TOOL MAKER'S MANUAL

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SCREW THREADS

It is generally known that the effective diameter of a thread is one of the most important characteristics which guarantees the interchangeability of male and female threads. In the shop and inspection departments, thread micrometers are most commonly used to control the effective diameter. One of the disadvantages of the thread micrometer is the narrow scope which is covered by such a micrometer, so that 4 or 5 thread micrometers are necessary to cover the control of threads up to one inch, causing a considerable investment for small shops, operators or inspectors.

The following tables and the description of a simple gadget give the turner and inspector the possibility to check the effective diameter of the commonly used threads in a cheap and very precise way. An investment of a few coppers for sewing needles and a few rubber discs (easily obtainable from a bicycle shop) are necessary and the threads can easily be checked, based on the generally known "three wire method". Push three needles of the appropriate size (see tables) through the rubber discs (see fig. 1) in such a way that, when gadget is put over the thread the elasticity of the rubber discs secures a precise position plus measurement over the needles with an ordinary micrometer. Compare the achieved measurement with the column "measurement over wires" in the table. If the obtained measurement is oversize or undersize in comparison with the figures in the table, the effective diameter is oversize or undersize for the same amount.

EXAMPLES:

$\frac{3}{8}$in. B.S.F. 1. Use needle No. 6, diameter .029in. according to table, obtained measurement over needles .400in. compared with figure in the table.................. .3868in.

effective diameter of thread oversize .... .0132in.

5/16in. B.S.F. 2. Use needle No. 7, diameter .026in. according to table, obtained measurement over needles .320in. compared with figure in table .... .322in.

effective diameter of thread undersize .... .002in.

The figures "measurement over wires" in the tables are worked out on the following basic formulas:—

Whitwork 55° thread.

$$\text{Measurement over wires} = \text{eff. dia} + 4.9939W - \frac{.9605}{N}$$

B.A. 47½° thread.

$$\text{Measurement over wires} = \text{eff. dia.} + 3.4829W - \frac{1.13633}{N}$$

The system of checking can be further extended to bigger threads, using for this purpose either music wires or the cylindrical parts of small drills. If Acme or Worm threads are to be checked, the following formula is valid:—

Acme form 29° thread.

$$\text{Measurement over wires} = \text{effff. dia.} + 4.9939W - \frac{1.93334}{N}$$

V.S. National form 60° thread.

Measurement over wires $= \text{eff. dia.} + 3W - \frac{.86602}{N}$

W = dia. of wire (needle).

N = number of threads per inch.

TESTING OF THREAD ANGLES

To check the thread angle, two measurements over the wires are necessary. For the first measurement the needle sizes recommended in the table can be used. For the second measurement larger needle or wire sizes ought to be used which have a diameter approx. 0.7 — 0.8 × pitch. In the case of a Whitworth thread, the thread angle is 55° (included angle), and the following formula which applies to any thread, regardless of angle, can be used:—

$$\sin d = \frac{A}{B - A}$$

A = difference in diameter of the large and small wire used.

B = difference between measurements over large and small wire.

d = one half of the included thread angle.

SETTING UP AND MEASURING OF ANGLES

The standard tools for laying-out and measuring of angles are the protractor and the sine bar. When issuing the sine bar for checking, the component has to be put on the sine bar or sine table and slip gauges are placed under one end of the bar until one angle face is parallel to the surface plate (fig. 2). To find the appropriate amount of slips which have to be used, the figures for "sine" in the trigonometric table have to be looked up. In case of a 10in. sine bar the figures in the table have to be multiplied by 10, if a 5in. bar has to be used, the figures have to be multiplied by 5.

EXAMPLE:

To set up a 30° angle, the sine of 30° has to be looked up in the trigonometric table.

Sine 30° = 0.500, for 10in. sine bar a 5in. slip has to be used, for 5in. sine bar, 2.500 slips have to be used.

If the job in question is too bulky to be put on the sine bar, or an adjustable angle bracket has to be set up, the sine bar can be turned over and can be used as explained in fig. 3. In such a case, the height over the roller has to be taken with the height gauge and the difference in the heights has to correspond with the figures of the sine of the trigonometric table multiplied by 10 or 5 respectively.

If the faces are too small to permit the use of a 10in. or 5in. sine bar, an auxiliary 1in. sine bar is easily made up by two 1-in. rollers, as shown in fig. 4. The rollers are touching each other and the difference in heights taken over the rollers must correspond with the figures of the trigonometric table. A piece of plasticine helps to keep the rollers in position.

CHECK OF ANGLE WITH TWO ROLLERS (fig. 5).

Set up one face of angle perpendicular to surface plate and ascertain perpendicular centre-distance of rollers by means of a dial or height gauge. (Watch unequal roller diameters). The angle can be worked out by means of formula $\tan\frac{a}{2} = \frac{R - r}{Cp.}$

R=radius of larger roller.

r=radius of smaller roller.

If the perpendicular setting of the job cannot be achieved, ascertain the centre-distance (C) with slip gauges and the angle can be worked out by means of formula $\sin\frac{a}{2} = \frac{R - r}{C}$

ANGULAR POSITIONING OF PINS (KEY WAYS) TO CENTRE LINE OF CYLINDER BORE (fig. 6).

The problem to position a pin or key way in angular relation to the centre line of the bore can be solved as follows. The requested angle between pin and centre line=a, the radius (R) of the bore is known, drop a roller in the bore (r=radius of roller) so that it touches the pin. Radius of pin is also known (A). The angle (b) can be worked out $\sin b = \frac{A + r}{R - r}$, measure with height gauge perpendicular position of centre of roller for centre of bore (y), calculate (y) by means of formula $y = (R - r) \times \cos(a + b)$. If the calculated value of (y) agrees with the measured value of (y), the centre angle (a) is correct.

MEASURING OF DOVETAIL SLIDES (figs. 7 & 8).

$$a = x - D\left(1 + \cot\frac{a}{2}\right),\ e = h \times \cot a,\ aft = a \div e.$$

$$b = y + D\left(1 \div \cot\frac{a}{2}\right),\ c = h \times \cot a,\ bft. = b - 2c.$$

The value for (x) can be obtained through micing over the rollers.

The value for (y) can be obtained by means of slip gauges between the two rollers. D=roller diameter.

YAPERS

SETTING A PRECISION TAPER (fig. 9).

The amount of a taper is usually given on the drawing, either in inches per foot or in degrees. To find the angle in degrees for given taper per foot, divide the taper in inches per foot by 24, the result of this division represents the tangents of half of the included angle (= angle with centre line).

Example: What angle is equivalent to taper 1in. per foot? $\frac{1}{24} = .04166$, $\tan\frac{a}{2} = .04166$, look up under "tan" in trigonometric table.

Result: $\frac{a}{2} = 2^{\circ}$ 23ft. 10in., $a = 4^{\circ}$ 46ft. 20in.

For setting up a taper on the lathe, look up under the column "tangents" the value of half of the included angle in the trigonometric table. This value represents the rise of the taper per inch and can easily be set up by means of a dial gauge which has to be fixed into the tool post on the centre line of the job. Use the lead screw nut (thread catching device) or slip gauges positioned against a stop to control the horizontal movement of the slide. If the rise of the clock per inch of the horizontal movement corresponds with the ascertained figure on the "tan" column, the taper is set up correctly.

Example: Set up included angle 4° 26ft. 20in., half included angle or angle with centre line=2° 13ft. 10in., tangents of this angle=.0416in., which figure represents the rise of the taper per inch of the clock fixed in the tool post.

CHECK OF TAPER.

The usual way of checking a taper is the sine bar. The job has to be put between the centres of the sine bar. Slips, corresponding to the angle with the centre line (see chapter—measuring of angles), have to be placed under the end of the sine bar. If the taper is correct, the face of the taper must be parallel to the surface plate.

TWO ROLLER METHOD: sleep taper (fig. 10).

The angle of a short and sleep taper can be checked by two micrometer readings over two pairs of rollers of different sizes. A=reading over large roller, B=reading over small roller, D and d=diameters of large and small rollers respectively.

$$\tan \frac{x}{2} = \frac{(D - d)}{(A - B) - (D - d)}$$

TWO ROLLER METHOD: small and long taper (fig. 11).

Taking two micrometer readings over a pair of rollers in a different heights, the taper can be worked out according to the formula:—

$$\tan x \frac{A - B}{2y}$$

A=measurement over rollers placed on slip gauges.
B=measurement over roller on small end of taper.
y=amount of slip gauges, x=angle with centre line.

CHECK OF INTERNAL TAPER (fig. 12).

Two balls of different diameters are to be placed in the internal taper and the distances of the top of the ball to the upper end of the taper ring measured by means of a depth micrometer. The angle x may be found from the formula:—

$$\sin x \frac{R - r}{(A \div r) - (B \div R)}$$

A=reading of depth micrometer to the top of small roller.

B=reading of depth micrometer to the top of large roller.

r and R=radius of small and large roller respectively.
x=angle with centre line.

CHECK OF END DIAMETERS OF TAPER RING GAUGE (fig. 13).

Given: Angle with centre line of taper gauge x. Thickness of Ring Gauge D.

Place in the bore of the gauge one ball with known radius (R) slightly protruding over the top of the gauge and measure difference in heights from top of ball to the upper face of the gauge (U). The end diameters of the gauge may be found from formula:—

Top diameter B=2 (R cos Ux+R — U) tan x.
Bottom diameter A=B — (2D tan x).

CYLINDRICAL BORES AND SEGMENTS

A system of checking bores not well enough known to operators and inspectors is explained in fig. 14. Build up the dimension of the bore in question with two well calibrated rollers and slip gauges and insert it in the bore, or slip the component over the built up dimension. With some practice, accuracy of .0001in. can be ascertained. Components in the machine can also be checked in the same way. Slight trouble may be encountered to keep the built up dimension, square in the bore when inserting. This can be simplified by means of a small gadget consisting of a well calibrated ball, sweated on a stem (fig. 15) which has to replace one roller and no difficulties when inserting will be encountered.

BORE OF CYLINDRICAL SEGMENT.

To find the diameter of the bore of a cylindrical segment the general known formula:—

$$\text{dia.} = \frac{(\frac{1}{2}\text{ chord})^2 + (\text{height})^2}{\text{height}}$$ has to be applied.

If the faces of the segment are square and flat and the job can be held down on the surface plate, the most precise and convenient method is the checking of the job with slip gauges and rollers of equal size in the vertical and horizontal direction. To obtain the height (y) and the chordal dimension (x) see fig. 16.

$x = \frac{1}{2}x$ (amount of slips + diameter of roller D).
y = amount of slips in vertical direction.

$$\text{Diameter of bore } \frac{x^2+y^2}{y} + \text{diameter of roller.}$$

If the faces are not flat or the job cannot be held down, position the job on the surface plate as shown in fig. 17. Level up the two rollers, after having inserted the appropriate amount of slips and ascertain in this way the chordal dimension (X). Measure with the height gauge the horizontal position of the centre line between the two rollers. To find the dimension (y), one roller of the same size has to be dropped into the lowest spot of the bore (see dotted lines) and the position of the centre of the ball may be measured with the height gauge. The difference between the two height gauge readings is the requested height (y).

$$\text{Diameter of bore} = \frac{X^2+y^2}{y}$$

OUTSIDE DIAMETER OF SEGMENT.

Sometimes broken parts of machines, gears, cylindrical discs, etc., are delivered into the tool room for replacement. Often only segments of such parts are available and the outside diameter has to be checked. Proceed as follows (fig. 19):—

Hold the component down on surface plate as shown on drawing and place two rollers of equal size under the outside diameter of the segment. Take a micrometer reading over the rollers (A). The reading (R) of the segment may be found from the formulas:—

$$B = \frac{A - 2r}{2}; \quad R = \frac{B^2}{4r}; \quad r = \text{radius of rollers.}$$

HINTS FOR TURNERS, GRINDERS, FITTERS, ETC.

With a little effort you can make yourself a few gadgets which will improve your efficiency considerably.

With a gadget sketched in fig. 20, you can transform an ordinary micrometer into a wall micrometer. The inserted steel ball is held in position by means of a cap, which can be slotted to fit the different sizes of anvils. By deducting the diameter of the ball from the micrometer reading, you can read directly the wall thickness of your bore and check the concentricity of the job. By measuring the wall thickness and deducting twice the amount from the outside diameter, the check of the size of the bore within accurate limits is now an easy matter.

Two-pointed caps are also easily made (fig. 21). The micrometer has now been transformed into a point micrometer, which enables you to check, precisely, recesses, core diameters of threads, etc.

Even a thread micrometer can be replaced by making one cap pointed, to fit the spindle and another cap with a "V" slot to fit the anvil (fig 22). When producing these two caps, the thread angle has to be considered.

In shops where a lot of grinding of three-fluted tools has to be done, a small 60° "V" block, which is easily adjusted to fit the micrometer, will save you a considerable time when checking the diameter of the three-fluted tool (fig. 23). Based on trigonometrical rules, the deduction of $\frac{1}{3}$ of the micrometer reading gives the outside diameter of the three-fluted tool.

When holes have to be drilled in accurate positions the following gadget (fig. 24) will be used very advantageously. Two gadgets are necessary and each consists of two parts, one oblong part, with a small reamed hole, and one cylindrical part with a cylindrical pip, which has a good push fit in the small cylindrical hole of the oblong. The pip has to be concentric to the outside diameter of the cylinder and the centre line must be square to the face of the oblong, which has to be hardened and ground, as the small bore has to be used as a guide for the drill.

When drilling holes in position, use the two gadgets as follows:—

Clamp the oblongs tightly on the job, and set up the requested distances by means of slip gauges between the cylindrical pins. After having ascertained the position, tighten up clamps and pull out the pins and use the small holes in the oblong as a drill guide.

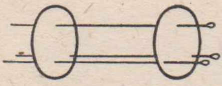


Fig.1

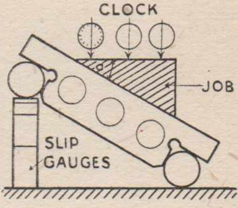


Fig.2

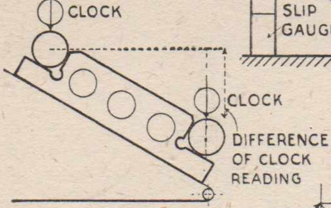


Fig.3

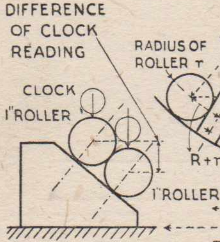


Fig.4

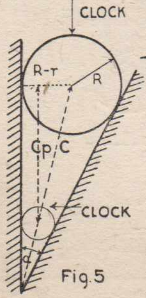


Fig.5

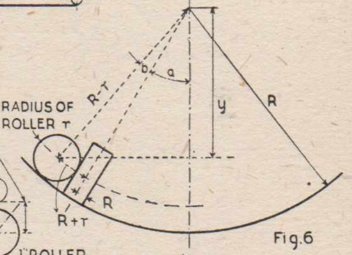


Fig.6

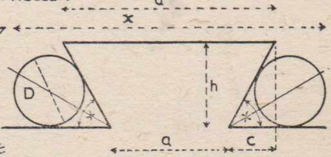


Fig.7

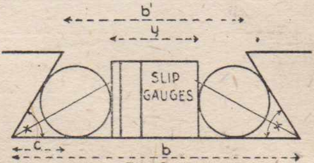


Fig.8

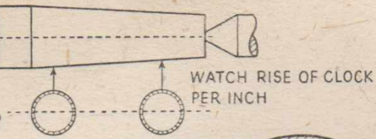


Fig. 9

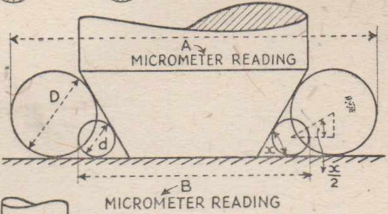


Fig. 10

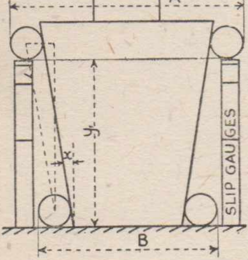


Fig. 11

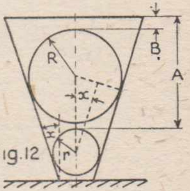


Fig. 12

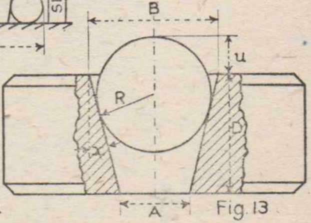


Fig. 13

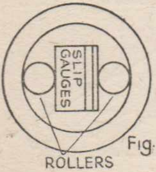


Fig. 14

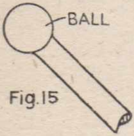


Fig. 15

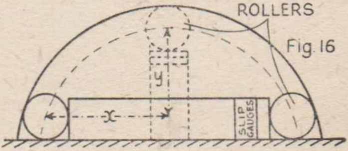


Fig. 16

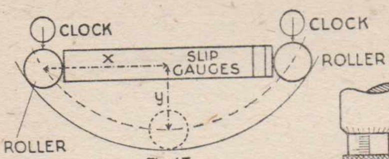


Fig.17

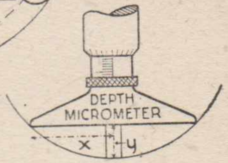


Fig 18

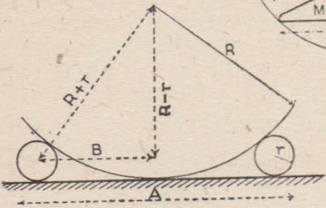


Fig.19

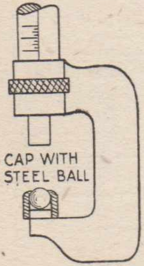


Fig. 20

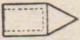


Fig. 21

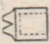


Fig. 22

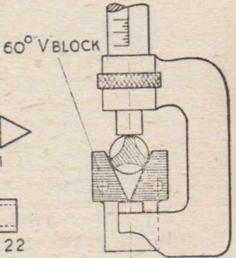


Fig. 23

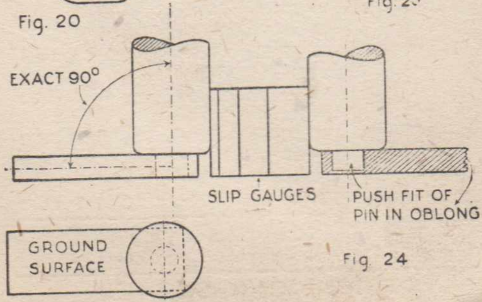


Fig 24

TAPERS AND ANGLES.

Angle with C/L	Taper per ft. included	Taper per in." with C/L	Angle with C/L	T. per ft. included	T. per in." with C/L
0 17" 54"	⅛	·0052	2 14 12	15/16	·0391
0 26 52	3/16	·0078	2 23 9	1	·0417
0 35 48	¼	·0104	2 58 54	1¼	·0521
0 44 45	5/16	·013	3 34 35	1½	·0625
0 53 42	⅜	·0156	4 10 13	1¾	·0729
1 2 39	7/16	·0182	4 46 48	2	·0833
1 11 35	½	·0208	5 56 48	2½	·1042
1 20 32	9/16	·0234	7 7 30	3	·125
1 29 51	⅝	·026	8 17 50	3½	·1458
1 38 27	11/16	·0286	9 27 46	4	·1666
1 47 22	¾	·03125	10 37 10	4½	·1875
1 56 19	13/16	·03386	11 46 6	5	·2083
2 5 16	⅞	·0365	14 2 10	6	·25

TAPER PER FOOT AND INCLUDED ANGLE.

Taper	Angle	Taper	Angle	Taper	Angle	Taper	Angle
1/64	0° 4' 28"	23/32	3 25 51	1⅞	8 56 2	4⅝	21 48 55
1/32	8 58	¾	3 34 48	1 15/16	9 13 51	4¾	22 23 28
1/16	17 53	25/32	3 43 44	2	9 31 37	4⅞	22 57 50
3/32	26 52	13/16	3 52 42	2⅛	10 7 11	5	23 32 12
⅛	35 46	27/32	4 1 38	2¼	10 42 41	5⅛	24 6 28
5/32	44 45	⅞	4 10 32	2⅜	11 18 12	5¼	24 40 43
3/16	53 44	29/32	4 19 31	2½	11 53 38	5⅜	25 14 51
7/32	1 2 39	15/16	4 28 26	2⅝	12 29 2	5½	25 48 53
¼	1 11 38	31/32	4 37 25	2¾	13 4 25	5⅝	26 22 52
9/32	1 20 33	1	4 46 19	2⅞	13 39 44	5¾	26 56 48
5/16	1 29 31	1 1/16	5 4 13	3	14 15 1	5⅞	27 30 35
11/32	1 38 30	1⅛	5 22 2	3⅛	14 50 15	6	28 4 21
⅜	1 47 26	1 3/16	5 39 55	3¼	15 25 27	6⅛	28 37 59
13/32	1 56 24	1¼	5 57 45	3⅜	16 - 34	6¼	29 11 36
7/16	2 5 18	1 5/16	6 15 38	3½	16 35 41	6⅜	29 45 4
15/32	2 14 7	1⅜	6 33 29	3⅝	17 10 32	6½	30 18 28
½	2 23 12	1 7/16	6 51 21	3¾	17 45 40	6⅝	30 51 49
17/32	2 32 10	1½	7 9 11	3⅞	18 20 35	6¾	31 25 2
9/16	2 41 7	1 9/16	7 27 -	4	18 55 31	6⅞	31 58 11
19/32	2 50 3	1⅝	7 44 49	4⅛	19 30 18	7	32 31 14
⅝	2 59 3	1 11/16	8 2 38	4¼	20 5 1		
21/32	3 7 57	1¾	8 20 28	4⅜	20 39 44		
11/16	3 16 56	1 13/16	8 38 17	4½	21 14 20		

STOCK TAPER FITS.

MORSE	Dia. Large End.	Length Taper"	Dia. Small End.	Taper per ft.	Taper per inch	½ included angle.
0	·3561	2	·252	·6246"	·05205"	1° 29' 30"
1	·475	2·125	·369	·59858"	·04988"	1° 26'
2	·700	2·5625	·572	·59941"	·04995"	1° 26'
3	·938	3·1875	·778	·60235"	·05019"	1° 26' 15"
4	1·231	4·0625	1·020	·62326"	·05193"	1° 29'
5	1·748	5·1875	1·475	·63151"	·05262"	1° 30' 30"
6	2·494	7·25	2·166	·62565"	·05213"	1° 30'
7	3·270	·10	2·750	·624"	·052"	1° 30'

JARNO	Dia." Large End.	Length Taper".	Dia. Small End.	Taper per ft.	½ included angle.
1	·125	·5	·1	·6"	1° 26"
2	·250	1	·2	"	"
3	·375	1·5	·3	"	"
4	·5	2	·4	"	"
5	·625	2·5	·5	"	"
6	·75	3	·6	"	"
7	·875	3·5	·7	"	"
8	1·000	4	·8	"	"
9	1·125	4·5	·9	"	"
10	1·25	5	1·0	"	"
11	1·375	5·5	1·1	"	"
12	1·5	6	1·2	"	"
13	1·625	6·5	1·3	"	"
14	1·75	7	1·4	"	"
15	1·875	7·5	1·5	"	"
16	2·000	8	1·6	"	"
17	2·125	8·5	1·7	"	"
18	2·25	9	1·8	"	"
19	2·375	9·5	1·9	"	"
20	2·5	10	2·0	"	"

JARNO FORMULAS } *S=Size No. Large Dia.=* $\frac{S}{8}$ *Small Dia.=* $\frac{S}{10}$ *Length =* $\frac{S}{2}$

STOCK TAPER FITS

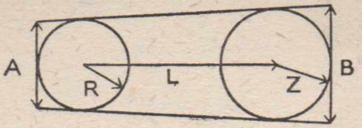
BROWN AND SHARPE	Large end Dia.	Taper per ft. in inches.	Small end Dia.	Taper per inch.	½ included angle.	Length Taper."
1	·239	·5	·2	·0416	1° 12"	·9375
2	·299	"	·25	"	"	1·1875
3	·375	"	·312	"	"	1·5
4	·420	"	·35	"	"	1·6875
5	·539	"	·45	"	"	2·125
6	·599	"	·5	"	"	2·375
7	·725	"	·6	"	"	3·00
8	·898	"	·75	"	"	3·5625
9	1·077	"	·9	"	"	4·25
10	1·26	·5161	1·0446	·043	1° 14"	5·
11	1·498	·5	1·25	·0416	1° 12"	5·9375
12	1·531	"	1·5	"	"	6·75
13	2·073	"	1·75	"	"	7·75
14	2·344	"	2·00	"	"	8·25
15	2·615	"	2·25	"	"	8·75
16	2·885	"	2·5	"	"	9·25
17	3·156	"	2·75	"	"	9·75
18	3·427	"	3·00	"	"	10·25

CLEVE-LAND	Large Dia.	Taper per ft.	Small Dia.	Taper per inch.	Length Taper.
0	·356	·625"	·2518	·05208"	2·21875
1	·475	·6"	·3688	·05"	2·4375
2	·700	·602"	·5714	·05017"	2·9375
3	·938	·602"	·7781	"	3·6875
4	1·231	·623"	1·0201	·05191"	4·625
5	1·748	·63"	1·4757	·0525"	5·875
6	2·494	·626"	2·1158	·05216"	8·25
7	3·27	·625"	2·7492	·05208"	11·25

Cincinnati Quick Release. 3½" per ft. included.
½ the included angle 8° 17' 50" Large end Dia. 2·75"

FORMULAS FOR TAPERS

T = Taper per inch.



$$L = \frac{Z-R}{T}\sqrt{1+T^2}$$

$$R = \frac{A}{L}\left[\sqrt{L^2+(B-a)^2}+(B-a)\right]$$

$$Z = \frac{B}{L}\left[\sqrt{L^2+(B-a)^2}-(B-a)\right]$$

$$\text{Taper per ft} = 24\left(\frac{Z-R}{\sqrt{L^2-(Z-R)^2}}\right)$$

$$A = R\sqrt{\frac{L-(Z-R)}{L+(Z-R)}}$$

$$B = Z\sqrt{\frac{L+(Z-R)}{L-(Z-R)}}$$

Dia.	Threads inch	eff. Dia.	Needle Nº	mean size of needle inches.	Measurement over needles	depth of thread.
1/8	40	·1090	11	·015	·1325"	·0160
3/16	24	·1608	8	·023	·1936"	·0267
1/4	20	·2108	6	·029	·2618"	·0320
5/16	18	·2769	5	·033	·3280"	·0356
3/8	16	·3350	4	·036	·3890"	·0400
7/16	14	·3918	2	·042	·4560"	·0457
1/2	12	·4466	1	·047	·5154"	·0534
9/16	12	·5091	1	·047	·5779"	·0534
5/8	11	·5668	1/0	·049	·6346"	·0582
11/16	11	·6293	1/0	·049	·6971"	·0582
3/4	10	·6860	2/0	·055	·7640"	·0640
B.S.W	*British standard Whitworth threads*					

Designating Nº	Dia. inches	Threads inch approx.	eff. Dia inches	Needle Nº	needle size.	Measurement over needles.	depth of thread.
0	·236	25·4	·2126	8	·023	·2480"	·0236
1	·209	28·2	·1874	9	·020	·2168"	·0213
2	·185	31·3	·1659	10	·017	·1889"	·0191
3	·161	34·8	·1441	10	·017	·1706"	·0172
4	·142	38·5	·1262	11	·015	·1489"	·0156
5	·126	43·1	·1120	11	·015	·1378"	·0139
6	·110	47·9	·0976	11	·015	·1261"	·0125
B.A	*British association thread 47½° angle.*						

Dia.	Threads inch	eff Dia.	Needle Nº	Mean size of needle inches	Measurement over needles.	depth of thread
3/16	32	·1675	10	·017	·1913"	·0200
7/32	28	·1959	9	·020	·2250"	·0229
1/4	26	·2254	8	·023	·2613"	·0246
9/32	26	·2566	8	·023	·2925"	·0246
5/16	22	·2834	7	·026	·3220"	·0291
3/8	20	·3430	6	·029	·3868"	·0320
7/16	18	·4019	5	·033	·4530"	·0356
1/2	16	·4600	4	·036	·5140"	·0400
9/16	16	·5225	4	·036	·5765"	·0400
5/8	14	·5793	2	·042	·6435"	·0457
11/16	14	·6418	2	·042	·7060"	·0457
3/4	12	·6966	1	·047	·7654"	·0534
13/16	12	·7591	1	·047	·8279"	·0534
7/8	11	·8168	1/0	·049	·8846"	·0582
1"	10	·9360	2/0	·055	1·0140"	·0640
B.S.F	*British Standard fine threads.*					

Screw Thread Formulas and Data.

N = *No. of T.P.I.* L = *lead of thread.* d = *depth of thread.*

F = *width of bottom of thread..* D = O.D.

T = *halix angle of thread.*

n = *number of threads wound round a screw.* P = *pitch.*

W = *diameter of wire used to check thread.*

M = *measure over wires.* S = *pitch diameter.*

$N = \frac{1}{P}$ $N = \frac{n}{L}$ $L = nPL = \frac{n}{N}$ $P = \frac{L}{n}$

$P = \frac{1}{N}$ $\text{Tan}\,T = \frac{3183\,L}{S}$

B = *projected distance above O.D. of 1 wire*

American National 60°

$B = 1{\cdot}5W - {\cdot}7578\,P$ $F = {\cdot}125\,P$

$d = {\cdot}6495\,P$ $S = D - d$

U.S. *V thread*

$B = 1{\cdot}5W. - {\cdot}866P$ $d = 866\,P$ $S = D - {\cdot}866\,P$

Square thread.

Diameter of ball Y *to measure thread* = $\frac{P\cos T}{2}$

$S = D - \frac{P}{2}$

Acme thread 29°

$B = 2{\cdot}5\,(W - {\cdot}4873\ P\cos T)$ $d = \frac{P}{2} + {\cdot}01$

$F = {\cdot}3705\,P - {\cdot}005$ $S = D - \frac{P}{2}$

Worm thread 29°

$B = 2{\cdot}5\,(W - {\cdot}5149\,P\cos T)$ $F = {\cdot}31\,P$

$d = {\cdot}6866\,P$ $S = D - {\cdot}6366\,P$

Buttress thread 45°

$F = {\cdot}125\,P - {\cdot}01$ $d = {\cdot}75\,P + {\cdot}01$ $S = D - {\cdot}75\,P$

3 Wire effective formula.

When E=effective diameter. G=best wire. N No of threads
A= ½ the included angle. M=measure over the wires.

$$E = M + \frac{\text{Cot } A}{2N} - G(1 + \text{Cosec } A)$$

To find effective diameter when M is known.

Nat. 60°	= M-(3W- ·86602 P)
Whit.	= M-(3·1657W-·96049 P)
B.A.	= M-(3·4829W-1·13633 P)
Lowenherz	= M-(3·2359W-1P)
Acme	= M-(4·9939W-1·93334 P)

To set roller or Wickman gauges for Male threads use slips as follows:—

Whitworth.	$= OD - 2\left(\frac{\cdot 6403}{T.P.I}\right) - (3{\cdot}1657\,W) + 1{\cdot}6008\,P$
B.A.	$= OD - 2\left(\frac{\cdot 6}{T.P.I}\right) - (3{\cdot}4829\,W) + 1{\cdot}7363\,P$
Nat or U.S. 60°	$= OD - 2\left(\frac{\cdot 6495}{T.P.I}\right) - (3\,W) + 1{\cdot}5155\,P$
Sharp V 60°	$= OD - 2\left(\frac{\cdot 866}{T.P.I}\right) - (3\,W) + 1{\cdot}732\,P$

To set roller gauges the following formula can also be used:—

E=effective diameter. P=pitch. T= ½ the thread angle.
b=diameter of wires or balls.

$$\text{Slips} = E - b\,(1 + \text{Cosec } T) + (\tfrac{1}{2}\, p \cot T)$$

Best wires for above formulas.

Whitworth	·5637 P	Min:506P	Max. ·853P
Metric	·5773 P	" ·505P	" 1·01 P
B.A	·5462P	" ·498P	" ·730P
Worm	·5149 P	—	—
Sharp V. 60°	—	" ·577P	" 1·555P

Best wire formula.

Where N=No. of threads per unit. G=Best wire.
A= ½ the included angle. $G = \text{Sec } A \div 2N$.

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Printed by Technical Suppliers Ltd., London, W. 6,
for Bernards (Publishers) Ltd.