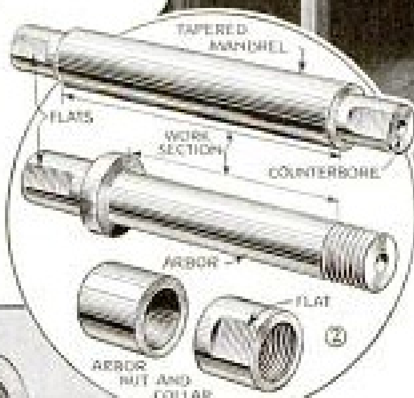
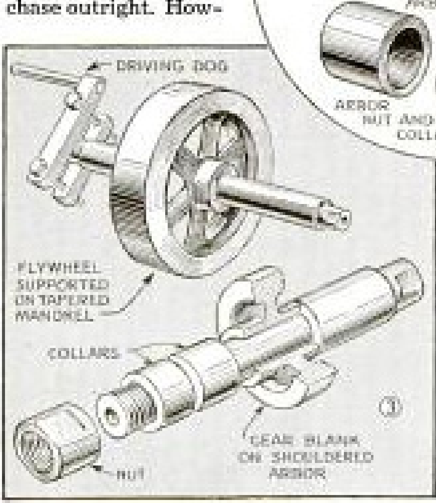
Precision MACHINE TOOLS *turned on your lathe*

How to turn mandrels and arbors—selecting materials, machining, centering, hardening and grinding

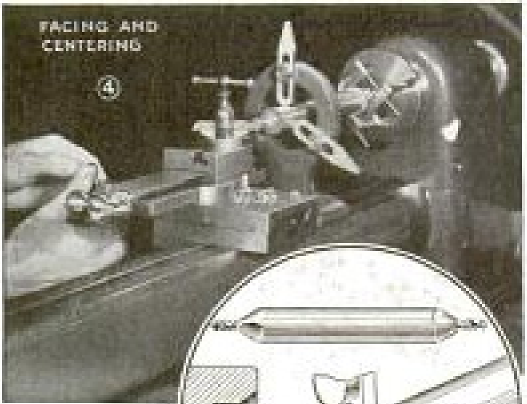
By H. J. CHAMBERLAND

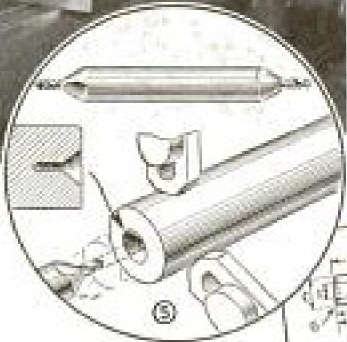


JUST as soon as you expand operations on your workshop metal-turning lathe beyond ordinary chuck and faceplate work you run squarely into the need for more machine-tool accessories. Among the very first you will require are precision mandrels and arbors, for without them you cannot well handle external machining operations on work that is precision-drilled and reamed to finish dimensions. Naturally, these tools are expensive to purchase outright. However, your metal-turning lathe is a versatile machine and you can, with a bit of ingenuity, use it to make its own accessories.



Mandrels come in sets and there should be one set for standard bores and another set for work bored undersize and intended to be hardened and ground. The range should be from ¼ in. to 1 in. in eighths of an inch or fourteen mandrels all told. The arbors should, of course, be of standard dimensions, ¾ and 1-in. size are advisable to begin with although any other sizes may be made as required. Conventional mandrels, Figs. 2, 3, and 11, taper .0005 in. in each inch of length and the entering end is usually this amount under the actual size. As the total taper

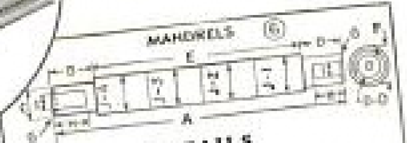




only amounts to .003 in. on a 6-in. length, it is difficult to accurately arrive at these measurements unless you have special equipment. Therefore, without sacrificing in the least the intended purpose of the tools, a new design has been adopted which makes it possible to get results identical with those derived from the standard procedure. The work length of each mandrel has been divided into four equal sections, each step increasing a predetermined amount, thus producing the required drive.

Arbors belong to the same tool family as mandrels but are of entirely different construction. Mandrels are intended to hold a single piece, whereas arbors can take several pieces of identical diameters and bores to be turned, milled or ground. Arbors have a wider range of applications and are usually termed gang or collar arbors, as they are threaded for nuts and have collars of various widths as components. Tool work requires good material, in this case first quality straight-carbon tool steel. However, keep in mind that with this steel, carbon predominates and varies as to the nature of the tools to be made. Fig. 8 lists the material required for the two sets of mandrels and gives the carbon content. Figs. 4 to 7 inclusive give the machining data and size of the combination center drill to use. Note particularly that the table, Fig. 7, is continued in Fig. 10 and that the letter operations refer back to the blanket sketch and the details in Fig. 6. Likewise Figs. 12 to 17 inclusive give the machining data for two styles of arbors.

Assuming that the material is at hand and regardless which size mandrel or arbor is to be machined first, a full-scale drawing of the part should be made by replacing each letter with its corresponding dimension, as taken from tables in Figs. 6 and 7. The



DETAILS

A	represents	total length
B B	"	length of undercut sections
C C	"	diameter of undercut sections
D D	"	diameter of counterbores
E	"	length of work section
F	"	turning diameter of work section
G G	"	radii
H H	"	length of flats
I I	"	width of flats
J	"	the four grinding diameters

Note—All counterbores D D to be [illegible] in. deep

SIZES OF CENTER DRILLS TO USE (in inches)

Size of Mandrel	Size of drill Body — Drill	Depth of countersink angle
¼	[illegible] x [illegible]	One-half
⅜ - ¾	[illegible] x No. 45	Two-thirds
⅞ - 1	.201 x [illegible]	Three-quarters

MANDRELS—All dimensions in inches ⑦

Size of mandrel as marked	Letter operation: Face	Turn		Face	Turn		File
	A	B B	C C	D D	E	F	G G
¼	3½	⅜	[illegible]	None	2½	.256	[illegible]
¼—.006	3½	⅜	[illegible]	None	2½	.250	[illegible]
⅜	4½	⅝	[illegible]	None	3	.381	[illegible]
⅜—.006	4½	⅝	[illegible]	None	3	.375	[illegible]
½	5	¾	[illegible]	[illegible]	3½	.508	[illegible]
½—.008	5	¾	[illegible]	[illegible]	3½	.500	[illegible]
⅝	5½	⅞	[illegible]	[illegible]	3¾	.633	[illegible]
⅝—.008	5½	⅞	[illegible]	[illegible]	3¾	.625	[illegible]
¾	6	⅞	⅝	⅝	4¼	.758	[illegible]
¾—.008	6	⅞	⅝	⅝	4¼	.750	[illegible]
⅞	6½	1	¾	[illegible]	4½	.883	[illegible]
⅞—.010	6½	1	¾	[illegible]	4½	.875	[illegible]
1	7	1	⅞	½	5	1.010	[illegible]
1—.010	7	1	⅞	½	5	1.000	[illegible]

MATERIAL REQUIRED FOR BOTH SETS OF MANDRELS		
Carbon Content—1.00 - 1.09		
Number of Pieces	Length in Inches	Diameter in Inches
1	7⅝	⅜
1	8⅝	½
1	10⅛	⅝
1	11⅛	¾
1	12⅛	⅞
1	13⅝	1
1	14⅛	1⅛

(8)

(9)

only important dimensions are the decimal ones as the others add nothing to the accuracy value of the tools. However, the closer you hold the fractional sections, the better.

Centering: This is the initial step and it is an important one. Mandrels and arbors, unlike shafts, spindles and other parts only centered to be machined, revolve on their centers during their entire life. This is ample reason why in this case center holes and bevels should be substantially larger than with regular work. While the combination drill need not be exactly the size recommended in Fig. 6, the countersunk section should be in proportion to the diameter.

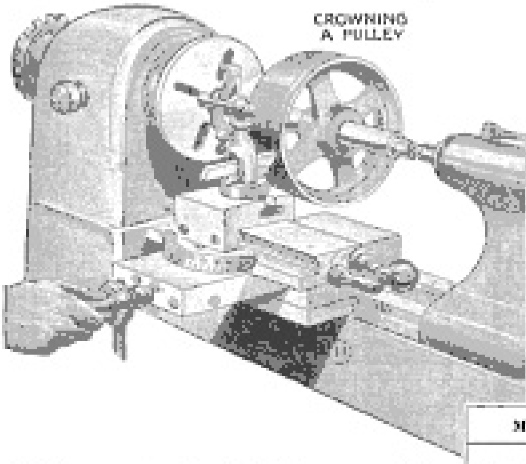
Turning: Turning operations on the tools, both mandrels and arbors, are ordinary procedure and simple. However, all decimal dimensions should be held close, due to threading and grinding requirements. The finish of these sections should be smooth even if emery cloth has to be used, and the turning should also be straight even if filing has to be done. Relative to a T-style arbor, Fig. 12, there is some unavoidable waste of material on account of a long work length as compared to style S which has a much shorter work surface. Fig. 1 shows the turning of the combined work and threaded sections. It is evident that the work section of arbors can be of any reasonable length to suit the requirements.

Counterboring the Ends: This operation is very essential, especially with mandrels, as it is intended to protect the centers from injury. It is represented by the letters D D in the table, Fig. 6, and also by I I in Fig. 13, and is illustrated in Fig. 4 which shows the usual set-up. The operation can be done at any time providing the tools have been either roughed or finish-turned. The operator should bear this in mind when centering the tools and make an allowance for both counterboring and facing. Or, you can usually do the three operations in sequence as in Fig. 4, face, center and counterbore.

Threading: When a lathe is not screw-cutting, threading arbors and arbor nuts must necessarily be done with a die and tap. To thread the arbors the procedure is no different in this case than others, namely, by holding the die stock against a flat drill pad in the tailstock spindle. It is advisable to chamfer the end of the work

MANDRELS—All dimensions in inches (10)

Size of mandrel as marked	Letter operation: Mill HH	Mill II	Grind J1	Grind J2	Grind J3	Grind J4
¼	½	7/16	.250	.2505	.251	.2515
¼—.008	½	[illegible]	.244	.2445	.245	.2455
⅜	½	[illegible]	.375	.3755	.376	.3765
⅜—.008	½	[illegible]	.369	.3695	.370	.3705
½	⅝	7/16	.500	.5005	.501	.5015
½—.008	⅝	7/16	.492	.4925	.493	.4935
⅝	¾	[illegible]	.625	.6255	.6265	.627
⅝—.008	¾	[illegible]	.617	.6175	.6185	.619
¾	¾	[illegible]	.750	.7505	.7515	.752
¾—.008	¾	[illegible]	.742	.7425	.7435	.744
⅞	⅞	¾	.875	.8755	.8765	.877
⅞—.010	⅞	¾	.865	.8655	.8665	.867
1	⅞	[illegible]	1.000	1.0005	1.0015	1.002
1—.010	⅞	[illegible]	.990	.9905	.9915	.992



Next to correct temperature comes the quenching medium. In this case water is best. The bath container should hold at least five gallons of rain water, and the addition of table salt, 2 lbs., gives better results. No time should be lost between taking the parts from the heating chamber, Fig. 9, and dipping them into the bath. The tools should be immersed in as near a vertical position as possible. The degree of warpage or distortion will usually be equivalent to the error. Such errors cannot be avoided altogether and

slightly so as to give the die a concentric start. The outer edge of the bore is next chamfered and the sides faced in the intended location. While the flats on mandrels and arbor nuts call for a milling operation, it can also be done by roughing in the grinder and filing carefully. Of course, a milling attachment, Fig. 14, is best for such jobs.

Collars: These are easily made from seamless steel tubing. A simple cutting-off operation followed by chamfering the bores, and filing the corners completes the job. The sides are sure to be parallel, and turning and boring is entirely eliminated. Chamfering can easily be done with a hand scraping tool as in Fig. 18. As the next step is hardening, tools should now be stamped with their respective sizes unless it is planned to etch them after grinding.

Hardening: Obviously, the life of any metal-working tool depends on its particular degree of hardness to resist wear. This degree of hardness in turn depends on the analysis of the steel, the temperature to which it is heated and the method by which it is cooled or, better said, quenched. The critical temperature, known as the point of recalescence, is the temperature at which the steel will harden best. With carbon tool steel it varies as to the carbon content, the more carbon, the less heat required. Depending on the quality of the steel, this variation is from 1450 degrees F., as high, to 1238 F., low. These figures are relative to 1.00-1.30 carbon content.

MATERIAL REQUIRED FOR BOTH ARBORS

ARBORS

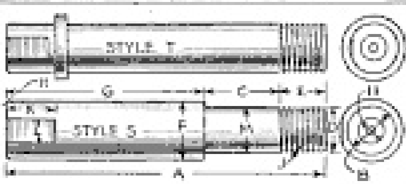
Material	Number of pieces	Length in inches	Diameter in inches
Use same	1	[illegible]	[illegible]
steel as	1	[illegible]	[illegible]
for	1	[illegible]	[illegible]
mandrels	For nuts 1	[illegible]	[illegible]

Note—If you prefer, you may order but two pieces and cut off sections for nuts

COLLARS

Material	Number of pieces	Length in inches	Diameter in inches	Bore in inches
Seamless steel tubing	1	2	1	[illegible]
	1	2	[illegible]	1

(12)



COMPLETE ARBORS

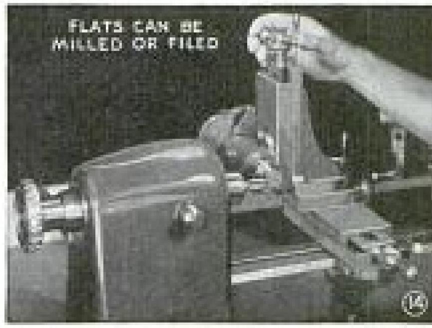
Details

A represents total length
B " turning dia. of work section
C " length of work section
D " turning dia. of thread section
E " length of thread section
F " turning dia. of body
G " length of body
H " radius
I " counterbore on ends
J " thread
K " length of flat
L " width of flat
M " grinding dia. of work section

Note—Use same center drill as for corresponding size mandrel

(13)

the parts should be straightened if necessary. This may be done by heating with a blowtorch at the proper location and striking the high spot with a hammer. Or the tool can be straightened in an arbor press. If .010 in. has been allowed for grinding, the eccentric error should be under .005 in. or grinding will not produce a concentric surface. All steels should be quenched at their lowest critical temperature to avoid brittleness. The bath should be kept at a temperature of 85-95 degrees F. With no pyrometer or thermocouple facilities, one must depend on the eye to observe the variation in colors during the heating process. The tools in question should be



quenched quickly when reaching a dark red. The collars, being machinery steel, can be quenched at a lighter color in a hot cyanide-of-potassium bath.

Grinding: As soon as the tools have been hardened, remove the scale from all surfaces with fine emery cloth by speeding in the lathe. Be especially particular with the center holes as they should be polished to a very fine finish. The grinding operation is nothing to be concerned about although accuracy does depend on this operation. Toolpost grinding equipment is comparatively inexpensive to buy, considering the good work it does. However, you can make your own. Grinding equipment, such as in Fig. 19, can often be made from discarded machinery parts. Whatever the set-up for external grinding where no coolant is used, the grinding wheel should be preferably of the so-called cut-off composition, medium grade and grain. The wheel should be about 4 in. in diameter with a ½-in. face, its surface speed should not be less than 4,500 f.p.m. nor more than 5,000 f.p.m. As for grinding the mandrels, the entire work section should be first trued cylindrically and straightened by making necessary adjustments on the lathe. The surface can then be given a coat of Prussian blue and the length divided into four equal parts as near as possible. This is best done with a pencil mark. As in the table, Fig. 6, section J-1 should be finish-ground first, and then the others in order. Section J-1 should be slightly undersize rather than over so as not to bind the work as it is pressed on. If the finish is not satisfactory, it is advisable to leave all dimensions slightly oversize, any .0001 or .0002 in. and polish to size with fine emery cloth. The feed should not be over

ARBORS—Continued (15)

All dimensions in inches

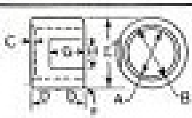
Size of arbor as marked	Letter operation						
	Face	Turn					
	A	B	C	D	E	F	G
¾	5¾	.760	1½	.750	1	1	3½
1	6¾	1.012	2	1.000	1	1½	3¾
	File	Face	Thread	Mill		Grind	
	H	H	J	K	L	M	
¾	5/16	⅜	¾-10 U.S.S.-R.H.	1	⅜	.750	
1	5/16	½	1-8	1	½	1.000	

Note—If lathe is screw-cutting, a finer thread is usually given the preference

ARBOR NUTS

Details

A—boring dia.
B—thread
C—width of chamfer
D—width
E—turning dia.
F—radius
G—length of flats
H—width of flats



(16)

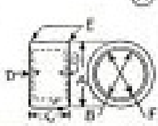
Arbor size	Letter operation / All dimensions in inches							
	Bore	Thrd	Form	Face	Turn	File	Mill	
	A	B	C	DD	E	F	G	H
¾	⅝	¾-10	1/16	1	1	1/16	⅝	⅝
1	27/32	1-8	1/16	1	1¼	1/16	¾	7/8

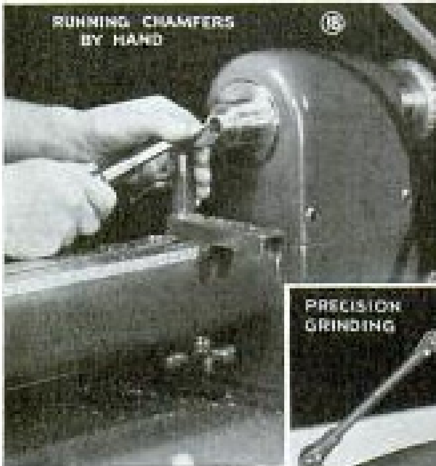
ARBOR COLLARS

Details

A —diameter (original, polish only)
B —bore (original)
C —cut-off (widths to suit)
DD—chamfer (form 1/16 in. wide)
EE —radii (file 1/16 in.)
F —grind (plus .002)

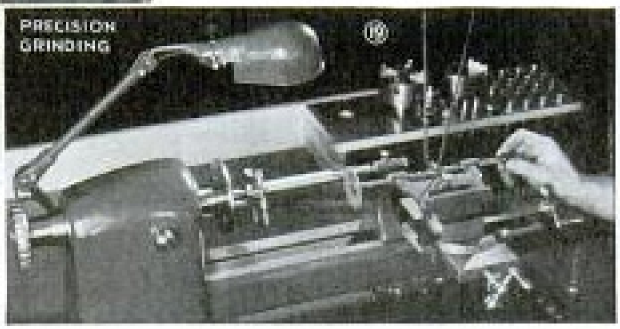
(17)





the wheel contacts the shoulder to square it with the work surface. As noted in Fig. 17, bores of the collars have to be ground .003 in. larger than their actual size to avoid lateral errors.

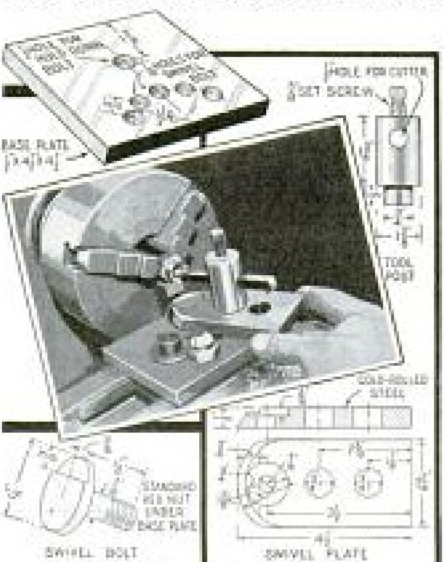
Before you attempt precision turning and grinding check over your lathe thoroughly. Test alinement of centers and check headstock bearings for both looseness and end play. Vibration imparted to the lathe through the drive belt from a



.0005 in. for each traverse movement and the latter should be very slow so as not to generate any heat. Other sections of the tools need not be ground. The grinding wheel should be dressed often to keep it in perfect balance. Fig. 19 shows grinding of the S-style, 1-in. arbor. In this case it is important that the side of

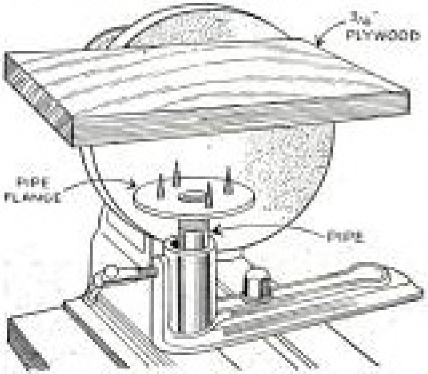
countershaft or due to a springy, uneven floor will make it difficult to work within specified limits. Should such conditions exist, they must be corrected.

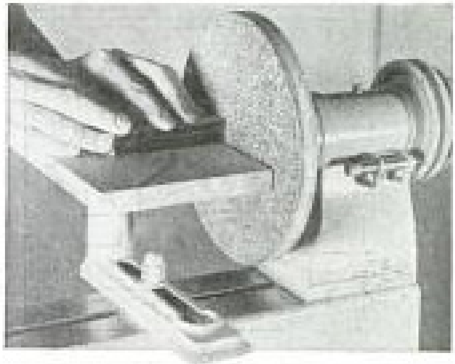
Swivel Tool Post on Lathe Simplifies Radius-Turning Jobs



Turning duplicate radii, either concave or convex, within narrow limits is a simple job with this swivel tool post made from cold-rolled stock. It is mounted in the T-slot of the compound slide rest, which is turned 90 degrees or parallel to the ways of the lathe, so that the screw can be used to regulate the depth of the cut. For concave cuts, the device is adjusted so that when the swivel arm, holding the tool post, is swung from side to side, with the fingers, the cutter will describe an arc ahead of the swivel point. For convex cuts, the adjustment is just the reverse, the arc described being behind the swivel point, in which case the tool post is moved to the rear hole. Shims between the base plate and the top of the T-slot regulate the height of the cutter. Keeping the swivel bolt and the top of the base plate well oiled will make for easy operation. The drawings give construction details and dimensions.—R. G. Bullard, Monterey Park, Calif.

Lathe Sanding Table Fits Toolpost Holder

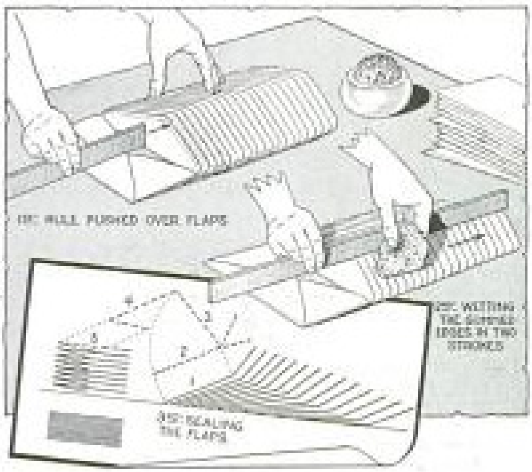




When squaring up small pieces of stock on a lathe sanding disk it is very often an advantage to have a table that can be adjusted easily and quickly to the best working height in relation to the disk. Made from a piece of plywood of a convenient size, a short length of pipe and a flange, you have a table that is adjustable both vertically and horizontally. The toolrest base forms the holder, and the sanding table is held in the desired position by simply running up the clamp screw.

Trick of Quickly Sealing a Number of Envelopes By Hand

Owners of small shops and stores who occasionally have a number of envelopes to seal, but have no machine for the job, can save time by hand-sealing them as follows: Bunch a number of them and then spread them as indicated in the first position of the drawing. Push a ruler, edge down, over the flaps, using one hand to keep them from slipping. Then wet the gummed edges with a couple of strokes of a wet sponge and lift the ruler straight up. To close the flaps, turn over each envelope as indicated by steps 1 to 5 and stack it, flap down, on a pile, applying pressure before the gum dries.



Wood Impregnated with Arsenated Petroleum Oil Is Safe from Rot

Arsenated petroleum oil has been found a good substitute for coal-tar creosote to protect wood against fungi or wood-boring insects. The oil costs much less than creosote, and is prepared by mixing arsenous chloride, 1 lb., and diphenylamine, 1 lb., with fuel oil, 42 gals. When wood is impregnated with the mixture, it is poisonous to insects and the pores are sealed against the penetration of moisture, which is necessary for the growth of fungi. The work can be dipped in the liquid or the latter can be applied with a large brush.

—G. M. Wood, New York.