49}$	11	176	$1\frac{14}{43}+\frac{13}{49}$	7	233	$1\frac{36}{47}+\frac{6}{49}$	11
112	$4\frac{10}{31}-\frac{13}{33}$	11	177	$2\frac{19}{47}+\frac{4}{49}$	11	234	$2\frac{21}{29}+\frac{6}{33}$	17
113	$3\frac{26}{47}-\frac{18}{49}$	9	178	$3\frac{28}{47}+\frac{11}{49}$	17	236	$2\frac{30}{43}+\frac{9}{49}$	17
114	$1\frac{35}{37}+\frac{25}{49}$	7	179	$2\frac{34}{47}-\frac{13}{49}$	11	237	$2\frac{12}{47}-\frac{3}{49}$	13
117	$7\frac{1}{47}-\frac{9}{49}$	20	181	$2\frac{8}{43}+\frac{12}{49}$	11	238	$2\frac{3}{31}+\frac{14}{33}$	15
118	$1\frac{8}{39}+\frac{24}{49}$	5	182*	$\frac{3}{39}+\frac{7}{49}$	...	239	$1\frac{23}{43}+\frac{15}{49}$	11
119	$3\frac{4}{23}-\frac{16}{33}$	8	183	$1\frac{24}{41}+\frac{8}{49}$	8	241	$1\frac{1}{41}+\frac{23}{49}$	9
121	$1\frac{14}{47}-\frac{15}{49}$	3	186*	$1\frac{7}{31}-\frac{11}{33}$	...	242	$2\frac{23}{41}-\frac{4}{49}$	15
122	$3\frac{41}{43}-\frac{17}{49}$	11	187	$1\frac{20}{47}+\frac{14}{49}$	8	243	$1\frac{29}{41}-\frac{3}{49}$	10
123	$1\frac{12}{43}+\frac{17}{49}$	5	189	$2\frac{26}{41}-\frac{15}{49}$	11	244	$2\frac{15}{31}+\frac{10}{33}$	17
125	$2\frac{33}{41}-\frac{12}{49}$	8	191	$1\frac{38}{47}+\frac{14}{49}$	10	246	$1\frac{6}{43}-\frac{16}{49}$	5
126	$3\frac{16}{19}-\frac{7}{20}$	11	192	$2\frac{22}{41}-\frac{12}{49}$	11	247	$2\frac{15}{43}-\frac{4}{49}$	14
127	$2\frac{23}{39}+\frac{12}{49}$	9	193	$1\frac{5}{37}-\frac{15}{49}$	4	249	$3\frac{4}{43}-\frac{2}{49}$	19
129	$5\frac{24}{41}+\frac{15}{49}$	19	194	$2\frac{22}{37}-\frac{16}{49}$	11	250	$2\frac{9}{37}-\frac{8}{49}$	13
131	$2\frac{40}{43}+\frac{21}{49}$	11	197	$1\frac{39}{43}+\frac{16}{49}$	11	...	....	...

* The indexing movements are exact for the divisions marked with an asterisk (*);
The errors of the other divisions are so slight as to be negligible for all ordinary classes of work, such as gear cutting etc.

This shows that these circles can be used. The factors 2, 2 and 11 remain uncancelled below the line. The amount the crank and index plate must be moved in their respective circles is next determined by multiplying together all these uncanceled factors. Thus 2 X 2 X 11 = 44. This means that we can index is revolution by turning the crank forward 44 holes in the 23-hole circle, and the index plate backward 44 holes in the 33-hole circle. The movement could also be forward 44 holes in the 33-hole circle and backward 44 holes in the 23-hole circle, without affecting the result. The movements obtained by the foregoing rule are expressed in compound indexing tables in the form of fractions, as, for example:

$$+\ \frac{44}{23}\ -\ \frac{44}{33}$$

The numerators represent the number of holes indexed and the denominators the circles used; the + and - signs show that the movements of the crank and index plate are opposite in direction. These fractions can often be reduced and simplified, so that it will not be necessary to move so many holes, by adding some number to them algebraically. The number is chosen by trial, and its sign should be opposite that of the fraction to which it is added. Suppose, for example, a fraction is added representing one complete turn, to each of the fractions referred to; then there will be a movement Of 21 holes in the 23-hole circle, and a movement of 11 holes in the opposite direction, in the 33-hole circle.

Differential Indexing: - This method is the same, in principle, as compound indexing, but differs from the latter in that the index plate is rotated by suitable gearing which connects it to the spiral-head spindle. This rotation or differential motion of the index plate takes place when the crank is turned, the plate moving either in the same direction as the crank or opposite to it, as may be required. The result is that the actual movement of the crank, at every indexing, is either greater or less than its movement with relation to the index plate. The differential method makes it possible to obtain almost any division, by using only one circle of holes for that division and turning the index crank in one direction, the same as for plain indexing. The gears to use for moving the index plate the required amount (when gears are required) are shown by the tables, " Simple and Differential Indexing." This table shows what divisions can be obtained by plain indexing, and also when it is necessary to use gears and the differential system. For example, if 50 divisions are required, the 20-hole index circle is used and the crank is moved 16 holes, but no gears are required. For 51 divisions, a 24-tooth gear is placed on the worm shaft and a 48-tooth gear is mounted on the spindle. Two idler gears having 24 and 44 teeth, respectively, connect these two gears. To illustrate the principle of differential indexing, suppose a dividing head is to be geared for 271 divisions. The table calls for a gear on the worm-shaft having 56 teeth; a spindle gear with 72 teeth; and a 24-toothed idler, which serves to rotate the index plate in the same direction as the crank. The sector should be set for giving the crank a movement of, 3 holes in the 21-hole circle. If the spindle and index plate were not connected through gearing, 280 divisions would be obtained by successively moving the crank 3 holes in the 21-hole circle, but the gears cause the index plate to turn in the same direction as the crank at such a rate that, when 271 indexings have been made, the work is turned one complete revolution; therefore, we have 271 divisions instead Of 280, the number being reduced because the total movement of the crank, for each indexing, is equal to its movement relative to the index plate, *plus* the movement of the plate itself when (as in this case) the crank and plate rotate in the same direction. If they were rotated in opposite directions, the crank would have a total movement equal to the amount it turned relative to the plate, *minus* the plate's movement. Sometimes it is necessary to use compound gearing, in order to move the index plate the required amount for each turn of the crank. The differential method cannot be used in connection with helical or spiral milling & because the spiral head is then geared to the lead-screw of the machine.

To Find Ratio of Gearing for Differential Indexing. - To find the gearing ratio for differential indexing, first select some approximate number A of divisions either greater or less than the required number N. To illustrate, if the required number N is 67**,** the approximate number A might be 70; then if 40 turns of the index crank are required for 1 revolution of the spindle,

$$\text{Gearing ratio R} = (A - N) \times \frac{40}{A}$$

If the approximate number A is less than N, the formula is the same as above except that A - *N* is replaced by *N* - *A*.

Example: Find the gearing ratio and indexing movement for 67 divisions. If *A* - 70,

$$\text{Gearing Ratio} = (70 - 67) \quad \frac{\mathbf{40}}{\mathbf{70}} = \frac{\mathbf{12}}{\mathbf{7}} = \text{Gear on spindle (driver)}$$

The fraction 12/ 7 is raised to obtain a numerator and denominator equivalent to available gears. For example,

Various combinations of gearing and index circles are possible for a given number of divisions. The index movements and gear combinations in the accompanying table apply to a given series of index circles and gear-tooth numbers. The approximate number A upon which any combination is based may be determined by dividing 40 by the fraction representing the indexing movement. For example, the approximate number used for 109 divisions equals

$$40 \text{ divided by } \frac{\mathbf{6}}{\mathbf{16}} \text{ Or } 40 \times \frac{\mathbf{16}}{\mathbf{6}} = 106\tfrac{2}{3}$$

If this approximate number is inserted in the preceeding formula, it will be found that the gear ratio is $\frac{7}{8}$ as shown in the table.

Second Method of Determining Gear Ratio. - In illustrating a somewhat different method of determining the gear ratio, 67 divisions will again be used. If 70 is selected as the approximate number, then turn of the index crank will be required

$$\frac{40}{70} = \frac{4}{7} \text{ or } \frac{12}{21}$$

If the crank is indexed four-sevenths of a turn sixty-seven times, it will make 4 X 67 – 38 $\frac{2}{7}$ revolutions. This is 1 $\frac{5}{7}$ turns less than the forty required for one revolution of the work (indicating that the gearing should be arranged to rotate the index plate in the same direction as the index crank to increase the indexing movement); hence the gear ratio

$$= 1\frac{5}{7} = \frac{12}{7}$$

To Find the Indexing Movement. - The indexing movement is represented

By the fraction $\frac{40}{A}$

For example, if 70 is the approximate number A used in calculating the gear ratio for 67 divisions, then, to find the required movement of the index crank, reduce 18 to any fraction of equal value and having as denominator any number equal to the number of holes available in an index circle. To illustrate,

$$\frac{40}{70} = \frac{4}{7} \text{ or } \frac{12}{21} = \frac{\text{Number of holes indexed}}{\text{Number of holes in index circle}}$$

Use of Idler Gears. - In differential indexing, idler gears are used **(1)** to rotate the index plate in the same direction as the index crank, thus *increasing* the actual indexing movement, or (2) to rotate the index plate in the opposite direction, thus *reducing* the actual indexing movement.

Case 1: If the approximate number A is *greater* than the actual number of divisions **N**, simple gearing will require one idler, and compound gearing no idler. Index plate and crank rotate in the same direction.

Case **2:** If the approximate number A *is less* than the actual number of divisions **N**, simple gearing requires two idlers, and compound gearing one idler. Index plate and crank rotate in opposite directions.

When Compound Gearing Is Required **-** In some cases, as when noted by referring to the table, it is necessary to use a train of four gears in order to obtain the required ratio with gear-tooth numbers in the available series.
Example: Find the gear combination and indexing movement for 99 divisions; assuming that an approximate number *A* of 100 is used.

$$\text{Ratio} = (100 - 99) \times \frac{40}{100} = \frac{4}{10} = \frac{4 \times 1}{5 \times 2} = \frac{32}{40} \times \frac{28}{56}$$

These final numbers conform to available gear sizes. The gears having **32** and **28** teeth are the drivers (gear on spindle and first gear on stud), and gears having 40 and 56 teeth are driven (second gear on stud and gear on worm).

The indexing movement is represented by the fraction 40/100, which is reduced to 8/20, the 20-hole index circle being used in this case.
Example: Determine the gear combination to use for indexing 53 divisions. If 56 is used as an approximate number (possibly after one or more trial solutions to find an approximate number and resulting gear ratio coinciding with available gears).

$$\text{Gear ratio} = (56 - 53) \text{ X } \frac{40}{56} = \frac{15}{7} = \frac{3 \text{ X } 5}{1 \text{ X } 7} = \frac{72 \text{ X } 42}{24 \text{ X } 56}$$

The tooth numbers above the line represent *gear on spindle and* first gear *on stud.* The numbers below the line represent *second gear on stud and gear on* worm.

$$\text{Indexing movement} = \frac{40}{56} = \frac{5}{7} = \frac{5 \text{ X } 7}{7 \text{ X } 7} = \frac{35 \text{ holes}}{49 \text{ hole circle}}$$

In setting sector arms, do not count the hole containing the index crank pin.

To Check the Number of Divisions Obtained with a Given Gear Ratio and Index Movement. - Invert the fraction representing the indexing movement and let C equal this inverted fraction. R = gearing ratio.

Case 1: If simple gearing is used with one idler or compound gearing with no idler,

$$\text{Number of divisions N} = 40\,C - RC$$

Case 2: If simple gearing is used with two idlers or compound gearing with one idler,

$$\text{Number of divisions N} = 40\,C + RC$$

Example: The gear ratio is 12/7 there is simple gearing and one idler (Case **1**), and the indexing movement is 12/21 making the inverted fraction C = 21/12 find the number of divisions N

$$N = 40 \text{ X } \frac{21}{12} - \frac{12}{7} \text{ X } \frac{21}{12} = 70 - \frac{21}{7} = 67$$

Example: The gear ratio is ⅞ two idlers are used with simple gearing (Case **2**) and the indexing movement is 6 holes in the 16-hole circle. Then.

$$N = 40 \text{ X } \frac{16}{6} + \frac{7}{8} \text{ X } \frac{16}{6} = 109$$

Block or Multiple Indexing for Gear Cutting

Teeth to be Cut	Number Indexed at Once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disk	Teeth to be Cut	Number Indexed at Once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disk
25	4	100	50	72	30	4	77	4	100	70	96	44	2
26	3	100	50	90	52	4	78	5	100	30	90	78	2
27	2	100	50	60	54	4	80	3	100	50	90	80	2
28	3	100	50	90	56	4	81	7	100	30	84	52	2
29	3	100	50	90	58	4	82	5	100	30	90	82	2
30	7	100	30	84	40	4	84	5	100	30	90	84	2
31	3	100	50	90	62	4	85	4	100	50	96	68	2
32	3	100	50	90	64	4	86	5	100	30	90	86	2
33	4	100	50	80	44	4	87	7	100	30	84	58	2
34	3	100	50	90	68	4	88	5	100	30	90	88	2
35	4	100	50	96	56	4	90	7	100	30	70	50	2
36	5	100	48	80	40	4	91	3	100	70	72	52	2
37	5	100	30	90	74	4	92	5	100	30	90	92	2
38	5	100	30	90	76	4	93	7	100	30	84	62	2
39	5	100	30	90	78	4	94	5	100	30	90	94	2
40	3	100	50	90	80	4	95	4	100	50	96	76	2
41	5	100	30	90	82	4	96	5	100	30	90	96	2
42	5	100	30	90	84	4	98	5	100	30	90	98	2
43	5	100	30	90	86	4	99	10	100	30	80	44	2
44	5	100	30	90	88	4	100	7	100	50	84	40	2
45	7	100	50	70	30	4	102	5	100	30	60	68	2
46	5	100	30	90	92	4	104	5	100	60	90	52	2
47	5	100	30	90	94	4	105	4	100	70	96	60	2
48	5	100	30	90	96	4	108	7	100	30	70	60	2
49	5	100	30	90	98	4	110	7	100	50	84	44	2
50	7	100	50	84	40	4	111	5	100	74	80	40	2
51	4	100	30	96	68	2	112	5	100	60	90	56	2
52	5	100	30	90	52	2	114	7	100	30	84	76	2
54	5	100	30	90	54	2	115	8	100	50	96	46	2
55	4	100	50	96	44	2	116	5	100	60	90	58	2
56	5	100	30	90	56	2	117	8	100	30	96	78	2
57	4	100	30	96	76	2	119	3	100	70	72	68	2
58	5	100	30	90	58	2	120	7	100	50	70	40	2
60	7	100	30	84	40	2	121	4	60	66	96	44	2
62	5	100	30	90	62	2	123	7	100	30	84	82	2
63	5	100	30	80	56	2	124	5	100	60	90	62	2
64	5	100	30	90	64	2	125	7	100	50	84	50	2
65	4	100	50	96	52	2	126	5	100	50	50	42	2
66	5	100	44	80	40	2	128	5	100	60	90	64	2
67	5	100	30	90	67	2	129	7	100	30	84	86	2
68	5	100	30	90	68	2	130	7	100	50	84	52	2
69	5	100	46	80	40	2	132	5	100	88	80	40	2
70	3	100	50	90	70	2	133	4	100	70	96	76	2
72	5	100	30	90	72	2	134	5	100	60	90	67	2
74	5	100	30	90	74	2	135	7	100	50	84	54	2
75	7	100	30	84	50	2	136	5	100	60	90	68	2
76	5	100	30	90	76	2	138	5	100	92	80	40	2

Block or Multiple Indexing for Gear Cutting

Teeth to be Cut	Number Indexed at Once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disk	Teeth to be Cut	Number Indexed at Once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disk
140	3	50	50	90	70	2	170	7	100	50	84	68	2
141	5	100	94	80	40	2	171	5	70	42	80	76	2
143	6	90	66	96	52	2	172	5	100	60	90	86	2
144	5	100	60	90	72	2	174	7	100	60	84	58	2
145	6	100	50	72	58	2	175	8	100	50	96	70	2
147	5	100	98	80	40	2	176	5	100	60	90	88	2
148	5	100	60	90	74	2	180	7	100	60	70	50	2
150	7	100	60	84	50	2	182	9	90	56	96	52	2
152	5	100	60	90	76	2	184	5	100	60	90	92	2
153	5	100	68	80	60	2	185	6	100	50	72	74	2
154	5	100	56	72	66	2	186	7	100	60	84	62	2
155	6	100	50	72	62	2	187	5	100	44	48	68	2
156	5	100	60	90	78	2	188	5	100	60	90	94	2
160	7	100	50	84	64	2	189	5	100	60	80	84	2
161	5	100	70	60	46	2	190	7	100	50	84	76	2
162	7	100	60	84	52	2	192	5	100	60	90	96	2
164	5	100	60	90	82	2	195	7	100	50	84	78	2
165	7	100	50	84	66	2	196	5	100	60	90	98	2
168	5	100	60	90	84	2	198	7	100	50	70	66	2
169	6	96	52	90	78	2	200	7	60	60	84	40	2

Block or Multiple Indexing for Gear Cutting -With the block system of indexing, a number of teeth are indexed at one time, instead of cutting the teeth consecutively, and the gear is revolved several times before the teeth are all finished. For example, when cutting a gear having 25 teeth, the indexing mechanism is geared to index four teeth at once (see table). The first time around, six widely separated tooth spaces are cut. The second time around, the cutter is one tooth behind the spaces previously milled. On the third indexing, the cutter has dropped back another tooth, thus finishing the gear (in this case) by indexing it around four times. The various combinations of change gears to use for block or multiple indexing are given in the accompanying table. The advantage claimed for block indexing is that the heat generated by the cutter (especially when cutting cast-iron gears of coarse pitch) is distributed more evenly about the rim and dissipated to a greater extent, thus avoiding distortion due to local heating and permitting higher speeds and feeds. The table given is intended for use with **Brown & Sharpe automatic gear-cutting machines**, but the gears for any other machine equipped with a similar indexing mechanism can be calculated. Assume, for example, that a gear cutter requires the following change gears for indexing a certain number of teeth: Driving gears having 20 and 30 teeth, respectively, and driven gears having 50 and 60 teeth. Then if it is desired to cut, say, every fifth tooth, multiply the fractions

$$\frac{20}{60} \text{ And } \frac{30}{50} \text{ By 5. Then, } \frac{20}{60} \text{ X } \frac{30}{50} \text{ X } \frac{5}{1} \text{ X } \frac{1}{1}$$

In this particular instance, then the blank could be divided so that every fifth space would be cut, by using gears of equal size. The number of teeth in the gear and the number of teeth indexed in each block must not have a, common factor.

Indexing for Rack Cutting -When racks are cut on a milling machine, there are two general methods of indexing. One is by using the graduated dial on the feed-screw and the other is by using an indexing attachment. The accompanying table shows the indexing movements when the first method is employed. This table applies to milling machines having feed-screws with the usual lead of ¼ inch and 250 dial graduations each equivalent to 0.001 inch of table movement.

$$\text{Actual rotation of feed screw} = \frac{\text{Linear pitch of rack}}{\text{Lead of feed-screw}}$$

Multiply *decimal* part of turn (obtained by above formula) by 250, to obtain dial reading for fractional part of indexing movement, assuming that dial has 250 graduations.

Indexing Movements for Cutting Rack Teeth on Milling Machine

These movements are for table feed-screws having the usual lead of ¼ inch

Pitch of Rack Tooth		Indexing, Movement		Pitch of Rack Teeth		Indexing, Movement	
Diametral Pitch	Linear or Circular	No. of Whole Turns	No. of .001 Inch Divisions	Diametral Pitch	Linear or Circular	No. of Whole Turns	No. of .001 Inch Divisions
2	1.5708	6	70.8	12	0.2618	1	11.8
2¼	1.3963	5	146.3	13	0.2417	0	241.7
2½	1.2566	5	6.6	14	0.2244	0	224.4
2¾	1.1424	4	142.4	15	0.2094	0	208.4
3	1.0472	4	47.2	16	0.1963	0	196.3
3½	0.8976	3	147.6	17	0.1848	0	184.8
4	0.7854	3	35.4	18	0.1745	0	174.8
5	0.6283	2	128.3	19	0.1653	0	165.3
6	0.5236	2	23.6	20	0.1571	0	157.1
7	0.4488	1	198.8	22	0.1428	0	142.8
8	0.3927	1	142.7	24	0.1309	0	130.9
9	0.3491	1	99.1	26	0.1208	0	120.8
10	0.3142	1	64.2	28	0.1122	0	112.2
11	0.2856	1	35.6	30	0.1047	0	104.7

Note: The linear pitch of the rack equals the circular pitch of gear or pinion, which Is to mesh with the rack. The table gives both standard diametral pitches and their equivalent linear or circular pitches.

Example. - Find indexing movement for cutting rack to mesh with a pinion of 10-diametral pitch.

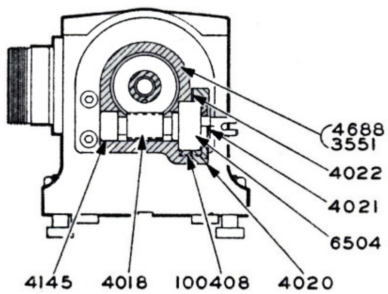
Indexing movement equals 1 whole turn of feed-screw plus 64.2 thousandths or divisions on feed-screw dial. The feed-screw may be turned this fractional amount by setting dial back to its zero position for each indexing (without backward movement of feed-screw), or, if preferred, 64.2 (in this example) may be added to each successive dial position as shown below.

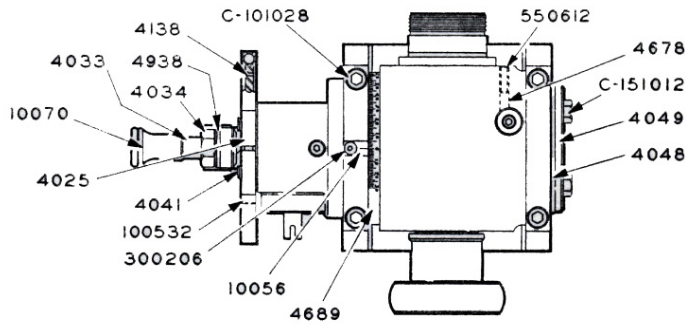
Dial reading for second position = 64.2 X 2 = 128.4 (complete movement = 1 turn + 64.2 additional divisions by turning feed-screw until dial reading is 128-4).

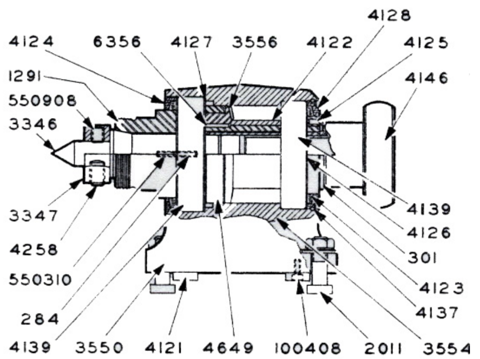
Third dial position = 64.2 X 3 = 192.6 (complete movement = 1 turn + 64.2 additional divisions by turning until dial reading is 192.6).

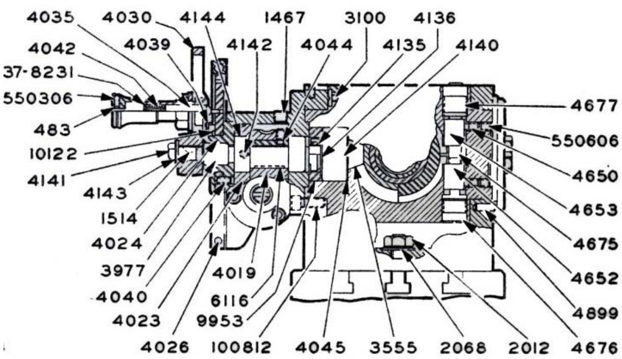
Fourth position = 64.2 X 4 - 250 = 6.8 (1 turn + 64.2 additional divisions by turning feed-screw until dial reading is 6.8 divisions past the zero mark); or, to simplify operation, set dial back to zero for fourth indexing (without moving feed-screw) and then repeat settings for the three previous indexings or whatever number can be made before making a complete turn of the dial.

Parts List for Hardinge TM-UM Dividing Head Assembly





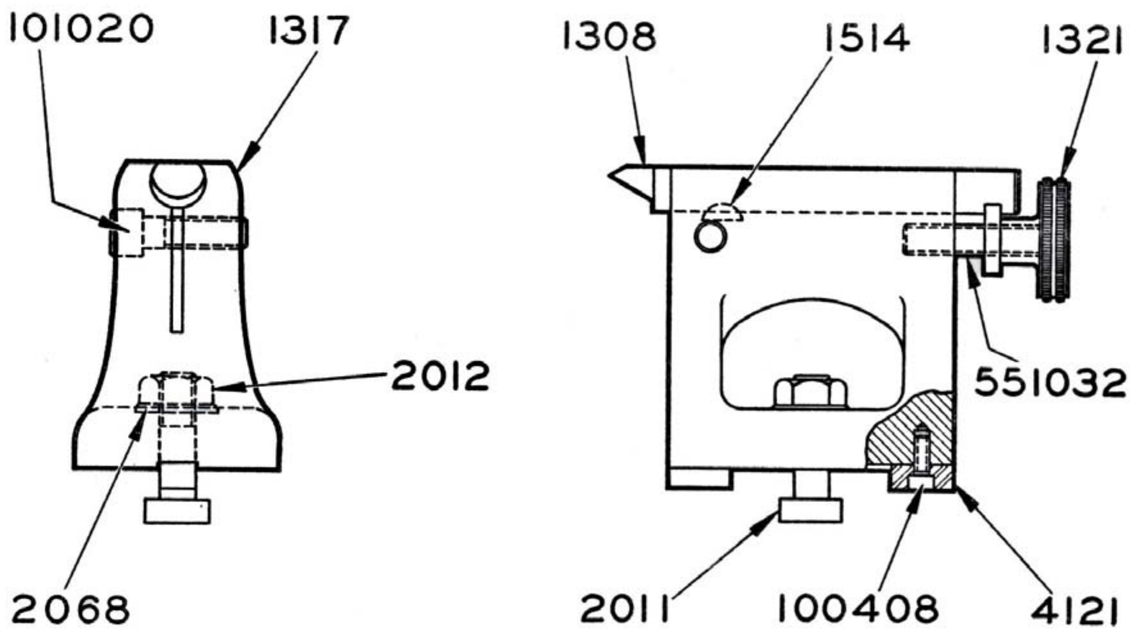




Part No.	No. Used	Part Name	Part No.	No. Used	Part Name	Part No.	No. Used	Part Name
284	1	Key Screw	4034	1	Lock Nut	4649	1	Lock Ring
301	1	Draw Spindle	4035	1	Plunger	4650	2	Keys
483	1	Plug	4039	1	Lock Screw	4652	1	Lock Bolt “lower”
1291	1	‡ Spindle	4040	3	Plate Screws	4653	1	Lock Bolt “upper”
1467	1	Plug	4041	1	Washer	4675	1	Lock Stud
1514	1	Key	4042	1	Spring	4676	1	Plug “lower”
2011	2	Screws	4044	1	Gear Screw	4677	1	Plug “upper”
2012	2	Nuts	4045	1	Shim	4678	2	Brass Plugs
2068	2	Washers	4048	1	Stop Plate	4688	1	Housing “plain”
3100	3	Screws	4049	1	Cover	4689	1	Graduation Ring
3346	1	Center	4121	2	Keys	4899	1	Dowel Pin
3347	1	Driving Dog	4122	1	Spacer	4938	1	Washer
3550	1	Base	4123	2	† Felt Washers	6116	1	Key
3551	1	Housing	4124	1	Front Felt Retainer	6356	1	Gear Key
3554	1	Body	4125	1	Lock Nut	6504	1	Bearing
3555	1	Pinion	4126	2	† Retaining Washers	37-8231	1	Snap Ring
3556	1	Gear	4127	1	Front Bearing Washer	9953	1	Retaining Nut
3977	1	Bearing	4128	1	Rear Retainer	10056	1	Zero Line Block
4018	1	* Worm	4135	1	Lock Nut	10070	1	Knob for Plunger
4019	1	Worm Gear	4136	1	Lock Washer	10122	1	Sector Arm Assm
4020	1	*Worm Bearing Cap	4137	1	Retainer Ring	100408	5	Key Screws
4021	1	* Lock Nut	4138	1	Index Plate	100532	1	Lock Bolt
4022	1	* Shim	4139	1	Bearing	100812	4	Worm Housing Screws
4023	1	Bushing	4140	1	Pinion Bearing	C-101028	4	Cap Screws
4024	1	Shaft	4141	1	Nut	C-151012	2	Stop Plate Screws
4025	1	Clamp Ring	4142	2	Screws	300206	1	Zero Block Screw
4026	1	Space Pin	4143	1	Washer	550306	2	Lock Screws
4030	1	Handle	4144	2	Bearings	550310	1	Lock Screw
4033	1	Sleeve	4145	1	* Worm Bearing	550606	2	Lock Screws
			4146	1	Handle Support Assm.	550612	2	Lock Screws
			4258	2	Set Screws	550908	1	Center Lock Screw

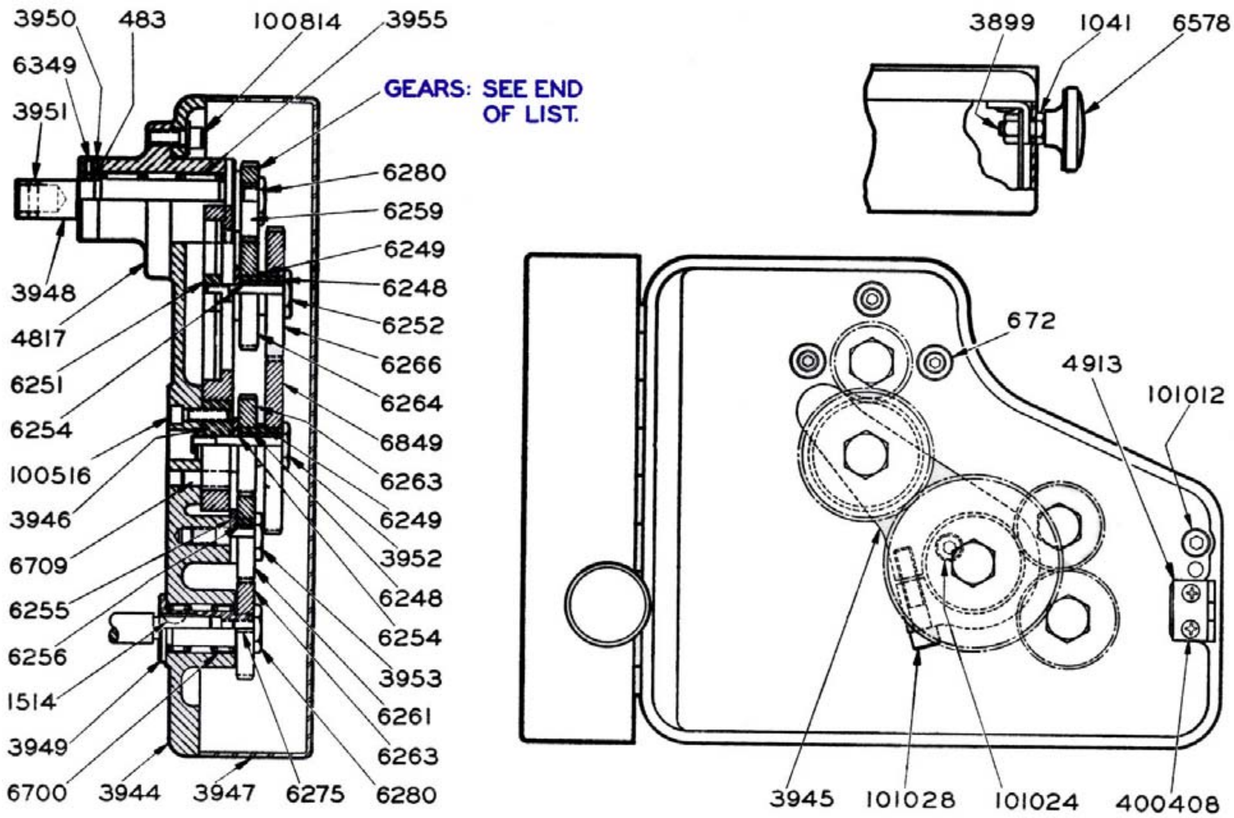
☺ *These Parts Not Used on Plain Dividing Head. ☺ † When Ordering Specify Front or Rear. ☺ ‡ When Ordering Specify Threaded or Taper

Parts List for Hardinge TM-UM Tailstock Assembly



Part No.	No. Used	Part Name	Part No.	No. Used	Part Name	Part No.	No. Used	Part Name
1308	1	Spindle	2011	1	Screw	100408	2	Key Screws
1317	1	Tailstock Body	2012	1	Nut	101020	1	Clamp Screw
1321	1	Handwheel	2068	1	Washer	551032	1	Handwheel Screw
1514	1	Key	4121	2	Table Keys			

Parts List for Hardinge TM-UM Tailstock Assembly



Part No.	No. Used	Part Name	Part No.	No. Used	Part Name	Part No.	No. Used	Part Name
483	1	Plug	3955	1	Bearing	6275	2	Keys
672	4	Washers	4817	1	Shaft Bushing	6280	2	Screws
1041	1	Nut	4913	1	Latch Plate	6349	1	Lock Nut Screw
1514	1	Key	6248	2	Bushings	6578	1	Knob
3899	1	Stud	6249	2	Spacers	6700	2	Bearings
3944	1	End Plate	6251	1	Clamp Nut	6709	2	Dowel Pins
3945	1	Bracket	6252	1	Clamp Bolt	6849	1	80 tooth Gear
3946	1	Plug	6254	2	Bushings (long)	100516	2	Plug Screw
3947	1	Guard	6255	1	Bushing (short)	100814	4	Bushing Screws
3948	1	Shaft	6256	1	Gear Bushing	101012	1	End Plate Screw
3949	1	Feed Screw Shaft	6259	1	35 Tooth Gear	101024	1	Screw
3950	1	Lock Nut	6261	2	40 Tooth Gear	101028	1	Bracket Screw
3951	1	Drive Screw	6263	2	45 Tooth Gear	400408	7	Guard Screw
3952	1	Long Clamp Bolt	6264	3	50 Tooth Gear			
3953	1	Short Clamp Bolt	6266	1	60 Tooth Gear			