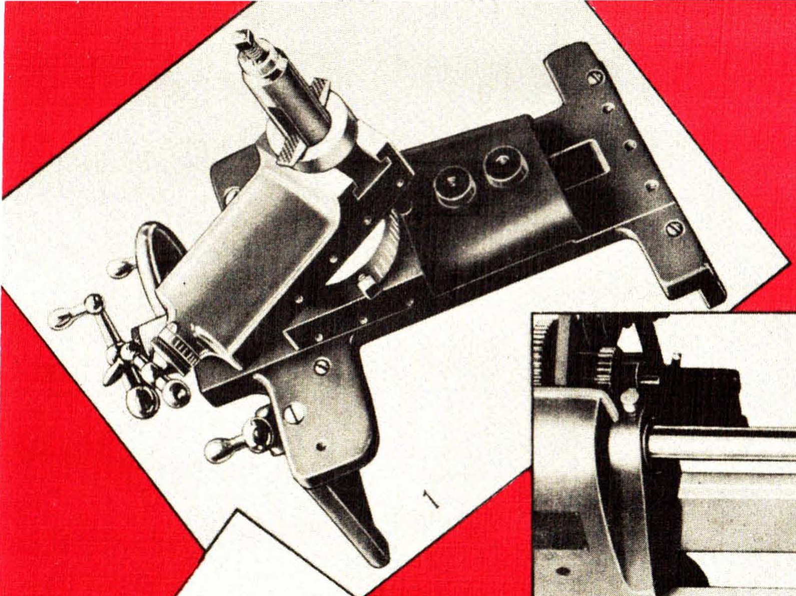
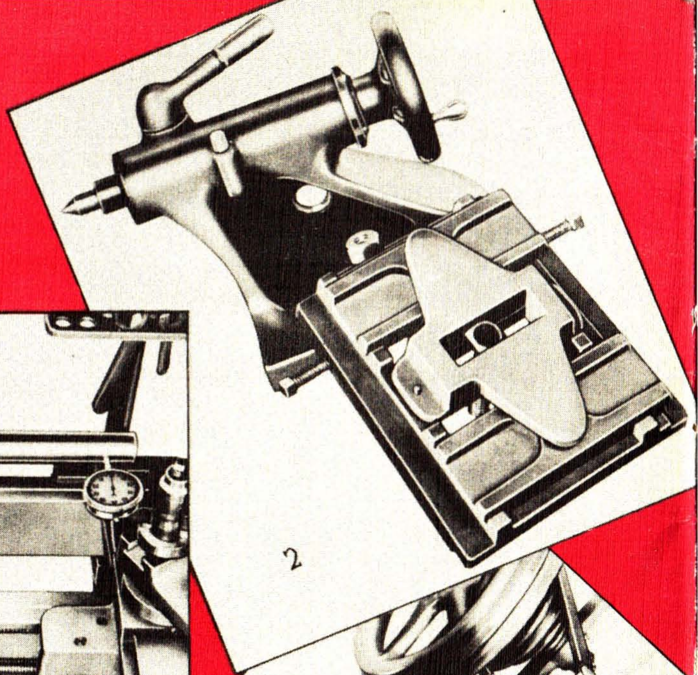
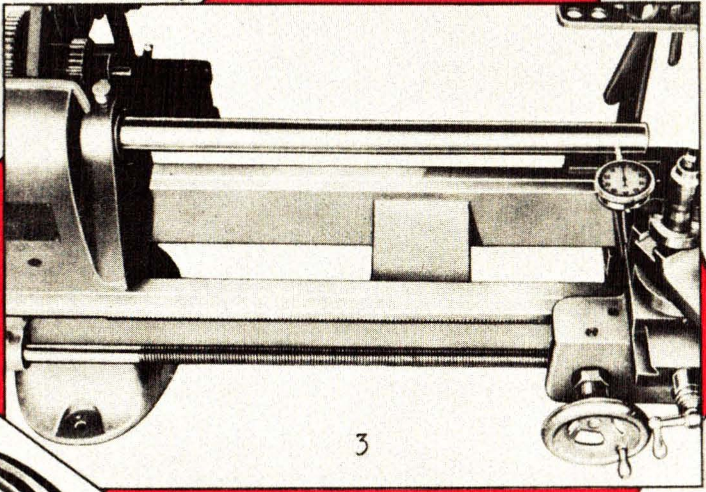
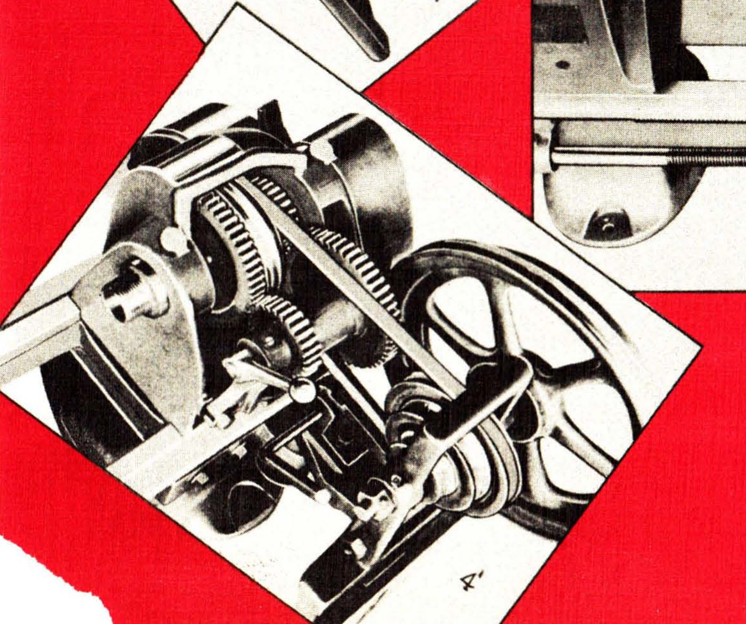
"American INDUSTRIAL LATHES"

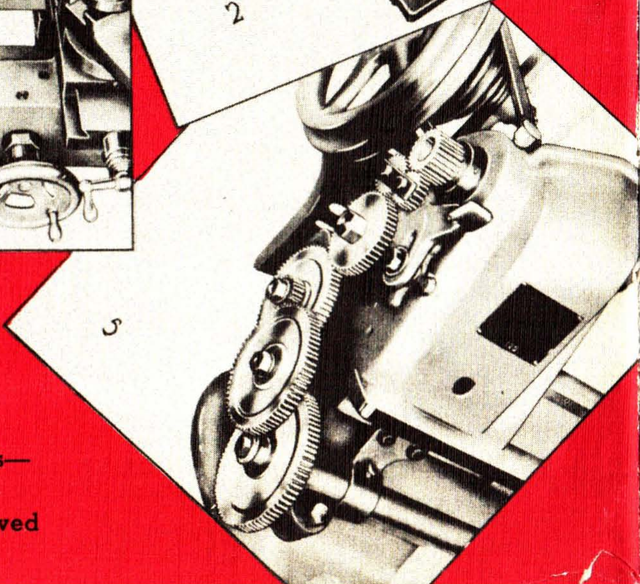
AMERICAN MACHINE & TOOL CO. OF PENNSYLVANIA, INC.
ROYERSFORD, PA.











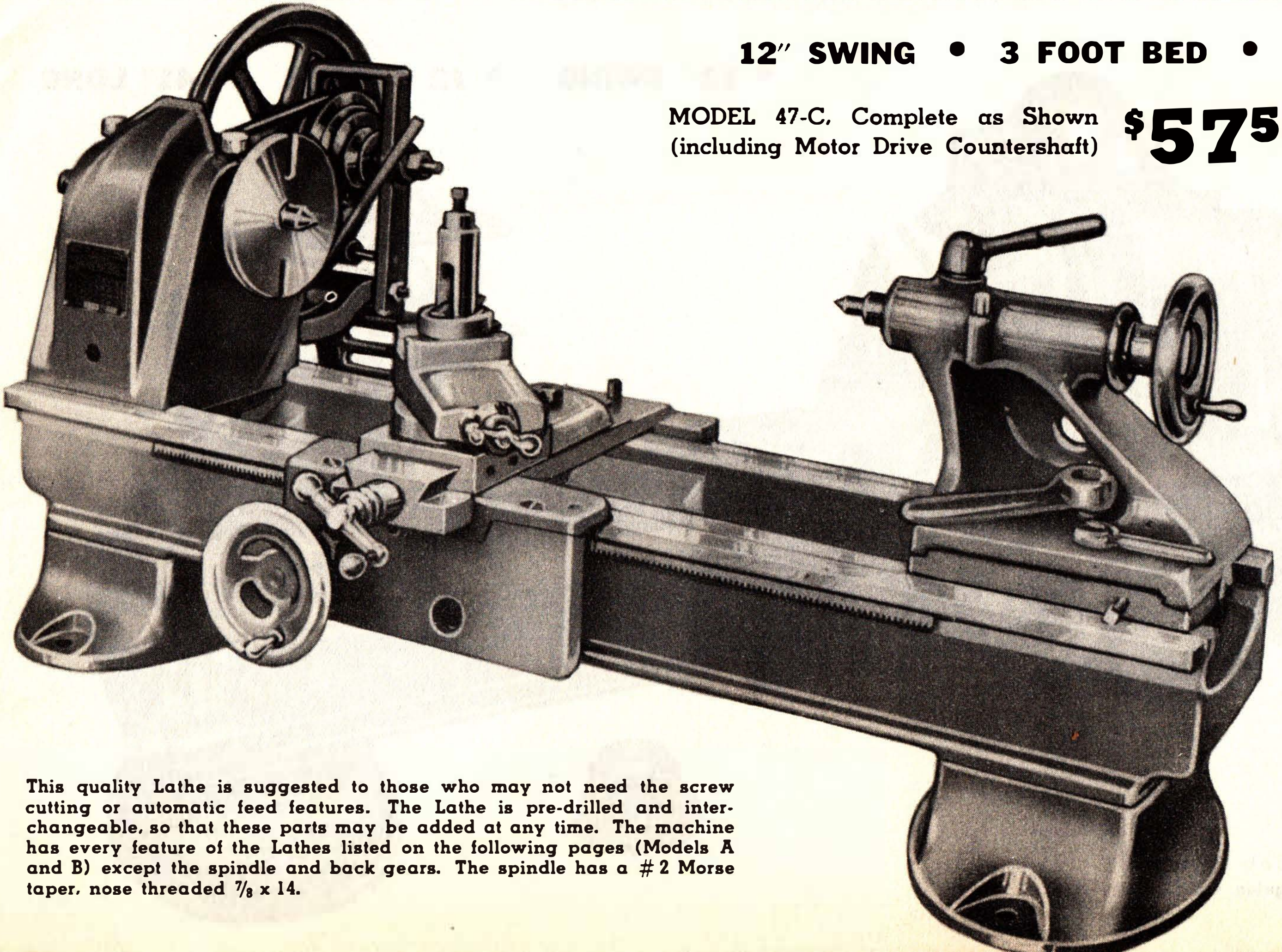
1. Saddle
2. Tailstock and Compensating Clamp
3. Alignment Test ± .001 12" From Nose
4. Machine Cut Back Gears—Covers Removed
5. Gear Train—Case Removed

1938 1-8-77 $10.00

AMERICAN INDUSTRIAL BENCH LATHE

12" SWING • 3 FOOT BED • 6 SPEEDS

MODEL 47-C, Complete as Shown (including Motor Drive Countershaft) $57.50



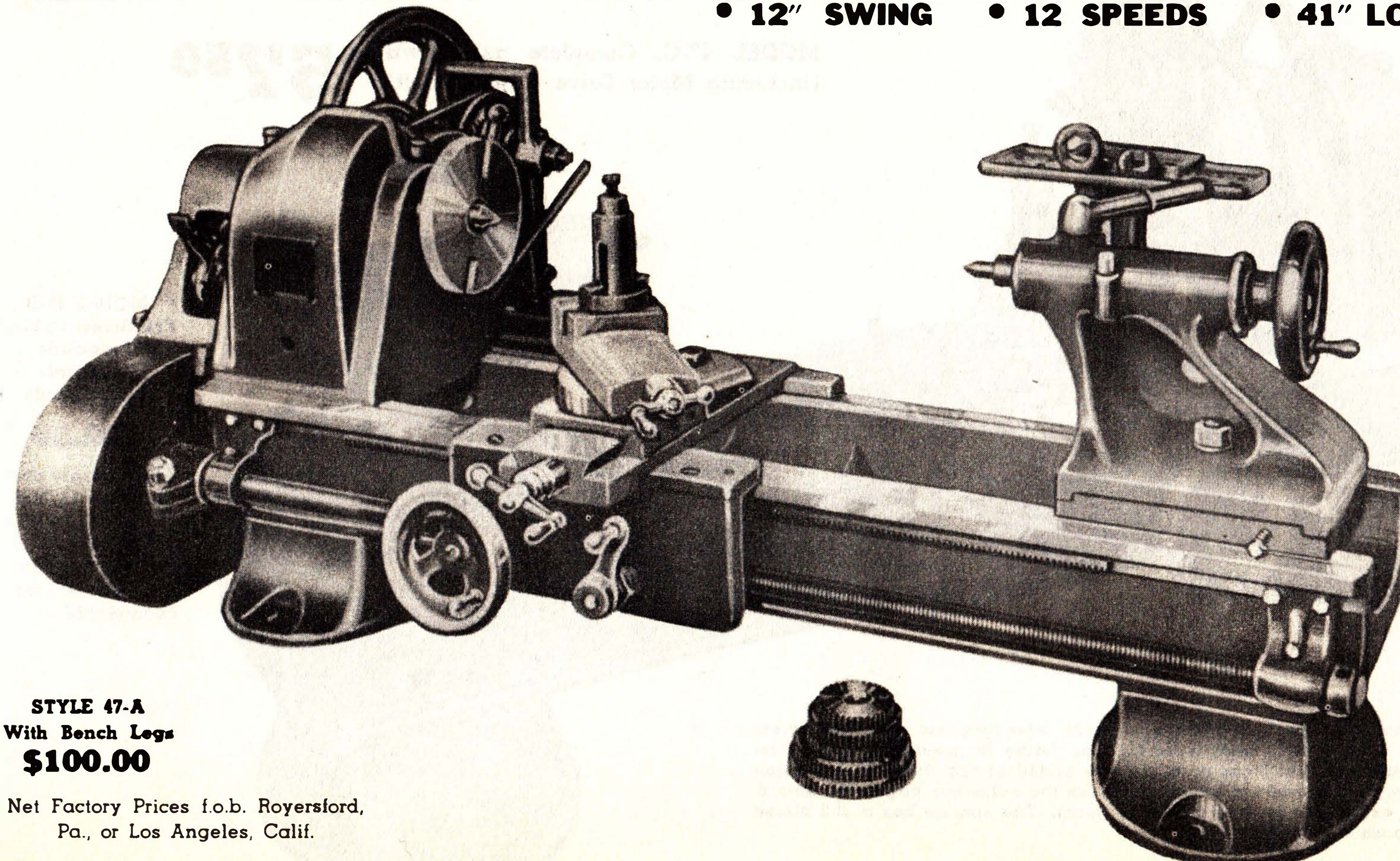
MODEL 47-D
Full Screw Cutting
Automatic
Reversible
Power Feeds

$82.50

All necessary parts to convert Model 47-C to Model 47-D, $27.50. May be added at any time. All parts interchangeable.

This quality Lathe is suggested to those who may not need the screw cutting or automatic feed features. The Lathe is pre-drilled and interchangeable, so that these parts may be added at any time. The machine has every feature of the Lathes listed on the following pages (Models A and B) except the spindle and back gears. The spindle has a # 2 Morse taper, nose threaded 7/8 x 14.

• 12″ SWING • 12 SPEEDS • 41″ LONG

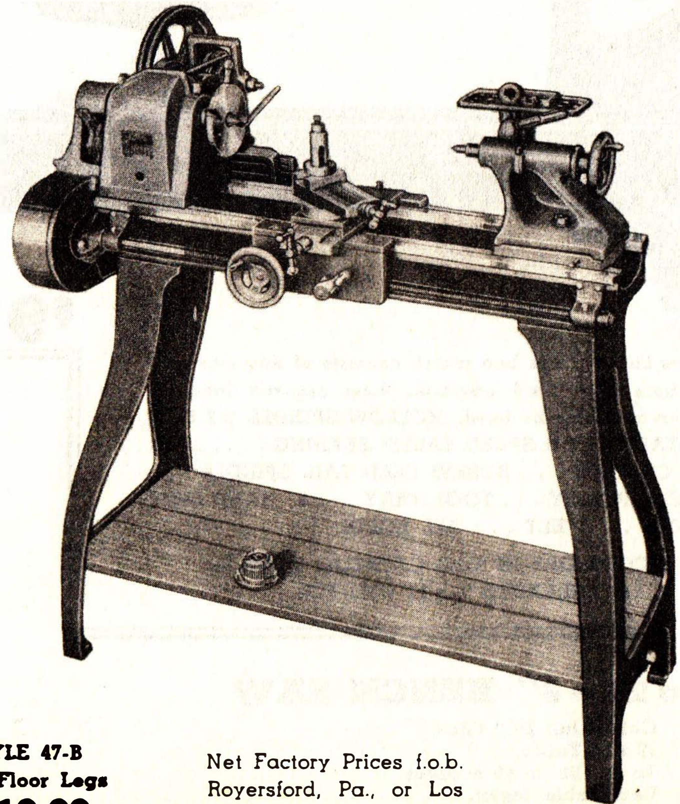


STYLE 47-A
With Bench Legs
$100.00

Net Factory Prices f.o.b. Royersford, Pa., or Los Angeles, Calif.

• BACK GEARED • REVERSIBLE POWER FEEDS • FULL SCREW CUTTING

SWING 12″ • 12 SPEEDS • GROUND SPINDLE • BRONZE BEARINGS • INTEGRAL COUNTERSHAFT • FULL V-BELT DRIVE • UNIVERSAL MOTOR MOUNT • STEEL BALL CRANKS • ADJUSTABLE GIBBS • HAND FILLED AND RUBBED FINISH • METRIC OR U. S. STANDARD OPTIONAL • ALL GUARDS INCLUDED • COLLET AND TOOL RACK • FACE PLATE • 2 CENTERS AND SLEEVE • MOTOR PULLEY • **ALL MODERN FEATURES** • #3 M. T. • ¾″ HOLE THROUGH SPINDLE • ROLLER CAM BELT TENSION DEVICE • ALL GEARS HOBBED • BUILT ENTIRELY OF GREY IRON AND STEEL • MICROMETER COLLARS • FULL SCREW CUTTING • CARRIAGE LOCK • GEARS FULLY ENCLOSED • V-CAM COMPOUND LOCK • CHANGE GEARS • WRENCHES • TAIL-CENTER OILER • TOOL POST.



Fully Equipped as Shown
Including Collet and Tool Rack

STYLE 47-B
With Floor Legs
$110.00

Net Factory Prices f.o.b. Royersford, Pa., or Los Angeles, Calif.

No. 104 – 12″ WOODWORKING LATHE

ANY LENGTH BED

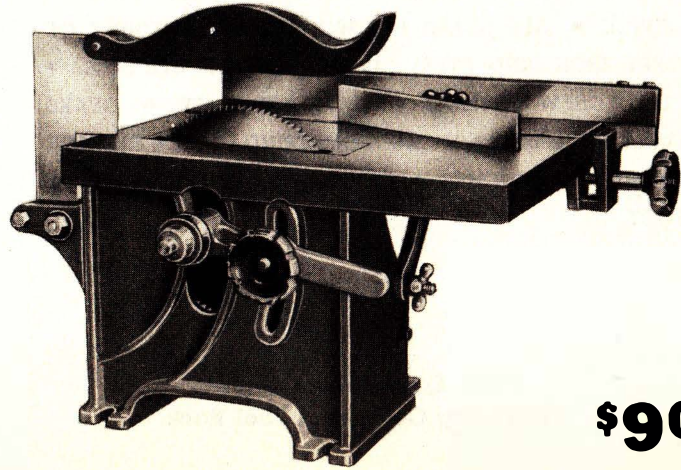
$900

Complete as shown (less bed which consists of any size any length timbers from 2 x 4 upwards, best secured locally). Channel iron may also be used. HOLLOW SPINDLE #2 M. T. . . . ADJUSTABLE HIGH SPEED BABBIT BEARINGS . . . SPUR AND CUP CENTERS . . . SCREW FEED TAIL SPINDLE . . . THREE SPEED PULLEY . . . TOOL TRAY . . . 8″ HAND REST AND HOLDER . . . FEET . . . ALL BOLTS.

ANY ACCESSORY IN THIS CATALOG #2 M. T.
OR THREADED 7/8 x 14 WILL FIT.

No 23 – 8″ BENCH SAW

Cuts a full 2 1/4″ thick.
12 x 14 Table.
Table tilts to 45 degrees.
Removable Insert.
Saw raises and lowers conveniently.
Bronze Bearings.

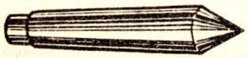


$900

CUP CENTER

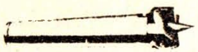
With replaceable center pin.

10058	#1 Morse	.75
10059	2 Morse	.80



60° MORSE CENTERS

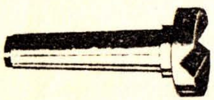
10054	#2 Morse	.75
10055	3 Morse	1.20
10056	1 Morse	.70



SPUR CENTER

#2 Morse shank with replaceable center pin.

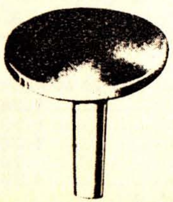
10057 .80



CROTCH CENTER PAD

Fits tailstock. Indispensable for drilling round stock in lathe.

10080	#1 Morse shank	2.00
10081	2 Morse shank	2.25



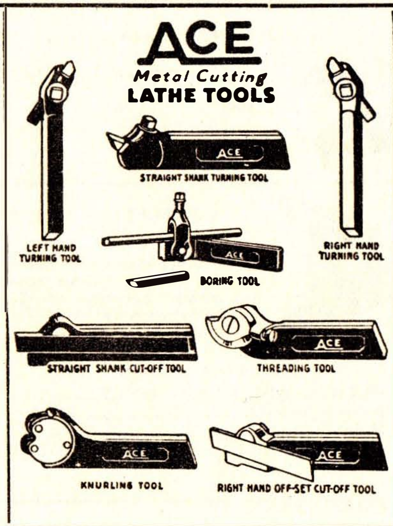
DRILL PAD

5" Diameter

Fits tailstock. Very useful for drilling holes in flatwork.

10053	#1 M.T.	2.25
10153	2 M.T.	2.45

Weight 2 lbs.



DROP-FORGED BY ARMSTRONG

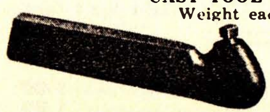
10088	Boring	3.00
10188	Straight	1.25
10288	Right hand	1.25
10388	Left hand	1.25
10488	Cutting off	1.50
10588	Cutting off R. H.	1.50
10688	Knurling	3.00
10788	Threading	2.50

Each Tool Complete with Wrench and Cutter

Shank size ⅜ x ¾"

CAST TOOL HOLDERS

Weight each 7 oz.



10073	Right hand	.50
10173	Left hand	.50
10273	Straight	.50
10373	Set of three	1.25

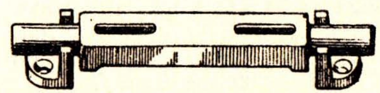
Shank size ⅜ x ¾. Takes ¼" cutters.

HIGH SPEED TOOL BITS

¼ x 2⅛

10189	Left turning	.30
10289	Right turning	.30
10389	Roughing (for steel)	.30
10489	Threading	.30
10589	Right corner	.30
10689	Brass turning	.30
10789	Blank	.15
10889	Extra boring bar ⅛ x 4	.30
10989	Extra boring bar 3/16 x 4½	.45
11089	Extra boring bar ¼ x 5	.55
11189	Extra cutting off blades 3/32 x ⅝	.50

FLOATING MOTOR MOUNT



For ¼ to ½ H.P. Motors

The torque of the motor keeps the belt tight. With extra feet this may be moved from place to place and used to operate several small machines. This works exceptionally well on small grinding or buffing heads.

100100	Complete with 2 feet. Weight 1 lb. 8 oz.	.50
101100	2 extra feet only. Weight 7 oz.	.15

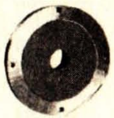
SCREW CENTER FACE PLATE
(Diameter 2″)

For holding slender pieces of wood by means of a screw or as small face plate.

10052	7/8 x 14 thread	1.00
10152	1¼ x 12 thread	1.00

Weight 8 oz.

CHUCK BACK PLATES



Fully machined to fit our standard chucks.

Adapter No.	Fits Chuck No.	
10064	10065	1.50
10164	10165	1.50
10264	10265	1.50
10364	10365	1.50
10464	100103	2.50
10564	101103	2.50

Specify thread wanted. 7/8 x 14 or 1¼ x 12.

CHUCK BACK PLATE (ROUGH)

Drilled and tapped to fit spindle. Semi-machined oversize on the diameter for fitting.

Specify diameter of recess in back of YOUR chuck. Any diameter up to 6″.

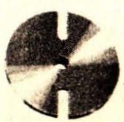
10063	Thread 7/8 x 14	1.00
10163	Thread 1¼ x 12	1.00
	SPECIAL THREADS (any thread you want. Plate diameter up to 6″)	1.50

BACK PLATE FOR WOOD FACE PLATE

10051	Thread 7/8 x 14	1.50
10151	Thread 1¼ x 12	1.50

Wt. 1 lb. 13 oz.

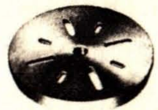
DOG DRIVING FACE PLATE



10050	Thread 7/8 x 14	2.25
10150	Thread 1¼ x 12	2.25

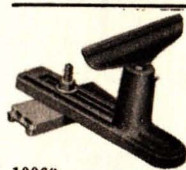
Weight 1 lb. 13 oz.

FACE PLATES, 8″ and 11″



	Thread	Dia.	Lbs.	
10049	7/8 x 14	8″	6	2.75
10149	1¼ x 12	8″	6	2.75
10249	1¼ x 12	11″	19	5.00

COMPLETE HAND REST UNIT



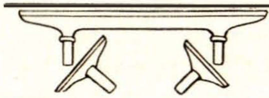
Bolts directly to lathe bed. For hand tooling wood or metal. Consists of T rest holder—clamp—1 3″ T rest—and 1 6″ T rest.

10060		2.50

Weight 4 lbs. 10 oz.

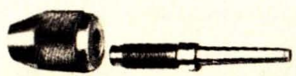
10083	HOLDER AND CLAMP ONLY	1.80
	Length overall	9″
	Height	3⅜″
	Weight	3 lbs. 6 ozs.

TEE OR HAND RESTS



10179	3″	(Shank 11/16 x 2¼)	.25
10279	6″	(Shank 11/16 x 2¼)	.35
10079	13″	(Double shank ea. 11/16)	.90
10086	8″	(Shank 13/16 x 5″)	.45
10186	18″	(Double shank ea. 13/16)	1.10
10379		Angle rest (not illustrated) 3½ x 2½ shank 11/16 x 3″	.45

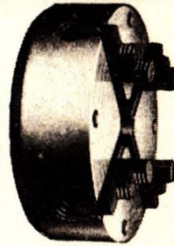
KEYLESS DRILL CHUCK AND ARBOR



Chuck has 3 hardened jaws. Capacity 0 to ½.

Chuck	10068	½ x 24 thread	1.00
Arbor	10069	#1 Morse shank	1.00
Arbor	10169	#2 Morse shank	1.00

4 JAW INDEPENDENT CHUCKS

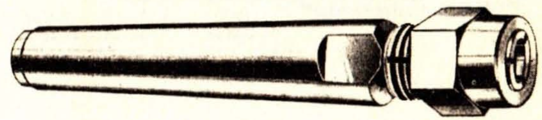


A substantial—inexpensive chuck. Semi-steel with hardened jaws.

10065	3″	3.50
10165	4″	4.50
10265	5″	6.50
10365	6″	8.00

Each jaw moves independently. The chuck will hold any shape material.

WOODRUFF CUTTER CHUCKS



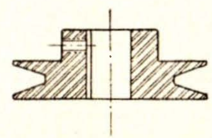
Very finely made. Holds Woodruff cutters with ½″ shanks, or end mills.

This type of holder is one of the most useful for milling on a lathe.

#3 Morse taper shank.

100101	7.20

CAST IRON VEE PULLEYS



Type "A" groove.

These pulleys are machined from the solid grey iron. The cost is very little more than die cast.

Sizes: 2″, 2½″, 3″, 3½″, 4″, 5″, 6″, 7″, 8″, 9″.

Bore: 2″ size ½ or ⅝.

Larger sizes: any size bore up to 1″.

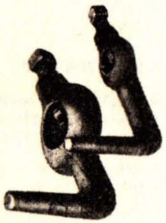
100102 Specify size desired.

Price **25c** per inch of diameter

101102	3 step 3½ x 2½ x 1½	1.25
102102	4 step 3½ x 3 x 2¼ x 1½	1.50
103102	3 step 4½ x 3½ x 2½	1.25
104102	2 step 2½ x 1¾	.75
105102	2 step 10″ x 9″ (any bore)	4.25

Many other sizes available.

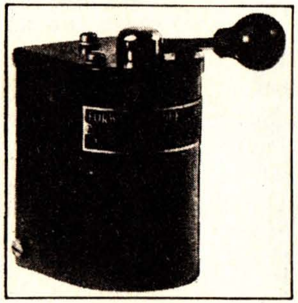
Multi-step pulley bores ½ or ⅝.



STANDARD LATHE DOGS
(Malleable Iron)

Designed for strength and service.

10070	Capacity ½″	**.45**
10170	Capacity ¾″	**.55**
10270	Capacity 1″	**.65**
	Weight 7 oz. each.	
10470	Set of 3	**1.50**



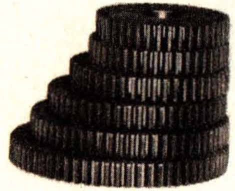
REVERSING SWITCHES

These miniature drum controllers are used either for reversing or plain starting and stopping.

(Either a reversing switch or a thread dial is necessary when chasing threads.)

10090
Inexpensive
4.25

10190
Has ⅛ thick copper tipped fingers
7.50



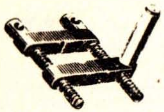
METRIC CONVERSION GEARS

All gears and parts necessary to cut right and left hand metric threads with the same accuracy as lathe having metric lead screw.

Cuts				
	.5	.75	1	1.25
	1.5	1.75	2	2.5
	3	3.5	4	4.5
	5	5.5	6	6.5
	7	mm. pitch		

(Note: When ordered with Lathe we will furnish either U. S. S. or Metric change gears at no extra cost.)

10078 .... **8.75**



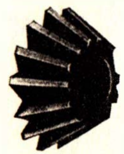
ADJUSTABLE LATHE DOG

Adjustable from 0 to 2″ for light work.

10370 .... **.85**

WOODRUFF CUTTERS (Straight Shank)

	Diameter	Thickness	Shank	Price
100105	½	⅛	½	**2.25**
101105	¾	3/16	½	**2.50**
102105	1	¼	½	**3.00**
103105	1⅛	3/16	½	**3.50**
104105	1¼	⅜	½	**3.75**

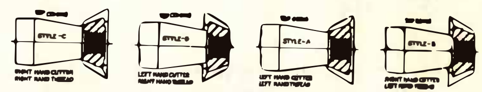


60° ANGULAR MILLING CUTTERS

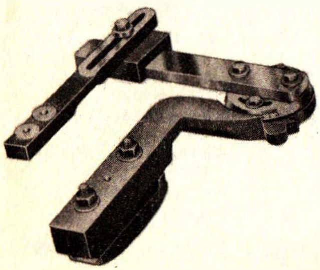
For cutting dove-tail slots where a nut could not be used on arbor end.

100108
Diameter 1⅝
9/16 Thick
3.00

Specify style of cutter you want.



See arbors on page 9.



TAPER ATTACHMENT

The taper attachment is used for turning or boring all classes of taper work. It is very useful where a large number of duplicate parts are required.

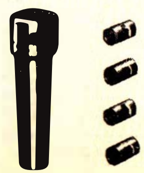
The attachment is bolted to the lathe bed and may remain in place, as it does not interfere with straight turning. It can be applied on either side of the saddle or tailstock. It is interchangeable and does not require fitting.

Maximum taper 6″ per ft.
Maximum length of taper in one setting 10″.
A longer guide bar may be used. Graduated in degrees.

10048 .... **15.00**

END MILLS

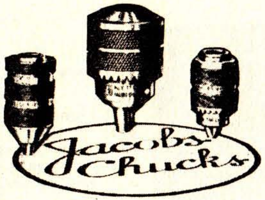
	Diameter	Flute Length	Price
100106	¼	⅝	**1.55**
101106	5/16	11/16	**1.65**
102106	⅜	¾	**1.90**
103106	7/16	⅞	**1.95**
104106	½	15/16	**2.10**



END MILL AND WOODRUFF CUTTER ADAPTER

#3 Morse Shank ½″ Hole
The cutter is held by an Allen screw. Smaller shanks than ½″ require a bushing.

100107	Adapter #3 M.T.	**2.00**
101107	Set of 4 bushings	**.75**



10066	1/16 to 1/2 cap.		5.75
10166	0 to 1/2 cap.		6.75

Weight 2 lbs.

HOLLOW SPINDLE CHUCK

10266	1/16 to 3/4	12.00

Weight 5 lbs.

In combination with the hollow arbor listed below this chuck permits work held to pass through the chuck into the lathe spindle.

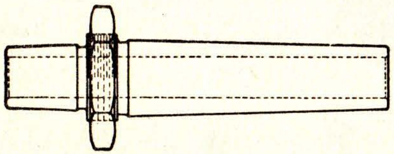
This is the chuck for valve grinding.

CENTER REST CHUCK

Bronze jaws. Acts as a steady rest. This is the chuck for centerless armatures.

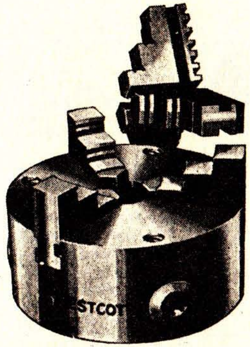
10366	1/4 to 3/4	8.00

ARBORS FOR JACOBS CHUCKS



Arbor No.		Fits Chuck No.	Price
10067	#1 M.T.	10066-10166	.70
10067	2 M.T.	10066-10166	.75
10067	3 M.T.	10066-10166	1.20
10167	3 M.T.	10266	3.25
10267	1 M.T.	10366	.70
10267	2 M.T.	10366	.75
10267	3 M.T.	10366	1.20

State arbor number and size Morse taper wanted.

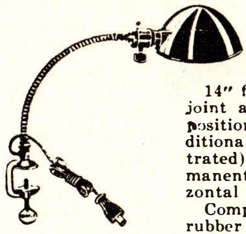


THREE JAW UNIVERSAL CHUCKS

Heat treated jaws — self centering for round or hexagonal work. Two pairs of jaws furnished (inside and outside).

100103	4″	18.95
101103	5″	21.00
102103	6″	23.00

(Adapter required)

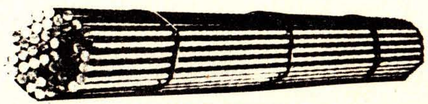


MACHINE LAMP

14″ flexible goose neck and swivel joint at socket. Adjustable to any position. Clamps in any place. Additional bracket furnished (not illustrated) by which lamp may be permanently attached in either horizontal or vertical position.

Complete with 6 ft. of approved rubber cord and parabolic shade (no bulb).

10082	1.75

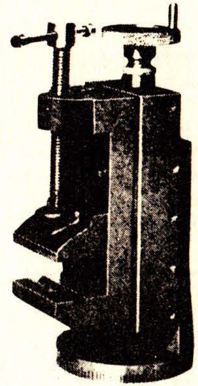


PACK-O-METAL

(Trade mark reg.)

Cold drawn steel — bright finish — free turning — SAE 1112. Any size round 1/8 to 1″, cut 3 feet long. Packed in standard fibre containers. Each package contains about 15 lbs. asst. sizes.

10087	1/8 to 1/2 asst.	2.00
10187	1/2 to 1 asst.	2.00



MILLING ATTACHMENT

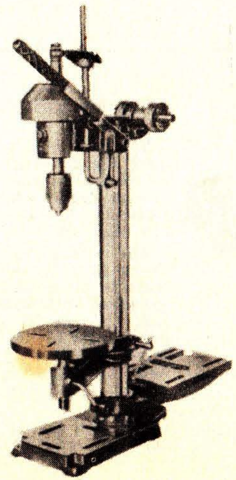
This complete attachment bolts rigidly on the cross-slide in place of the compound, which is easily removed. The segment is graduated in degrees and it will turn to any angle.

The STANDARD vise may be removed and work clamped to the machined face, which has drilled and tapped holes.

The vertical lift hand wheel is also provided with a micrometer collar.

10074	12.75

Weight 11 lbs.



1/2″ CAP. LIGHT DRILL PRESS

20″ tubular steel column.

1/2″ capacity chuck.

Depth stop.

Adjustable idler pulleys.

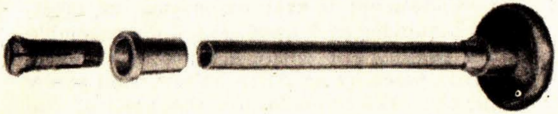
Adjustable motor mount.

Swinging table.

Spindle lock.

No. 14	9.00

DRAW-IN COLLET CHUCK ATTACHMENT



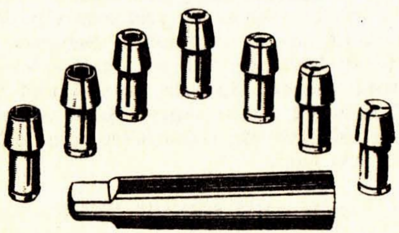
Collet chucks are precision holding devices. They are widely used for manufacturing and in the tool room. Each collet chuck will only hold one size of drill or rod. Made of tempered steel—ground all over.

The adapter and collet fit in the spindle nose taper. The draw bar passes through the spindle and screws on the collet. Turning the hand wheel to the right tightens—to the left releases the work.

10062 Draw bar, adapter, 1 collet chuck **18.00**

10162 1/16 to 1/2 by 32nds. Specify size wanted. One furnished.

BRASS COLLET CHUCKS



These chucks are very handy for holding drills, end mills and short pieces of rod.

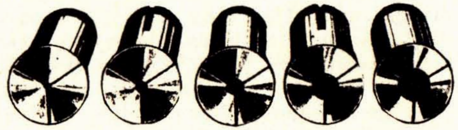
The chucks fit into a recess in a Morse taper shank. An adapter with a tapered hole to fit the chuck taper screws into the recess and closes the chuck concentrically.

Complete, 7 chucks, 1/16 to 3/8—Morse shank to fit chucks and closing adapter.

10084 Complete with #2 M T Shank **4.25**

10085 Complete with #3 M T Shank **4.50**

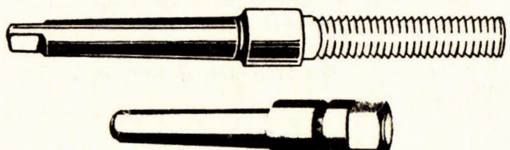
PRECISION COLLET CHUCKS



10162 1/16 to 1/2" by 32nds .... each **4.00**
Specify size wanted.

For rectangular sizes .... each **5.00**

MILLING CUTTER OR GENERAL PURPOSE ARBORS



Accurately ground Morse taper shanks. Arbors will hold standard milling cutters. Useful for many other purposes. Furnished complete with 3 spacing collars and finished nut.

10069 1/2" Arbor #1 M.T. shank—1/2 x 24ths
Cap. between nut and shoulder 1 3/8 .... **1.10**

10169 1/2" Arbor #2 M.T. shank—1/2 x 24ths
Cap. between nut and shoulder 1 3/8 .... **1.20**

10061 5/8" Arbor #3 M.T. shank
Cap. between nut and shoulder 1 1/8 .... **3.75**

10161 5/8" Arbor #3 M.T. shank
Cap. between nut and shoulder 3 1/4 .... **4.25**

10261 5/8" Arbor tapped 7/8 x 14, to screw on spindle nose. Capacity between nut and shoulder 2 1/2 .... **1.50**

THREAD DEPTH STOP

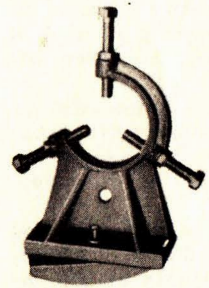
Convenient for thread chasing—for producing duplicate threads or turned work.

The knurled knob is turned slightly for each chip until the full depth for which the attachment is set is reached.

(The lathe is tapped for this attachment.)

10076 .... **2.75**

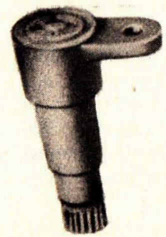
STEADY REST



Holds long work in position for accurate turning.

10072 Capacity 3 1/2". Weight 8 lbs. **4.50**

THREAD DIAL INDICATOR



This indicates when to re-engage the split nut for thread chasing.

With this attachment the carriage may be returned to the starting point for each cut in threading by means of the hand wheel—otherwise a reversing motor and switch is necessary.

10077 .... **4.25**

ANGULAR CUTTER ARBORS

10361 Left hand **1.00**

10461 Right hand **1.00**

This Description of the American Industrial Lathe, While Not Intended to Be a Complete Manual of Lathe Operation, Contains Useful Information of General Interest.

QUALITY

The words massive, rigid, scientific and precision are so generally employed to describe anything from a threshing machine to a measuring instrument that we purposely do not use these terms. We produce a general all-purpose Lathe at a very low price. One of the main essentials is weight, and every part of the machine contains all the metal we could conveniently put into it. No skimping of material has been attempted.

To produce a good article at low cost our design embodies complete interchangeability. This has been practically accomplished. Even our head and tail stocks will interchange with each other.

The picture of the Lathe being checked with a bar passed through the spindle bushing and showing a discrepancy of plus or minus .001 . . . 12″ from the spindle nose is true. None of our Lathes are worse than this.

The machine is suitable for any use within its capacity. We have attachments for all common machine shop operations and it is so inexpensive that it may readily be adapted for some purpose where a special machine would be necessary, at a great saving of cost.

HEADSTOCK

The headstock is of the enclosed box type. It is held on the bed by two steel clamps. In accord with our policy of interchangeability the spindle runs in two bronze sleeve bearings; each 1½″ long with oil groove and oil cup. With ordinary lubrication these bearings will give very long service. If they ever have to be replaced the insertion of two new bearings restores the original factory alignment. We think this is better than a split adjustment which destroys whatever "precision" was there in the first place. Heavy duty motors use this construction and Lathes like this have been in continual use in our own plant for several years without showing perceptible wear. New bronze bearings cost 45c each. They are standard and may be purchased everywhere.

The motor switch is built into the headstock. The drive belt is enclosed and there are no obstructions to snag your sleeve and interfere with the free use of the Lathe for filing, etc.

SPINDLE

The spindle is ground and polished. Hole through spindle 25/32 . . . nose bored #3 Morse taper . . . threaded 1¼ x 12 . . . adjustment nut for end play provided on end of spindle. Standard collets and draw bar available. The collet and tool rack is included with the Lathe as standard equipment.

VEE BELT DRIVE

Complete vee belt drive is standard on all Lathes. We furnish Gilmer belts, which give long service.

This type of belt, of course, is endless. If replacement is ever necessary, the headstock spindle and back gears dis-assemble very easily. The entire spindle assembly is held in place by an Allen hollow head screw and the take-up collar on the back of the headstock.

The Allen screw is reached through the hole in the cone pulley. It sets on a milled flat on the spindle. Be careful to replace it on this flat so as not to mar the spindle.

The back gears are held in place and located by two bushings in the back gear bracket. Remove the back gear guards and the screws which hold these bushings in place are visible.

TAILSTOCK

Weight 32 pounds. Has compensating clamp which locks easily and securely. Witness mark shows alignment. Set-over ¾″ for taper turning. Oil well and oiler for tailstock center. Spindle ground and polished with #2 Morse taper. Hand wheel to feed spindle travel. Hand lever spindle lock with brass cam.

BED AND BENCH FEET

Weight together 118 pounds. Four flat ways. Width of bed 7¾″. Carriage rides on the two outside ways. The bed is strengthened by box braces its entire length.

AUTOMATIC FEEDS AND REVERSE

The Lathe as shipped has the gear train set for a slow feed, .0024 approx. per spindle revolution. Still slower feeds may be obtained by additional gears.

The gear train may be entirely disengaged or the direction of feed reversed by a lever on the side of the headstock.

All gears hobbed from grey iron or steel.

Finish: All castings filled — two coats pyroxylin enamel—all hand wheels and ball cranks polished.

CARRIAGE CROSS SLIDE AND COMPOUND

Long bearing surfaces. All necessary features such as micrometer collars . . . steel ball cranks and adjustable gibbs on all wearing surfaces are provided.

The carriage has a lock to hold it firmly in one position on the bed, and this should always be used when facing.

The hand feed gear and pinion mounted on the inside of the apron are also provided with an adjustment to remove back lash from between the hand feed gear and rack. These are the gears which are operated by the hand wheel to move the carriage manually along the bed. A split nut controlled by a lever on the front of the apron is used for threading or automatic feed.

The cross slide has a travel of 8″.

The compound slide will travel over 3″.

It is graduated—swivels 360° and has a V cam lock.

3″ is not the total travel, but only the movement between nut and shoulder when both parts of the compound are even.

This long movement is very convenient, but it does not mean that accurate turning could be accomplished with 3″ of the upper slide overhanging.

The slide should always be used with the position of the upper slide as near normal as possible.

The compound slide carries the steel tool post which has a broached opening to take standard tool holders for ¼″ cutters. ⅜″ cutters may be held directly in the tool post slot.

The tool holder and cutter should also be held as short as possible. Too much overhang will cause spring and may cause the tool to catch in the work, damaging both the work and the tool.

PROPER ADJUSTMENT OF TOOL SLIDES

As noted in the last paragraph, all parts of the carriage assembly have gibbed adjustments for tension and wear.

If these gibbs are not properly adjusted a slop of only .001 will cause a considerable discrepancy in your work.

The ball cranks and hand wheel are not supposed to spin. The gibbs should be tightened by means of the adjusting screws until there is a definite "feel" or resistance to the particular slide you are operating.

BACK GEARS

Ratio 3.43 to 1 . . . grey iron . . . 12 pitch . . . 9/16 face. Supported in a one-piece bracket. Easily engaged or disengaged by hand lever on eccentric spindle. Fully protected by cast iron guards . . . oiling system Gits ball and well in back gear hub. Safety lock pin in spindle cone pulley and gear uses a screw driver . . . not fingers.

COUNTERSHAFT

A two-step machined cast iron pulley 10″ and 9″ "A" groove takes the power from the motor to the cone pulley on the countershaft.

The spindle is bronze bushed with oil cups. The bracket which holds the countershaft is bolted to the bed of the Lathe, not the headstock. It is adjustable in all directions for proper alignment with the cone pulley on headstock. The countershaft trunnions on hardened cone point screws and the entire system is hung so low that it is below the level of the top of the headstock.

BELT TENSION DEVICE

The bracket supporting the countershaft carries the eccentric roller cam belt tension device. It is connected to the countershaft by a cast iron link and a hand lever which actuates the steel cam releases the belt for speed changes or tightening. A wide range of adjustment is provided to compensate for wear and belt stretch. A separate adjustable motor base that fits any motor and bolts to the countershaft is furnished as standard equipment.

ARRANGEMENT OF THE GEARS FOR THREAD CUTTING

All gears hobbed from grey iron or steel.

The **SCREW GEAR** is the one on the end of the lead screw.

A chart on the front of the headstock shows which gears to employ. This description is intended to show you why we use those gears so that you will know how to cut threads other than those shown on the chart.

The proper gears to cut the wanted thread are found like this:

Multiply the thread you want by 3.

This gives you the number of teeth in the screw gear.

DEMONSTRATION

Wanted thread = 24
$24 \times 3 = 72$

You need a 72 tooth gear on the lead screw.

DEMONSTRATION

Wanted thread = 40
$40 \times 3 = 120$

No gear with 120 teeth is furnished. The same effect can be had by using a 60 tooth gear and making it turn ½ as fast. This is called compounding and this is what is meant by the 2 to 1 . . . 1 to 2 . . . on the gear chart. 1 to 1 means simple gearing . . . no compound.

Both a 48 tooth and a 24 tooth gear are furnished. Put these two gears on a compound bushing. This bushing holds both gears together so they revolve as a unit. (Two of these bushings are furnished with each Lathe. We ship them in the gear case in the gear train assembly.)

Arrange these two gears on the bushing so that the small gear (24 teeth) is the driving gear and the large gear (48 teeth) is the driven gear.

Now, each time the large gear makes one revolution the small gear will do the same . . . but the larger gear having twice as many teeth will make the screw turn ½ as fast, viz.:

$$\frac{120}{3} = 40 \qquad \frac{60}{3} \times \frac{48}{24} = 40$$

DEMONSTRATION

Wanted thread 4
$4 \times 3 = 12$

No gear with 12 teeth is furnished.

As in the previous demonstration, the effect is also obtained by compounding. But now you do the reverse. In the last case you used a screw gear with less teeth than were indicated. Now you must use a gear with a greater number of teeth than you want. Therefore, the lead screw will run slower.

Place a 24 tooth gear on the lead screw. Now put the other 24 tooth gear and the 48 tooth gear on the compound bushing but REVERSE their positions. The larger gear will now be the driving gear and be outside and the smaller gear will be the driven gear and inside.

As before, this compounding changes the speed of the screw gear, but this time it does the reverse, and makes it turn twice as fast instead of ½ as fast.

In these demonstrations on compounding we only used ratios of 1 to 2 and 2 to 1 to produce the desired results.

Any combination of gears that will produce the same result is also proper and may be necessary.

For example, we just used a 24 tooth gear at 2 to 1 to produce 4 threads per inch. We could just as well use any multiple of 12, viz., 24 . . . 36 . . . 48 . . . etc., and make them run proportionally.

$$\frac{24}{2} = 12 \qquad \frac{36}{3} = 12 \qquad \frac{48}{4} = 12$$

The division is of course obtained by compounding as:

$$\frac{24}{2} = \frac{24}{1} \times \frac{24}{48} = 12$$
$$\frac{36}{3} = \frac{36}{1} \times \frac{24}{72} = 12$$

You will also notice that the same result might be obtained by a double compound, viz.:

$$\frac{48}{4} = 12 \qquad \frac{48}{2 \times 2} = 12 \qquad \frac{48 \times 24 \times 24}{1 \quad 48 \quad 48} = 12$$

Many threads not listed on the gear chart may be obtained by double compounding.

The assembly of the double compound may be a little confusing. Always notice that the ratio you want is obtained by dividing the DRIVEN GEAR by the DRIVING GEAR. This reverses the position of the two gears on the second compound. On the first compound it is the outside gear which drives, whereas on the second compound it is the inside gear.

Why Multiplying the Thread You Want by 3 Gives You the Number of Teeth Required in the Screw Gear

The gear on the lathe spindle has 24 teeth.

The lead screw has 8 threads per inch.

Therefore, a 24 tooth gear put on the lead screw will make one complete turn every time the spindle makes one turn (with simple gearing).

Since the spindle and lead screw both revolve at the same speed; the lead screw having eight threads per inch will move the carriage and cutting tool past the work ⅛" during 1 complete turn . . . or 8 threads per inch.

$$\frac{\text{screw gear } 24}{\text{spindle gear } 24} \times \frac{8}{1} = 8 \text{ threads per inch}$$

or

$$\frac{\text{screw gear wanted}}{\text{spindle gear } 24} \times \frac{8}{1} = \frac{\text{screw gear}}{3}$$

$$\therefore \frac{\text{screw gear}}{3} = \text{thread}$$

or

$$\text{screw gear} = 3 \times \text{thread wanted}$$

WHICH GIVES US THE GENERAL FORMULA

$$\frac{\text{screw gear}}{\text{spindle gear}} \times \text{No. of threads per inch on lead screw} = \text{thread}$$

The Intermediate Gears of a Simple Gear Train Do NOT Affect the Velocity of the Final Gear in the Train

On removing the gear cover you will notice several gears connecting the spindle gear with the screw gear. Two of these gears reverse the direction of feed. Another gear is just an idler and serves mainly to transmit the motion of the spindle gear to a more convenient place.

In the previous examples these gears were not considered, as they do NOT affect the velocity of the lead screw gear.

In a Simple Gear Train the Ratio Is Only Between the First or Spindle Gear and the Last or Screw Gear

This is important and mentioned for the following reason: In arranging the gears to cut the thread you want it may happen that the combination you select will not be large enough to mesh between the idler gear and the screw gear. In this case you simply insert any convenient gear where you need it. As noted, this extra idler gear you insert in the train does not affect the speed of the final gear (screw gear), only its direction of rotation.

AFTER ARRANGING YOUR GEARS TO CUT A THREAD, TURN OVER THE SPINDLE A FEW TIMES AND MEASURE THE LEAD OF THE THREAD TO MAKE SURE YOU ARE RIGHT.

Why a Reversing Switch and Motor or a Thread Dial Is Necessary for Cutting Threads

Several cuts are needed in order to chase a thread to its proper depth.

Each time a cut is taken the carriage must be returned to the starting point.

This may be done by disengaging the split nut on the apron and returning the carriage by means of the hand wheel (this is the quickest way) . . . by pulling the belt back by hand or by means of a reversing switch and motor which enables one to reverse the direction of the motor.

The first method can only be used with the aid of a thread dial. If you disconnect the gear train there is no assurance that the next cut will start in exactly the same place as the previous one.

The thread dial is illustrated elsewhere in the catalogue. Notice the graduations. If the split nut lever is closed at any noted graduation on the thread dial the split nut may be opened at any point and the carriage returned to the starting place by hand. As the thread dial revolves, the split nut lever is closed at the same graduation noted. The tool will then enter the next cut at exactly the same place where you started.

With a reversing switch and motor you retract your cutting tool and push the switch lever . . . this reverses the direction of your motor and returns the carriage to the starting point.

MULTIPLE THREADS

A multiple thread has the same parts or dimensions as its number, except its lead, which is its number divided by the number of the multiple.

A double 36 thread, for example, is a 36 thread with the lead of 1/18 inch. You set the lathe for 18 threads.

Triple 36 would have the lead of 1/12 inch, etc.

The easiest method of doing this is to have a series of holes or slots in the face plate. The plate furnished with the lathe only has two slots. If you chase one thread as usual and then move the dog to the opposite slot the second thread will start 180° from the first and you will get a double thread.

A triple thread requires three slots, etc.

METRIC THREADS

It so happens that the Metric System of lineal measurement is divisible into the standard inch. This makes it possible by means of change gears to cut metric threads on a lathe having a lead screw divided in inches.

25.4 millimeters equal 1 inch.

It follows that one complete revolution of the lead screw which equals ⅛" in travel is equivalent to $\frac{25.4}{8}$ or 3.175 mm.

If you will refer back to the paragraph under the heading "Why We Multiply by Three" you will note that a 24 tooth screw gear will turn the lead screw one complete revolution for every corresponding revolution of the spindle. This would be equivalent to 3.175 millimeters of movement or lead to each revolution.

The screw gear then would need to have 3.175 times 24 as many teeth in order to cut a thread of 1 mm. lead to each spindle revolution. $3.175 \times 24 = 76.2$, which would be the number of teeth required on the screw gear.

Since a gear with a fraction of a tooth is impossible, we multiply by the smallest number (5) that will clear the fraction to a whole number.

This gives us 381. A gear with this many teeth is rather inconvenient. So, 381 being exactly divisible by 3, we get $\frac{381}{3} = 127$.

This now brings us back to the compound gearing. We know that a screw gear with 76.2 teeth will cut a lead of 1 mm. 76.2 is 3/5 of 127. If we use a screw gear with 127 teeth we have to compound it so as to make the 127 tooth gear turn 3/5 as fast.

So, a 127 tooth screw gear compounded × 3/5 will cut a lead of 1 mm. per spindle revolution.

$$\frac{30}{50} \times \frac{127}{24} \times \frac{8}{1} = 1 \text{ mm.}$$

A second compound, of course, gives us any multiple we want of 1 mm.

$$\frac{30}{50} \times \frac{48}{24} \times \frac{127}{24} \times \frac{8}{1} = 2 \text{ mm.}$$

$$\frac{30}{50} \times \frac{72}{24} \times \frac{127}{24} \times \frac{8}{1} = 3 \text{ mm.}$$

Many other permutations are possible.

INSTALLING THE LATHE

Every precaution has been used both in manufacture and shipment to get the machine to you as near perfect as possible.

To maintain the accuracy that has been built into the machine it is essential that it be properly installed.

It might seem that the heavier a machine the less easy it would distort from improper mounting, but just the reverse is true. The Lathe is quite heavy for its size and a heavy machine warps very easily if it is not set level.

The same installations and instructions apply to both the bench and floor models. There is no assurance that the surface you are going to place it on is level. The machine should be leveled and carefully shimmed underneath the feet before pulling the bolts down tight.

No breaking in is necessary. The bearings have been properly fitted, but don't forget that none of the wearing parts on the machine will function properly unless consistently oiled.

THREAD CUTTING

The included angle of the thread cutting tool for U. S. S. coarse or fine threads is 60 degrees.

It is possible to take successive cuts until the proper depth has been reached by just setting the tool square against the work and feeding the tool forward by means of the cross-slide.

This method is not good and the proper accepted way is to set your compound at half the thread angle (30 degrees) and feed the tool forward by means of the compound slide. In this manner the tool only cuts on the leading side and a much cleaner and accurate job is possible. Since the tool only cuts on one side, the side of the tool which does not cut should have a slight additional clearance. In other words, measured from the center line of your tool the angle of one-half is 30 degrees, and the angle of the other half may be 27 or 28 degrees.

ACME THREADS

The included angle of the ACME THREAD is 29 degrees.

$$\text{Pitch} = \frac{1}{\text{number of threads per inch}}$$

Depth = ½ P + .010

Flat (at top of thread) .3707 × P

Flat (at root of thread) .3707 × P — .0052

SQUARE THREADS

If you could unwind a screw thread and straighten it out it would be a straight line.

If you only unwound one complete turn the length of this line would be the hypothenuse of the angle formed by the circumference of the screw (altitude) and the lead of the screw (base).

If you increase or decrease the screw diameter it is clear that the altitude of this triangle changes but the base remains the same.

This changes the thread angle, even though you do not change the pitch or lead of the screw.

Since it is necessary to have a clearance on the sides of any cutting tool, you will observe that this clearance is not the same for screws of various diameters even though they may have the same pitch or lead.

The width of a cutting tool for a square thread is exactly one-half the pitch, but it is customary to make the thread in the nut a few thousandths wider in order to provide clearance.

There should also be a clearance of about .005 between the bottom of the thread in the nut and the external diameter of the screw.

Observe that it is essential to have the proper thread form, otherwise the nut and screw will not fit. An inexpensive thread gauge may be purchased which indicates the proper angle of the tool and its position in relation to the work.

A left hand thread is cut the same way as a right hand thread excepting that the carriage is fed in the opposite direction and the compound is turned so that the right hand edge of the tool is the leading or cutting edge.

CHUCKING DEVICES

In order to hold and drive the work to be machined various types of holding devices are necessary. A Lathe is just as useful as its holding devices and your ingenuity in devising means of holding irregular and odd shaped work.

The holding device in most common use is the chuck, of which there are two general types.

The INDEPENDENT chuck has independently operated jaws and is used to hold rectangular or odd shaped work. It usually has four jaws and will hold round work as well.

With UNIVERSAL chucks the three jaws open and close simultaneously. This chuck is used for round and hexagonal work only.

If you only have one chuck, it is obvious that the INDEPENDENT chuck is the one to have, as this chuck will hold any shaped work, including round.

The extreme diameter of the chuck used on any Lathe should not be larger than will clear the shears of the lathe bed with the jaws fully extended. Since the jaws on nearly all chucks will extend beyond the body of the chuck itself, a 6″ chuck for example will hold work considerably larger than 6″.

The AMERICAN INDUSTRIAL LATHE will swing a piece of work 12″ in diameter. A chuck large enough to hold work so large is rather cumbersome and not versatile, as well as being expensive. A 4″ or 6″ independent chuck is recommended. If you have an occasional piece of large work you can hold it on a face plate. An 11″ plate listed in this catalogue only costs $5.00.

The DRILL CHUCK, which is used for holding small round work like rods, is essential. This type of chuck is fitted with a #2 Morse taper shank which fits either the headstock or tailstock spindles. If this chuck is fitted with a hollow shank it can be used for holding long pieces of rod, which pass through the chuck into the headstock spindle.

The headstock spindle has a #3 Morse taper. A bushing is furnished with the Lathe as standard equipment which reduces the size to #2 Morse.

If you use a hollow shank on the drill chuck its capacity is of course limited by the size of the shank. If it is desired to hold work such as valve stems, valves, etc., which might require the full capacity of the spindle (¾″), it is necessary to fit the chuck with a #3 shank.

CENTERING THE WORK IN AN INDEPENDENT CHUCK

As noted, the jaws of an independent chuck operate individually. The face of these chucks usually have concentric ring marks on the face which help indicate the position of the jaws. In machining round work, open the jaws wide enough to receive it, using these marks as a guide. Next, tighten the work by alternately turning the adjusting screw first on one jaw, then the one directly opposite. Now tighten the other two jaws.

At this point the jaws should be only tight enough to barely hold the work.

Revolve the chuck slowly by hand and mark the high spot with a piece of chalk.

Now loosen the jaw opposite the mark and tighten the one next to the mark.

If the mark happens to come between two jaws you will have to loosen two and tighten two.

When you have centered the work to your satisfaction, again tighten one jaw at a time carefully until you are sure the work is securely held.

Some shapes of work, such as rings or pieces with a sufficiently large hole, may be held on the inside with the jaws pressing outward.

If you have occasion to remove the chuck jaws, you will notice that they bear a number corresponding to the number on the slot from which they were removed. These jaws must be replaced in the same order.

NEVER LEAVE THE ADJUSTING WRENCH IN THE CHUCK WHEN NOT IN USE.

LOCATING WORK CENTERS ON WORK HELD IN INDEPENDENT CHUCK

It is common practice to use the Lathe for boring accurately located holes. Also large holes and recesses may be bored which are beyond the capacity of the ordinary drilling machine. If you can hold the work, all that is required is one drill large enough for your boring tool to enter. The hole may be then enlarged to any size you require.

If it is essential that the hole be perpendicular to any surface, this surface has to be machined first so that it lies flat against the chuck face. If this surface or position cannot be machined, the work must be shimmed or supported in some manner against the chuck face so that the hole will lie in the plane you want. If the hole is to be very accurately located, first ascertain that the tailstock is in alignment. Do not depend upon the witness mark. (See paragraph on accurate alignment of head and tail centers.) Center punch the exact center of where you want the hole located. Mount the work in the chuck as directed. Now slide the tailstock forward to a position where a few turns of the hand wheel will enable you to bring the tail center against the work.

By adjusting the chuck until the center punch mark is in exact line with the point of the tail center you can locate the center of the hole very accurately.

If you own an indicator, here is a better method. A piece of ground steel bar with a 60 degree center turned on one end and another center recessed in the opposite end is supported between your tail center and the center punch mark. By rotating the work you can readily detect when it is in line. It is possible to use this method without an indicator. With a piece of white paper underneath the work a gap of .001 is visible.

The most accurate method of centering employs the use of the steady rest or center rest as it is sometimes called.

The end of the work is held by the chuck and the other end is supported by the steady rest.

Whenever a positive center must be located and no material can be removed from the O. D., this is the only satisfactory method.

For example, putting an extension shank on a drill . . . repairing a taper shank which has no center, etc. Note the next paragraph.

THE STEADY REST

All material, no matter how large in diameter, will bend if pressure is applied. The amount of bend depends on the material—its diameter and the distance from where it is held to where you apply the pressure.

If you cannot apply sufficient pressure on the cutting tool without springing the work, it requires additional support. In some cases if the work has a center, you are able to do this with the tailstock. Or, it may be that even with the support of the tailstock, the work still yields because of its length. This indicates that the steady rest must be used.

The steady rest can be moved axially along the bed and clamped where wanted. It has three movable jaws which are adjusted against the work just tight enough to prevent lost motion and yet permit the work to turn freely.

Work with accurate centers supported between the head and tail centers is easy to adjust in the steady rest. To support centerless work one end of which is in the chuck requires a little more skill. This is like the extension drill shank and taper job mentioned in the chapter on "locating work centers."

First—adjust the work in the chuck. After it turns as true as you can make it, adjust the steady rest, then complete the adjustment.

The work should be gripped in the chuck jaws as close to the ends as possible. Usually not much grip is needed to drive, but be careful. If the work must not be marred, place a shim of tin plate or brass between the work and the chuck jaws.

TAPER BORING WITH THE STEADY REST

For very short taper holes not more than two inches long you may use the compound slide.

For longer work it is necessary to use a steady rest.

The work is held at one end by a lathe dog driven by the face plate and supported at the other end by the steady rest.

After mounting the work, unscrew the face plate a few turns. Now tie the work to the plate with a heavy cord, or best of all a leather belt lace.

Screw the face plate back into position, which will tighten the lashings of the cord or lace and hold the work firmly against the head center.

By adjusting the jaws of the steady rest and locating its position on the bed you can obtain any taper you want.

HOLDING AND DRIVING BY MEANS OF A LATHE DOG

A lathe dog is a clamping device which is attached to the work to be driven. A tang or projection on the dog engages a hole or slot in the face plate. This drives the work.

A conventional form of dog is not necessary. Any clamp attached to the work and engaging a driving pin in the face plate is satisfactory. In some cases, for example a spoked pulley, all that is needed is a pin in the face plate to engage one of the spokes. A little ingenuity here . . . and you can drive most anything.

Be careful if you use a lathe dog with a tang that the tang is entirely free in the slot. If the tang should engage the bottom of the slot you can readily see that the work will not rest freely on the centers.

All work machined in this manner is supported and rotates between the lathe centers. A solid piece of work such as a solid bar or a casting has to be centered and center drilled in order to rotate on these centers. Lathe centers are standard; they all have a taper of 60 degrees included angle. To obtain accurate work your center in the work must be the same. Also make sure that the point of the lathe center does not strike the bottom of the hole.

Various types of center drills can be purchased. Some are known as combination drills. These have a straight drill projection beyond the taper, which is a positive means of preventing the lathe center from striking bottom. However, without a good set up these drills break very easily and you will do just as well by drilling a small hole deep enough with an ordinary drill and then use an ordinary 60 degree center reamer to form the taper. This type of reamer will last indefinitely and you only need one size; with the other style you may need a number of different sizes.

To center the work, the first thing you have to do is to find the center on each end as close as you can. Use any method you think best. A hermaphrodite divider is about as simple as any, if you do not happen to have more elaborate tool equipment. This has a sharp point on one leg and the other leg is rounded and bent. On round stock, if you place the rounded leg against the work and scribe several small arcs as near the center as you can, you will readily be able to center punch it somewhere near the true center. Chalking the ends shows the marks clearly.

After centering both ends with the center punch place your work between the lathe centers. Screw the tailstock spindle forward until the work is quite well supported. By rotating the work with your left hand and holding a piece of chalk in the right you will be able to mark where the work turns out. Or if you wish you can put a tool in the tool post and by running the carriage back and forth you will be able to detect any eccentricity. A piece of white paper placed underneath the work will help you see.

These suggestions for centering the work may be unnecessary. If you have plenty of stock to remove, accurate centering would not be needed.

Again, if the work does have to be centered accurately, you may have to move your center punch marks, which you can easily do by holding the punch at an angle and tapping the hole toward the desired side.

The work is now ready to be center drilled. A drill chuck of at least ½" capacity and which may be used in either the tail or headstock is a necessity. With the drill chuck in the headstock holding the drill, place your work between the drill and the tailstock center. As you hold the work with your left hand you will be able to feed it forward by means of the screw feed in the tailstock. Some materials such as brass have a tendency to dig in. For this reason the thrust of your work as you hold it should be towards the tailstock.

After having removed enough material to obtain a plain surface where you desire it, measure it either with a caliper or micrometer to make sure it is not tapered. Remember the tailstock is adjustable. Move it in the desired direction until your work is parallel.

A great deal of work having a hole large enough to be supported on an arbor is machined in this manner. Standard arbors to fit every size of standard hole may be obtained. These arbors are hardened and ground and are slightly undersize at one end and oversize at the other and have a center at each end. The small end of the arbor is pressed into the hole. A drop of oil to prevent the arbor from freezing is a good precaution.

You can make a satisfactory arbor yourself.

SHARPENING LATHE CUTTING TOOLS

Elsewhere in this catalog you will find illustrated a set of ground cutters and boring bars. These finished ground tools are made of high speed steel and only cost 25c each—very little more than the unground tool. It is both a necessity and a convenience to be able to sharpen your own tools, but it is a good idea to buy whichever of these tools you may need and use them as samples. Do not regrind them until you have learned how to duplicate them from an unground cutter.

You will notice that all of these tools have a rake or angle running away from the cutting edge. Only the keen cutting edge of the tool must come in contact with the work. The degree of this angle depends on the material you are turning. The smaller the included angle of the cutting edge the weaker it is and the more it will have a tendency to grab. You will notice that a clearance angle on the sides is common to all the tools, but for soft, tenacious materials such as brass no clearance or rake is necessary on the top of the tool.

Both wear and heat destroy the cutting edge. It is for this reason that the speed of the rotating work is definitely limited. High speed bits such as these listed are much superior to carbon, but a tungsten carbide tool will stand approximately twice the cutting speed of high speed steel.

GRINDING

A grinding wheel of the proper grit and grade of hardness and operating at the proper speed cuts very freely. It is comparatively easy to grind a tool on the proper wheel. A bad one or one running too slow will damage your tools and make it very difficult. The proper surface speed of the grinding wheel is roughly a mile a minute.

When grinding the cutting tool, endeavor to do so with as little pressure against the wheel as possible. If you notice any discoloration it means that the tool is being burnt or annealed, which of course will destroy its cutting property. The tool should be kept cool by dipping frequently in water.

As you grind the tool it should be moved back and forth. Holding it in one place will not produce as uniform a finish and is also liable to dig a groove in the wheel.

It is good policy to have a wheel for nothing else but sharpening.

If you use the wheel for grinding castings, etc., it will have to be dressed frequently.

After sharpening a tool, remove burrs and round point with oilstone.

SPINDLE SPEEDS

	Cone Belt Position		
Driver	Left	Center	Right
9″	270	486	875
Back gear meshed	82	141	254
10″	170	306	551
Back gear meshed	49	89	131

CUTTING SPEEDS FOR VARIOUS METALS

Material		Heavy Cut	Finishing Cut
Brass	F.P.M.	150	200
Aluminum	"	200	300
Cast Iron	"	60	80
Machine Steel	"	90	100
Bronze	"	90	100
Tool Steel (Annealed)	"	50	75

The above table is in feet per minute. Multiply the diameter of your work in feet by 3.1416. Using the above table of spindle speeds you can set the machine accordingly.

This table of cutting speeds is not intended as a definite set rule.

When facing, you can see that the speed near the center is very slow and increases as you approach the periphery. A compromise is necessary. THE CUTTING SPEEDS ARE CALCULATED FOR HIGH SPEED CUTTERS.

CHECKING THE ALIGNMENT OF HEAD AND TAIL CENTERS

The tailstock body rests on a machined slide. It is adjustable transversely. This adjustment is used for taper turning. If a piece of work is held by a lathe dog and supported by the headstock center at one end and the tail center at the other you can see that if the tailstock is moved back across the Lathe the work will lay at an angle. Since the carriage moves parallel to the bed, the resultant work will be tapered. The amount or degree of this taper depends BOTH on the length of the work and the amount of tailstock set over.

The tailstock is provided with a witness mark which shows when the tailstock center is supposed to be in exact alignment with the head center.

For very accurate work this mark should not be depended on. If you have a ground steel bar or a bar which you have turned yourself and which is accurately centered at each end you can support this between the centers. By mounting an indicator or a tool in the tool post you can run the carriage back and forth until the tailstock is properly aligned.

Another method is to have a bar with two collars turned on it one near each end. By taking a light cut on each collar you can determine with a caliper when the two diameters are identical. Which shows that the tailstock is in line.

TAPER TURNING

Tapered work may be turned or bored either by using the compound slide rest or the setover on the tailstock. Another method, used when there are a number of duplicate pieces to be made, is the taper attachment listed elsewhere in this catalog. To use this, the feed screw in the cross slide is removed. A link attached to the cross slide carries a sliding member which engages the guide bar fastened to the bed of the lathe. The guide bar may be set at an angle. When the carriage is moved along the bed of the lathe the shoe or sliding member will follow the guide bar and move the cross slide back and forth across the lathe bed.

The amount of taper is usually given in either inches per foot or degrees.

If the taper is 1″ per foot it means that if the work is exactly 12″ long, one end of the work is 1″ larger in diameter than the other. You will notice that there is a direct relation between the length of the work and the taper.

You may measure the amount of tailstock setover by sliding the tailstock up near the headstock and using a ruler. This measurement should be one-half the amount of taper specified.

If the taper is 1″ per foot and the length of your work is 8″, 8″/12″ × ½ of the taper per foot specified equals amount of tailstock setover.

The point of the cutting tool should be exactly on center either for turning or boring a taper.

One of the most commonly used tapers you will want to make will be for Morse or Brown & Sharpe shanks or adapters. A nice way to standardize a bored adapter or socket is to have a finishing reamer. Since it is quite certain that you will at least have one standard part to which to fit the other, you can obtain good results on sockets without a reamer.

After turning the work put a chalk line on it; then by turning it in the opposite member you will see what correction to make. The work should be turned nice and smooth and be free from tool marks. It is permissible and proper to use a fine file or emery cloth, but this does not mean that you are to machine the work with a file. Even if polished to a nice shine, rough turned work will not make a good fit.

Taper boring cannot be done by using the tailstock setover method. The compound slide rest may be used but this has a limited travel. See chapter on "Taper Boring with the Steady Rest."

MEASUREMENT

Accurate measurements mean good machine work.

Some folks seem to have an inherent sense as to just what a good measurement in machine work really means.

If you are not one of the fortunate ones or if your experience in measuring has been limited to woodwork, it is well that you make yourself understand how accurate you have to measure before attempting to machine anything to size in the lathe.

A dozen pork chops and one dozen pounds of pork chops require an entirely different understanding of measure.

The first measure (one dozen) is definite and finite.

The second measure is entirely different.

The average grocers scale is probably accurate within plus or minus 1%. One per cent of a pound is roughly one-sixth of an ounce, representing a movement of the indicating hand hardly more than the width of the graduations on the scale dial.

We don't expect the grocer to weigh pork chops on a druggist balance, so for this purpose the measure is very satisfactory.

Now let's see how a difference of one per cent would affect a dimension on wood or metal.

One per cent of the length of a six inch board is 6/100 inches or approximately 1/16".

One per cent of the diameter of a 1" shaft is .010.

You probably already see for yourself that the board measurement is not so very bad. The shaft measurement, however, is very poor indeed and useless.

If it happens to be + .010 it certainly will not go in a 1" hole.

If it is — .010 it will wobble in the hole like a loose tooth.

.010 is 1/100 inch or less than ⅓ of the 32nd graduations on a foot rule. .005 is ½ of this amount and still not nearly close enough to the required dimension.

How close then, you may ask, do we have to measure and what is meant by an inch?

Just this. As was shown before, a measure such as one dozen is definite but other measurements are not. We cannot measure exactly one inch. The best we can do is to approach it as closely as the use dictates, which in the case of machined fits means about 1/10 of 1% or approximately 1/1000 of an inch to each inch in diameter.

ALLOWANCE FOR FITS

Ordinary Running Fits

Diameter	Allowance
Up to ½	— .0005 to .001
½ to 1	— .00075 to .0015
1 to 2	— .0015 to .0025
2 to 3½	— .002 to .003
3½ to 6	— .0025 to .004

Driving Fits for Permanent Assembly

Diameter	Allowance
Up to 2	+ .0005 to .001
2 to 3½	+ .00075 to .00125
3½ to 6	+ .001 to .0015

You will notice that for a 1" shaft the difference in diameter between a running fit and a driving fit is only .001 to .002.

All the running fits are minus.

The driving fits are plus and it might seem peculiar that the same exactness of measure is needed for this kind of fit.

When a shaft is pressed into a hole smaller than itself the excess size of the shaft must either expand the part into which it is pressed or the excess material will be sheared off.

If the shaft is too much oversize it will shear, leaving no assurance that enough material remains to maintain a permanent assembly.

Again, if it does enter without shearing, it may so expand the part into which it is inserted so as to affect its operation.

The ball bearing is a common commodity of close manufacture. Its inner race is usually a press fit on the shaft. When the shaft is pressed in place the inner race will expand. Since the total clearance in the ball bearing to allow its free rotation is very small, too large a shaft will take up the entire amount and jam the bearing.

Don't let these so-called close measurements scare you. Skilled workers made fits just as good hundreds of years ago with poor equipment. The only modern difference is our facilities to produce identical dimensions in quantity.

The feed screws on the lathe tool slides have 20 threads per inch. One complete revolution of the crank equals fifty thousandths.

Remember, this will reduce the diameter of your work twice as much.

If you have 1/16 to remove, the slide must move 1/32 or .03125.

The best way to do this is to take a light cut and then measure your work without backing off the cutting tool. Now revolve the micrometer collar ONLY, until the zero on the collar coincides with the witness mark on the slide. Let us suppose that at this point your work now measures so that you still have .021 to remove. Lock the collar by tightening the screw through it.

Brown & Sharpe Micrometers are considered the standard of accuracy.

The screw and collar will now move together. Turn the crank until the collar shows a movement of .008.

After taking this cut you should still have .005 to remove. Now move the crank and collar through .002, favoring it so that you just pass the witness mark.

After taking the last cut your work should be so close to size that a rub with emery cloth or a smooth file should give you the EXACT size.

Always measure the work after each cut when you are close to size.

MILLING ON THE LATHE

The back geared screw cutting Lathe has the various speeds and power necessary to do certain classes of milling very effectively.

The milling attachment which clamps to the cross slide in place of the compound is the easiest means of holding work for the milling of keyways . . . dove tails . . . slotting . . . squaring shaft ends, etc. The Lathe is particularly adaptable to this class of work.

The usual attachment will swivel to any angle and the gibbed slide is fitted with a screw and micrometer collar permitting proper adjustment of the work.

The work is held in a vise which may be removed if necessary, so that the machined face of the attachment can also be used to hold odd shaped pieces.

A type of cutter known as an end mill is generally employed. These cutters may be obtained with a straight shank to be held in a collet or with a taper shank fitting directly into the spindle nose.

Another very useful type of cutter is the Woodruff, which also has a straight shank and may be held very securely by means of a special chuck listed elsewhere in this catalog.

Many shops do not have a milling machine and there may be occasion to do some work for which the regular milling attachment is not adapted.

It will be noted that end mills, as their name indicates, will cut on the end of the tool as well as the periphery, whereas ordinary milling cutters or the Woodruff type cut only on the periphery. With this last type of cutter the capacity of the machine is definitely limited by the space between the saddle and the spindle less one-half of the cutter diameter.

If this space is large enough for your work it is possible to clamp work directly to the saddle. The Woodruff cutter, of course, can only be used close to the spindle nose. It is for that reason that we list various types of arbors which hold standard inexpensive milling cutters.

By the use of spacing collars and by the movement of the saddle you can locate the work exactly where you want it.

By the use of end mills work of much larger diameter may be handled.

FACE PLATE WORK

The same general instructions for locating work centers in a four jaw chuck are applicable to face plate work in general.

Any convenient means may be employed to hold the work on the face plate.

An angle block can be bolted to the plate, which in turn holds the work.

Clamps may be used, or as is sometimes possible when it is necessary to use the full capacity of the machine, the work may be screwed directly to the face plate.

For very accurate work it is always good to take a light cut from the front of the face plate — particularly a new one — to make sure that the face of the plate is square to the spindle.

WOOD TURNING

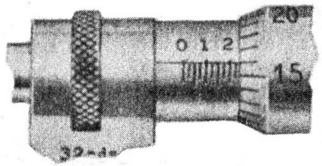
Any variety of wood turning may be done on an engine lathe.

The only difference between the ordinary wood lathe and the screw cutting lathe is that the latter contains many refinements and features which are not entirely necessary for wood turning.

Wood can be turned with an ordinary hand rest but no one can deny that much less skill is required and much better work can be obtained by the use of a mechanically operated saddle. Many of the more modern pattern and wood working shops are now using this type of lathe.

If necessary, higher speeds can be obtained by using a smaller drive pulley on the countershaft.

How to Read Micrometers Graduated to Thousandths of an Inch

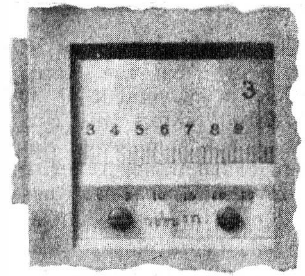


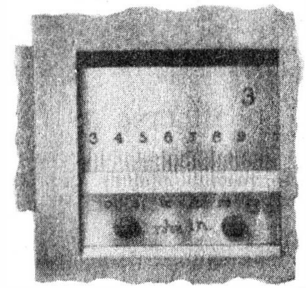
THE customary pitch of the screw is 1-40″ (40 threads to the inch). Thus, the distance traversed by the screw or spindle during one complete revolution is 1-40″ or .025″. As the graduations on the barrel conform to the pitch of the screw (40 to the inch), each division equals .025″ and every four divisions represent 0, .100″, .200″, etc. (10ths of an inch); each tenth of an inch is numbered 0, 1, 2, etc. The beveled edge of the thimble is graduated into 25 parts and figured every fifth division 0, 5, 10, 15 and 20. When 25 of these graduations have passed the horizontal line on the barrel, the spindle, having made one revolution, has moved .025″. Thus, when the spindle moves only far enough to cause one graduation to pass the horizontal line on the barrel, it will have moved 1-25 of .025″, or .001″. The distance between the graduations on the thimble is great enough to permit half and quarter thousandths of an inch to be readily estimated.

To read—First note the last figure visible on the scale on the barrel, representing the tenths of an inch. Multiply the number of divisions visible beyond this figure by 25 and add the number of the division on the scale on the thimble that coincides with the line of graduations on the barrel. Then this sum expressed in thousandths, added to the tenths shown, is the reading.

Example:—In the cut, shown above, .200″ (2-10″) is shown by the figures on the scale on the barrel and one graduation beyond a tenth graduation is also visible while on the bevel on the thimble the graduations show 16 divisions from the zero to the line coincident with the horizontal line on barrel. Then the reading = .200″ + .025″ + .016″ = .241″.

Reading the Vernier—English Measure





Cuts show the Vernier used with a scale which is graduated into 40ths or .025ths of an inch. The Vernier has 25 divisions which are numbered every 5th division and which equal, in extreme length, 24 divisions on the scale, or 24 × 1/40″ = 24 × .025″ = .600″. Thus, one division on the Vernier equals 1/25 of .600″ = .024″. Therefore, the difference between a division on the Vernier and a division on the scale = .025″ — .024″ = .001″.

When the reading is exact, with respect to the number of fortieths of an inch, the zero on the Vernier coincides with a graduation on the scale—either inch, tenth or fortieth, as the case may be. This leaves a space between lines on the scale and the 1, 2, 3, 4, 5, 6, etc. lines on the Vernier of .001″, .002″, .003″, .004″, .005″, .006″, etc., respectively, the difference increasing .001″ at each Vernier division in numerical order until, at the 25th graduation, the lines again coincide (see upper cut).

Thus, when the 1st, 2nd or 3rd, etc. line on the Vernier coincides with a line on the scale, the zero on the Vernier has moved 1, 2, or 3, etc. thousandths of an inch past the previous fortieth graduation to bring these lines together.

To read—Note the inches, tenths and fortieths of an inch that the zero on the Vernier has moved from the zero on the scale and to this reading add the number of thousandths indicated by the line on the Vernier that coincides with a line on the scale.

Example:—The upper cut shows the zero graduation on the Vernier coinciding with a fortieth graduation on the scale (the second fortieth beyond an even tenth graduation). This indicates that the reading is exact with respect to the fortieths of an inch. The reading therefore equals 2.000″ + .300″ + .050″ = 2.350″. The lower cut, however, shows the 18th Vernier graduation coinciding with a line on the scale. This indicates that .018″ should be added to the scale reading. The reading, then, equals 2.000″ + .300″ + .050″ + .018″ = 2.368″.

Verniers with 25 divisions are used, for English Measure, on all Brown & Sharpe Verniers with the exceptions of Thread Tool Verniers No. 576 and Gear Tooth Verniers No. 580, 20 to 2 diam. pitch, on which Verniers with 20 divisions are used.

Courtesy Brown & Sharpe Mfg. Co.

American National Coarse and Fine Thread Dimensions and Tap Drill Sizes

(*Continued*)

Nominal Size	Outside Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Tap Drill	Decimal Equivalent of Tap Drill
1⅜- 6	1.3750	1.2667	1.1585	1 7-32	1.2187
12	1.3750	1.3209	1.2668	1 19-64	1.2969
1½- 6	1.5000	1.3917	1.2835	1 11-32	1.3437
12	1.5000	1.4459	1.3918	1 27-64	1.4219
1¾- 5	1.7500	1.6201	1.4902	1 9-16	1.5625
2 - 4½	2.0000	1.8557	1.7113	1 25-32	1.7812
2¼- 4½	2.2500	2.1057	1.9613	2 1-32	2.0312
2½- 4	2.5000	2.3376	2.1752	2 1-4	2.2500
2¾- 4	2.7500	2.5876	2.4252	2 1-2	2.5000
3- 4	3.0000	2.8376	2.6752	2 3-4	2.7500
3¼- 4	3.2500	3.0876	2.9252	3	3.0000
3½- 4	3.5000	3.3376	3.1752	3 1-4	3.2500
3¾- 4	3.7500	3.5876	3.4252	3 1-2	3.5000
4- 4	4.0000	3.8376	3.6752	3 3-4	3.7500

American National Pipe Thread Tap Drill Sizes

Sizes of Pipe, Inches	Number of Threads to Inch	Root Diameter Small End of Pipe and Gage, Inches	Tap Drill	
			Size	Decimal Equivalent
1-8	27	.3339	R	.339
1-4	18	.4329	7-16	.437
3-8	18	.5676	37-64	.578
1-2	14	.7013	23-32	.719
3-4	14	.9105	59-64	.921
1	11 1-2	1.1441	1 5-32	1.156
1 1-4	11 1-2	1.4876	1 1-2	1.500
1 1-2	11 1-2	1.7265	1 47-64	1.734
2	11 1-2	2.1995	2 7-32	2.218
2 1-2	8	2.6195	2 5-8	2.625
3	8	3.2406	3 1-4	3.250
3 1-2	8	3.7375	3 3-4	3.750
4	8	4.2344	4 1-4	4.250

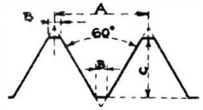
V Threads

Minor Diameter for V Thread = outside diameter of Screw $- \dfrac{1.732}{\text{Threads per inch}}$

Example—Minor Diameter for ¾″ V Thread, 10 threads per inch = $.750'' - \dfrac{1.732''}{10} = .750'' - .1732'' = .5768''$, Minor Diameter.

Courtesy Brown & Sharpe Mfg. Co.

American National Coarse and Fine Thread Dimensions and Tap Drill Sizes



$A = \text{pitch} = \dfrac{1}{\text{No. of Threads per Inch}}$

n = Number of threads per inch

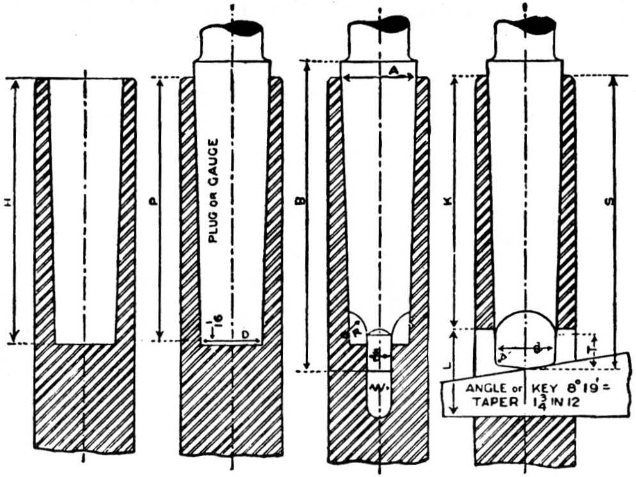
$C = \text{depth} = \text{pitch} \times .649519 \text{ or } \dfrac{.649519}{n}$

$B = \text{flat} = \dfrac{\text{Pitch}}{8}$

Nominal Size	Outside Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Tap Drill	Decimal Equivalent of Tap Drill
*0-80	.0600	.0519	.0438	3-64	.0469
*1-64	.0730	.0629	.0527	53	.0595
72	.0730	.0640	.0550	53	.0595
*2-56	.0860	.0744	.0628	50	.0700
64	.0860	.0759	.0657	50	.0700
*3-48	.0990	.0855	.0719	47	.0785
56	.0990	.0874	.0758	45	.0820
*4-40	.1120	.0958	.0795	43	.0890
48	.1120	.0985	.0849	42	.0935
*5-40	.1250	.1088	.0925	38	.1015
44	.1250	.1102	.0955	37	.1040
*6-32	.1380	.1177	.0974	36	.1065
40	.1380	.1218	.1055	33	.1130
*8-32	.1640	.1437	.1234	29	.1360
36	.1640	.1460	.1279	29	.1360
*10-24	.1900	.1629	.1359	25	.1495
32	.1900	.1697	.1494	21	.1590
*12-24	.2160	.1889	.1619	16	.1770
28	.2160	.1928	.1696	14	.1820
¼-20	.2500	.2175	.1850	7	.2010
28	.2500	.2268	.2036	3	.2130
5/16-18	.3125	.2764	.2403	F	.2570
24	.3125	.2854	.2584	I	.2720
⅜-16	.3750	.3344	.2938	5-16	.3125
24	.3750	.3479	.3209	Q	.3320
7/16-14	.4375	.3911	.3447	U	.3680
20	.4375	.4050	.3726	25-64	.3906
½-13	.5000	.4501	.4001	27-64	.4219
20	.5000	.4675	.4351	29-64	.4531
9/16-12	.5625	.5084	.4542	31-64	.4844
18	.5625	.5264	.4903	33-64	.5156
⅝-11	.6250	.5660	.5069	17-32	.5312
18	.6250	.5889	.5528	37-64	.5781
¾-10	.7500	.6850	.6201	21-32	.6562
16	.7500	.7094	.6688	11-16	.6875
⅞- 9	.8750	.8029	.7307	49-64	.7656
14	.8750	.8286	.7822	13-16	.8125
1- 8	1.0000	.9188	.8376	7-8	.8750
14	1.0000	.9536	.9072	15-16	.9375
1⅛- 7	1.1250	1.0322	.9394	63-64	.9844
12	1.1250	1.0709	1.0168	1 3-64	1.0469
1¼- 7	1.2500	1.1572	1.0644	1 7-64	1.1094
12	1.2500	1.1959	1.1418	1 11-64	1.1719

*American National Standard Wood Screws are made in same numbers and corresponding body diameters as starred sizes.

Morse Tapers



Number of Taper	Diam. of Plug at Small End, Inches	Diam. at End of Socket, Inches	SHANK: Whole Length of Shank, Inches	SHANK: Shank Depth, Inches	Depth of Hole, Inches	Standard Plug Depth, Inches	TONGUE: Thickness of Tongue, Inches	TONGUE: Length of Tongue, Inches	TONGUE: Rad. of Mill for Tongue, Inches	TONGUE: Diameter of Tongue, Inches	TONGUE: Radius of Tongue, Inches	KEYWAY: Width of Keyway, Inches	KEYWAY: Length of Keyway, Inches	KEYWAY: End of Socket to Keyway, Inches	Taper per Foot	Taper per Inch	Number of Key
	D	A	B	S	H	P	t	T	R	d	a	W	L	K			
0	.252	.3561	2 11/32	2 7/32	2 1/32	2	5/32	1/4	5/32	.235	.04	.160	9/16	1 15/16	.62460	.05205	0
1	.369	.475	2 9/16	2 7/16	2 3/16	2 1/8	13/64	3/8	3/16	.343	.05	.213	3/4	2 1/16	.59858	.04988	1
2	.572	.700	3 1/8	2 15/16	2 5/8	2 9/16	1/4	7/16	1/4	17/32	.06	.260	7/8	2 1/2	.59941	.04995	2
3	.778	.938	3 7/8	3 11/16	3 1/4	3 3/16	5/16	9/16	9/32	23/32	.08	.322	1 3/16	3 1/16	.60235	.05019	3
4	1.020	1.231	4 7/8	4 5/8	4 1/8	4 1/16	15/32	5/8	5/16	31/32	.10	.478	1 1/4	3 7/8	.62326	.05193	4
5	1.475	1.748	6 1/8	5 7/8	5 1/4	5 3/16	5/8	3/4	3/8	1 13/32	.12	.635	1 1/2	4 15/16	.63151	.05262	5
6	2.116	2.494	8 9/16	8 1/4	7 3/8	7 1/4	3/4	1 1/8	1/2	2	.15	.760	1 3/4	7	.62565	.05213	6
7	2.750	3.270	11 5/8	11 1/4	10 1/8	10	1 1/8	1 3/8	3/4	2 5/8	.18	1.135	2 5/8	9 1/2	.62400	.05200	7

Useful Information

To find the circumference of a circle, multiply the diameter by 3.1416.

To find the diameter of a circle, multiply the circumference by .31831.

To find the area of a circle, multiply the square of the diameter by .7854.

To find the surface of a ball (sphere), multiply the square of the diameter by 3.1416.

To find the side of a square equal in area to a given circle, multiply the diameter by .8862.

Doubling the diameter of a pipe increases its capacity four times.

The radius of a circle × 6.283185 = the circumference.

The square of the circumference of a circle × .07958 = the area.

Half the circumference of a circle × half its diameter = the area.

The circumference of a circle × .159155 = the radius.

The square root of the area of a circle × .56419 = the radius.

The square root of the area of a circle × 1.12838 = the diameter.

A gallon of water (U. S. standard) weighs 8½ pounds and contains 231 cubic inches. A cubic foot of water contains 7½ gallons, 1728 cubic inches, and weighs 62½ pounds at a temperature of about 39 degrees Fahrenheit.

These weights change slightly above and below this temperature.

Metric and English Conversion Tables

Measures of Length

1 meter = 39.37 inches; 3.28083 feet; 1.0936 yds.

1 centimeter = .3937 inch

1 millimeter = .03937 inch, or 1-25 inch nearly

1 kilometer = 0.62137 mile

1 foot = .3048 meter

1 inch = 2.54 centimeters; 25.4 millimeters

PREPARED AND PHOTO-LITHOGRAPHED BY THE MAJESTIC PRESS, INC., PHILA.

Courtesy Brown & Sharpe Mfg. Co.

NATURAL SINES

Degrees	0′	10′	20′	30′	40′	50′	60′	Co-sines
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01454	0.01745	89
1	0.01745	0.02036	0.02327	0.02618	0.02908	0.03199	0.03490	88
2	0.03490	0.03781	0.04071	0.04362	0.04653	0.04943	0.05234	87
3	0.05234	0.05524	0.05814	0.06105	0.06395	0.06685	0.06976	86
4	0.06976	0.07266	0.07556	0.07846	0.08136	0.08426	0.08716	85
5	0.08716	0.09005	0.09295	0.09585	0.09874	0.10164	0.10453	84
6	0.10453	0.10742	0.11031	0.11320	0.11609	0.11898	0.12187	83
7	0.12187	0.12476	0.12764	0.13053	0.13341	0.13629	0.13917	82
8	0.13917	0.14205	0.14493	0.14781	0.15069	0.15356	0.15643	81
9	0.15643	0.15931	0.16218	0.16505	0.16792	0.17078	0.17365	80
10	0.17365	0.17651	0.17937	0.18224	0.18509	0.18795	0.19081	79
11	0.19081	0.19366	0.19652	0.19937	0.20222	0.20507	0.20791	78
12	0.20791	0.21076	0.21360	0.21644	0.21928	0.22212	0.22495	77
13	0.22495	0.22778	0.23062	0.23345	0.23627	0.23910	0.24192	76
14	0.24192	0.24474	0.24756	0.25038	0.25320	0.25601	0.25882	75
15	0.25882	0.26163	0.26443	0.26724	0.27004	0.27284	0.27564	74
16	0.27564	0.27843	0.28123	0.28402	0.28680	0.28959	0.29237	73
17	0.29237	0.29515	0.29793	0.30071	0.30348	0.30625	0.30902	72
18	0.30902	0.31178	0.31454	0.31730	0.32006	0.32282	0.32557	71
19	0.32557	0.32832	0.33106	0.33381	0.33655	0.33929	0.34202	70
20	0.34202	0.34475	0.34748	0.35021	0.35293	0.35565	0.35837	69
21	0.35837	0.36108	0.36379	0.36650	0.36921	0.37191	0.37461	68
22	0.37461	0.37730	0.37999	0.38268	0.38537	0.38805	0.39073	67
23	0.39073	0.39341	0.39608	0.39875	0.40142	0.40408	0.40674	66
24	0.40674	0.40939	0.41204	0.41469	0.41734	0.41998	0.42262	65
25	0.42262	0.42525	0.42788	0.43051	0.43313	0.43575	0.43837	64
26	0.43837	0.44098	0.44359	0.44620	0.44880	0.45140	0.45399	63
27	0.45399	0.45658	0.45917	0.46175	0.46433	0.46690	0.46947	62
28	0.46947	0.47204	0.47460	0.47716	0.47971	0.48226	0.48481	61
29	0.48481	0.48735	0.48989	0.49242	0.49495	0.49748	0.50000	60
30	0.50000	0.50252	0.50503	0.50754	0.51004	0.51254	0.51504	59
31	0.51504	0.51753	0.52002	0.52250	0.52498	0.52745	0.52992	58
32	0.52992	0.53238	0.53484	0.53730	0.53975	0.54220	0.54464	57
33	0.54464	0.54708	0.54951	0.55194	0.55436	0.55678	0.55919	56
34	0.55919	0.56160	0.56401	0.56641	0.56880	0.57119	0.57358	55
35	0.57358	0.57596	0.57833	0.58070	0.58307	0.58543	0.58779	54
36	0.58779	0.59014	0.59248	0.59482	0.59716	0.59949	0.60182	53
37	0.60182	0.60414	0.60645	0.60876	0.61107	0.61337	0.61566	52
38	0.61566	0.61795	0.62024	0.62251	0.62479	0.62706	0.62932	51
39	0.62932	0.63158	0.63383	0.63608	0.63832	0.64056	0.64279	50
40	0.64279	0.64501	0.64723	0.64945	0.65166	0.65386	0.65606	49
41	0.65606	0.65825	0.66044	0.66262	0.66480	0.66697	0.66913	48
42	0.66913	0.67129	0.67344	0.67559	0.67773	0.67987	0.68200	47
43	0.68200	0.68412	0.68624	0.68835	0.69046	0.69256	0.69466	46
44	0.69466	0.69675	0.69883	0.70091	0.70298	0.70505	0.70711	45
Sines	60′	50′	40′	30′	20′	10′	0′	Degrees

NATURAL COSINES

NATURAL COSINES

Degrees	0′	10′	20′	30′	40′	50′	60′	Sines
0	1.00000	1.00000	0.99998	0.99996	0.99993	0.99989	0.99985	89
1	0.99985	0.99979	0.99973	0.99966	0.99958	0.99949	0.99939	88
2	0.99939	0.99929	0.99917	0.99905	0.99892	0.99878	0.99863	87
3	0.99863	0.99847	0.99831	0.99813	0.99795	0.99776	0.99756	86
4	0.99756	0.99736	0.99714	0.99692	0.99668	0.99644	0.99619	85
5	0.99619	0.99594	0.99567	0.99540	0.99511	0.99482	0.99452	84
6	0.99452	0.99421	0.99390	0.99357	0.99324	0.99290	0.99255	83
7	0.99255	0.99219	0.99182	0.99144	0.99106	0.99067	0.99027	82
8	0.99027	0.98986	0.98944	0.98902	0.98858	0.98814	0.98769	81
9	0.98769	0.98723	0.98676	0.98629	0.98580	0.98531	0.98481	80
10	0.98481	0.98430	0.98378	0.98325	0.98272	0.98218	0.98163	79
11	0.98163	0.98107	0.98050	0.97992	0.97934	0.97875	0.97815	78
12	0.97815	0.97754	0.97692	0.97630	0.97566	0.97502	0.97437	77
13	0.97437	0.97371	0.97304	0.97237	0.97169	0.97100	0.97030	76
14	0.97030	0.96959	0.96887	0.96815	0.96742	0.96667	0.96593	75
15	0.96593	0.96517	0.96440	0.96363	0.96285	0.96206	0.96126	74
16	0.96126	0.96046	0.95964	0.95882	0.95799	0.95715	0.95630	73
17	0.95630	0.95545	0.95459	0.95372	0.95284	0.95195	0.95106	72
18	0.95106	0.95015	0.94924	0.94832	0.94740	0.94646	0.94552	71
19	0.94552	0.94457	0.94361	0.94264	0.94167	0.94068	0.93969	70
20	0.93969	0.93869	0.93769	0.93667	0.93565	0.93462	0.93358	69
21	0.93358	0.93253	0.93148	0.93042	0.92935	0.92827	0.92718	68
22	0.92718	0.92609	0.92499	0.92388	0.92276	0.92164	0.92050	67
23	0.92050	0.91936	0.91822	0.91706	0.91590	0.91472	0.91355	66
24	0.91355	0.91236	0.91116	0.90996	0.90875	0.90753	0.90631	65
25	0.90631	0.90507	0.90383	0.90259	0.90133	0.90007	0.89879	64
26	0.89879	0.89752	0.89623	0.89493	0.89363	0.89232	0.89101	63
27	0.89101	0.88968	0.88835	0.88701	0.88566	0.88431	0.88295	62
28	0.88295	0.88158	0.88020	0.87882	0.87743	0.87603	0.87462	61
29	0.87462	0.87321	0.87178	0.87036	0.86892	0.86748	0.86603	60
30	0.86603	0.86457	0.86310	0.86163	0.86015	0.85866	0.85717	59
31	0.85717	0.85567	0.85416	0.85264	0.85112	0.84959	0.84805	58
32	0.84805	0.84650	0.84495	0.84339	0.84182	0.84025	0.83867	57
33	0.83867	0.83708	0.83549	0.83389	0.83228	0.83066	0.82904	56
34	0.82904	0.82741	0.82577	0.82413	0.82248	0.82082	0.81915	55
35	0.81915	0.81748	0.81580	0.81412	0.81242	0.81072	0.80902	54
36	0.80902	0.80730	0.80558	0.80386	0.80212	0.80038	0.79864	53
37	0.79864	0.79688	0.79512	0.79335	0.79158	0.78980	0.78801	52
38	0.78801	0.78622	0.78442	0.78261	0.78079	0.77897	0.77715	51
39	0.77715	0.77531	0.77347	0.77162	0.76977	0.76791	0.76604	50
40	0.76604	0.76417	0.76229	0.76041	0.75851	0.75661	0.75471	49
41	0.75471	0.75280	0.75088	0.74896	0.74703	0.74509	0.74314	48
42	0.74314	0.74120	0.73924	0.73728	0.73531	0.73333	0.73135	47
43	0.73135	0.72937	0.72737	0.72537	0.72337	0.72136	0.71934	46
44	0.71934	0.71732	0.71529	0.71325	0.71121	0.70916	0.70711	45
Co-sines	60′	50′	40′	30′	20′	10′	0′	Degrees

NATURAL SINES

NATURAL TANGENTS

Degrees	0′	10′	20′	30′	40′	50′	60′	Cotan-gents
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01455	0.01746	89
1	0.01746	0.02036	0.02328	0.02619	0.02910	0.03201	0.03492	88
2	0.03492	0.03783	0.04075	0.04366	0.04658	0.04949	0.05241	87
3	0.05241	0.05533	0.05824	0.06116	0.06408	0.06700	0.06993	86
4	0.06993	0.07285	0.07578	0.07870	0.08163	0.08456	0.08749	85
5	0.08749	0.09042	0.09335	0.09629	0.09923	0.10216	0.10510	84
6	0.10510	0.10805	0.11099	0.11394	0.11688	0.11983	0.12278	83
7	0.12278	0.12574	0.12869	0.13165	0.13461	0.13758	0.14054	82
8	0.14054	0.14351	0.14648	0.14945	0.15243	0.15540	0.15838	81
9	0.15838	0.16137	0.16435	0.16734	0.17033	0.17333	0.17633	80
10	0.17633	0.17933	0.18233	0.18534	0.18835	0.19136	0.19438	79
11	0.19438	0.19740	0.20042	0.20345	0.20648	0.20952	0.21256	78
12	0.21256	0.21560	0.21864	0.22169	0.22475	0.22781	0.23087	77
13	0.23087	0.23393	0.23700	0.24008	0.24316	0.24624	0.24933	76
14	0.24933	0.25242	0.25552	0.25862	0.26172	0.26483	0.26795	75
15	0.26795	0.27107	0.27419	0.27732	0.28046	0.28360	0.28675	74
16	0.28675	0.28990	0.29305	0.29621	0.29938	0.30255	0.30573	73
17	0.30573	0.30891	0.31210	0.31530	0.31850	0.32171	0.32492	72
18	0.32492	0.32814	0.33136	0.33460	0.33783	0.34108	0.34433	71
19	0.34433	0.34758	0.35085	0.35412	0.35740	0.36068	0.36397	70
20	0.36397	0.36727	0.37057	0.37388	0.37720	0.38053	0.38386	69
21	0.38386	0.38721	0.39055	0.39391	0.39727	0.40065	0.40403	68
22	0.40403	0.40741	0.41081	0.41421	0.41763	0.42105	0.42447	67
23	0.42447	0.42791	0.43136	0.43481	0.43828	0.44175	0.44523	66
24	0.44523	0.44872	0.45222	0.45573	0.45924	0.46277	0.46631	65
25	0.46631	0.46985	0.47341	0.47698	0.48055	0.48414	0.48773	64
26	0.48773	0.49134	0.49495	0.49858	0.50222	0.50587	0.50953	63
27	0.50953	0.51320	0.51688	0.52057	0.52427	0.52798	0.53171	62
28	0.53171	0.53545	0.53920	0.54296	0.54673	0.55051	0.55431	61
29	0.55431	0.55812	0.56194	0.56577	0.56962	0.57348	0.57735	60
30	0.57735	0.58124	0.58513	0.58905	0.59297	0.59691	0.60086	59
31	0.60086	0.60483	0.60881	0.61280	0.61681	0.62083	0.62487	58
32	0.62487	0.62892	0.63299	0.63707	0.64117	0.64528	0.64941	57
33	0.64941	0.65355	0.65771	0.66189	0.66608	0.67028	0.67451	56
34	0.67451	0.67875	0.68301	0.68728	0.69157	0.69588	0.70021	55
35	0.70021	0.70455	0.70891	0.71329	0.71769	0.72211	0.72654	54
36	0.72654	0.73100	0.73547	0.73996	0.74447	0.74900	0.75355	53
37	0.75355	0.75812	0.76272	0.76733	0.77196	0.77661	0.78129	52
38	0.78129	0.78598	0.79070	0.79544	0.80020	0.80498	0.80978	51
39	0.80978	0.81461	0.81946	0.82434	0.82923	0.83415	0.83910	50
40	0.83910	0.84407	0.84906	0.85408	0.85912	0.86419	0.86929	49
41	0.86929	0.87441	0.87955	0.88473	0.88992	0.89515	0.90040	48
42	0.90040	0.90569	0.91099	0.91633	0.92170	0.92709	0.93252	47
43	0.93252	0.93797	0.94345	0.94896	0.95451	0.96008	0.96569	46
44	0.96569	0.97133	0.97700	0.98270	0.98843	0.99420	1.00000	45
Tan-gents	60′	50′	40′	30′	20′	10′	0′	Degrees

NATURAL COTANGENTS

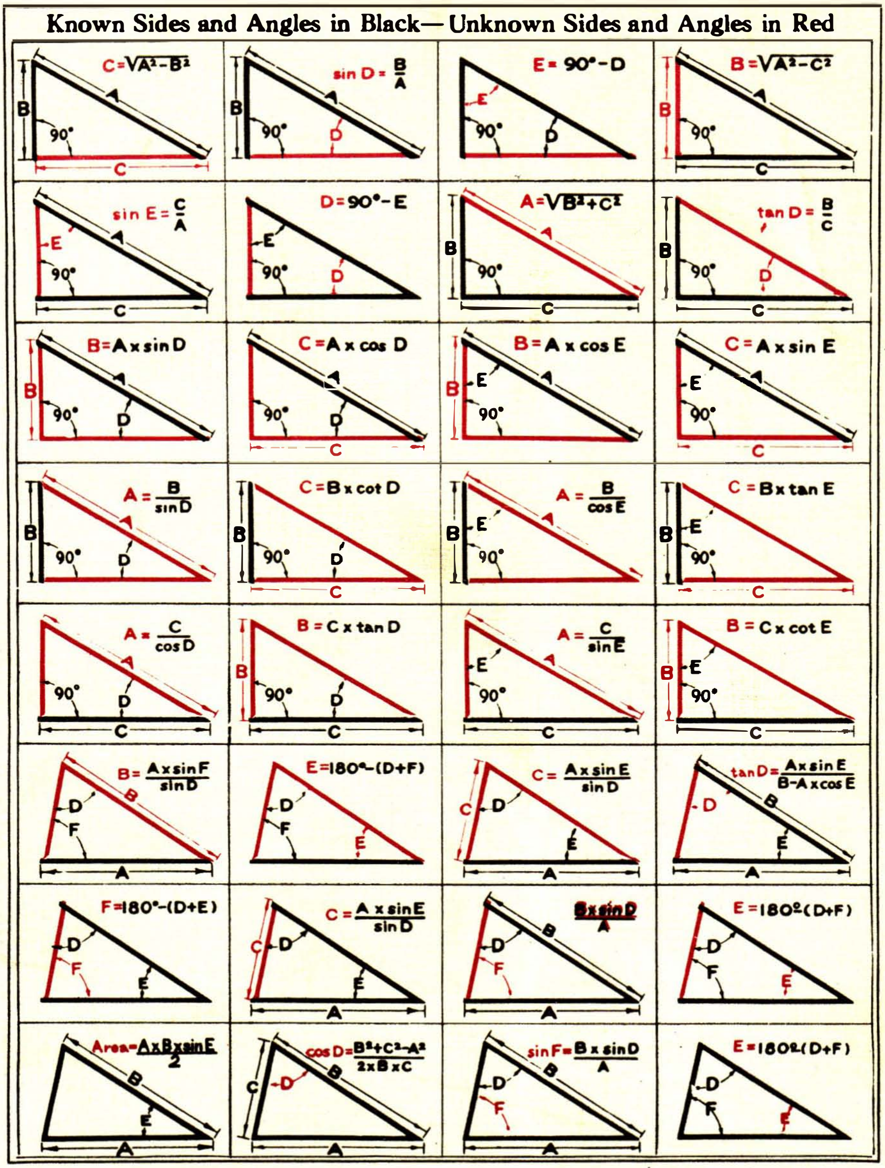
NATURAL COTANGENTS

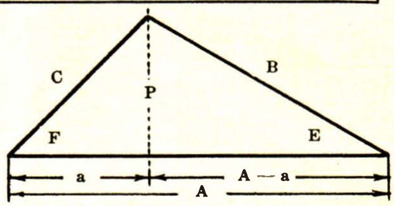
Degrees	0′	10′	20′	30′	40′	50′	60′	Tan-gents
0	∞	343.77371	171.88540	114.58865	85.93979	68.75009	57.28996	89
1	57.28996	49.10388	42.96408	38.18846	34.36777	31.24158	28.63625	88
2	28.63625	26.43160	24.54176	22.90377	21.47040	20.20555	19.08114	87
3	19.08114	18.07498	17.16934	16.34986	15.60478	14.92442	14.30067	86
4	14.30067	13.72674	13.19688	12.70621	12.25051	11.82617	11.43005	85
5	11.43005	11.05943	10.71191	10.38540	10.07803	9.78817	9.51436	84
6	9.51436	9.25530	9.00983	8.77689	8.55555	8.34496	8.14435	83
7	8.14435	7.95302	7.77035	7.59575	7.42871	7.26873	7.11537	82
8	7.11537	6.96823	6.82694	6.69116	6.56055	6.43484	6.31375	81
9	6.31375	6.19703	6.08444	5.97576	5.87080	5.76937	5.67128	80
10	5.67128	5.57638	5.48451	5.39552	5.30928	5.22566	5.14455	79
11	5.14455	5.06584	4.98940	4.91516	4.84300	4.77286	4.70463	78
12	4.70463	4.63825	4.57363	4.51071	4.44942	4.38969	4.33148	77
13	4.33148	4.27471	4.21933	4.16530	4.11256	4.06107	4.01078	76
14	4.01078	3.96165	3.91364	3.86671	3.82083	3.77595	3.73205	75
15	3.73205	3.68909	3.64705	3.60588	3.56557	3.52609	3.48741	74
16	3.48741	3.44951	3.41236	3.37594	3.34023	3.30521	3.27085	73
17	3.27085	3.23714	3.20406	3.17159	3.13972	3.10842	3.07768	72
18	3.07768	3.04749	3.01783	2.98869	2.96004	2.93189	2.90421	71
19	2.90421	2.87700	2.85023	2.82391	2.79802	2.77254	2.74748	70
20	2.74748	2.72281	2.69853	2.67462	2.65109	2.62791	2.60509	69
21	2.60509	2.58261	2.56046	2.53865	2.51715	2.49597	2.47509	68
22	2.47509	2.45451	2.43422	2.41421	2.39449	2.37504	2.35585	67
23	2.35585	2.33693	2.31826	2.29984	2.28167	2.26374	2.24604	66
24	2.24604	2.22857	2.21132	2.19430	2.17749	2.16090	2.14451	65
25	2.14451	2.12832	2.11233	2.09654	2.08094	2.06553	2.05030	64
26	2.05030	2.03526	2.02039	2.00569	1.99116	1.97680	1.96261	63
27	1.96261	1.94858	1.93470	1.92098	1.90741	1.89400	1.88073	62
28	1.88073	1.86760	1.85462	1.84177	1.82906	1.81649	1.80405	61
29	1.80405	1.79174	1.77955	1.76749	1.75556	1.74375	1.73205	60
30	1.73205	1.72047	1.70901	1.69766	1.68643	1.67530	1.66428	59
31	1.66428	1.65337	1.64256	1.63185	1.62125	1.61074	1.60033	58
32	1.60033	1.59002	1.57981	1.56969	1.55966	1.54972	1.53987	57
33	1.53987	1.53010	1.52043	1.51084	1.50133	1.49190	1.48256	56
34	1.48256	1.47330	1.46411	1.45501	1.44598	1.43703	1.42815	55
35	1.42815	1.41934	1.41061	1.40195	1.39336	1.38484	1.37638	54
36	1.37638	1.36800	1.35968	1.35142	1.34323	1.33511	1.32704	53
37	1.32704	1.31904	1.31110	1.30323	1.29541	1.28764	1.27994	52
38	1.27994	1.27230	1.26471	1.25717	1.24969	1.24227	1.23490	51
39	1.23490	1.22758	1.22031	1.21310	1.20593	1.19882	1.19175	50
40	1.19175	1.18474	1.17777	1.17085	1.16398	1.15715	1.15037	49
41	1.15037	1.14363	1.13694	1.13029	1.12369	1.11713	1.11061	48
42	1.11061	1.10414	1.09770	1.09131	1.08496	1.07864	1.07237	47
43	1.07237	1.06613	1.05994	1.05378	1.04766	1.04158	1.03553	46
44	1.03553	1.02952	1.02355	1.01761	1.01170	1.00583	1.00000	45
Cotan-gents	60′	50′	40′	30′	20′	10′	0′	Degrees

NATURAL TANGENTS

MACHINERY'S TRIANGLE CHART

For the Rapid Solution of Right Angle and Oblique Angle Triangles





$\sin E = \frac{P}{B} \quad \therefore \quad P = B \sin E$

$\sin F = \frac{P}{C} \quad \therefore \quad P = C \sin F$

$\cos E = \frac{A - a}{B} \quad \therefore \quad A - a = B \cos E$

$\cos F = \frac{a}{C} \quad \therefore \quad a = C \cos F$

$\frac{\text{side opposite angle}}{\text{hypothenuse}} = \text{sine}$

$\frac{\text{side adjacent angle}}{\text{hypothenuse}} = \text{cosine}$

$\frac{\text{side opposite angle}}{\text{side adjacent angle}} = \text{tangent}$

$\frac{\text{sine}}{\text{cosine}} = \text{tangent}$