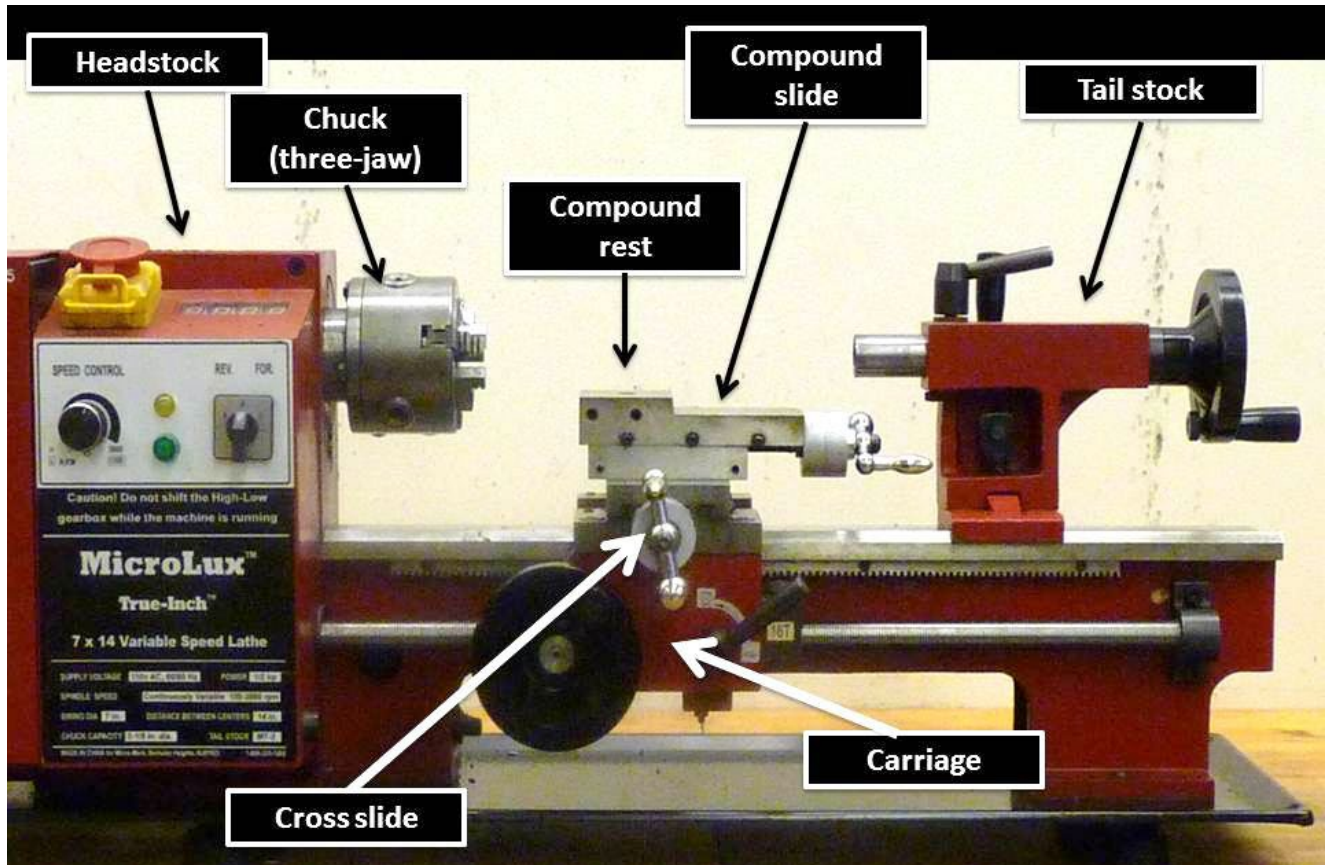


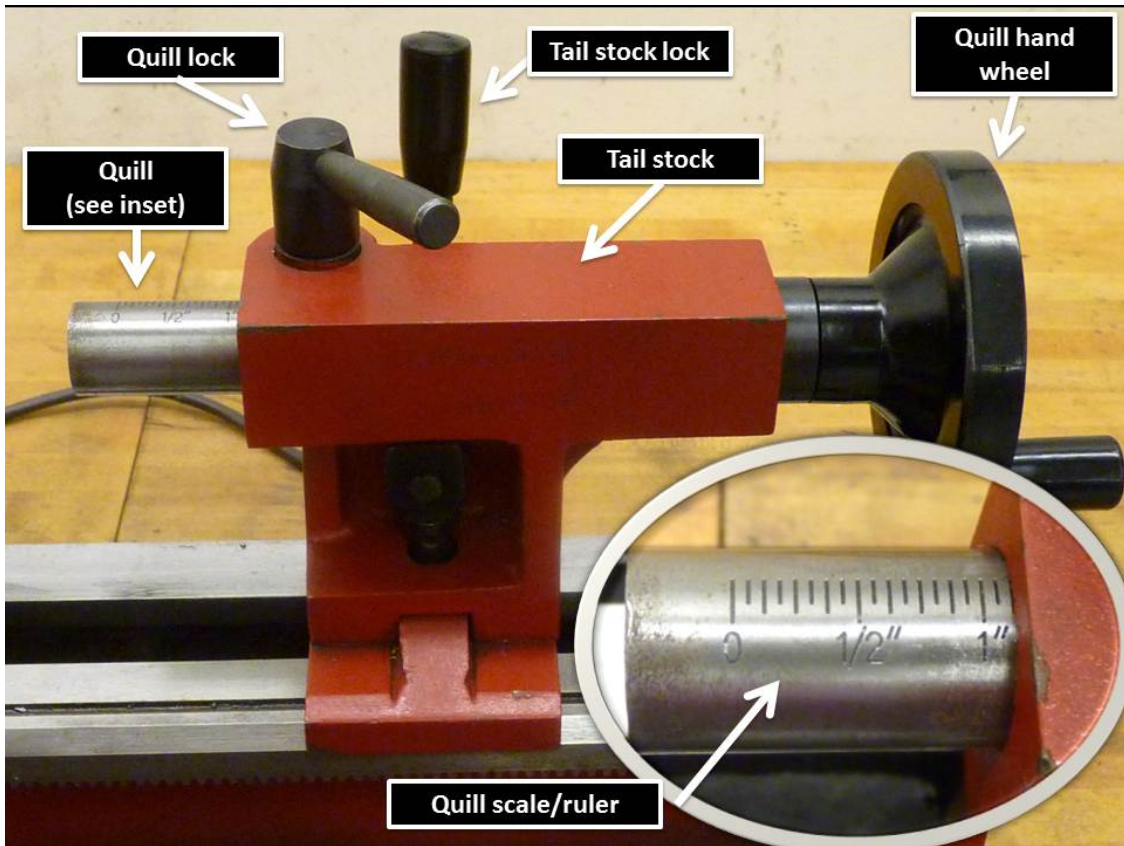
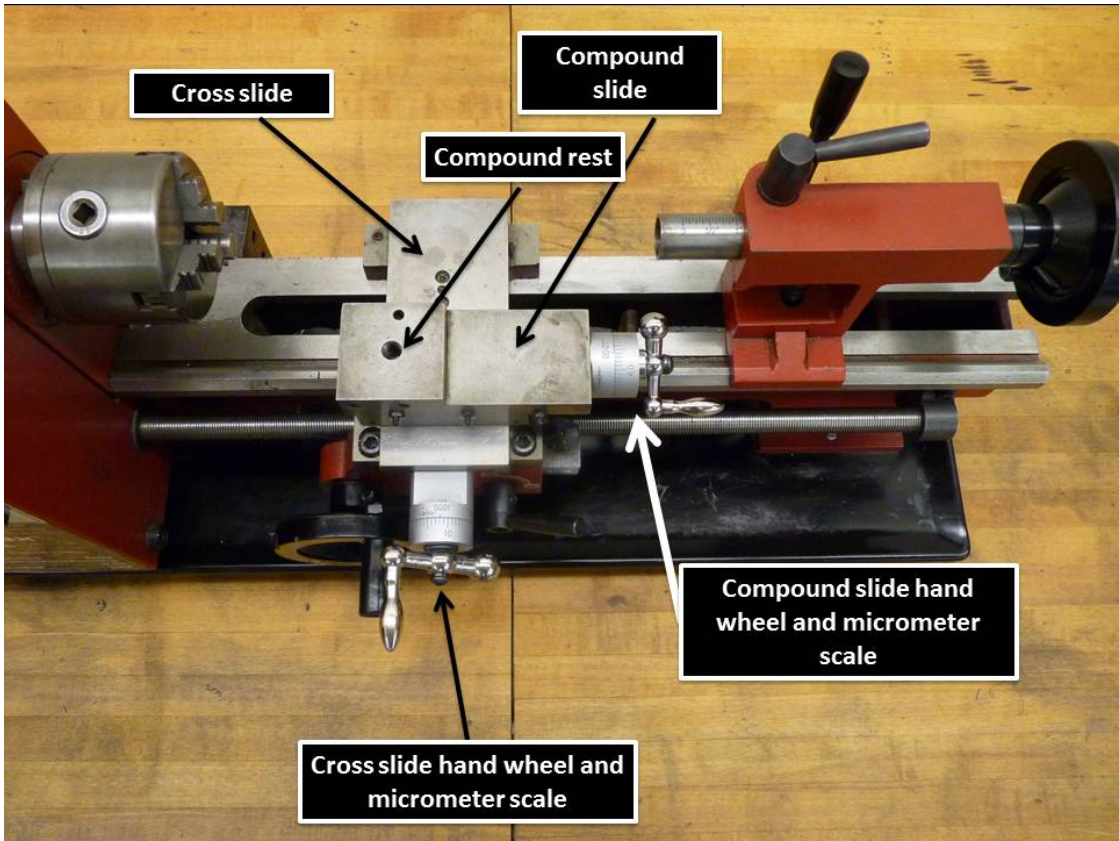
Join the live stream at <https://youtu.be/FIV0BfFAXGM>



## METAL LATHE OPERATION

This is a compilation of information on lathe operation, built around the U.S. Army training circular on lathe operation. It includes work by Paul Bianchi, Gene Beckwith, Ken Cance, John Huth, Lucas Pemberton, Greg Beckwith, John Maddox, and source material from [littlemachineshop.com](http://littlemachineshop.com) and [sherline.com](http://sherline.com)





# Machine Shop Safety

- **Safety Glasses**
  - **EVERYONE MUST WEAR SAFETY GLASSES WITH SIDE SHIELDS IN THE SHOP.**
    - Even when you're not working on a machine, you must wear safety glasses. A chip from a machine someone else is working on could fly into your eye.
- **Clothes and Hair**
  - Check your clothes and hair before you walk into the shop. In particular:
    - REMOVE JEWELRY
    - IF YOU HAVE LONG HAIR OR A LONG BEARD, TIE IT UP.
      - If your hair is caught in spinning machinery, it will be pulled out if you're lucky. If you're unlucky, you will be pulled into the machine.
    - NO LOOSE CLOTHING.
      - Ties, scarves, loose sleeves, etc. are prohibited
    - NO GLOVES
    - WEAR APPROPRIATE SHOES
      - No open toed sandals. Wear shoes that give a sure footing. If you are working with heavy objects, steel toes are recommended.
- **Safe Conduct in the Shop**
  - Know where the emergency stop is before operating the lathe.
  - Be aware of what's going on around you.
  - Concentrate on what you're doing. If you get tired, leave.
  - Don't hurry. If you catch yourself rushing, slow down.
  - Don't rush speeds and feeds. You'll end up damaging your part, the tools, and maybe the machine itself.
  - Listen to the machine. If something doesn't sound right, turn the machine off.
  - Don't let someone else talk you into doing something dangerous.
  - No shouting or other loud noises.
  - Don't attempt to measure a part that's moving.
- **Machining**
  - IF YOU DON'T KNOW HOW TO DO SOMETHING, ASK!
  - BEFORE YOU START THE MACHINE:
    - Study the machine. Know which parts move, which are stationary, and which are sharp. Spin the chuck by hand to insure that all is clear!
    - Double check that your workpiece, tool bit, holder, and post are securely held.
    - Remove chuck keys, wrenches and anything else that can become a projectile.
  - DO NOT LEAVE MACHINES RUNNING UNATTENDED!
  - REMOVE CHIPS WITH PLIERS OR A CHIP BRUSH – NEVER YOUR FINGERS!
  - Always stop the lathe before making adjustments.
  - Never lay tools directly on the lathe ways.
  - File left-handed if possible.
  - Use two hands when sanding the workpiece. Do not wrap sand paper or emory cloth around the workpiece.
  - Do not change spindle speeds until the lathe comes to a complete stop.
  - CLEAN UP MACHINES AFTER YOU USE THEM!
    - A dirty machine is unsafe and uncomfortable to work on.
    - Do not use compressed air to blow machines clean. This endangers people's eyes and can force dirt into machine bearings.

Courtesy of the U.S. Army

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## General Lathe Chuck Speed and Other Rules

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### For determining chuck speed when facing and turning hard metal stock

(12L14, 1144, or 1018 cold-rolled steel, bronze, 303 or 304 stainless, and drill rod)

**300 ÷ diameter of the part to be machined = chuck speed** (adjust as required)

examples:

*chuck speed for a ½" diameter piece should be approximately 600 rpm*

*chuck speed for a 5/8" diameter piece should be approximately 480 rpm*

*chuck speed for a 1" diameter piece should be approximately 300 rpm*

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### For determining chuck speed when facing and turning soft metal and plastic stock

(brass, aluminum, abs, delrin, pvc)

**400 ÷ diameter of the part to be machined = chuck speed** (adjust as required)

---

### For determining chuck speed when drilling on the lathe

**150 ÷ diameter of the drill** (adjust as required)

---

### Other rules of lathe use

- Extension from the chuck jaws of parts to be machined should never exceed more than 3X the diameter of the part without live center or steady rest support (see p.11).

**Example:** *The maximum extension for a 5/8" diameter piece chucked in the headstock chuck should be 1 7/8" before live center support is required (see p. 11).*

- **Quill extension** before inserting an accessory: On BIR's floor standing lathes the tailstock quill should be extended 1" on the quill scale/ruler before inserting any tailstock accessory. On the table-top mini-lathes the tailstock quill should be extended ½" on the quill scale/ruler before inserting any tailstock accessory (see p. 1).
- **Tool bit height** is set at center, whether facing or turning. Use a dead center or aluminum bar to help.
- **Wipe clean** the lathe chuck jaws and tail stock quill interior before using any lathe.

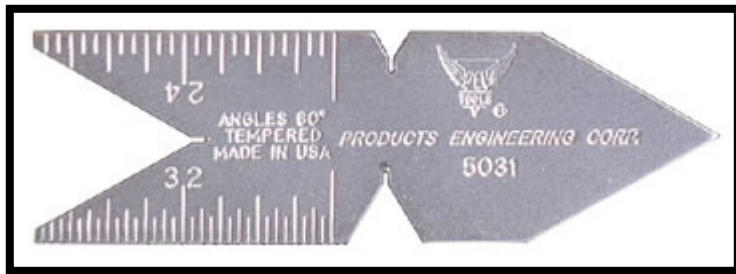
## Some common lathe work support tools



Micrometer for measuring o.d.



Telescoping gage set for measuring holes like valve casings



60° center gage for setting tool bit angles and for single point threading set up.



Small hole gages for measuring small tone holes and for setting trumpet valve slides parallel.



Magnetic base dial indicator for tracking travel and centering parts.



Flush mount magnetic base dial indicator (1" and 2" shown). Great for tracking tool bit travel.

### DECIMAL EQUIVALENT CHART: FRACTIONAL, METRIC, WIRE GAGE & LETTER SIZES

SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES	SIZE	DECIMAL INCHES
#80	0.0135"	#55	0.0520"	#36	0.1065"	#15	0.1800"	6.5mm	0.2559"	S	0.3480"	39/64"	0.6094"
.35mm	0.0138	1.35mm	0.0531	2.75mm	0.1083	4.6mm	0.1811	F	0.2570	8.9mm	0.3504	15.5mm	0.6102
#79	0.0145	#54	0.055	7/64"	0.1094	#14	0.1820	6.6mm	0.2598	9mm	0.3543	5/8"	0.6250
1/64"	0.0156	1.4mm	0.0551	#35	0.1100	#13	0.1850	G	0.2610	T	0.3580	16mm	0.6299
.4mm	0.0157	1.45mm	0.0571	2.8mm	0.1102	4.7mm	0.1850	6.7mm	0.2638	9.1mm	0.3583	41/64"	0.6406
#78	0.0160	1.5mm	0.0591	#34	0.1110	4.75mm	0.1870	17/64"	0.2656	23/64"	0.3594	16.5mm	0.6496
.45mm	0.0177	#53	0.0595	#33	0.1130	3/16"	0.1875	6.75mm	0.2657	9.2mm	0.3622	21/32"	0.6562
#77	0.0180	1.55mm	0.0610	2.9mm	0.1142	4.8mm	0.1890	H	0.2660	9.25mm	0.3642	17mm	0.6693
.5mm	0.0197	1/16"	0.0625	#32	0.1160	#12	0.1890	6.8mm	0.2677	9.3mm	0.3661	43/64"	0.6719
#76	0.0200	1.6mm	0.0630	3mm	0.1181	#11	0.1910	6.9mm	0.2717	U	0.3680	11/16"	0.6875
#75	0.0210	#52	0.0635	#31	0.1200	4.9mm	0.1929	I	0.2720	9.4mm	0.3701	17.5mm	0.6890
.55mm	0.0217	1.65mm	0.0650	3.1mm	0.1220	#10	0.1935	7mm	0.2756	9.5mm	0.3740	45/64"	0.7031
#74	0.0225	1.7mm	0.0669	1/8"	0.1250	#9	0.1960	J	0.2770	3/8"	0.3750	18mm	0.7087
.6mm	0.0236	#51	0.0670	3.2mm	0.1260	5mm	0.1969	7.1mm	0.2795	V	0.3770	23/32"	0.7188
#73	0.0240	1.75mm	0.0689	3.25mm	0.1280	#8	0.1990	K	0.2810	9.6mm	0.3780	18.5mm	0.7283
.72	0.0250	#50	0.0700	#30	0.1285	5.1mm	0.2008	9/32"	0.2812	9.7mm	0.3819	47/64"	0.7344
.65mm	0.0256	1.8mm	0.0709	3.3mm	0.1299	#7	0.2010	7.2mm	0.2835	9.75mm	0.3839	19mm	0.7480
#71	0.0260	1.85mm	0.0728	3.4mm	0.1339	13/64"	0.2031	7.25mm	0.2854	9.8mm	0.3858	3/4"	0.7500
.7mm	0.0276	#49	0.0730	#29	0.1360	#6	0.2040	7.3mm	0.2874	W	0.3860	49/64"	0.7656
#70	0.0280	1.9mm	0.0748	3.5mm	0.1378	5.2mm	0.2047	L	0.2900	9.9mm	0.3898	19.5mm	0.7677
#69	0.0292	#48	0.0760	#28	0.1405	#5	0.2055	7.4mm	0.2913	25/64"	0.3906	25/32"	0.7812
.75mm	0.0295	1.95mm	0.0768	9/64"	0.1406	5.25mm	0.2067	M	0.2950	10mm	0.3937	20mm	0.7874
#68	0.0310	5/64"	0.0781	3.6mm	0.1417	5.3mm	0.2087	7.5mm	0.2953	X	0.3970	51/64"	0.7969
1/32"	0.0312	#47	0.0785	#27	0.1440	#4	0.2090	19/64"	0.2969	Y	0.4040	20.5mm	0.8071
.8mm	0.0315	2mm	0.0787	3.7mm	0.1457	5.4mm	0.2126	7.6mm	0.2992	13/32"	0.4062	13/16"	0.8125
#67	0.0320	2.05mm	0.0807	#26	0.1470	#3	0.2130	N	0.3020	Z	0.4130	21mm	0.8268
#66	0.0330	#46	0.0810	3.75mm	0.1476	5.5mm	0.2165	7.7mm	0.3031	10.5mm	0.4134	53/64"	0.8281
.85mm	0.0335	#45	0.0820	#25	0.1495	7/32"	0.2188	7.75mm	0.3051	27/64"	0.4219	27/32"	0.8438
#65	0.0350	2.1mm	0.0827	3.8mm	0.1496	5.6mm	0.2205	7.8mm	0.3071	11mm	0.4331	21.5mm	0.8465
.9mm	0.0354	2.15mm	0.0846	#24	0.1520	#2	0.2210	7.9mm	0.3110	7/16"	0.4375	55/64"	0.8594
#64	0.0360	#44	0.0860	3.9mm	0.1535	5.7mm	0.2244	5/16"	0.3125	11.5mm	0.4528	22mm	0.8661
#63	0.0370	2.2mm	0.0866	#23	0.1540	5.75mm	0.2264	8mm	0.3150	29/64"	0.4531	7/8"	0.8750
.95mm	0.0374	2.25mm	0.0886	5/32"	0.1562	#1	0.2280	O	0.3160	15/32"	0.4688	22.5mm	0.8858
#62	0.0380	#43	0.0890	#22	0.1570	5.8mm	0.2283	8.1mm	0.3189	12mm	0.4724	57/64"	0.8906
#61	0.0390	2.3mm	0.0906	4mm	0.1575	5.9mm	0.2323	8.2mm	0.3228	31/64"	0.4844	23mm	0.9055
1mm	0.0394	2.35mm	0.0925	#21	0.1590	A	0.2340	P	0.3230	12.5mm	0.4921	29/32"	0.9062
#60	0.0400	#42	0.0935	#20	0.1610	15/64"	0.2344	8.25mm	0.3248	1/2"	0.5000	59/64"	0.9219
#59	0.0410	3/32"	0.0938	4.1mm	0.1614	6mm	0.2362	8.3mm	0.3268	13mm	0.5118	23.5mm	0.9252
1.05mm	0.0413	2.4mm	0.0945	4.2mm	0.1654	B	0.2380	21/64"	0.3281	33/64"	0.5156	15/16"	0.9375
#58	0.0420	#41	0.0960	#19	0.1660	6.1mm	0.2402	8.4mm	0.3307	17/32"	0.5312	24mm	0.9449
#57	0.0430	2.45mm	0.0965	4.25mm	0.1673	C	0.2420	Q	0.3320	13.5mm	0.5315	61/64"	0.9531
1.1mm	0.0433	#40	0.0980	4.3mm	0.1693	6.2mm	0.2441	8.5mm	0.3346	35/64"	0.5469	24.5mm	0.9646
1.15mm	0.0453	2.5mm	0.0984	#18	0.1695	D	0.2460	8.6mm	0.3386	14mm	0.5512	31/32"	0.9688
#56	0.0465	#39	0.0995	11/64"	0.1719	6.25mm	0.2461	R	0.3390	9/16"	0.5625	25mm	0.9843
3/64"	0.0469	#38	0.1015	#17	0.1730	6.3mm	0.2480	8.7mm	0.3425	14.5mm	0.5709	63/64"	0.9844
1.2mm	0.0472	2.6mm	0.1024	4.4mm	0.1732	E	0.2500	11/32"	0.3438	37/64"	0.5781	1"	1.0000
1.25mm	0.0492	#37	0.1040	#16	0.1770	1/4"	0.2500	8.75mm	0.3445	15mm	0.5906		
1.3mm	0.0512	2.7mm	0.1063	4.5mm	0.1772	6.4mm	0.2520	8.8mm	0.3465	19/32"	0.5938		

- To convert to millimeters: Multiply inches x 25.4
  - To convert to inches: Multiply millimeters x 0.03937\*
- \*For slightly greater accuracy when converting to inches, divide millimeters by 25.4*

## Tap Drill Size Chart

### tap drill sizes (75% prob. thread)

TAP SIZE	DRILL SIZE	TAP SIZE	DRILL SIZE	TAP SIZE	DRILL SIZE	TAP SIZE	DRILL SIZE
0-80	3/64	6-40	33	M10x1.5	8.5mm	M24x3	21mm
M1.6x.35	1.25mm	M4x.7	3.3mm	7/16-14	U	1-8	7/8
1-64	53	8-32	29	7/16-20	25/64	1-12	29/32
M2x.4	1.6mm	8-36	29	M12x1.75	10mm	1-14	15/16
1-72	53	10-24	25	1/2-13	27/64	1-1/8 - 7	63/64
2-56	51	10-32	21	1/2-20	29/64	1-1/8 - 12	1-3/64
2-64	50	M5x.8	4.2mm	M14x2	12mm	M30x3.5	26.5mm*
M2.5x.45	2.05mm	12-24	16	9/16-12	31/64	1-1/4 - 7	1-7/64*
3-48	47	12-28	14	9/16-18	33/64	1-1/4 - 12	1-11/64*
3-56	45	M6x1	5mm	5/8-11	17/32	1-3/8 -6	1-3/16*
4-40	43	1/4-20	7	5/8-18	37/64	1-3/8 - 12	1-9/32*
4-48	42	1/4-28	3	M16x2	14mm	M36x4	1-1/4*
M3x.5	2.5mm	5/16-18	F	3/4-10	21/32	1-1/2 - 6	1-11/32*
5-40	38	5/16-24	I	3/4-16	11/16	1-1/2 - 12	1-27/64*
5-44	37	M8x1.25	6.7mm	M20x2.5	17mm		
M3.5x.6	2.9mm	3/8-16	5/16	7/8-9	49/64		
6-32	36	3/8-24	Q	7/8-14	13/16		

## Mini-lathe package and other lathe support information

<b>Machine tool accessories and supplies</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a></li> <li>• <a href="http://www.shars.com">www.shars.com</a></li> <li>• <a href="http://www.travers.com">www.travers.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="http://www.mscdirect.com">www.mscdirect.com</a></li> <li>• <a href="http://www.harborfreight.com">www.harborfreight.com</a></li> <li>• <a href="http://www.mcmaster.com">www.mcmaster.com</a></li> <li>• <a href="http://www.grainger.com">www.grainger.com</a></li> </ul>																		
<b>Learning and modifications</b>	<ul style="list-style-type: none"> <li>• BIR lathe manual</li> <li>• BIR USB flash drive materials</li> <li>• <a href="http://www.littlemachineshop.com/Info/MiniLatheUsersGuide.pdf">http://www.littlemachineshop.com/Info/MiniLatheUsersGuide.pdf</a></li> <li>• <a href="http://www.gizmology.net/changeears.htm">http://www.gizmology.net/changeears.htm</a></li> <li>• <a href="http://www.mini-lathe.com/">http://www.mini-lathe.com/</a></li> <li>• <a href="http://warhammer.mcc.virginia.edu/ty/7x10/">http://warhammer.mcc.virginia.edu/ty/7x10/</a></li> <li>• <a href="http://www.varminal.com/alath.htm">http://www.varminal.com/alath.htm</a></li> </ul>																			
<b>To purchase mini-lathes</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.micromark.com">www.micromark.com</a> 7 X 16</li> <li>• <a href="http://www.grizzley.com">www.grizzley.com</a> 7 X 14 and larger</li> <li>• <a href="http://www.musicmedic.com">www.musicmedic.com</a></li> </ul>																			
<b>Sources for brass, plastic, and steel</b>	<ul style="list-style-type: none"> <li>• <b>BIR suppliers: Allied, Badger State, Ferree's, Votaw, Kraus, J.L. Smith, Music-Medic, etc.</b></li> <li>• <a href="http://www.onlinemetals.com">www.onlinemetals.com</a></li> <li>• <a href="http://www.speedymetals.com">www.speedymetals.com</a></li> <li>• <a href="http://www.metalsdepot.com">www.metalsdepot.com</a></li> <li>• <a href="http://www.allmetalsonline.com">www.allmetalsonline.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="http://www.travers.com">www.travers.com</a></li> <li>• <a href="http://www.mscdirect.com">www.mscdirect.com</a></li> <li>• <a href="http://www.usplastic.com">www.usplastic.com</a></li> <li>• <a href="http://www.mcmaster.com">www.mcmaster.com</a></li> </ul>																		
<b>Common materials used</b>	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:50%; text-align: center;">Material</th> <th style="width:50%; text-align: center;">Alloy #</th> </tr> </thead> <tbody> <tr> <td>Solid brass</td> <td style="text-align: center;">360</td> </tr> <tr> <td>Soft easy-to-machine steel</td> <td style="text-align: center;">12L14</td> </tr> <tr> <td>Steel for making dent rods/nose pickers</td> <td style="text-align: center;">1144</td> </tr> <tr> <td>Steel to be hardened to make reamers and cutters</td> <td>Oil, Air, or Water hardening drill rod, or D-2 tool steel</td> </tr> <tr> <td>Stainless steel for machining</td> <td style="text-align: center;">303 is best</td> </tr> <tr> <td>Plastic to be glued</td> <td style="text-align: center;">ABS</td> </tr> <tr> <td>Plastic for mallets and other stuff that strikes</td> <td style="text-align: center;">Delrin</td> </tr> <tr> <td> </td> <td> </td> </tr> </tbody> </table>		Material	Alloy #	Solid brass	360	Soft easy-to-machine steel	12L14	Steel for making dent rods/nose pickers	1144	Steel to be hardened to make reamers and cutters	Oil, Air, or Water hardening drill rod, or D-2 tool steel	Stainless steel for machining	303 is best	Plastic to be glued	ABS	Plastic for mallets and other stuff that strikes	Delrin		
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<b>Some good lathe names to look for used</b>	<b>South Bend, Atlas, Sears, Clausing, Cincinnati, Rockwell, Supermax, Jet (Taiwan), Leblond, Hercules, Emco, Logan, Nardini</b>																			



## Mini-lathe package and other lathe support information

Quantity	Item #	Description	Cost 2016	Extension	Source
1	82710	Micro-Mark 7 X 16 mini-lathe (plus shipping)	1,299.95 + \$68.00 shipping	\$1,367.95	<a href="http://www.micromark.com/MicroLux-7x16-Mini-Lathe">http://www.micromark.com/MicroLux-7x16-Mini-Lathe</a>
1	3112	Quick Change tool post set	134.95	134.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1728	Cut-off blade	19.95	19.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1246	Boring Bar Set	19.95	19.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1148	Drill Chuck w/arbor (#2 morse taper)	22.85	22.85	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1189	Live Center (#2 morse taper)	23.18	23.18	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
3	02603165	¼" high speed steel tool bits	1.75	5.25	<a href="http://www.mscdirect.com">www.mscdirect.com</a>
1	46820155	6" Mill File – smooth cut	10.28	10.28	<a href="http://www.mscdirect.com">www.mscdirect.com</a>
1	82847476	File Handle	4.22	4.22	<a href="http://www.mscdirect.com">www.mscdirect.com</a>
1	1230	Center drill/countersink set	8.95	8.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	?	4-Drawer Tool Cart	200.00	200.00	Hardware/home improvement center
<b>Total w/cart:</b>				<b>\$1,406.92</b> (prices current 1.16.19)	

### Other stuff you might want:

Quantity	Item #	Description	Cost 2012	Source
1	3770	Clamp knurler with 6 sets of knurls	63.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	3088	Cutting fluid	3.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1669	*3/8" shank indexable carbide bit set	32.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	2531	Magnetic back for dial indicator	4.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	1236	1" dial indicator	12.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	2743	60° center gauge	9.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	2879	Telescoping gauge set	14.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	3093	Small hole gauge set	12.95	<a href="http://www.littlemachineshop.com">www.littlemachineshop.com</a>
1	57-001-301	0-1" micrometer	26.29	www.travers.com
1	57-001-125	0 -25 mm micrometer	27.49	www.travers.com