THREAD ROLLING
on the AUTOMATIC

THIRD EDITION

SALVO TOOL & ENGINEERING COMPANY
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INTRODUCTION

This manual has been prepared for use with "Salvo" thread rolling equipment, and as a general thread rolling reference for the automatic screw machine industry.

The knowledge and experience contained herein is only a very small part of the service and experience "Salvo" has made available to the screw machine industry for fifty years.

"Salvo", as the pioneers in straddle thread rolling, designs and manufactures the highest quality tools available anywhere.

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CONTENTS

ROLL FORMING ON THE AUTOMATIC

The term "Roll Forming" for the purpose of this discussion, will be considered straddle rolling where the dies are brought on from the side, and are driven by the part that is being formed.

Roll forming is the process of displacing metal in a precise and controlled manner, this is done by forcing the die into the blank gradually as it rotates. (See Fig. 1)

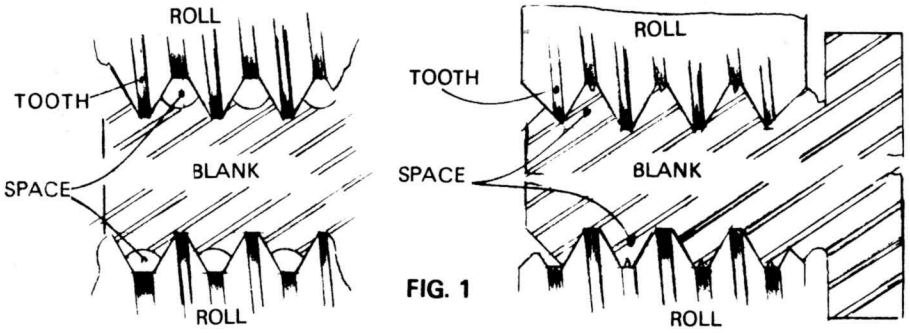


FIG. 1

METAL BEING DISPLACED BY STRADDLE ROLLING PROCESS

Note that the metal upset or displaced by the "tooth" of the die is absorbed by the "space" of the die. This, of course, involves a great deal of force. To balance this force, two dies are used, in an opposing configuration, and must be synchronised in relation to one another. It should be noted that although the dies are forcing the metal up into its "spaces" the wedge action of the threads plus the general movement of the metal tends to elongate the part.

This seldom, if ever, causes any sizing problem in the length of the part, however, it does account for some discrepancies in the rolling process. For instance, since tooth and the space are equal, the amount of metal displaced below the pitch diameter line should equal the space left above the pitch diameter line, it seldom does except on very long threads. On very short threads, where there is little length to restrict the lengthwise flow of metal, it is necessary to use a larger blank diameter than would be used for a longer thread of the same pitch and diameter.

This lengthwise flow of metal during rolling causes another problem, (called chamfer break) which is premature breakage of the dies, at the point where the "tooth" on dies breaks through

the chamfer on the blank. This is caused by the metal moving lengthwise, and the wedge action of the part chamfer, at that point. (See Fig. 2) This can be eliminated by using the proper chamfers as indicated in Fig. 2-B and C. Note that with the longer angle where the thread breaks through the chamfer it is supported most of the way opposite the pressure point by a tiny ridge of metal so as to somewhat offset that pressure, and support the thread at that point. It can be seen from 'B' and 'C' that the most support is obtained with the longer angle. This is especially important when rolling the tougher materials such as stainless, stressproof, etc. which tend to work harden, especially when rolled too slowly.

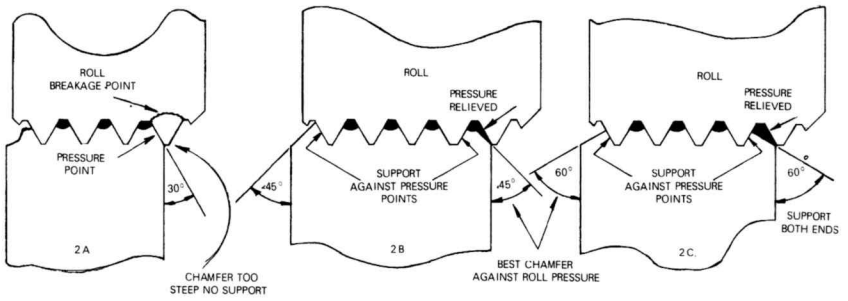


FIG. 2

TYPES OF BLANK CHAMFERS

One very important phase of thread rolling is the feed at which the dies approach the center line of the part. (Feed per Revolution). Different threads, on different materials, require different feeds per revolution. All threads should be rolled as fast and smooth as possible, too slow a feed, or any hesitation, will result in work hardening and unnecessary side pressure, both of which take away from total roll life. Almost all two roll, straddle type, thread rolling, should be done between .006 and .018 feed per revolution of the spindle.

SET UP AND ADJUSTMENT

When setting up a "Salvo" attachment following these steps in order will save time and effort.

A. Preparation of the blank to be rolled

The blank should be shaved wherever possible, held within .001, and should be taken from .001 above the mean of the pitch diameter to be rolled. Chamfer angles should be 30° off the center line of the work piece. The blank should be straight and smooth, and chamfer angles should run a minimum of .005 below the root diameter of the thread.

B. Bushings

Check the charts on Pages 35-41 Bushing Index, install and locate the bushings in their proper position.

C. Installation of rolls

Install rolls being sure to lubricate the pins with a good grade of machine oil.

D. Setting root diameter

Set the distance between the rolls to root diameter -minus a small amount allowed for spring or stretch of the attachment. Root setting can be determined by looking up thread depth on the chart on page 26 and subtracting 2 times the thread depth from the major diameter of the part. The spring or stretch in the attachment will vary with size and type of material from .002 to .006 hence (major diameter minus 2 times thread depth, minus .002 to .006 equals Root Setting). Since the pin on the solid or bushed side of the attachment is in a fixed position, (parallel with the dovetail), it is necessary only to adjust to the root setting on the moveable pin, being careful to set both ends equal distance from solid side. (See Fig. 3)

E. Synchronising dies

Back the screw out of the micro adjusting plug until the rolls turn independent of each other, rotate the rolls in an outward direction until the "synchronising arrows" are directly across from each other. Tighten the screw in the micro adjusting plug, moving the gears back into mesh, and locking the micro adjusting plug in the center or zero position, (See Fig. 4), so that the final fine adjustment may be made in either direction.

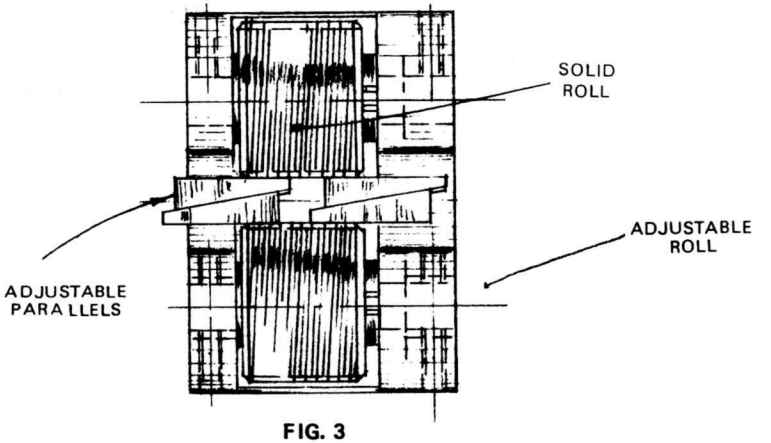


FIG. 3

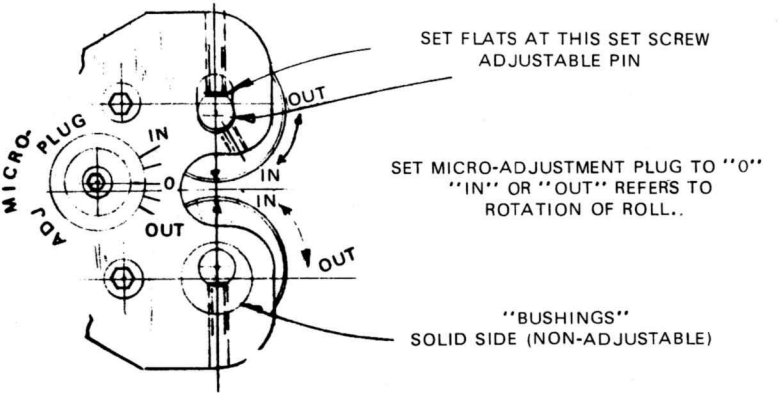


FIG. 4

MOVEMENT OF ROLLS IN RELATION TO
MICRO-SYNCHRONISING ADJUSTING PLUG

F. Prepare the adapter

Since most "Salvo" adapters can be used on more than one machine and position; it is necessary to check the float spring, to be sure the roll on the solid or bushing side of the attachment, contacts the blank first. See the adapter chart on page 22 under the machine and position being used, to determine the location of the spring. (No change in the spring is necessary on the Cone or Greenlee).

G. Mount the adapter

Having set up the adapter with the spring in the proper position, mount the adapter. Place the adapter in position, location as central as possible to the blank to be rolled, and tighten securely (final adjustment may be made by moving attachment in dovetail).

It is much better to mark the blank very lightly in order to establish synchronisation than to go directly to center, as this may damage the dies. The best way to do this is as follows, making sure that the machine is on the high point of the cam, back the thread rolling slide out until there is enough room to insert and clamp the thread rolling head. Move the slide forward until both rolls contact the work. Now, either back the machine off from the high point, or run over the high point to clear the attachment. Move the slide in .010" to .020" which will be sufficient to mark the blank and determine how closely the dies are synchronised.

H. Checking Synchronisation

There should be a very clean single groove. If not, loosen the micro adjusting screw slightly and rotate in either direction. (Be sure to lock screw after each move.) If no improvement, then rotate in the opposite direction. It may be necessary to advance or retard a full tooth. If so, loosen the micro adjusting screw and back it out all the way. Rotate roll in the direction which improves the condition, remesh the gear and tighten.

I. Centering

Once a clean groove has been established, it is only necessary to move the slide in until the attachment is on the center of the blank, when the cam is at the high point. Finding the exact center is very important, and there are a number of ways to achieve this. The quickest way is with a "Salvo" centering attachment. It is simple and inexpensive and can save time and money. A description and directions for its use are on page 19.

If a centering tool is not available an accurate way to find the center line of the thread rolling attachment in relation to the center line of the work piece to be rolled is as follows.

Remove one roll from the adjustable side of the attachment. Note: Move only the outside locking screws. Install the attachment in the adapter, then back off the slide as far as it will go, (or in some cases as on the New Britains, Cones and Greenlees, move the adapter). Jog the machine to the high point of the thread rolling cam, then advance the attachment to the approximate center of the blank. (See Fig. 5) Place a dial indicator on the top or bottom of the attachment. Then move the attachment in and out with the slide adjusting screw. While moving the attachment in and out, note the indicator reaches a high point then drops off when it goes over the center line. Determine the high point of the indicator, and that is the established center line.

It is very important not to go past or over center while rolling, (this can damage rolls and gears). For this reason it is much better to stay .005" back of the center than to take a chance of going over center, replace the one roll and re-synchronise. Return the attachment to the adapter and tighten securely. Run one cycle. The part should now be acceptable from a visual inspection. If it is possible, mic. or gage the part in the machine. If it is not acceptable but the part looks good, it is safe to continue around and cut-off, for a thorough inspection. If the part has slivers or flakes, check previous steps, especially synchronisation.

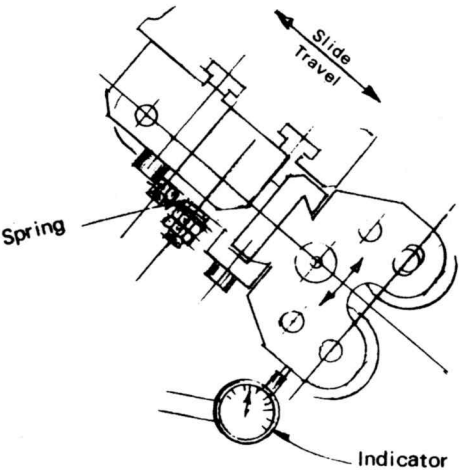


FIG. 5

FINDING CENTER LINE OF PART

I - INSPECTION OF THE PART

Below are the conditions possible and the necessary steps to correct them.

PART WILL NOT FIT GAGE

P.D. Large (If O.D. of thread is not smooth and full,) simply move the rolls closer together by means of the adjustable pin. If, however, the O.D. of the thread is smooth and full, lower the blank diameter to where the thread is slightly rough and not quite full. If the gage still will not spin on, the distance between the rolls may now be closed in.

"NO GO" GAGE GOES ON

P.D. is undersize. Simply open the distance between the rolls. If this produces an undersize O.D. increase the blank gradually until major is within tolerance. (NOTE - DO NOT TRY TO FILL THE THREAD FULL AND SMOOTH UNLESS IT'S ABSOLUTELY NECESSARY AS THIS WILL REDUCE ROLL LIFE.)

O.D. OF THE THREAD TOO SMALL

Gradually increase blank diameter until desired result is achieved.

CONCENTRICITY

When P.D. and/or O.D. of the thread is not concentric with the rest of the part, the cause is very often that the thread being rolled is very short (6 threads or less). Since there are so few threads, any unbalance between "tooth" and "space" results in uneven force, causing dies to penetrate deeper on one side of the part than the other.

The condition can be corrected by increasing or decreasing thread length up to ½ of the decimal pitch, which will balance the above condition, it is usually easier to increase the thread length, which may be removed by rechamfering or cutting off the excess.

II - MATERIALS

STAINLESS

When rolling stainless steel, very often rolls have to be designed special, as this material has a tendency to stretch, causing a "long lead", which will cause interference with the pitch dia. gaging. This condition must be compensated for in the

design of the dies. Feeds of .012" to .014" per revolution of the work spindle are normal, this material work hardens very fast and the faster the thread can be rolled, the less resistance there will be to rolling.

BRASS

Threads that are to be rolled in brass, must have a special grade of brass, especially tempered for thread rolling. Ordinary half-hard brass, or free machining brass, does not lend itself too well to thread rolling. All manufacturers of brass rod know this condition and have a thread rolling temper that is very satisfactory. Feed on brass should run at a higher rate, usually from .014" to .018" feed per revolution of the work spindle. The exact feed will vary depending upon the pitch and diameter of the thread to be rolled.

SCREW STOCK

Leaded screw stock can be run approximately the same feed per revolution, as brass, although the feed per revolution is a lot less critical.

FOR FURTHER INFORMATION on the proper feed per revolution on various thread pitches and materials, contact SALVO TOOL AND ENGINEERING COMPANY.

III - CAMS

Many times a special stroke is required for certain threads in order to clear the index of the machine with the attachment. Write SALVO TOOL AND ENGINEERING for quotations on all thread rolling cams, which are made from high quality steel, and hardened.

IV - COOLANT

It is well to remember that a good grade of cutting oil with a maximum viscosity should be used to reduce friction on the roll pins. Should a soluable oil be used, such as in brass or aluminum, the thread rolls should be bushed with a bronze bushing to minimize the possibility of galling on the pins.

Wherever bushed rolls are required, it is necessary to use high speed steel pins, or highly polished carbide pins.

SPLINE ROLLING

In spline rolling it is necessary to hold a constant number of teeth over wires, to a close tolerance.

It is somewhat different and a little more difficult to develope the spline roll and the blank diameter, to get the proper number of teeth, at the proper wire reading, and major diameter than a particular thread.

KNURLS AND SERRATIONS

Knurls are fairly simple to roll, but in order to get a good clean knurl with no flaking or slivering and good die life it is necessary to know something about them. Regardless of the exact number of teeth produced, it must be possible to divide the circumference of the blank evenly by the decimal pitch, for example.

A one inch diameter 30 T.P.I. (T.P.I. = Teeth per inch) knurl would be calculated as follows:
Decimal pitch is equal to 1" divided by the T.P.I. hence; 30 T.P.I. divided into 1" equals .0333. The circumference of a one inch diameter is 3.1416.
3.1416 divided by .0333 equals 94.2 teeth. Since pitch must divide evenly into the circumference of the blank, and it obviously does not, the blank must be increased to 95 teeth or decreased to 94 teeth. Multiply the number of teeth desired by the decimal pitch .0333, and it will equal the circumference of the blank, dividing this by π equals the corrected blank diameter.

TYPICAL SPLINE, KNURL, or SERRATION SET-UP

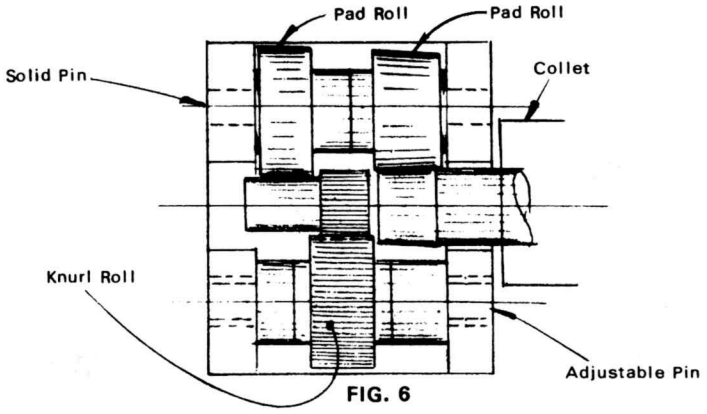


FIG. 6

Broken Gears or Roll Hubs

Always make sure the non-adjustable roll is contacting the work first, this is controlled by the spring in the adapter.

Check the high point of the cam to determine if the cam has worn to where there are too many revolutions on center. (Dwell)

Check to see if the cam is going into high speed too soon. If the slots in the roll are too narrow it will cause the rolls to bind up on the gears before the thread is completely formed and will cause excessive wear on the gear train, gear breakage and/or breaking off of the hub of the roll. (See Fig. 7) Excessive bending of the work piece while rolling will also cause this condition. Going over center is one of the greatest causes of this condition.

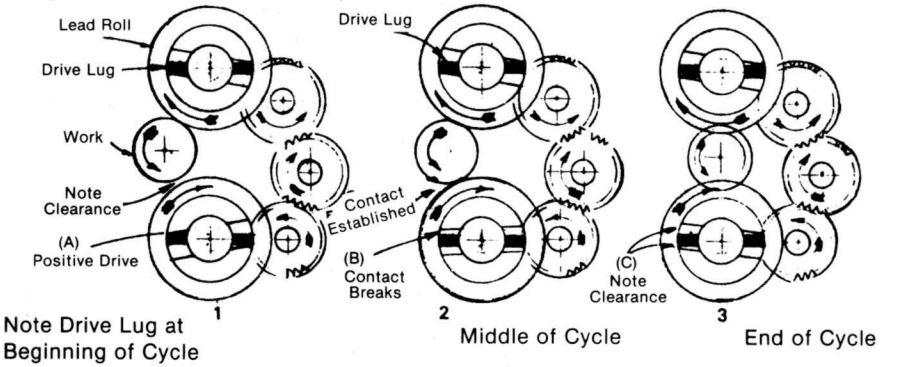
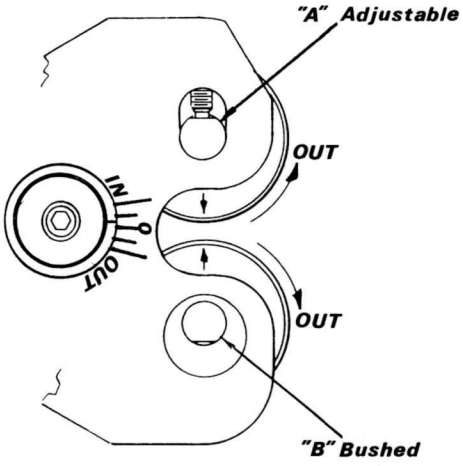


Fig. 7

Excessive movement of the attachment, either toward the collet or away from it, (assuming that the feed is right, and the rolls are properly synchronised), can be caused by rolls that are too large or too small for the part being rolled

To determine if this is the condition, raise the blank from the mean of the pitch diameter to .005" above the mean, and make sure to open the rolls a corresponding amount. It may be necessary to synchronise the rolls again at this point. Should this fail to produce a perfect thread in appearance, go to the mean diameter minus .005" By going through these two steps it can be readily determined if it is the roll diameter that is causing the problem. This condition may also be caused by a mis-alignment of the attachment with relation to the work spindle.



Install "A" roll in adjustable side of head.

"B" roll in bushed side of head.

With the backlash taken out in the outward direction. Place the arrows on center.

The arrows are fairly accurate, however, depending on the condition of the attachment, a deviation of a few degrees above or below center may be necessary.

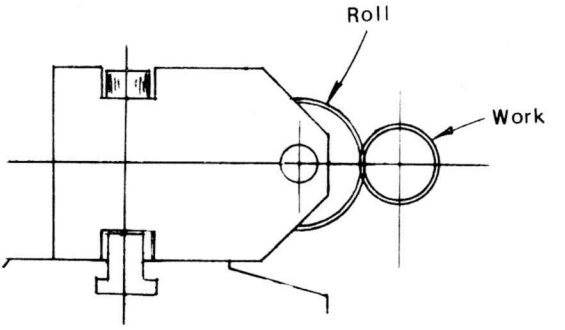


Fig. 8

BASIC BUMP ROLLING CONFIGURATION

BUMP ROLLING

Bump rolling is the simplest form of thread rolling and is adequate for most short run jobs or for parts that do not have critical tolerances. Bump rolling is done by forcing a single roll in, perpendicular to the center, to the proper pitch diameter.

The rate of feed is considerably lower than straddle rolling since the penetration is perpendicular, rather than tangent to the blank. This would be between .001" and .002" feed per revolution of the spindle for most threads.

It is, however, more difficult to maintain size since the metal is not confined between two fixed dies.

OPERATOR'S CHECK LIST OF PROBLEMS

SLIVERS OR FLAKES IN THREADS

1 - Rolls are not synchronised.
2 - Center line of attachment not parallel with the center line of the work.
3 - Cross slide, or adapter pin, worn.
4 - Correct roll not contacting the work first. Always have nonadjustable roll contact work blank first.
5 - Over filling rolls (blank too large).
6 - Material not adaptable to cold working.
7 - Rough finish on the blank.
8 - Seamy stock.
9 - Work bending during rolling.

DRUNKEN THREADS

1 - Rolls not synchronised.
2 - Center line of attachment not parallel with the center line of the work.
3 - Correct roll not contacting the work first.
4 - Inaccurate rolls.
5 - Work bending during rolling.

INCORRECT O.D. AND P.D.

1 - Pitch diameter and major diameter both oversize - correct over-size blank.
2 - Pitch diameter oversize, major diameter correct size. Correct oversize blank, and close in rolls.
3 - Pitch diameter oversize, major diameter undersize. Setting between rolls too great.
4 - Major diameter oversize, if finished thread is full, blank too large, or thread on the roll deeper than necessary.

5 - Pitch diameter correct size, major diameter undersize. Blank too small.

6 - Pitch diameter and major diameter both undersize. Blank too small and rolls too close together.

7 - Out-of-round thread, out-of-round blank, or center line of rolls not parallel with center line of work, unbalanced thread, (see page 11, Concentricity) Feed rate too high. Insufficient work revolutions or material not ductile enough for cold forming. Not going to center line of work.

TAPERED THREADS

1 - Pitch diameter straight, major diameter tapered and thread not full on small end. Tapered blank.

2 - Pitch diameter and major diamter both tapered same way. Tapered blank and rolls set up with taper to match.

3 - Pitch diamter and major diameter tapered in opposite directions. Re-set adjustable roll.

4 - Pitch diameter oversize, thread not filled out on end with small major diameter. Rolls not parallel or work bending during rolling.

POOR THREAD FORM

1 - Poor thread form in the rolls, or work bending during rolling.

2 - Rolls not synchronised, or too many revolutions. (Feed not fast enough)

3 - Proper roll not contacting the work first.

4 - Roll not correct diameter.

5 - Center of attachment not parallel with the center line of work.

6 - Collapsing hole. Drill hole after rolling if possible, or use supporting mandrel.

INSTRUCTIONS FOR THE USE OF THE SALVO CENTERING ATTACHMENT FOR MODELS BBL, BBP, CBL, AND DBL THREAD ROLLING ATTACHMENTS.

PLACE THE BASE IN THE ADAPTER MAKING SURE THAT THE SLIDE IS ON THE HIGH POINT OF THE CAM. ADJUST THE SLIDE UNTIL THE SWING LEAF IS FLUSH IN TWO PLACES WITH THE BLADE, AS SHOWN IN FIG. 1.

FOR THE SMALL DOVETAIL, USE THE BLADE, SET UP AS SHOWN IN FIG. 1.

FOR THE LARGE DOVETAIL, USE EITHER #1 OR #2 BLADE ACCORDING TO THREAD SIZE RANGE AS MARKED, SET UP AS SHOWN IN FIG. 2.

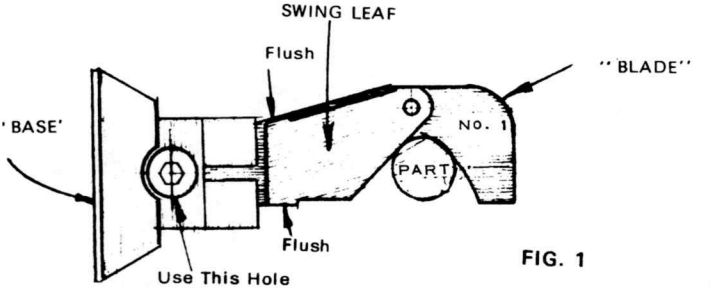


FIG. 1

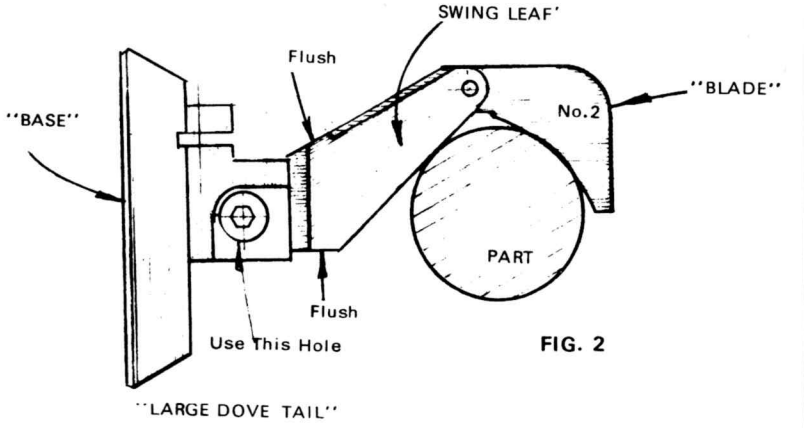
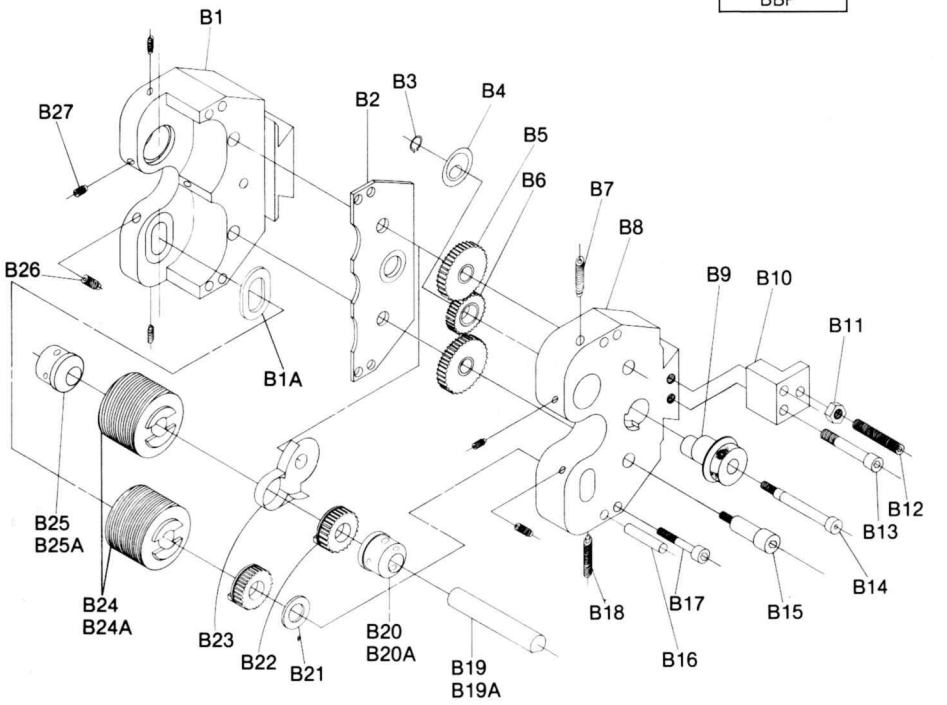


FIG. 2

MODELS
CBL*
CBS
BBL
DBL
BBP



SALVO STANDARD SERIES ATTACHMENT

PART NO.	NAME	REQ'D	NONE REQ'D
B1	Block	1	
B1A	Wear Plate	1	
B2	Sub Plate	1	
B3	Snap Ring	1	
B4	Ret. Cap	1	
B5	Idler Gear	2	
B6	Adjusting Gear	1	
B7	Roll Shaft Retaining Screw	2	
B8	Gear Plate	1	
B9	Micro Adj. Plug	1	
B10	Stop Block	1	
B11	Jam Nut	1	
B12	Stop Screw	1	
B13	Mounting Screw	2	
B14	Micro Plug Adj. Screw	1	
B15	Idler Gear Shoulder Screw	2	
B16	Dowel Pin	2	
B17	Plate to Block Tie Screw	2	Not "CBL"
B18	Roll Shaft Adj. Screw	2	
B19	Carbide Roll Shaft	2	
B19A	Steel Roll Shaft	2	
B20	Eccentric Roll Shaft Bushing	1	Not "BBP"
B20A	Concentric Roll Shaft Bushing	1	
B21	Thrust Washer	1	
B22	Drive Gear	2	
B23	Chip Guard	2	
B24	Thread Rolling Dies Per Specification	2	Lapped Hole for Part No. B19
B24A	Thread Rolling Dies Per Specification	2	Bushed Hole for Part No. B19 A
B25	Eccentric Roll Shaft Bushing	1	Not "BBP"
B25A	Concentric Roll Shaft Bushing	1	
B26	Roll Shaft Adj. Screw	2	
B27	Bushing Locator Index Screw	2	

HOW TO ORDER REPLACEMENT PARTS

Refer to Drawing and Parts List, and Specify Quantity, Part Name, Part No., Model Attachment and Serial No.

Example:
2 - B-22 Drive Gears for Model CBL*, Serial No. 3625

POSITION OF SPRING IN ADAPTER IN RELATION TO CROSS SLIDE

Machine Name	No. of Spindles	Slide Position	Model	SEE PAGE 22 Figure
Brown & Sharpe	1	Rear	OOG, OG & 2G	B
"	1	Front	" " "	A
Cones	All	All		–
Davenport	5	B, C, & D		–
Greenlee	6	All		–
Nat'l Acme-Gridley	6	2nd Double Decker	All	A
" " "	6	3rd	"	B
" " "	6	4th	"	A
" " "	8	4th		B
" " "	8	5th		A
New Britain	6	5th	#60 & 61	E
" "	6	4th	#51, 52, 60, 61, 62 & 635	C
" "	6	5th	#601, 656 & 657	C
" "	6	3rd	#51 & 635	D
" "	6	4th	#601 & 602	D
" "	6	5th	#51, 52, 62 & 635	D
" "	6	6th	#656 (65) & 657	D
" "	8	4th	#826	D
" "	8	5th	"	C
" "	8	6th	"	D
" "	8	7th	"	C
Warner & Swasey	6	4th	All	A
" "	6	5th	"	B
" "	5	3rd	"	A
" "	5	4th	"	B

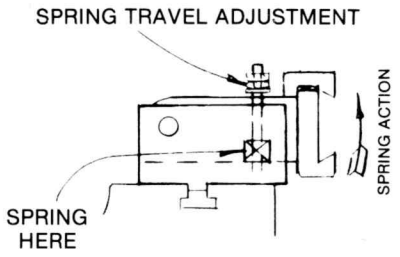


Fig. A

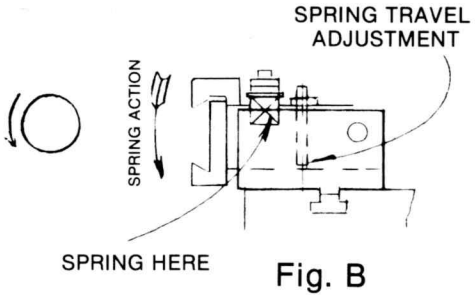


Fig. B

* NOTE: REMOVE STOP SCREW FOR 3RD POSITION.

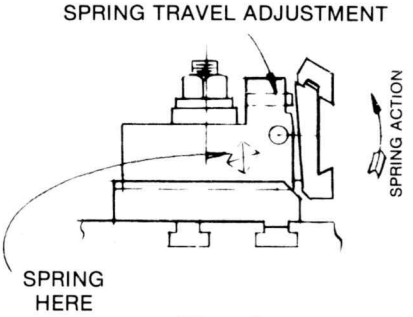


Fig. C

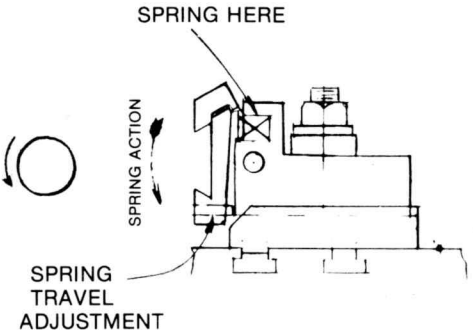


Fig. D

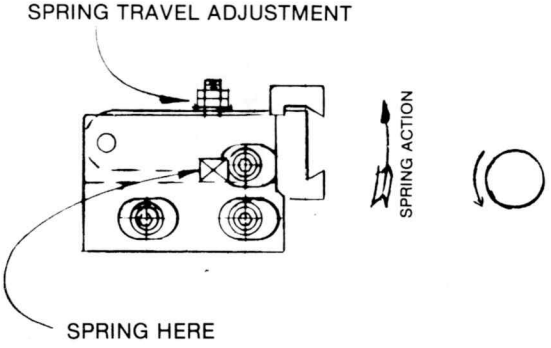
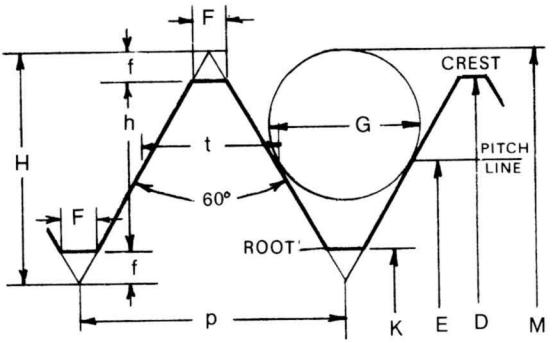


Fig. E

* NOTE: SPRING TRAVEL ADJ. SCREW SHOULD BE BACKED OFF SUBSTANTIALLY OR COMPLETELY REMOVED FOR 3rd POSITION.

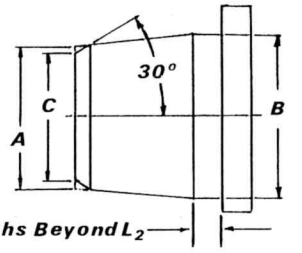
THREAD FORMULA



E=D-h=D-0.64952 p
F=0.1250 p
f=0.10825 p
G=0.57735p BEST
G=1.01036p MAX.
G=0.50518p MIN.
H=0.86603p
h=0.64952p
M=E-H+3G

American National Thread

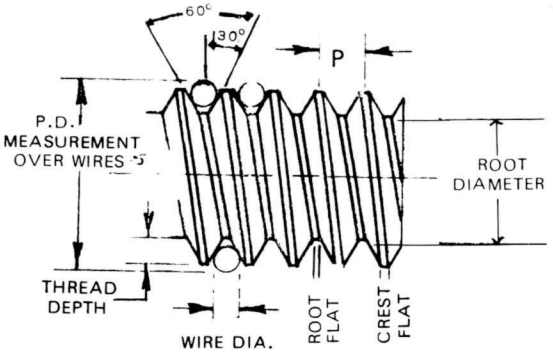
See opposite page for clarification of formulas.



	Blank Dim. For Set-up Ref.		
Pipe Size	A*	B	C
1/16 - 27	.271	.288	.233
1/8 - 27	.364	.380	.322
1/4 - 18	.477	.503	.424
3/8 - 18	.612	.638	.560
1/2 - 14	.758	.792	.692
3/4 - 14	.968	1.002	.902
1 - 11 1/2	1.214	1.256	1.136
1 1/4 - 11 1/2	1.557	1.601	1.480
1 1/2 - 11 1/2	1.796	1.841	1.718
2 - 11 1/2	2.269	2.316	2.191
2 1/2 - 8	2.720	2.791	2.629
3 - 8	3.341	3.416	3.250

*Nominal dimension only. Diameters will vary slightly depending on conditions.

BASIC THREAD FORM



The following are formulas for determining the various elements of American National Threads.

On the following page some of the calculations have already been made and will be pointed out in the formulas below.

1. DECIMAL PITCH = number of threads per inch (T.P.I.) divided into 1.000" Example: 1.000 divided by 20 T.P.I. = .050" (see column "B")

2. FLAT (crest & root) = 1/8 of decimal pitch
   Example: 20P = .050 ÷ 8 = .00625 flat (crest & root)

3. THREAD DEPTH = .64952 times decimal pitch
   Example: .64952 × .050 = .0324 (see column "C", 20 pitch)

4. WIRE SIZE (for measuring pitch dia. over wires) .57735 × Dec. Pitch = Wire Dia. Example: wires to measure 20 pitch = .57735 × .050 = .02887 (see column "D-1") .57735 × decimal pitch is for best wire size, however from 1.01036 to .50518 × decimal pitch may be used (see columns "D-2" and "D-3") any wires between minimum and maximum may be used. However column "F" would have to be figured for wires used.

5. MEASUREMENT OF PITCH DIA. OVER WIRES - Pitch dia. over wires is equal to pitch dia. of part, minus column "E", plus column "F", or pitch dia. over wires is equal to; pitch dia. of part minus .86603 × decimal pitch, (column "E") plus 3 times wire dia.

Example: 1" - 20 pitch thread with pitch dia. of .96752

.96752	pitch dia.
−.04330	(col. "E"-20P = .86603 × .050)
.92422	remainder
+.08661	(col. "F" 3 × wire) (3 × .02887)
1.01083	measurement over wires

No. 5 Example

.96752	pitch dia.
−.04330	(column "E" or .86603 × .050)
.92422	remainder
+.10800	(3 × .036 wire)
1.03222	measurement over wires

No. 6 Example

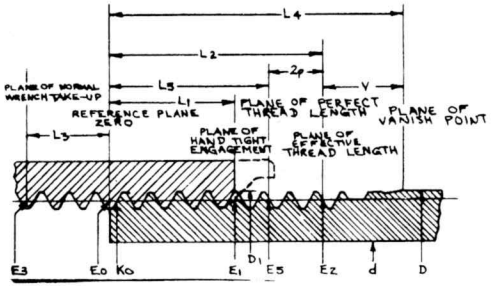
6. FOR ALTERNATE WIRES - for this example use .036 wires. From .02526 to .05052 could be used.

AMERICAN NATIONAL THREADS

thds. per inch A	decimal pitch B	basic thread depth C	"D" WIRE SIZES			.86603 x decimal pitch "E"	3 times best wire size "F"
			1 best	2 maximum	3 minimum		
4	0.25000	0.16238	0.14434	0.25259	0.12630	0.21651	0.43302
4 1/2	0.22222	0.14434	0.12830	0.22453	0.11226	0.19245	0.38490
5	0.20000	0.12990	0.11547	0.20207	0.10104	0.17321	0.34641
5 1/2	0.18182	0.11809	0.10497	0.18370	0.09185	0.15746	0.31491
6	0.16667	0.10825	0.09622	0.16839	0.08420	0.14434	0.28866
7	0.14286	0.09279	0.08248	0.14434	0.07217	0.12372	0.24744
8	0.12500	0.08119	0.07217	0.12630	0.06315	0.10825	0.21651
9	0.11111	0.07217	0.06415	0.11226	0.05613	0.09622	0.19245
10	0.10000	0.06495	0.05774	0.10104	0.05052	0.08660	0.17322
11	0.09091	0.05905	0.05249	0.09185	0.04593	0.07873	0.15747
12	0.08333	0.05413	0.04811	0.08420	0.04210	0.07217	0.14433
13	0.07692	0.04996	0.04441	0.07772	0.03886	0.06662	0.13323
14	0.07143	0.04639	0.04124	0.07217	0.03608	0.06186	0.12372
16	0.06250	0.04059	0.03608	0.06315	0.03157	0.05413	0.10824
18	0.05556	0.03608	0.03207	0.05613	0.02807	0.04811	0.09621
*19	0.05263	0.0348	0.0300	0.03999	0.0284	0.04668	0.090
20	0.05000	0.03248	0.02887	0.05052	0.02526	0.04330	0.08661
22	0.04545	0.02952	0.02624	0.04592	0.02296	0.03936	0.07872
24	0.04167	0.02706	0.02406	0.04210	0.02105	0.03608	0.07218
26	0.03846	0.02498	0.02221	0.03886	0.01943	0.03331	0.06663
27	0.03704	0.02406	0.02138	0.03742	0.01871	0.03208	0.06414
28	0.03571	0.02320	0.02062	0.03608	0.01804	0.03093	0.06186
30	0.03333	0.02165	0.01924	0.03368	0.01684	0.02887	0.05772
32	0.03125	0.02030	0.01804	0.03157	0.01579	0.02706	0.05412
36	0.02778	0.01804	0.01604	0.02807	0.01403	0.02406	0.04812
40	0.02500	0.01624	0.01443	0.02526	0.01263	0.02165	0.04329
44	0.02273	0.01476	0.01312	0.02296	0.01148	0.01968	0.03936
48	0.02083	0.01353	0.01203	0.02105	0.01052	0.01804	0.03609
50	0.02000	0.01299	0.01155	0.02021	0.01010	0.01732	0.03465
56	0.01786	0.01160	0.01031	0.01804	0.00902	0.01546	0.03093
64	0.01562	0.01015	0.00902	0.01579	0.00789	0.01353	0.02706
72	0.01389	0.00902	0.00802	0.01403	0.00702	0.01203	0.02406
80	0.01250	0.00812	0.00722	0.01263	0.00631	0.01083	0.02166
11 1/2	.08696	.0565	.0502	.08786	.04393	.07531	.1506
T.P.I.	$\frac{1.000}{\text{T.P.I.}}$	.64952XP	.57735XP	1.01036XP	.50518XP	.86603XP	3 x WIRE DIA.

*Note Whitworth Form only.

NOMINAL PIPE SIZES (inches)	THREADS PER INCH	Limits on taper at pitch line per foot		LEAD IN LENGTH OF EFFECTIVE THREAD	60 ANGLE OF THREAD
		MAXIMUM	MINIMUM		
		INCH	INCH	INCH	DEGREES
1/16, 1/8———	27	7/8	11/16	±0.003	±2½
1/4, 3/8———	18	7/8	11/16	.003	2
1/2, 3/4———	14	27/32	11/16	.003	2
1, 1-1/4, 1-1/2, 2——	11½	27/32	11/16	.003	1½
2½ and larger———	8	13/16	23/32	.006	1½



NOMINAL PIPE SIZE	OUTSIDE DIAMETER OF PIPE D	THRD'S PER INCH n	PITCH OF THREAD P	DEPTH OF THREAD h	Pitch Diameter at Beginning of External Thread Eo	LENGTH OF EFFECTIVE THREAD			VANISHING THREADS		INCREASE IN DIAMETER PER THREAD =0.0625/n	Helix Angle at Midpoint of Effective Thread Length	HAND TIGHT ENGAGE-MENT L1
						LENGTH L2		DIAMETER E2	V				
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1/16——	0.3125	27	0.03704	0.02963	0.27118	0.2611	7.05	0.28750	0.1285	3.47	0.00231	2 –25′	0.160
1/8——	.405	27	.03704	.02963	.36351	.2639	7.12	.38000	.1285	3.47	.00231	1 –49′	.1615
1/4——	.540	18	.05556	.04444	.47739	.4018	7.23	.50250	.1928	3.47	.00347	2 –4′	.2278
3/8——	.675	18	.05556	.04444	.61201	.4078	7.34	.63750	.1928	3.47	.00347	1 –37′	.240
1/2——	.840	14	.07143	.05714	.75843	.5337	7.47	.79179	.2478	3.47	.00446	1 –41′	.320
3/4——	1.050	14	.07143	.05714	.96768	.5457	7.64	1.00179	.2478	3.47	.00446	1 –19′	.339
1———	1.315	11½	.08696	.06957	1.21363	.6828	7.85	1.25630	.3017	3.47	.00543	1 –17′	.400
1-1/4——	1.660	11½	.08696	.06957	1.55713	.7068	8.13	1.60130	.3017	3.47	.00543	1 –0′	.420
1-1/2——	1.900	11½	.08696	.06957	1.79609	.7235	8.32	1.84130	.3017	3.47	.00543	0 –52′	.420
2———	2.375	11½	.08696	.06957	2.26902	.7565	8.70	2.31630	.3017	3.47	.00543	0 –41′	.436
2-1/2——	2.875	8	.12500	.100000	2.71953	1.1375	9.10	2.79062	.4337	3.47	.00781	0 –50′	.682
3———	3.500	8	.12500	.100000	3.34062	1.2000	9.60	3.41562	.4337	3.47	.00781	0 –41′	.766
3-1/2——	4.000	8	.12500	.100000	3.83750	1.2500	10.00	3.91562	.4337	3.47	.00781	0 –35′	.821
4———	4.500	8	.12500	.100000	4.33438	1.3000	10.40	4.41562	.4337	3.47	.00781	0 –31′	.844
5———	5.563	8	.12500	.100000	5.39073	1.4063	11.25	5.47862	.4337	3.47	.00781	0 –25′	.937

METRIC THREAD STANDARDS
I.S.O. METRIC 6g LIMITS

THREAD SIZE Metric ENGLISH	BASIC THREAD DEPTH	MAJOR DIA. LIMITS Max./Min.	PITCH DIA. LIMITS Max./Min.	MINOR DIA. LIMITS Max./Min.
M 4 × .5 .1575 × .0197	.0132	.1567 .1525	.1439 .1409	.1326 .1282
M 4 × .7 .575 × .0276	.0183	.1566 .1511	.1387 .1352	.1228 .1173
M 4.5 × .5 .1772 × .0197	.0132	.1764 .1722	.1636 .1606	.1522 .1497
M 4.5 × .75 .1772 × .0295	.0195	.1763 .1708	.1571 .1536	.1401 .1344
M 5 × .5 .1969 × .0197	.0132	.1961 .1919	.1833 .1803	.1719 .1676
M 5 × .8 .1969 × .0315	.0208	.1959 .1900	.1754 .1717	.1572 .1512
M 5.5 × .5 .2165 × .0197	.0132	.2157 .2116	.2030 .2000	.1916 .1872
M 6 × .75 .2362 × .0295	.0195	.2354 .2298	.2162 .2122	.1991 .1931
M 6 × 1 .2362 × .0394	.0257	.2352 .2281	.2096 .2052	.1869 .1796
M 7 × .75 .2756 × .0295	.0195	.2747 .2692	.2556 .2516	.2385 .2324
M 7 × 1 .2756 × .0394	.0257	.2746 .2675	.2490 .2446	.2263 .2190
M 8 × .75 .3150 × .0295	.0195	.3141 .3086	.2949 .2910	.2779 .2718
M 8 × 1 .3150 × .0394	.0257	.3139 .3069	.2883 .2839	.2656 .2584
M 8 × 1.25 .3150 × .0492	.0319	.3139 .3055	.2819 .2772	.2535 .2453
M 9 × .75 .3543 × .0295	.0195	.3535 .3480	.3343 .3304	.3172 .3112
M 9 × 1 .3543 × .0394	0.257	.3533 .3462	.3277 .3233	.3050 .2976
M 9 × 1.25 .3543 × .0492	.0319	.3532 .3449	.3213 .3166	.2929 .2847
M 10 × .75 .3937 × .0295	.0195	.3928 .3873	.3737 .3697	.3566 .3506
M 10 × 1 .3937 × .0394	.0257	.3927 .3856	.3671 .3627	.3444 .3371
M 10 × 1.25 .3937 × .0492	.0319	.3926 .3843	.3606 .3560	.3322 .3240

METRIC THREAD STANDARDS
I.S.O. METRIC 6g LIMITS

THREAD SIZE Metric ENGLISH	BASIC THREAD DEPTH	MAJOR DIA. LIMITS Max./Min.	PITCH DIA. LIMITS Max./Min.	MINOR DIA. LIMITS Max./Min.
M 10 × 1.5 .3937 × .0591	.0382	.3924 .3831	.3541 .3489	.3200 .3105
M 11 × .75 .4331 × .0295	.0195	.4322 .4267	.4130 .4091	.3960 .3899
M 11 × 1 .4331 × .0394	.0257	.4320 .4250	.4065 .4020	.3837 .3765
M 11 × 1.5 .4331 × .0591	.0382	.4318 .4225	.3935 .3883	.3593 .3499
M 12 × 1 .4724 × .0394	.0257	.4714 .4643	.4458 .4412	.4231 .4156
M 12 × 1.25 .4724 × .0492	.0319	.4713 .4630	.4394 .4342	.4109 .4022
M 12 × 1.5 .4724 × .0591	.0382	.4712 .4619	.4328 .4273	.3987 .3890
M 12 × 1.75 .4724 × .0689	.0444	.4711 .4607	.4263 .4204	.3866 .3757
M 14 × 1 .5512 × .0394	.0257	.5502 .5431	.5246 .5199	.5019 .4944
M 14 × 1.25 .5512 × .0492	.0319	5501 .5417	.5181 .5129	.4897 .4809
M 14 × 1.5 .5512 × .0591	.0382	.5499 .5406	.5116 .5061	.4775 .4677
M 14 × 2 .5512 × .0787	.0507	.5497 .5387	.4985 .4922	.4531 .4411
M 15 × 1 .5906 × .0394	.0257	.5895 .5824	.5639 .5593	.5412 .5337
M 15 × 1.5 .5906 × .0591	.0382	.5893 .5800	.5509 .5454	.5169 .5071
M 16 × 1 .6299 × .0394	.0257	.6289 .6218	.6033 .5987	.5806 .5731
M 16 × 1.5 .6299 × .0591	.0382	.6287 .6194	.5903 .5848	.5562 .5465
M 16 × 2 .6299 × .0787	.0507	.6284 .6174	.5773 .5710	.5318 .5198
M 17 × 1 .6693 × .0394	.0257	.6683 .6612	.6427 .6380	.6200 .6125
M 17 × 1.5 .6693 × .0591	.0382	.6680 .6587	.6297 .6242	.5956 .5858
M 17 × 2 .6692 × .0787	.0507	.6678 .6568	.6167 .6105	.5712 .5592

CONTINUED ON NEXT PAGE

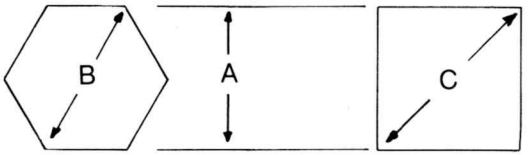
METRIC THREAD STANDARDS
I.S.O. METRIC 6g LIMITS

THREAD SIZE Metric ENGLISH	BASIC THREAD DEPTH	MAJOR DIA. LIMITS Max./Min.	PITCH DIA. LIMITS Max./Min.	MINOR DIA. LIMITS Max./Min.
M 18 × 1 .7087 × .0394	.0257	.7076 .7006	.6820 .6774	.6593 .6519
M 18 × 1.5 .7087 × .0591	.0382	.7074 .6981	.6691 .6635	.6350 .6252
M 18 × 2.5 .7087 × .0984	.0631	.7070 .6938	.6431 .6363	.5863 .5725
M 20 × 1 .7874 × .0394	.0257	.7864 .7793	.7608 .7561	.7381 .7306
M 20 × 1.5 .7874 × .0591	.0382	.7861 .7769	.7478 .7423	.7137 .7039
M 20 × 2.5 .7847 × .0984	.0631	.7857 .7726	.7218 .7151	.6650 .6512
M 22 × 1 .8661 × .0394	.0257	.8651 .8580	.8395 .8349	.8168 .8093
M 22 × 1.5 .8661 × .0591	.0382	.8649 .8556	.8265 .8210	.7924 .7827
M 22 × 2.5 .8661 × .0984	.0631	.8645 .8513	.8006 .7939	.7437 .7300
M 24 × 1 .9449 × .0394	.0257	.9439 .9368	.9183 .9133	.8956 .8878
M 24 × 1.5 .9449 × .0591	.0382	.9436 .9343	.9053 .8999	.8712 .8610
M 24 × 3 .9449 × .1181	.0755	.9430 .9282	.8663 .8584	.7981 .7817
M 25 × 1 .9843 × .0394	.0257	.9832 .9761	.9576 .9527	.9349 .9272
M 25 × 1.5 .9843 × .0591	.0382	.9830 .9737	.9446 .9387	.9106 .9004
M 27 × 1 1.0630 × .0394	.0257	1.0620 1.0549	1.0364 1.0315	1.0317 1.0059
M 27 × 1.5 1.0630 × .0591	.0382	1.0617 1.0524	1.0234 1.0175	.9893 .9791
M 27 × 2 1.0629 × .0787	.0507	1.0615 1.0505	1.0104 1.0039	.9649 .9529
M 27 × 3 1.0630 × .1181	.0755	1.0611 1.0463	.9844 .9765	.9162 .8988
M 28 × 1 1.1024 × .0394	.0257	1.1013 1.0943	1.0757 1.0708	1.0530 1.0453
M 28 × 1.5 1.1024 × .0591	.0382	1.1011 1.0918	1.0628 1.0569	1.0287 1.0185

METRIC THREAD STANDARDS
I.S.O. METRIC 6g LIMITS

THREAD SIZE Metric ENGLISH	BASIC THREAD DEPTH	MAJOR DIA. LIMITS Max./Min.	PITCH DIA. LIMITS Max./Min.	MINOR DIA. LIMITS Max./Min.
M 30 x 1	.0257	1.1801	1.1545	1.1318
1.1811 x .0394		1.1730	1.1496	1.1240
M 30 x 1.5	.0382	1.1798	1.1415	1.1074
1.1811 x .0591		1.1706	1.1356	1.0972
M 30 x 3.5	.0880	1.1790	1.0895	1.0100
1.1811 x .1378		1.1623	1.0812	.9917
M 32 x 1.5	.0382	1.2586	1.2202	1.1861
1.2598 x .0591		1.2493	1.2143	1.1760
M 33 x 1.5	.0382	1.2978	1.2596	1.2255
1.2992 x .0591		1.2887	1.2537	1.2154
M 33 x 2.0	.0507	1.2977	1.2466	1.2011
1.2992 x .0787		1.2867	1.2400	1.1891
M 33 x 3.5	.0880	1.2971	1.2076	1.1281
1.2992 x .1378		1.2804	1.1993	1.1098
M 35 x 1.5	.0382	1.3767	1.3383	1.3043
1.3780 x .0591		1.3674	1.3324	1.2941
M 36 x 1.5	.0382	1.4161	1.3777	1.3436
1.4173 x .0591		1.4068	1.3718	1.3335
M 36 x 4	.1004	1.4150	1.3127	1.2218
1.4173 x .1574		1.3963	1.3039	1.2016
M 37 x 1.5	.0382	1.4554	1.4171	1.383
1.4567 x .0591		1.4461	1.4111	1.3729
M 39 x 1.5	.0382	1.5342	1.4958	1.4617
1.5354 x .0591		1.5249	1.4899	1.4516
M 39 x 4	.1004	1.5331	1.4308	1.3399
1.5354 x .1574		1.5144	1.4220	1.3197
M 40 x 1.5	.0382	1.5735	1.5352	1.5011
1.5748 x .0591		1.5643	1.5293	1.4909
M 42 x 1.5	.0382	1.6523	1.6139	1.5798
1.6535 x .0591		1.6430	1.6080	1.5697
M 42 x 4.5	.1128	1.6511	1.5360	1.4337
1.6535 x .1772		1.6314	1.5267	1.4117
M 45 x 1.5	.0382	1.7704	1.7320	1.6980
1.7717 x .0591		1.7611	1.7261	1.6878
M 45 x 4.5	.1128	1.7692	1.6541	1.5518
1.7717 x .1772		1.7495	1.6448	1.5298
M 48 x 1.5	.0382	1.8885	1.8502	1.8161
1.8898 x .0591		1.8792	1.8439	1.8055
M 48 x 5	.1253	1.8870	1.7591	1.6454
1.8898 x .1969		1.8861	1.7493	1.6214
M 50 x 1.5	.0382	1.9672	1.9289	1.8948
1.9685 x .0591		1.9580	1.9226	1.8843

DISTANCE ACROSS CORNERS OF HEXAGONS AND SQUARES



B = 1.1547 A

C = 1.4142 A

A	B	C		A	B	C		A	B	C
3/8	.4329	.5303		1 1/8	1.2990	1.5910		1 7/8	2.1650	2.6516
7/16	.5051	.6187		1 3/16	1.3712	1.6793		1 15/16	2.2372	2.7400
1/2	.5773	.7071		1 1/4	1.4434	1.7677		2 "	2.3094	2.8284
9/16	.6494	.7955		1 5/16	1.5155	1.8561		2 1/16	2.3815	2.9168
5/8	.7216	.8839		1 3/8	1.5877	1.9445		2 1/8	2.4537	3.0052
11/16	.7937	.9723		1 7/16	1.6598	2.0329		2 3/16	2.5259	3.0936
3/4	.8659	1.0606		1 1/2	1.7320	2.1213		2 1/4	2.5981	3.1820
13/16	.938	1.1490		1 9/16	1.8042	2.2097		2 5/16	2.6702	3.2703
7/8	1.0102	1.2374		1 5/8	1.8764	2.2981		2 3/8	2.7424	3.3587
15/16	1.0824	1.3258		1 11/16	1.9485	2.3865		2 7/16	2.8145	3.4471
1 "	1.1547	1.4142		1 3/4	2.0207	2.4708		2 1/2	2.867	3.5355
1 1/16	1.2268	1.5026		1 13/16	2.0929	2.5632				

ORDERING

1. THE BASIC ATTACHMENT

To save time, it is best to start with the machine that is to be used. Select the largest attachments that will fit on the machine, this will give the greatest range of sizes. Check to be sure the throat or opening in attachment is large enough to clear shoulders or stock diameters: Be sure to check any foot notes pertaining to the machine and position. (See page 33)

2. REPAIR PARTS

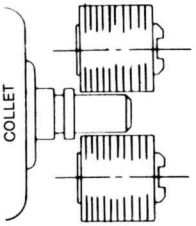
Select needed parts from the charts on pages 20 and 21. Give the part name, number, model and serial number of the attachment.

3. THREADING DIES

Specify, size, pitch, pitch diameter. Whether part is to be plated, type of material to be rolled, coolant to be used, thread length and type of roll. (See charts on following pages)

SALVO TOOL & ENGINEERING COMPANY
3948 Burnsline Rd.• P.O. Box 129 • Brown City, MI 48416
Fax: (810) 346-2616 Phone: (810) 346-2727
www.salvotool.com

BASIC SALVO THREAD ROLLS



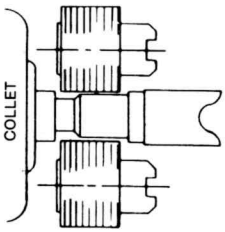
TYPE SC-1

STANDARD ROLL

Full length thread working face except for drive slot area.

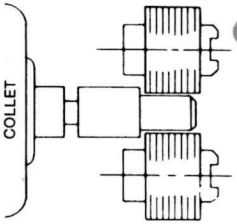
Short Hub — .030" long
Slot Hub — .156" long

Stan. T.L.
CBL* - .812
BBL - 1.062
DBL - 1.312



TYPE SC-2

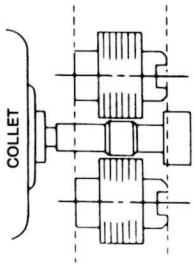
SHORTER THREAD LENGTH THAN STANDARD



TYPE SC-3

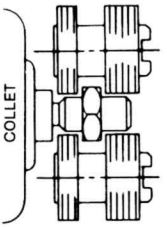
LONG HUB ON COLLET SIDE

Standard drive Hub one end.



TYPE SC-4

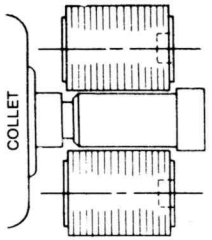
ROLLS HAVE NARROW WORKING FACE IN CENTER



TYPE SC-5

FOR ROLLING BOTH ENDS OF A PART HAVING SAME SIZE AND PITCH OF THREADS AT EACH END

Standard drive slots.

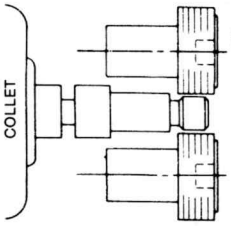


TYPE SD-1

MAXIMUM THREAD POSSIBLE ON ROLLS

Drive slots recessed one end only.

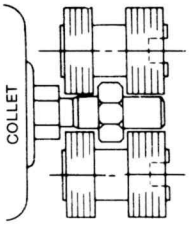
Stan. T.L.
CBL* - .890
BBL - 1.140
DBL - 1.390



TYPE SD-3

LONG HUB ON COLLET SIDE

Recessed slot.

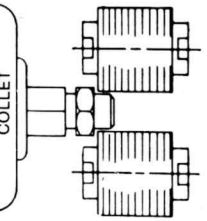


TYPE SD-5

STRADDLE TYPE FOR ROLLING SAME SIZE AND PITCH ON BOTH ENDS OF PART

Recessed slot one end only.

BASIC SALVO THREAD ROLLS

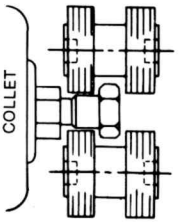


TYPE SCR-1

REVERSIBLE TYPE ROLL

Maximum thread length with standard slots both ends.

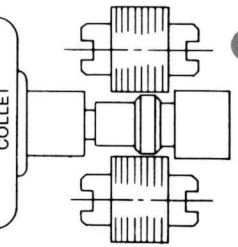
Stan. T.L.
CBL* - .688
BBL - .938
DBL - 1.188



TYPE SDR-5

STRADDLE TYPE

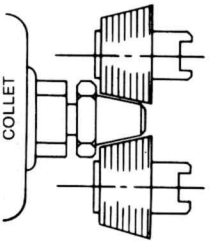
Recessed slots both ends. Modification of SCR-5.



TYPE SCR-4

REVERSIBLE TYPE ROLL

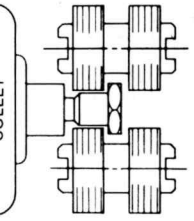
Standard slots both ends.



TYPE SQ-2

TAPER ROLLS FOR ROLLING PIPE THREADS IN ATTACHMENTS USING PARALLEL ROLL PINS NOT SET AT PIPE ANGLE

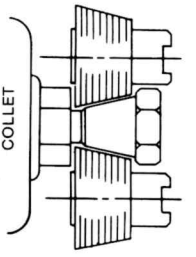
Large end of thread on part next to collet.



TYPE SCR-5

REVERSIBLE TYPE ROLLS FOR NARROW THREAD BEHIND SHOULDER

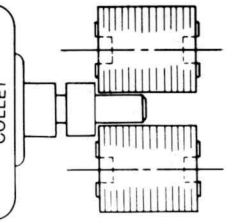
Standard slots both ends.



TYPE SK-2

TAPER ROLLS FOR ROLLING PIPE THREADS IN ATTACHMENTS USING PARALLEL ROLL PINS NOT SET AT PIPE ANGLE

Small end of thread on part next to collet. Standard slots one end.

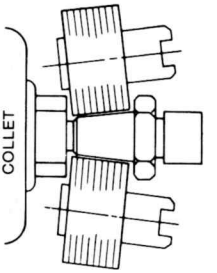


TYPE SDR-1

MAXIMUM ROLL THREAD FACE

Recessed slots both ends.

Stan. T.L.
CBL* -.800
BBL - 1.050
DBL - 1.300

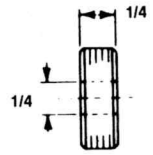


TYPE SS-1

STRAIGHT ROLLS FOR ROLLING TAPER PIPE THREADS IN ATTACHMENTS WITH ROLL PINS SET AT PIPE ANGLE

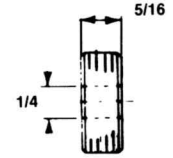
Standard slots one end.

SALVO STANDARD BUMP ROLLS



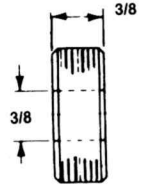
TYPE S-1

Use in these Holders:
Salvo—SA-00
Reed—A00-54
Brown & Sharpe—83-200
Det. Tap 309-5



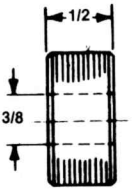
TYPE S-2

Use in these Holders:
Salvo—SA-00
Reed—A00-54
Brown & Sharpe—83-200
Det. Tap 309-5



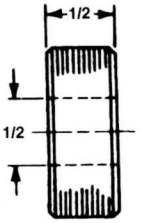
TYPE S-3

Use in these Holders:
Salvo—SA-0; SB-00
Reed—A00-86; AO-86
Brown & Sharpe—84-100; 83-120
Det. Tap 309-4



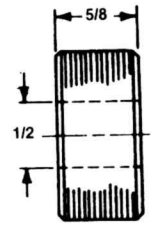
TYPE S-4

Use in these Holders:
Salvo—SA-0; SB-00
Reed—A00-86; AO-86
Brown & Sharpe—84-100; 83-120
Det. Tap 309-4



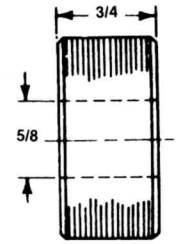
TYPE S-5

Use in these Holders:
Salvo—SA-2; SB-0
Reed—AO-108; A2-108
Brown & Sharpe—84-120; 83-122
Det. Tap 309-6



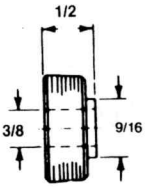
TYPE S-6

Use in these Holders:
Salvo—SA-2; SB-0
Reed—AO-108; A2-108
Brown & Sharpe—84-120; 83-122
Det. Tap 309-6



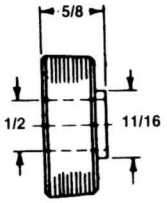
TYPE S-7

Use in these Holders:
Salvo—SB-2 Reed—A2-1210
Brown & Sharpe—84-122



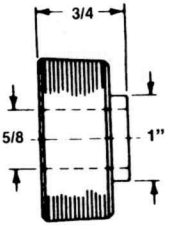
TYPE T-1

Use in these Holders:
Salvo—SA-0; SB-00
Reed—A00-86; A0-86
Brown & Sharpe—84-100; 83-120
Det. Tap 309-4



TYPE T-2

Use in these Holders:
Salvo—SA-2; SB-0
Reed—AO-108; A2-106
Brown & Sharpe—84-120; 83-122
Det. Tap 309-6



TYPE T-3

Use in these Holders:
Salvo—SB-2
Reed—A2-1210
Brown & Sharpe—84-122

VARIOUS APPLICATIONS OF THE "CBL"

MACHINE	MODEL & SIZE	MACHINE SERIAL NO.	SPIN-DLE	POS.	SLIDE SLOT WIDTH	MACH. ADAPTER	SLIDE TRAVEL REQ'D
Acme Gridley	9/16 R, RA	22326 CM Last	6	3-4	½ Key	312 BAR	19/16
	9/16, 1" RA	A23051 Start	6	3-4	½ Key	312 BAR	19/16
	9/16, 1" RA, RAN	B23510 Last	6	3-4	½ Key	312 BAR	19/16
	9/16, 1" RA, RAN	B23511 Start	6	3-4	½ Key	312 BAR	
	5/8 RN		6	3-4	½ Key	312 BAR	
	9/16 R, 9/16, 1" RA, RAN & 5/8 RN	D. Decker	6	2	½ Key	312 BG	
	1, 1¼ R, 1 RAS, 1¼ RA	71633 B Last	6	3-4	5/8 Key	312 BBS	
	1¼ RA	71634B Start	6	3-4	5/8 Key	312 BBS	
	1 5/8 R, RA, RB		6	3-4	¾ Key	312 BBS	
	2 RAS, RB		6	3-4	¾ Key	312 BBS	
	2, 2¼, 2 5/8 RA		6	3-4	¾ Key	312 BBS	
	¾ RA	BD70016 Last	8	4-5	½ Key	None	
	¾ RA	BD70017 Start	8	4-5	½ Key	312 BAC	
	1¼ RB, 1 5/8 RBN	AM40189 & 90	8	4-5	5/8 Key	312 BBS	
Greenlee	1		6	3-4	2½	312 DA	2
	1 5/8, 2		6	3-4	2 29/32	312 DB	
Davenport			**5**	**C**		**312 AC**	
	B		5	D		312 ADA	
Conomatic	1 TB, TC, TS, SL		6	3 ▲	1½	312 FA	
	1 TV, TVA, 1¼ TVB		6	4 ▲	1½	312 FA	3¼
	1" TV, TVA, 1¼ TVB		6	5 ▲	1½	312 FA	3¼
	1" SL		6	4	1½	312 FAS	
	1" TB, TC, TS		6	4	1½	312 FAS	
	1" to 1 5/8 # S's, TA, TAA, A		6	5 ▲	1¾	312 FB	
	1"A, VK, 1¼ VL, 1½ VM, 1 5/8 VN, 1 7/8		8	5 ⊙	1¾	312 FB	17/8
New Britain	#51, 52		6	4-5*		312 CJ	
	60, 61		6	4 *		312 CJ	
	62, 601, 602, 656		6	4-5		312 CJ	
	60		6	5		312 CG	
	61		6	5		312 CB	
	826		8	5-6		312 CJ	

* MAY INTERFERE WITH SHAVE TOOL IN ADJACENT POSITION.

▲SLIDE GUIDE & KEEPER "ALTER"
⊙ALTER SLIDE TO CLEAR ATTACHT. CHECK END SLIDE FOR CLEARANCE
CHECK "SHAVE TOOL" FOR CLEARANCE

VARIOUS APPLICATIONS OF THE "BBL"

MACHINE	MODEL & SIZE	MACHINE SERIAL NO.	SPIN-DLE	POS.	SLIDE SLOT WIDTH	MACH. ADAPTER	SLIDE TRAVEL REQ'D
Acme Gridley	1 3/8, 1 5/8, R, RA. 1 5/8, 2 RAS	¾ Tee Slots	4	2	Make	¾ Key in 312 BBL	
	1" RAS, 1¼ RA – Up to	Last Ser #71633 B	6	3-4	5/8	312 BBL	2 1/8
	1 5/8 RA, RB, 2" RB, RAS		6	3-4	3/4	312 BEL	
	1 5/8 RA, RB, 2RB, RAS	D. Decker	6	2	3/4	312 BWL	
	2, 2¼, 2 5/8 RA		6	3-4	3/4	312 BEL	
	2, 2¼, 2 5/8, 3½ RA, 2 5/8, 3½ RB	2 5/8 RB to	4	2-3	3/4	312 BFL	
	3 RA Ser. 38211 Only	Ser. 38289	4	2-3	3/4	312 BFL	
	2 5/8, 3½ RB, 3, 3½ RA	2,5/8 RB to #84805	6	3-4	3/4	312 BFL	
	1¼ RB, 1 5/8 RBN		8	4-5	5/8	312 BBL	
	1 5/8 RA, RB, 2 RB		8	4-5	3/4	312 BC	
	2¼, 2 5/8 RA, RB		8	4-5	3/4	312 BEL	
	3½, 4 RB		8	4-5	3/4	312 BFL	
	4 RB		6	3-4	3/4		
	5¼ RAC Chucker		6		5/8	312 BBL	

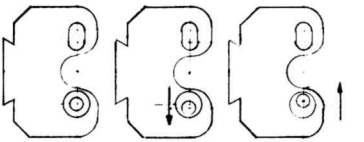
VARIOUS APPLICATIONS OF THE "BBL"

MACHINE	MODEL & SIZE	MACHINE SERIAL NO.	SPINDLE	POS.	SLIDE SLOT WIDTH	MACH. ADAPTER	SLIDE TRAVEL REQ'D
New Britain	52		6	4-5	9/16 Key	312 CA	1 15/16
	61		6	4	3/4	312 CD	
	601		6	4	1½	312 CD	1 7/8
	61		6	5		312 CB	
	601		6	5	1½	312 CD	1 19/32
	602		6	4	1½	312 CD	
	62 also 3rd Pos. using "Tee Slots"		6	4-5	¾	312 CD	
	656 (65) Chucker		6	5	¾	312 CD	
	826 (slide type) Chucker		8	5-6	¾	312 CDL	3¾
	826		8	4	¾	312 CDL	
					CHECK SHAVE TOOL CLEARANCE		
Conomatic	1 SW, 1¼ SJ, SK, SO, SM, SX	▲	6	5	1¾	312 F	
	1½ SJ, SK, SO, SM, SY	▲	6	5	1¾	312 F	
	1 5/8, TA, TAA, A	▲	6	5	1¾	312 F	
	2 SN	▲	6	5	1¾	312 F	4 3/16
	2¼ SD	▲	6	5	2½	312 FC	4 5/16
	2 5/8 SE	▲	6	5	2½	312 FC	4 5/16
	1 5/8 TF, TM, TW	▲	6	4-5	1¾	312 F	
	2¼ SD	▲	6	2	3 Cent.	312 FFF	4 5/16
	2¼ SD	▲	6	4	3 Cent.	312 FF	
	3½, 4 SF, SZ	▲	6	5	3 —	312 FE	4 5/8
	1 A, VK, 1¼ VL, W, 1½ VM& WW, 1 5/8, VB, VE, VN, A		8	5	1¾	312 F	1 7/8
	2¼ GA	⊙	8	5	3	312 F	2½
	2 5/8 GB, 3 GI	⊙	8	5	3	312 FE	2½
	2¼ GL, 2 5/8 GK, 3 GN, 3 1/8 GM		8	5	2½	312 FC	
	2¼ GA	▲	8	4	3 Cent.	312 FF	3 5/16
	2¼ GA	▲	8	6	3 Cent.	312 FFB	3 5/16
	2¼, 2 5/8, 3¼ C		8	5-6	2½	312 FC	

VARIOUS APPLICATIONS OF THE "DBL"

Acme Gridley	1 3/8, 1 5/8 R, RA, 1 5/8, 2 RAS		4	2nd	¾ Key	312 BBL	
	1 5/8 RA, RB, 2 RB, RAS		6	3-4	¾ Key	312 BEL	
	1 5/8 RA, RB; 2 RB, RAS	D. Decker	6	2	¾ Key	312 BWL	
	2, 2¼, 2 5/8 RA		6	3-4	¾ Key	312 BEL	
	2, 2¼, 2 5/8 RA; 2 5/8 RB 3½ RB; 3 RA, Ser. #38211	2 5/8 RB to Serial 38289	4	2-3	¾ Key	312 BFL	
	2 5/8, 3½ RB, 3, 3½ RA		6	3-4	¾ Key	312 BFL	
	1¼ RB, 1 5/8 RBN		8	4-5	5/8 Key	312 BBL	
	1 5/8 RA, RB, 2 RB		8	4-5	¾ Key	312 BC	
	2¼, 2 5/8 RA, RB		8	4-5	¾ Key	312 BEL	
	3½, 4 RB		8	4-5	¾ Key	312 BFL	
	4 RB		6	3-4	¾ Key		
New Britian	61		6	4	¾ Key	312 CD	
	61		6	5	—	312 CB	
	62 also 3rd Pos. using Tee Slots		6	4-5	¾	312 CD	
	826 Slide Type		8	5-6	¾	312 CDL	3¾
	826		8	4	¾	312 CDL	
					CHECK SHAVE TOOL CLEARANCE		
Conomatic	2 SN	▲	6	5	1¾	312 F	4 5/16
	2¼ SD, 2 5/8 SE	▲	6	5	2½	312 FC	4 5/16
	2¼ SD	▲	6	2	3 Cent.	312 FFF	4 5/16
	2¼ SD	▲	6	4	3 Cent.	312 FF	
	3½, 4 SF, SZ	▲	6	5	3	312 FE	4 5/8
	1 5/8 VB, VE, VN, A	⊙	8	5	1¾	312 F	1 7/8
	2¼ GA	⊙	8	5	3	312 FF	2½
	2 5/8 GB, 3 GI	⊙	8	5	3	312 FE	2½
	2¼ GL, 2 5/8 GK, 3 GN, 3 1/8 GM	⊙	8	5	2½	312 FC	
	2¼ GA	▲	8	4	3 Cent.	312 FF	3 5/16
	2¼ GA	▲	8	6	3 Cent.	312 FFB	3 5/16
	2¼, 2 5/8, 3¼ C		8	5-6	2½	312 FC	

▲ SLIDE GUIDE & KEEPER "ALTER"
⊙ ALTER SLIDE TO CLEAR ATTACHT.
CHECK END SLIDE FOR CLEARANCE
CHECK "SHAVE TOOL" FOR CLEARANCE



CENTER ECCENTRIC OUT ECCENTRIC IN

BUSHING POSITION REFERRED TO, IN CHARTS.

THREAD SIZE	BUSHING POSITION	STOCK OPENING
M 3.5 × .35	IN - CENT	(.821) .712 C
6 - 32	IN - CENT	(.807) .727 C
M 4 × .7	IN - CENT	(.851) .680 C
8 - 32	IN - CENT	(.815) .719 C
- 36	IN - CENT	(.891) .643 C
10 - 24	IN - CENT	(.864) .670 C
- 28	IN - CENT	(.780) .754 C
- 32	IN - CENT	(.871) .663 C
M 5 × .75	IN - CENT	(.750) .781 C
M 5 × .8	IN - CENT	(.778) .754 C
12 - 24	IN - CENT	(.846) .688 C
- 28	IN - CENT	(.772) .762 C
- 32	IN - CENT	(.900) .634 C
M 6 × .5	IN - CENT	(.754) .779 C
M 6 × .75	IN - CENT	(.857) .674 C
M 6 × 1	IN - CENT	(.760) .772 C
1/4 - 20	IN - CENT	(.735) .797 C
- 24	IN - CENT	(.853) .681 C
- 28	IN - CENT	(.790) .744 C
- 32	IN - CENT	(.740) .792 C
- 36	IN - CENT	(.704) .828 C
- 40	IN - CENT	(.902) .632 C
M 7 × 1	IN - CENT	(.799) .732 C
5/16 - 18	IN	(.881)
- 20	IN - CENT	(.836) .698 C
- 24	IN - CENT	(.763) .769 C
- 28	IN - CENT	(.712) .820 C
- 32	IN - CENT	(.675) .857 C
- 36	IN - CENT	(.645) .887 C
- 40	IN - CENT	(.621) .911 C
M 8 × 1	IN - CENT	(.718) .815 C
M 8 × 1.25	IN - CENT	(.798) .734 C
M 9 × 1	IN - CENT	(.716) .816 C
3/8 - 16	IN - CENT	(.746) .786 C
- 18	IN - CENT	(.697) .835 C
- 20	IN - CENT	(.655) .877 C
- 24	OUT - CENT	(.644) .890 C
- 27	IN - CENT	(.900) .634 C
- 28	IN - CENT	(.892) .642 C
- 32	IN - CENT	(.863) .671 C
- 36	IN - CENT	(.841) .693 C
- 40	IN - CENT	(.823) .711 C
M 10 × 1	IN - CENT	(.796) .736 C
M 10 × 1.25	IN - CENT	(.856) .676 C
M 10 × 1.5	OUT - CENT	(.656) .877 C
M 11 × 1.5	IN - CENT	(.680) .853 C
7/16 - 14	IN - CENT	(.738) .794 C
- 16	IN - CENT	(.638) .849 C
7/16 - 18	IN - CENT	(.638) .894 C
- 20	OUT - CENT	(.634) .900 C
- 24	OUT - CENT	(.687) .847 C
- 27	OUT - CENT	(.716) .818 C
- 28	OUT - CENT	(.725) .809 C
- 32	IN - CENT	(.893) .641 C
M 12 × 1	IN - CENT	(.754) .778 C
M 12 × 1.25	IN	(.808)
M 12 × 1.5	IN - CENT	(.858) .674 C
M 12 × 1.75	OUT - CENT	(.734) .801 C
1/2 - 12	IN - CENT	(.859) .675 C
- 13	IN - CENT	(.824) .710 C
- 14	IN - CENT	(.795) .739 C
- 16	IN - CENT	(.744) .788 C
- 18	IN - CENT	(.707) .825 C
- 20	IN - CENT	(.677) .855 C
- 24	IN - CENT	(.632) .900 C
- 27	OUT - CENT	(.631) .903 C
- 28	OUT - CENT	(.638) .896 C
- 32	OUT - CENT	(.662) .872 C
M 13 × 1.5	IN - CENT	(.660) .872 C
M 14 × 1	IN - CENT	(.872) .660 C
M 14 × 1.25	OUT - CENT	(.829) .706 C
M 14 × 1.5	OUT - CENT	(.777) .756 C
M 14 × 2	OUT - CENT	(.672) .861 C
9/16 - 12	IN - CENT	(.699) .838 C
- 14	OUT - CENT	(.760) .774 C
- 18	IN - CENT	(.903) .631 C
- 20	IN - CENT	(.879) .655 C
- 24	IN - CENT	(.843) .691 C
- 27	IN - CENT	(.823) .711 C
- 28	IN - CENT	(.817) .717 C
- 32	IN - CENT	(.797) .737 C
M 15 × 1	IN - CENT	(.712) .819 C
M 15 × 1.5	IN - CENT	(.798) .734 C
5/8 - 11	IN - CENT	(.805) .729 C
- 12	IN - CENT	(.773) .761 C
- 14	IN - CENT	(.718) .814 C
- 16	IN - CENT	(.679) .853 C
- 18	- CENT	.882 C
- 20	- CENT	.907 C
- 24	- CENT	.884 C
- 27	OUT - CENT	(.670) .864 C
- 28	OUT - CENT	(.676) .858 C
- 32	OUT - CENT	(.695) .839 C
M 16 × 1.5	- CENT	.893 C
M 16 × 2	IN - CENT	(.722) .810 C
11/16 - 12	OUT - CENT	(.719) .815 C

CONTINUED ON NEXT PAGE

CBL* DATA

THREAD SIZE	BUSHING POSITION	STOCK OPENING
11/16 - 14	OUT - CENT	(.773) .761 C
- 16	**	(.974)
- 18	OUT	.841
- 20	OUT	.865
- 24	OUT	.901
- 27	OUT	.907
- 28	OUT	.901
M 18 × 1.5	OUT	.912
M 18 × 2.5	OUT - CENT	(.748) .786 C
3/4 - 10	OUT	.898
- 14	IN	.898
- 16	IN	.869
- 18	IN	.846
3/4 - 20	IN	.826
- 24	IN	.799
- 28	IN	.780
- 32	- CENT	.771 C
M 20 × 1	- CENT	.860 C
M 20 × 1.5	- CENT	.796 C
13/16 - 12	- CENT	.786 C
- 14	- CENT	.826
- 16	- CENT	.854
- 18	- CENT	.878
- 20	- CENT	.896
- 24	- CENT	.904
- 32	- CENT	.869
M 22 x 1.5	**	.968

PIPE THREADS NPT, NPTF, NPS & NPSM

1/8 - 27 NPT	IN - CENT	(.818) .838 C
1/4 - 18 NPT	OUT - CENT	(.734) .922 C
3/8 - 18 NPT	OUT - CENT	(.804) .852 C
1/2 - 14 NPT	- CENT	(.737) .919 C *

*NOTE: Exceptionally Small Stock Opening

**Special Eccentric Required (.097in)

THREAD SIZE	BUSHING POSITION	STOCK OPENING
M 6.3 × 1	IN - CENT	(1.519) 1.196 C
1/4 - 20	IN - CENT	(1.444) 1.274 C
- 24	IN - CENT	(1.382) 1.390 C
- 28	IN - CENT	(1.452) 1.266 C
- 32	IN - CENT	(1.394) 1.324 C
M 7 × 1	OUT - CENT	(1.202) 1.513 C
5/16 - 18	IN - CENT	(1.415) 1.303 C
- 20	IN - CENT	(1.354) 1.364 C
- 24	IN - CENT	(1.260) 1.458 C
- 28	IN - CENT	(1.466) 1.252 C
- 32	IN - CENT	(1.420) 1.298 C
- 36	IN - CENT	(1.383) 1.335 C
- 40	IN - CENT	(1.354) 1.364 C
M 8 × 1	IN - CENT	(1.198) 1.518 C
M 8 × 1.25	IN - CENT	(1.306) 1.410 C
M 9 × 1	IN - CENT	(1.392) 1.324 C
3/8 - 16	IN - CENT	(1.430) 1.289 C
- 18	IN - CENT	(1.366) 1.352 C
- 20	IN - CENT	(1.313) 1.405 C
- 24	IN - CENT	(1.235) 1.483 C
- 28	OUT - CENT	(1.184) 1.534 C
- 32	IN - CENT	(1.480) 1.239 C
- 36	IN - CENT	(1.450) 1.268 C
- 40	IN - CENT	(1.426) 1.292 C
M 10 × 1	IN - CENT	(1.391) 1.324 C
M 10 × 1.25	IN - CENT	(1.470) 1.246 C
M 10 × 1.5	IN - CENT	(1.218) 1.498 C
M 11 × 1.5	IN - CENT	(1.236) 1.479 C
7/16 - 14	IN - CENT	(1.314) 1.404 C
- 16	IN - CENT	(1.241) 1.477 C
- 18	IN - CENT	(1.183) 1.535 C
- 20	OUT - CENT	(1.227) 1.491 C
- 24	IN - CENT	(1.461) 1.257 C
- 27	IN - CENT	(1.427) 1.291 C
- 28	IN - CENT	(1.417) 1.301 C
- 32	IN - CENT	(1.384) 1.334 C
- 36	IN - CENT	(1.360) 1.360 C
- 40	IN - CENT	(1.337) 1.381 C
M 12 × 1	IN - CENT	(1.194) 1.522 C
M 12 × 1.25	IN - CENT	(1.264) 1.451 C
M 12 × 1.5	IN - CENT	(1.336) 1.381 C
M 12 × 1.75	IN - CENT	(1.406) 1.310 C
1/2 - 12	IN - CENT	(1.330) 1.388 C
- 13	IN - CENT	(1.282) 1.436 C
- 14	IN - CENT	(1.243) 1.475 C
- 16	OUT - CENT	(1.187) 1.531 C
- 18	OUT - CENT	(1.238) 1.480 C
1/2 - 20	OUT - CENT	(1.279) 1.439 C
- 24	IN - CENT	(1.480) 1.238 C
- 28	IN - CENT	(1.442) 1.276 C
- 32	IN - CENT	(1.413) 1.305 C
M 13 × 1.5	IN - CENT	(1.512) 1.204 C
M 14 × 1	OUT - CENT	(1.210) 1.505 C
M 14 × 1.25	IN - CENT	(1.216) 1.501 C
M 14 × 1.5	IN - CENT	(1.276) 1.441 C
M 14 × 2	IN - CENT	(1.397) 1.318 C
9/16 - 12	IN - CENT	(1.368) 1.350 C
- 14	IN - CENT	(1.294) 1.424 C
- 16	IN - CENT	(1.237) 1.481 C
- 18	IN - CENT	(1.193) 1.525 C
- 20	OUT - CENT	(1.206) 1.512 C
- 24	OUT - CENT	(1.259) 1.459 C
- 28	OUT - CENT	(1.297) 1.421 C
- 32	OUT - CENT	(1.325) 1.393 C
M 15 × 1	IN - CENT	(1.467) 1.248 C
M 15 × 1.5	OUT - CENT	(1.324) 1.391 C
5/8 - 11	OUT - CENT	(1.324) 1.394 C
- 12	OUT - CENT	(1.370) 1.348 C
- 14	IN - CENT	(1.471) 1.247 C
- 16	IN - CENT	(1.423) 1.295 C
- 18	IN - CENT	(1.388) 1.331 C
- 20	IN - CENT	(1.356) 1.362 C
- 24	IN - CENT	(1.311) 1.407 C
- 27	IN - CENT	(1.287) 1.431 C
- 28	IN - CENT	(1.279) 1.439 C
- 32	IN - CENT	(1.255) 1.463 C
M 16 × 1.5	IN - CENT	(1.373) 1.344 C
M 16 × 2	IN - CENT	(1.476) 1.240 C
11/16 - 12	IN - CENT	(1.221) 1.497 C
- 14	OUT - CENT	(1.206) 1.512 C
- 16	OUT - CENT	(1.253) 1.465 C
- 18	OUT - CENT	(1.291) 1.427 C
- 20	OUT - CENT	(1.320) 1.398 C
- 24	OUT - CENT	(1.365) 1.353 C
- 28	OUT - CENT	(1.397) 1.321 C
- 32	OUT - CENT	(1.421) 1.297 C
M 18 × 1.5	OUT - CENT	(1.385) 1.332 C
M 18 × 2	OUT - CENT	(1.282) 1.434 C
M 18 × 2.5	IN - CENT	(1.184) 1.532 C
3/4 - 10	OUT - CENT	(1.366) 1.352 C
- 12	OUT - CENT	(1.455) 1.263 C
- 16	IN	(1.484)
- 18	IN - CENT	(1.454) 1.264 C
- 20	IN - CENT	(1.429) 1.289 C

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THREAD SIZE	BUSHING POSITION	STOCK OPENING
3/4 - 24	IN - CENT	(1.393) 1.325 C
- 28	IN - CENT	(1.368) 1.350 C
- 32	IN - CENT	(1.348) 1.370 C
M 20 x 1	IN - CENT	(1.230) 1.486 C
M 20 x 1.5	IN - CENT	(1.314) 1.403 C
13/16 - 12	IN - CENT	(1.323) 1.395 C
- 14	IN - CENT	(1.271) 1.447 C
- 16	IN - CENT	(1.234) 1.484 C
- 18	IN - CENT	(1.203) 1.515 C
- 20	OUT - CENT	(1.185) 1.533 C
- 24	OUT - CENT	(1.221) 1.497 C
- 32	OUT - CENT	(1.266) 1.452 C
M 22 x 1	OUT - CENT	(1.449) 1.266 C
M 22 x 1.5	OUT - CENT	(1.366) 1.350 C
7/8 - 9	IN - CENT	(1.193) 1.525 C
- 10	OUT - CENT	(1.218) 1.500 C
- 12	OUT - CENT	(1.290) 1.428 C
- 14	OUT - CENT	(1.340) 1.377 C
- 16	OUT - CENT	(1.380) 1.338 C
- 18	OUT - CENT	(1.410) 1.308 C
- 20	OUT - CENT	(1.434) 1.284 C
- 24	OUT - CENT	(1.471) 1.247 C
15/16 - 10	OUT - CENT	(1.468) 1.250 C
- 28	IN - CENT	(1.517) 1.201 C
- 32	IN - CENT	(1.502) 1.216 C
31/32 - 18	IN - CENT	(1.489) 1.229 C
- 20	IN - CENT	(1.471) 1.247 C
- 24	IN - CENT	(1.433) 1.275 C
- 28	IN - CENT	(1.423) 1.295 C
- 32	IN - CENT	(1.408) 1.310 C
31/32 - 40	IN - CENT	(1.387) 1.331 C
M 25 x 1	IN - CENT	(1.386) 1.330 C
1" - 12	IN - CENT	(1.489) 1.229 C
- 14	IN - CENT	(1.449) 1.269 C
- 16	IN - CENT	(1.419) 1.299 C
- 18	IN - CENT	(1.396) 1.322 C
- 20	IN - CENT	(1.378) 1.340 C
- 24	IN - CENT	(1.350) 1.368 C
- 28	IN - CENT	(1.330) 1.388 C
- 32	IN - CENT	(1.315) 1.403 C
- 40	IN - CENT	(1.293) 1.425 C
1 1/16 - 12	IN - CENT	(1.300) 1.418 C
- 14	IN - CENT	(1.262) 1.486 C
- 16	IN - CENT	(1.232) 1.456 C
- 18	IN - CENT	(1.208) 1.510 C
- 20	IN - CENT	(1.190) 1.528 C
- 24	OUT - CENT	(1.202) 1.516 C
- 28	OUT - CENT	(1.222) 1.496 C
- 32	OUT - CENT	(1.237) 1.481 C
M 27 x 1.5	IN - CENT	(1.214) 1.502 C
M 28 x 1.5	OUT - CENT	(1.268) 1.448 C
1 1/8 - 12	OUT - CENT	(1.250) 1.468 C
- 14	OUT - CENT	(1.290) 1.428 C
- 16	OUT - CENT	(1.320) 1.398 C
- 18	OUT - CENT	(1.343) 1.375 C
- 20	OUT - CENT	(1.361) 1.357 C
- 24	OUT - CENT	(1.388) 1.329 C
- 28	OUT - CENT	(1.409) 1.309 C
- 32	OUT - CENT	(1.424) 1.294 C

PIPE THREADS NPT, NPTF & NPSM

1/8 - 27	IN - CENT	(1.374) 1.466 C
1/4 - 18	IN - CENT	(1.442) 1.398 C
3/8 - 18	OUT - CENT	(1.250) 1.590 C
1/2 - 14	IN - CENT	(1.276) 1.564 C
3/4 - 14	IN - CENT	(1.400) 1.440 C

NATIONAL GARDEN HOSE THREAD

1 1/16 - 11 1/2	IN - CENT	(1.362) 1.478 C

THREAD SIZE	BUSHING POSITION	STOCK OPENING BLOCK	STOCK OPENING PLATE
M 6 × .5	IN - CENT	(1.816) 1.640 C	(1.534) 1.170 C
M 6 × .75	IN - CENT	(1.752) 1.704 C	(1.470) 1.234 C
M 6 × 1	IN - CENT	(1.706) 1.750 C	(1.424) 1.280 C
M 6.3 × 1	IN - CENT	(1.724) 1.732 C	(1.442) 1.262 C
1/4 - 20	IN - CENT	(1.669) 1.789 C	(1.387) 1.319 C
- 24	IN - CENT	(1.743) 1.714 C	(1.461) 1.244 C
- 28	IN - CENT	(1.649) 1.809 C	(1.367) 1.339 C
- 32	IN - CENT	(1.799) 1.659 C	(1.517) 1.189 C
M 7 × 1	IN - CENT	(1.781) 1.674 C	(1.449) 1.204 C
5/16 - 18	IN - CENT	(1.782) 1.676 C	(1.500) 1.162 C
- 20	IN - CENT	(1.716) 1.742 C	(1.434) 1.272 C
- 24	IN - CENT	(1.611) 1.847 C	(1.329) 1.377 C
- 28	IN - CENT	(1.813) 1.645 C	(1.531) 1.175 C
- 32	IN - CENT	(1.763) 1.695 C	(1.481) 1.225 C
- 36	IN - CENT	(1.722) 1.736 C	(1.440) 1.266 C
- 40	IN - CENT	(1.690) 1.768 C	(1.408) 1.298 C
M 8 × 1	IN - CENT	(1.818) 1.638 C	(1.536) 1.168 C
M 8 × 1.25	IN - CENT	(1.661) 1.796 C	(1.379) 1.326 C
M 9 × 1	IN - CENT	(1.669) 1.758 C	(1.417) 1.288 C
3/8 - 16	IN - CENT	(1.741) 1.717 C	(1.459) 1.247 C
- 18	IN - CENT	(1.670) 1.788 C	(1.388) 1.318 C
- 20	IN - CENT	(1.610) 1.848 C	(1.328) 1.378 C
- 24	IN - CENT	(1.524) 1.934 C	(1.242) 1.464 C
- 28	IN - CENT	(1.802) 1.656 C	(1.520) 1.186 C
- 32	IN - CENT	(1.759) 1.699 C	(1.477) 1.229 C
- 36	IN - CENT	(1.727) 1.821 C	(1.445) 1.261 C
- 40	IN - CENT	(1.700) 1.758 C	(1.418) 1.288 C
M 10 × 1	IN - CENT	(1.658) 1.798 C	(1.376) 1.328 C
M 10 × 1.25	IN - CENT	(1.747) 1.710 C	(1.465) 1.240 C
M 10 × 1.5	IN - CENT	(1.504) 1.923 C	(1.222) 1.482 C
M 11 × 1.5	IN - CENT	(1.484) 1.903 C	(1.202) 1.503 C
7/16 - 14	IN - CENT	(1.570) 1.888 C	(1.288) 1.418 C
- 16	IN - CENT	(1.488) 1.908 C	(1.206) 1.500 C
- 18	IN - CENT	(1.805) 1.653 C	(1.523) 1.183 C
- 20	IN - CENT	(1.759) 1.699 C	(1.477) 1.229 C
- 24	IN - CENT	(1.689) 1.769 C	(1.407) 1.299 C
- 27	IN - CENT	(1.651) 1.807 C	(1.369) 1.337 C
- 28	IN - CENT	(1.639) 1.819 C	(1.357) 1.349 C
- 32	IN - CENT	(1.600) 1.858 C	(1.318) 1.388 C
- 36	IN - CENT	(1.570) 1.888 C	(1.288) 1.418 C
- 40	IN - CENT	(1.546) 1.912 C	(1.264) 1.442 C
M 12 × 1	IN - CENT	(1.814) 1.642 C	(1.438) 1.172 C
M 12 × 1.25	IN - CENT	(1.462) 1.883 C	(1.180) 1.523 C
M 12 × 1.5	IN - CENT	(1.542) 1.913 C	(1.260) 1.443 C
M 12 × 1.75	IN - CENT	(1.624) 1.833 C	(1.342) 1.363 C
1/2 - 13	IN - CENT	(1.481) 1.901 C	(1.199) 1.507 C
- 14	IN - CENT	(1.436) 1.856 C	(1.154) 1.552 C
- 16	IN - CENT	(1.799) 1.659 C	(1.517) 1.189 C
- 20	IN - CENT	(1.707) 1.751 C	(1.425) 1.281 C
- 24	IN - CENT	(1.646) 1.812 C	(1.364) 1.342 C
- 28	IN - CENT	(1.599) 1.859 C	(1.317) 1.389 C
- 32	IN - CENT	(1.566) 1.892 C	(1.284) 1.422 C
M 13 × 1.5	IN - CENT	(1.680) 1.776 C	(1.398) 1.306 C
M 14 × 1	IN - CENT	(1.773) 1.682 C	(1.491) 1.212 C
M 14 × 1.25	OUT - CENT	(1.702) 1.754 C	(1.232) 1.472 C
M 14 × 1.5	OUT - CENT	(1.632) 1.824 C	(1.162) 1.542 C
M 14 × 2	IN - CENT	(1.546) 1.911 C	(1.264) 1.441 C
9/16 - 12	IN - CENT	(1.511) 1.931 C	(1.229) 1.477 C
- 14	IN - CENT	(1.425) 1.845 C	(1.143) 1.563 C
- 16	OUT - CENT	(1.677) 1.781 C	(1.207) 1.499 C
9/16 - 18	IN - CENT	(1.815) 1.643 C	(1.533) 1.173 C
- 20	IN - CENT	(1.780) 1.678 C	(1.498) 1.208 C
- 24	IN - CENT	(1.727) 1.731 C	(1.445) 1.261 C
- 27	IN - CENT	(1.698) 1.760 C	(1.416) 1.290 C
- 28	IN - CENT	(1.689) 1.769 C	(1.407) 1.299 C
- 32	IN - CENT	(1.661) 1.791 C	(1.379) 1.327 C
- 36	IN - CENT	(1.638) 1.820 C	(1.356) 1.350 C
- 40	IN - CENT	(1.619) 1.839 C	(1.337) 1.369 C
M 15 × 1	IN - CENT	(1.538) 1.919 C	(1.256) 1.449 C
M 15 × 1.5	IN - CENT	(1.659) 1.796 C	(1.377) 1.326 C
5/8 - 11	IN - CENT	(1.662) 1.796 C	(1.380) 1.326 C
- 12	IN - CENT	(1.614) 1.844 C	(1.332) 1.374 C
- 14	IN - CENT	(1.539) 1.919 C	(1.257) 1.449 C
- 16	IN - CENT	(1.482) 1.902 C	(1.200) 1.506 C
- 18	IN - CENT	(1.439) 1.859 C	(1.157) 1.549 C
- 20	OUT - CENT	(1.633) 1.825 C	(1.121) 1.543 C
- 24	OUT - CENT	(1.686) 1.772 C	(1.216) 1.490 C
- 27	OUT - CENT	(1.715) 1.743 C	(1.245) 1.461 C
- 28	OUT - CENT	(1.724) 1.734 C	(1.254) 1.452 C
- 32	OUT - CENT	(1.752) 1.706 C	(1.282) 1.424 C
M 16 × 1.5	OUT - CENT	(1.614) 1.843 C	(1.144) 1.561 C
M 16 × 2	IN - CENT	(1.520) 1.936 C	(1.238) 1.466 C
11/16 - 12	OUT - CENT	(1.797) 1.661 C	(1.327) 1.379 C
- 14	IN - CENT	(1.780) 1.678 C	(1.498) 1.208 C
- 16	IN - CENT	(1.733) 1.725 C	(1.451) 1.317 C
- 18	IN - CENT	(1.695) 1.763 C	(1.413) 1.293 C
- 20	IN - CENT	(1.666) 1.792 C	(1.384) 1.322 C
- 24	IN - CENT	(1.619) 1.839 C	(1.337) 1.369 C
- 28	IN - CENT	(1.649) 1.871 C	(1.305) 1.401 C
- 32	IN - CENT	(1.563) 1.895 C	(1.281) 1.425 C
M 18 × 1.5	IN - CENT	(1.600) 1.856 C	(1.318) 1.387 C
M 18 × 2	IN - CENT	(1.702) 1.754 C	(1.420) 1.284 C
M 18 × 2.5	IN - CENT	(1.803) 1.652 C	(1.521) 1.182 C
3/4 - 10	IN - CENT	(1.618) 1.840 C	(1.336) 1.370 C
- 12	IN - CENT	(1.529) 1.929 C	(1.247) 1.459 C
- 16	OUT - CENT	(1.617) 1.841 C	(1.147) 1.559 C
- 18	OUT - CENT	(1.655) 1.803 C	(1.185) 1.521 C
- 20	OUT - CENT	(1.685) 1.773 C	(1.215) 1.491 C
- 24	OUT - CENT	(1.729) 1.729 C	(1.259) .1447 C
- 28	OUT - CENT	(1.760) 1.698 C	(1.290) 1.416 C
- 32	OUT - CENT	(1.785) 1.673 C	(1.315) 1.391 C
M 20 × 1	OUT - CENT	(1.933) 1.522 C	(1.463) 1.240 C
M 20 × 1.5	OUT - CENT	(1.831) 1.626 C	(1.361) 1.344 C
13/16 - 10	OUT - CENT	(1.731) 1.727 C	(1.261) 1.445 C
- 12	OUT - CENT	(1.820) 1.638 C	(1.350) 1.356 C
- 14	OUT - CENT	(1.885) 1.573 C	(1.415) 1.291 C
- 16	OUT - CENT	(1.932) 1.526 C	(1.462) 1.244 C
- 18	OUT - CENT	(1.825) 1.633 C	(1.543) 1.163 C
- 20	OUT - CENT	(1.801) 1.657 C	(1.519) 1.187 C
- 24	IN - CENT	(1.765) 1.693 C	(1.483) 1.223 C
- 28	IN - CENT	(1.739) 1.719 C	(1.457) 1.249 C
- 30	IN - CENT	(1.728) 1.730 C	(1.446) 1.260 C
- 32	IN - CENT	(1.720) 1.738 C	(1.438) 1.268 C
- 36	IN - CENT	(1.704) 1.754 C	(1.422) 1.284 C
M 22 × 1.5	IN - CENT	(1.618) 1.838 C	(1.336) 1.368 C
M 22 × 1	IN - CENT	(1.534) 1.921 C	(1.252) 1.451 C
7/8 - 9	IN - CENT	(1.815) 1.643 C	(1.533) 1.173 C
- 10	IN - CENT	(1.768) 1.690 C	(1.468) 1.220 C
- 12	IN - CENT	(1.696) 1.762 C	(1.414) 1.292 C
- 14	IN - CENT	(1.645) 1.813 C	(1.363) 1.343 C

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THREAD SIZE	BUSHING POSITION	STOCK OPENING BLOCK	STOCK OPENING PLATE
7/8 - 16	IN - CENT	(1.604) 1.854 C	(1.322) 1.384 C
- 18	IN - CENT	(1.574) 1.884 C	(1.292) 1.414 C
- 20	IN - CENT	(1.550) 1.908 C	(1.268) 1.438 C
- 24	IN - CENT	(1.513) 1.933 C	(1.231) 1.475 C
- 28	IN - CENT	(1.487) 1.907 C	(1.205) 1.501 C
- 32	IN - CENT	(1.467) 1.887 C	(1.185) 1.521 C
15/16 - 10	IN - CENT	(1.516) 1.936 C	(1.234) 1.472 C
- 12	IN - CENT	(1.444) 1.864 C	(1.162) 1.544 C
- 14	OUT - CENT	(1.643) 1.815 C	(1.173) 1.533 C
- 16	OUT - CENT	(1.682) 1.776 C	(1.212) 1.494 C
- 18	OUT - CENT	(1.713) 1.745 C	(1.243) 1.463 C
- 20	OUT - CENT	(1.736) 1.772 C	(1.266) 1.440 C
- 24	OUT - CENT	(1.772) 1.686 C	(1.302) 1.404 C
- 27	OUT - CENT	(1.792) 1.666 C	(1.322) 1.384 C
- 28	OUT - CENT	(1.798) 1.660 C	(1.328) 1.378 C
- 32	OUT - CENT	(1.818) 1.640 C	(1.348) 1.358 C
M 24 X 1.5	OUT - CENT	(1.732) 1.742 C	(1.262) 1.442 C
31/32 - 18	OUT - CENT	(1.840) 1.618 C	(1.370) 1.336 C
- 20	OUT - CENT	(1.863) 1.595 C	(1.393) 1.313 C
- 24	OUT - CENT	(1.899) 1.559 C	(1.429) 1.277 C
- 28	OUT - CENT	(1.925) 1.534 C	(1.455) 1.252 C
- 32	OUT - CENT	(1.933) 1.513 C	(1.475) 1.231 C
- 36	OUT - CENT	(1.918) 1.498 C	(1.490) 1.216 C
- 40	OUT - CENT	(1.905) 1.485 C	(1.503) 1.203 C
M 25 X 1	OUT - CENT	(1.903) 1.482 C	(1.503) 1.200 C
1" - 8	OUT - CENT	(1.662) 1.796 C	(1.192) 1.514 C
- 10	OUT - CENT	(1.770) 1.688 C	(1.300) 1.406 C
- 12	OUT - CENT	(1.843) 1.615 C	(1.373) 1.333 C
- 14	OUT - CENT	(1.895) 1.653 C	(1.425) 1.281 C
- 16	OUT - CENT	(1.934) 1.524 C	(1.464) 1.242 C
- 18	OUT - CENT	(1.914) 1.494 C	(1.494) 1.212 C
- 20	OUT - CENT	(1.890) 1.470 C	(1.518) 1.198 C
1 1/16 - 20	IN - CENT	(1.812) 1.646 C	(1.530) 1.176 C
- 24	IN - CENT	(1.784) 1.674 C	(1.502) 1.204 C
- 28	IN - CENT	(1.764) 1.694 C	(1.482) 1.224 C
- 32	IN - CENT	(1.749) 1.709 C	(1.467) 1.239 C
- 36	IN - CENT	(1.737) 1.721 C	(1.455) 1.251 C
M 27 X 1.5	IN - CENT	(1.834) 1.620 C	(1.552) 1.150 C
M 28 X 1.5	IN - CENT	(1.716) 1.740 C	(1.434) 1.270 C
1 1/8 - 10	IN - CENT	(1.791) 1.667 C	(1.509) 1.197 C
- 12	IN - CENT	(1.736) 1.722 C	(1.454) 1.252 C
- 14	IN - CENT	(1.696) 1.762 C	(1.414) 1.292 C
- 16	IN - CENT	(1.666) 1.792 C	(1.384) 1.322 C
- 18	IN - CENT	(1.643) 1.815 C	(1.316) 1.345 C
- 20	IN - CENT	(1.623) 1.835 C	(1.359) 1.365 C
- 24	IN - CENT	(1.595) 1.863 C	(1.313) 1.393 C
- 28	IN - CENT	(1.575) 1.883 C	(1.293) 1.413 C
- 32	IN - CENT	(1.560) 1.898 C	(1.278) 1.428 C
M 30 X 1.5	IN - CENT	(1.570) 1.900 C	(1.288) 1.506 C
M 30 X 2	IN - CENT	(1.544) 1.912 C	(1.262) 1.442 C
1 3/16 - 10	IN - CENT	(1.602) 1.856 C	(1.320) 1.386 C
- 12	IN - CENT	(1.546) 1.912 C	(1.264) 1.442 C
- 14	IN - CENT	(1.507) 1.927 C	(1.225) 1.481 C
- 16	IN - CENT	(1.477) 1.897 C	(1.195) 1.511 C
- 18	IN - CENT	(1.454) 1.874 C	(1.172) 1.534 C
- 20	IN - CENT	(1.435) 1.927 C	(1.153) 1.553 C
- 24	OUT - CENT	(1.629) 1.829 C	(1.159) 1.547 C
- 28	OUT - CENT	(1.649) 1.809 C	(1.179) 1.527 C
- 32	OUT - CENT	(1.664) 1.794 C	(1.194) 1.512 C
1 1/4 - 10	OUT - CENT	(1.622) 1.836 C	(1.152) 1.554 C
- 12	OUT - CENT	(1.677) 1.781 C	(1.207) 1.499 C
- 14	OUT - CENT	(1.717) 1.741 C	(1.247) 1.459 C
- 16	OUT - CENT	(1.747) 1.711 C	(1.277) 1.429 C
- 18	OUT - CENT	(1.770) 1.688 C	(1.300) 1.406 C
- 20	OUT - CENT	(1.788) 1.670 C	(1.318) 1.388 C
- 24	OUT - CENT	(1.816) 1.642 C	(1.346) 1.360 C
- 28	OUT - CENT	(1.838) 1.620 C	(1.368) 1.338 C
- 32	OUT - CENT	(1.853) 1.605 C	(1.383) 1.323 C
M 32 X 1	OUT - CENT	(1.857) 1.600 C	(1.387) 1.318 C
M 33 X 1.5	OUT - CENT	(1.910) 1.546 C	(1.440) 1.264 C
M 33 X 2	OUT - CENT	(1.846) 1.610 C	(1.376) 1.328 C
1 5/16 - 10	OUT - CENT	(1.810) 1.648 C	(1.340) 1.366 C
- 12	OUT - CENT	(1.867) 1.591 C	(1.397) 1.309 C
- 14	OUT - CENT	(1.906) 1.552 C	(1.436) 1.270 C
- 16	OUT - CENT	(1.936) 1.522 C	(1.466) 1.240 C
- 18	OUT - CENT	(1.919) 1.499 C	(1.489) 1.217 C
- 20	OUT - CENT	(1.900) 1.480 C	(1.508) 1.198 C
- 24	OUT - CENT	(1.872) 1.452 C	(1.536) 1.170 C
1 9/16 - 20	IN - CENT	(1.822) 1.636 C	(1.540) 1.166 C
- 24	IN - CENT	(1.803) 1.654 C	(1.521) 1.185 C
- 28	IN - CENT	(1.789) 1.669 C	(1.507) 1.199 C
- 32	IN - CENT	(1.778) 1.680 C	(1.496) 1.210 C
1 5/8 - 10	IN - CENT	(1.814) 1.644 C	(1.532) 1.174 C
- 11	IN - CENT	(1.792) 1.666 C	(1.510) 1.196 C
- 12	IN - CENT	(1.775) 1.683 C	(1.493) 1.213 C
- 14	IN - CENT	(1.747) 1.711 C	(1.465) 1.241 C
- 16	IN - CENT	(1.726) 1.732 C	(1.444) 1.262 C
- 18	IN - CENT	(1.710) 1.748 C	(1.428) 1.278 C
- 20	IN - CENT	(1.698) 1.768 C	(1.416) 1.290 C
- 24	IN - CENT	(1.678) 1.780 C	(1.396) 1.310 C
1 11/16 - 12	- CENT	1.839 C	1.465 C
- 16	- CENT	1.858 C	1.388 C
- 18	- CENT	1.874 C	1.404 C
- 20	- CENT	1.888 C	1.418 C
1 3/4 - 10	- CENT	1.896 C	1.426 C
- 12	- CENT	1.935 C	1.465 C
- 14	- CENT	1.915 C	1.493 C
- 16	- CENT	1.922 C 1.894 C	1.514 C
- 18	- CENT	1.878 C	1.530 C
- 20	- CENT	1.922 C	1.542 C
M 45 X 1.5	- CENT	1.840 C	1.558 C

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PIPE THREADS NPT, NPTF, NPSM			
THREAD SIZE	BUSHING POSITION	STOCK OPENING	
		BLOCK	PLATE
1/8 - 27 NPT	- CENT	1.920	1.450
1/4 - 18 NPT	- CENT	1.970	1.500
3/8 - 18 NPT	IN	1.876	1.594
1/2 - 14 NPT	OUT	1.996	1.534
3/4 - 14 NPT	OUT	1.842	1.468
1 - 11 1/2 NPT	-CENT	1.722	1.440
1 1/4 - 11 1/2 NPT	IN	1.818	1.536
1/8 - 27 NPTF	- CENT	1.950	1.480
1/4 - 18 NPTF	- CENT	1.993	1.522
3/8 - 18 NPTF	OUT	1.860	1.578
1/2 - 14 NPTF	OUT	1.984	1.546
3/4 - 14 NPTF	OUT	1.896	1.614
1 - 11 1/2 NPTF	- CENT	1.712	1.430
1 1/4 - 11 1/2 NPTF	IN	1.812*	1.530

*NOTE: Exceptionally Small Stock Opening

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