SINGLE-SPINDLE

GRIDLEY AUTOMATIC TURRET LATHES

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GRIDLEY AUTOMATIC TURRET LATHE[1]

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

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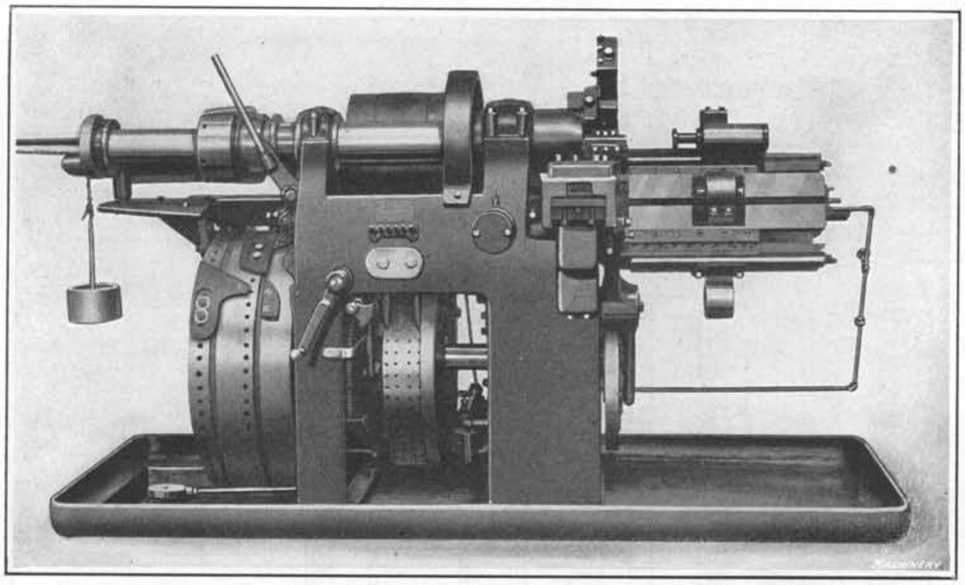


Fig. 1. Front View of Gridley Single-spindle Automatic Turret Lathe

GRIDLEY automatics are built in three types, namely a single-spindle automatic turret lathe, a four-spindle automatic screw machine and a semi-automatic piston and piston ring machine. The original Gridley automatic, which was designed by George O. Gridley, in 1904, was of the single-spindle type, having a maximum capacity for bars up to 2⅛ inches in diameter. This machine met with such success that a multiple-spindle machine was designed and put on the market in 1908. Although the design of these two machines is essentially the same as when first put on the market, numerous improvements have been made from time to time, to make them more productive. The piston and piston ring machine is patterned after the single-spindle automatic turret lathe, and differs from it chiefly in the design of the tool-slide, which travels back and forth and does not index. It is not fully automatic in that it is necessary for the operator to insert and remove the work by hand. In the following article, attention will be directed chiefly to the design, construction, operation, tool equipment, etc., of the single-spindle automatic turret lathe.

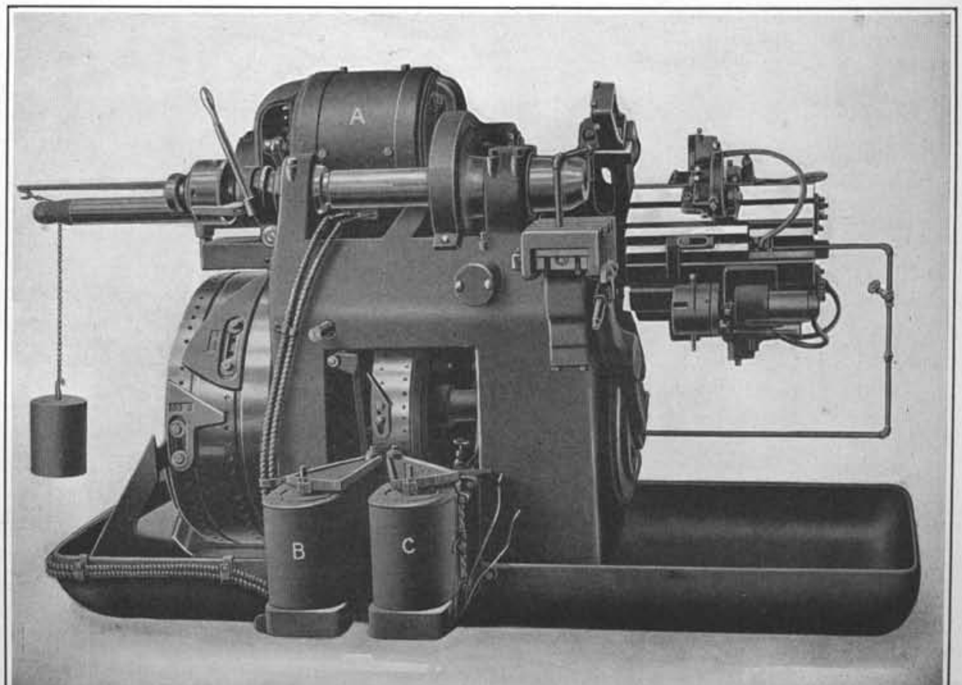
Principles of Design

The chief point of interest in the design of the Gridley automatic turret lathe is the turret or tool-slide around which the machine is built. The turret is of practically square cross-section, the four surfaces being in a plane parallel to the axis of the spindle; on each face is a tool-slide for carrying the holders for the various cutting tools. This design makes it possible to support the tools close to the cutting point and completely obviates spring and consequent inaccuracy. This design of turret also permits one tool to be placed behind another, thus greatly increasing the range of the machine and particularly adapting it for handling work requiring the use of more end-working tools than there are tool-slides.

On the belt-driven type of machine, the spindle is driven by a belt through back-gears from the pulley shaft at the rear of the machine which carries three pulleys—one driver (the center wide-faced pulley), and two loose pulleys. In the majority of cases, both belts are arranged to drive the spindle in a forward direction, but one can be reversed to give a backward speed for threading, when desired. The turret carries four slides which are moved back and forth by means of cams on the large camshaft drum at the left-hand end of the machine; this movement is secured through a draw-bar, as will be described later. The cross-slides are operated by cams on the disk at the right-hand end of the machine, the rear or cutting-off arm being operated on the rocking arm principle. The turret is indexed by means of a worm-wheel on the turret shaft, driven by a worm on the revolving shaft. This shaft is operated intermittently through a pin clutch, the whole revolving mechanism being driven by a separate belt from the countershaft, as will be described later.

Construction and Operation of Headstock

The headstock comprises a work-spindle A, Fig. 3, which rotates in two phosphor-bronze bearings, A_1, and A_2; the spindle is driven by gear A_3 attached to it by a key as shown, which receives power from a pinion on the pulley shaft at the rear of the machine. The pulley shaft carries three pulleys B, C and D. The two belts can be thrown alternately on the driving pulley C when it is desired to rotate the spindle in either direction or at different speeds, or they can both be thrown on the idler pulleys B and D when it is desired to stop the rotation of the work-spindle. The belt shifting levers E and E_1 are controlled by dogs mounted on cam drum E_2



[1]For information on automatic screw machine practice previously published in MACHINERY, see "Examples of Screw Machine Set-ups" in the November, 1914, number, and articles there referred to.

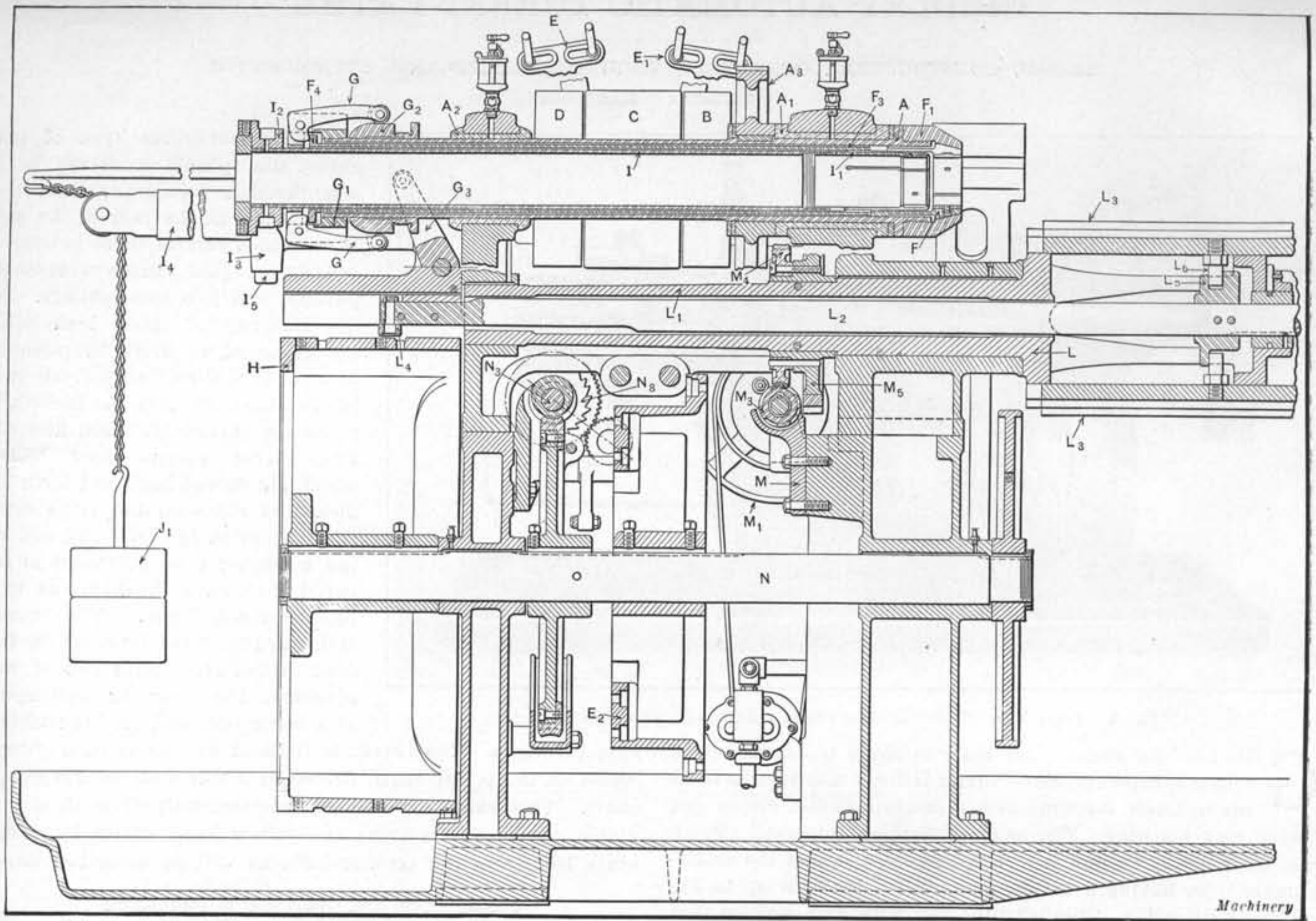


Fig. 3. Sectional View taken through Gridley Single-spindle Automatic Turret Lathe, showing Spindle Construction, Turret Construction and Operation of Main Cam-shaft. Note that Turret is swung around out of Correct Position to show Section

Operation of Chuck-closing and Stock-feeding Mechanism

The bar stock being operated on is held in the spring collet or chuck F in spindle A and is closed by being forced into a nose cap F_1 that is screwed on the nose of the spindle. The closing of the chuck on the stock if effected through the sleeve F_3 which bears against the rear end of the chuck and passes completely through the spindle of the machine. At the rear end of this sleeve is a flanged collar F_4, against which bear two fingers G. These fingers are fulcrumed in collar G_1, which is screwed on the rear end of the spindle. The long end of fingers G carries rollers running on sliding collar G_2, which is moved back and forth by the bellcrank lever G_3 carrying a roll on its lower arm that is operated by cams on the main cam drum H. This cam drum carries cam blocks K_1, and K_2, Fig. 5, cam K_1 withdrawing the collar from beneath the fingers and allowing the spring tension in the chuck to force the sleeve back and thus release the grip of the chuck on the work, whereas cam K_2 through bellcrank lever G_3 forces collar G_2 beneath the fingers, raising them up and, through the

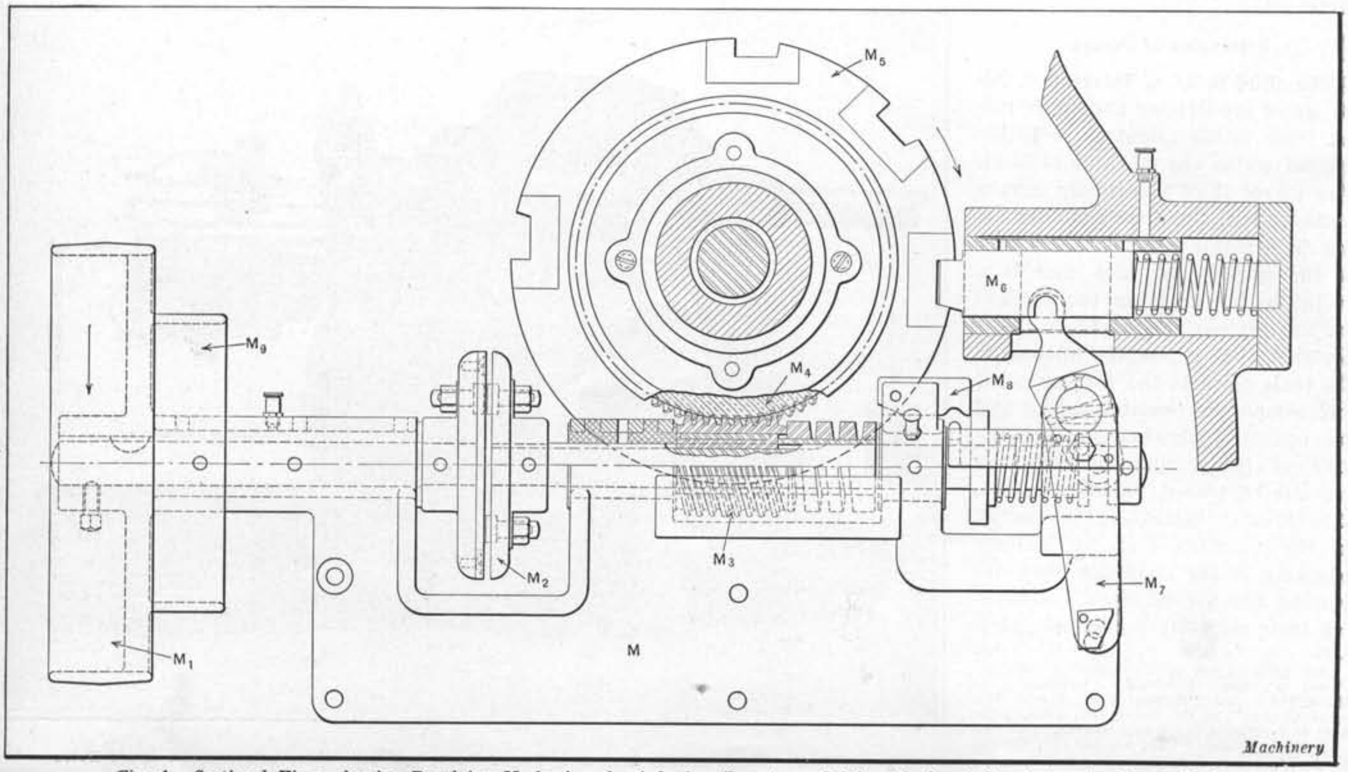


Fig. 4. Sectional View, showing Revolving Mechanism for indexing Turret on Gridley Single-spindle Automatic Turret Lathe

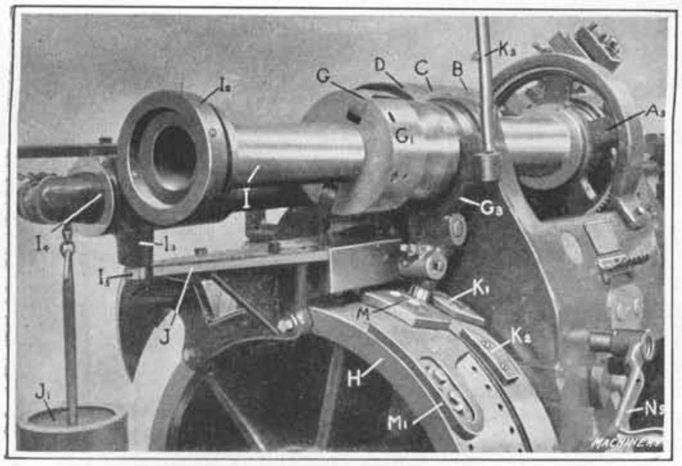


Fig. 5. End View of Gridley Single-spindle Automatic Turret Lathe, showing Cams for opening and closing Chuck and advancing Stock Stop, also Cams for operating Stock Pusher

short end of the fingers, forcing sleeve F_2 forward to close the chuck. Bellcrank lever G_3 has a hole in it in which an operating lever K_3 is inserted for opening and closing the chuck by hand when setting up the machine and adjusting the grip of the chuck on the work.

The feeding of the stock is accomplished by a combined weight and cam action. As shown in Fig. 3, a pusher or tube I carries at its front end a split chuck or pusher I_1, which has jaws suitably shaped for gripping the stock. The rear end of the pusher-tube I carries a collar I_2 in which runs a half yoke forming a part of bracket I_3. This combined bracket and yoke, in turn, is supported on bar-type bracket I_4.

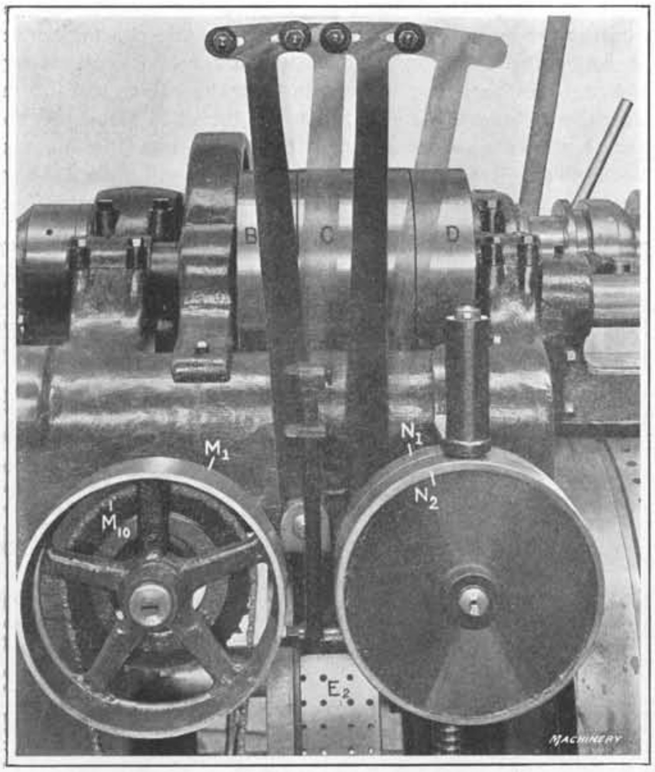


Fig. 6. Rear View, showing Drive for Main Cam-shaft and Indexing Mechanism

In action, cam J, Fig. 5, attached to cam drum H withdraws the pusher-tube I so that the feed chuck I_1 is drawn back on the stock an amount equal to or slightly greater than the desired length of the ordinary feed. Then when roll I_5 passes down the return side or incline of cam J, weight J_1, which has been lifted by the cam, carries pusher I forward, and the chuck is opened. The feed chuck carries the stock forward until it contacts with the stop held on one corner of the turret, as will be described later. The feed chuck then remains in the forward position until cam J again comes into action to withdraw it.

Construction and Operation of Turret

The turret, as has been previously explained, is the feature around which this machine has been built. In construction, it comprises a square casting L, Fig. 3, having an extended shank L_1 that passes through the machine and is supported in bearings located in both ends of the headstock. Passing through the center of this extended shank is a draw-bar L_2 for operating the four tool-slides L_3. This draw-bar carries a roll L_4, which is operated upon by cams on drum H. The turret L does not move back and forth, but is indexed to bring the various

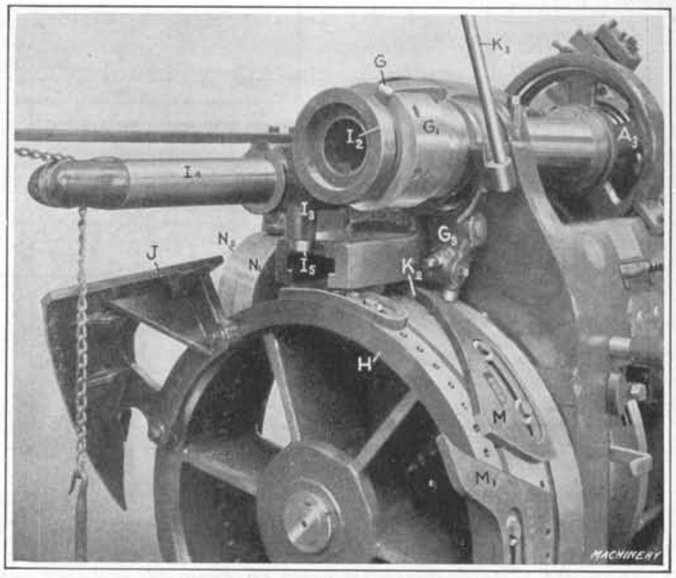


Fig. 7. End View of Gridley Single-spindle Automatic Turret Lathe, showing Stock-pusher Operating Cam out of Engagement with Operating Roll

tool-slides in line with the work, as will be subsequently explained. The tool-slides L_3 are operated by collar L_5 on draw-bar L_2; there is a groove in the collar which is cut away, as shown, for the greater part of its circumference, the full part of the groove being in the position where the various tool-slides are to be advanced toward the chuck. This collar also returns the slides to their backward position. Each tool-slide,

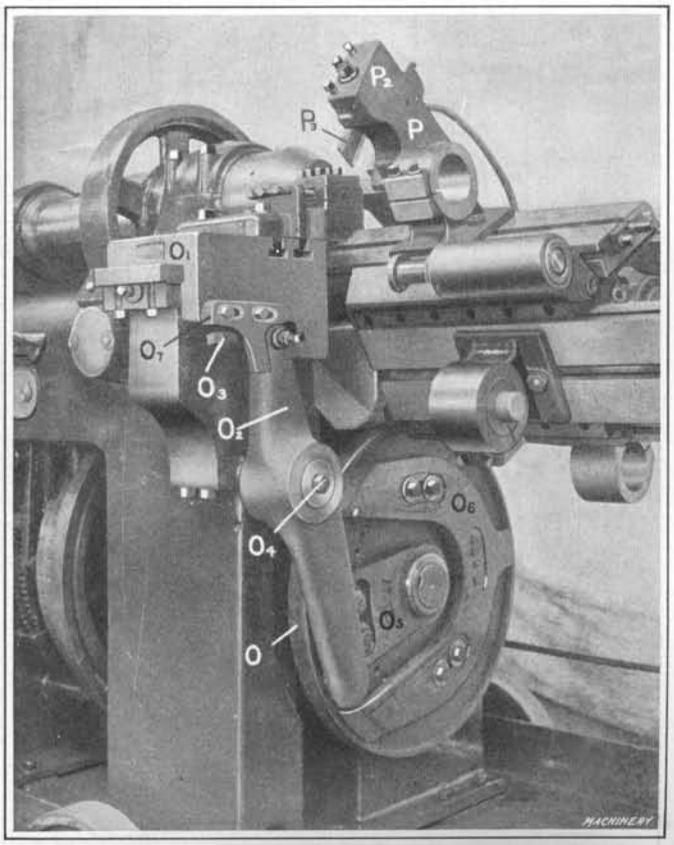


Fig. 8. Close View, showing Method of operating Forming Slide and Cutting-off Arm

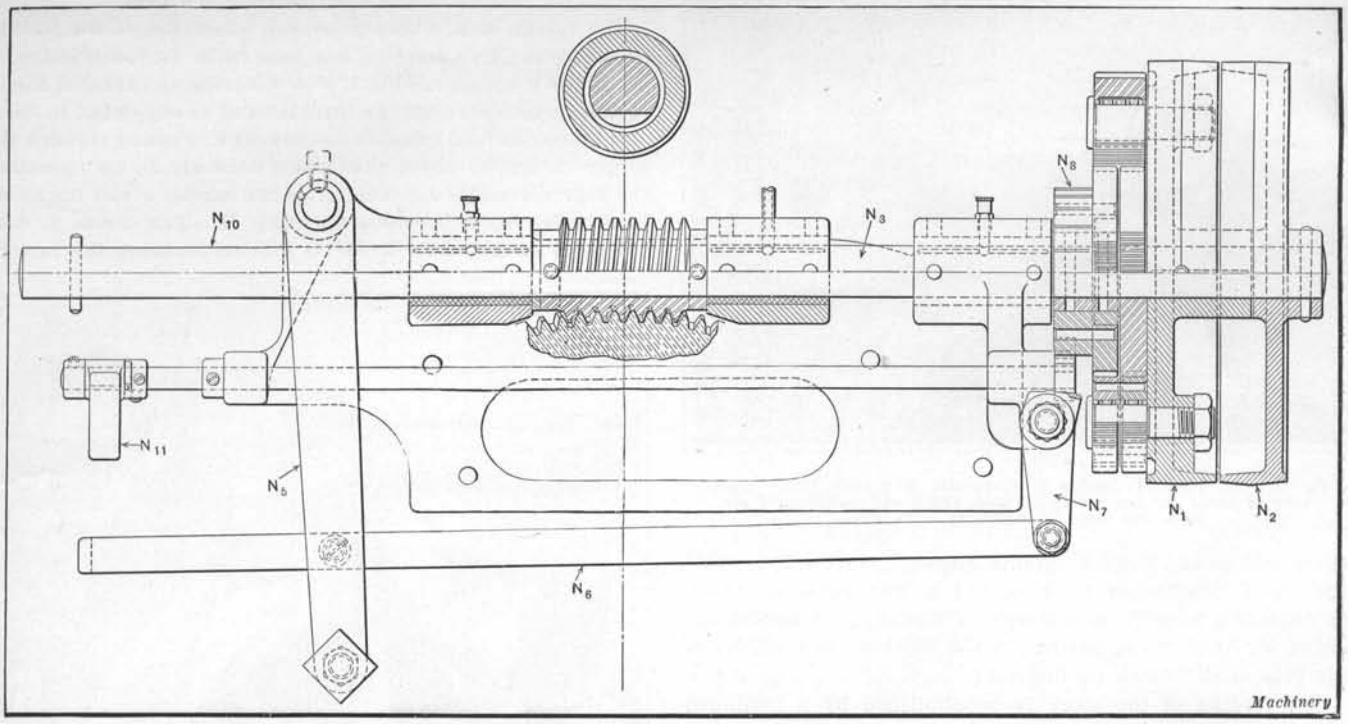


Fig. 9. Sectional View through Power Feed Bracket, showing Differential Gear Mechanism, Indexing Worm, Driving Worm, and Worm-wheel

as shown, carries a stud L_6, which engages with the slot in collar L_5 when the turret has been indexed to bring the various slides into the operating position.

Draw-bar L_2 is operated by cams on drum H, a set of two cams being required for each turret position. Cam M, Fig. 5, advances the turret to bring the stop into position, and cam M, Fig. 7, advances the tool-slides on the turret. Cam M_1 returns the slides to their backward position. The turret tools, as shown in Fig. 1, are clamped to the faces of the slides, which are provided with T-slots for aligning purposes; these slides, as previously explained, are moved back and forth in gibbed grooves, in the four slide grooves in the turret and carry toolholders which are bored in alignment with the spindle. One corner of the turret is machined to receive the corner stop for the stock.

Turret-indexing Mechanism

The indexing mechanism for the turret is operated by a separate belt from those used for driving the spindle and for rotating the main cam-shaft. It consists of two shafts: the one on which the pulley is attached which revolves continuously, and the one carrying the worm and the other half of the clutch, which revolves only when the turret is being indexed. Fig. 4 shows a sectional view taken through the indexing mechanism. Reference to this illustration will show that the indexing mechanism is carried on a separate bracket M and

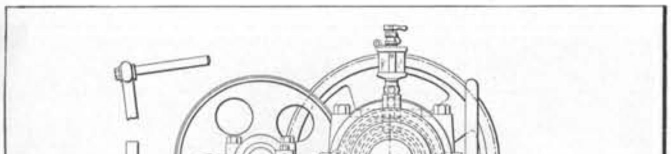


Fig. 10. Rear End View, showing Power Feed Mechanism and Main Cam Drum

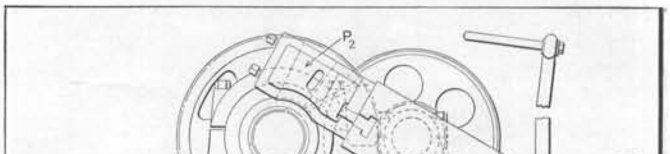


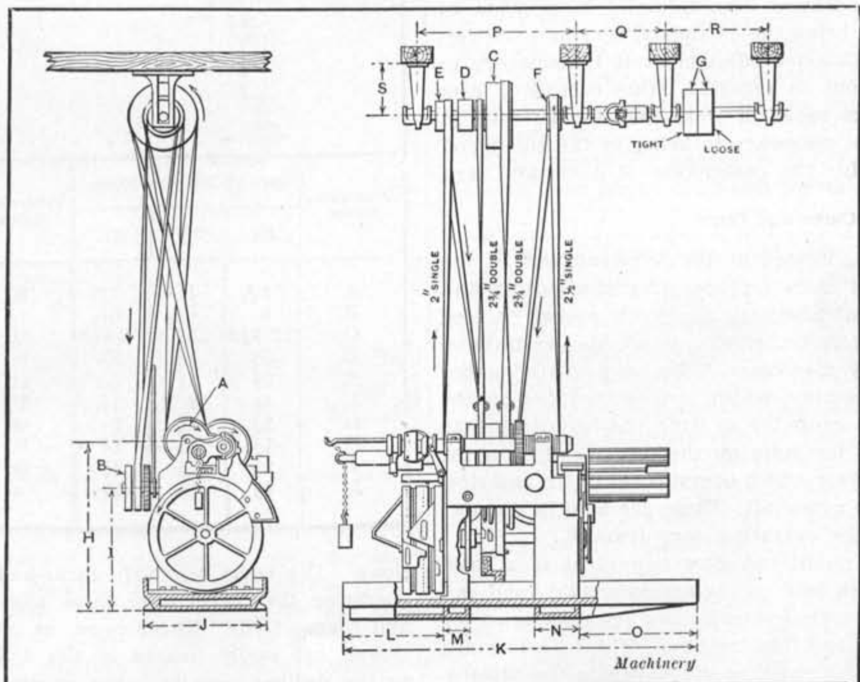
Fig. 11. Diagram illustrating Method of operating Forming Slide and Cutting-off Arm, also showing Construction of Turret and Turret Slide

consists of a pulley M_1 which is belted to the countershaft, and through a combination friction and pin clutch M_2 drives worm M_3; worm M_3, in turn, meshes with worm-wheel M_4, which is screwed and doweled to the index plate M_5, the latter being pinned to the extended shank L_1, Fig. 3, of the turret casting. Worm M_3 is also backed up by a stiff spiral spring as shown, which always keeps its teeth in accurate mesh with the indexing worm-wheel. The index plate M_5 is provided with five hardened blocks which act as locating stops for the locking pin M_6. These blocks are carefully hardened and ground and then set in place so that each indexing of the turret is accurately accomplished. The locking stop is also hardened and ground and is backed up with a stiff spring so as to keep it in constant contact with the turret index plate. It will be noted that there are five locating points in the index plate, but only four turret faces. The fifth point is used for indexing for the stock stop held on one corner of the turret when all the other positions are full.

The operation of this indexing device is as follows: Upon the completion of the operation of any of the turret tools on the work and when the slide has receded far enough so that the tool clears the work, a dog set on the operating cam drum E_2, Fig. 3, in the T-slot on the right-hand side of the drum operates lever M_7, Fig. 4, and withdraws locking pin M_6 from contact with the block in the index plate M_5. When the locking pin is completely withdrawn, trip M_8 is operated, allowing the spring on the friction shaft to come into action and engage the friction disks M_2.

In order to eliminate the shock of quick engagement, these disks are provided with leather faces which engage before the driving blocks contact. When the lever M_7 leaves the indexing cam, locking pin M_6 is forced forward against index plate M_5. As soon as the indexing slot comes opposite locking pin M_6, the spring behind it forces it into this slot, stopping the motion of the turret and at the same time bringing the friction disk out of engagement and locking them in this position by means of the trip M_8 previously mentioned. The indexing cams can be so placed on the drum that the turret can be made to skip one or more index positions if desired, or the slots or the locking-pin can be plugged up to serve the same purpose. On the later types of machine, pulley M_9 is replaced by a sprocket M_{10}, as shown in Fig. 6, for driving the oil pump.

TABLE 1. PRINCIPAL DIMENSIONS OF PULLEYS, COUNTERSHAFT, FLOOR PLAN, ETC.



Machine Size	Principal Dimensions of Pulleys, Floor Plan, Etc. — Pulleys: Pulley	A	B	C	D	E	F	G
2¼	Diameter, inches	11	12	18	8	8	9	14
	Width of face, inches	..	..	6	6	4	4	5
3¼	Diameter, inches	11	12	18	8	8	9	14
	Width of face, inches	..	..	6	6	4	4	5
4¼	Diameter, inches	11	12	15	10	6	9	16
	Width of face, inches	..	..	6	6	4	4	6
5	Diameter, inches	11	12	15	10	6	9	16
	Width of face, inches	..	..	6	6	4	4	6

Principal Dimensions, Inches

Machine Size	H	I	J	K	L	M	N	O	P	Q	R	S
2¼	45	32	32½	93	25	7½	11½	34	41	22½	27	14½
3¼	45	32	32½	93	25	7½	11½	34	41	22½	27	14½
4¼	50	32	32¾	104	35¼	7½	11½	34	41	22½	27	14½
5	50	32	32¾	104	35¼	7½	11½	34	41	22½	27	14½

Operation of Main Cam-shaft

The main cam-shaft N, Fig. 3, which runs the entire length of the machine and carries all the operating cams, is driven by a separate belt from the countershaft. As shown in Fig. 6, the power feed is contained in a separate bracket which is located at right angles to the main cam-shaft. This bracket carries two pulleys N_1 and N_2; the former rotates the shaft N_3, Fig. 3, through planetary gears and reduces the speed for driving the cam-shaft at the "cutting" speed. Pulley N_2 drives shaft N_3 direct and at a fast speed for taking care of the idle movements, such as returning and advancing the tool-slides to the cutting position, feeding the stock, closing the chuck, and indexing. Plunger N_4, Fig. 10, is a brake which is always in contact with pulley N_2, Fig. 9, for the purpose of stopping the pulley as soon as possible after the belt has been shifted from pulley N_2 to pulley N_1.

The change from fast to slow speed is accomplished through lever N_5, connecting link N_6, and lever N_7, Fig. 9. The lever N_5 is shifted by dogs on the left-hand side of the center cam drum E_2, Fig. 3. There are two slots on the side of this cam drum, one slot being used to shift this lever in one direction, and the other slot to return it to its original position. When lever N_7, Fig. 9, is shifted from pulley N_1 to N_2, it drives the power feed shaft direct. This gives the fast feed and is so much faster than the planetary gears that the ratchet N_8 runs away from the pawl. This, of course, separates the connection between the pulley carrying the planetary gears N_1 and the feed shaft. When setting up the machine, the power feed shaft can be rotated by hand-lever N_9, Fig. 10, which is located directly on worm-shaft N_{10}, Fig. 9. When it is desired to stop the rotation of the feed shaft, the feed-release clutch N_{11} is operated, thus lifting the pawl from contact with ratchet N_8 and breaking the connection between the planetary gears and the main feed shaft.

Operation of Forming and Cutting-off Slides

The forming and cutting-off slides are both operated from cam disk O, Fig. 8, one one side of which are placed the cams for operating the forming slide, and on the other side the cams for operating the cut-off slide. Reference to Figs. 8 and 11 will show that the forming slide O_1 is operated by a lever O_2 and adjusting screw O_3 that comes in contact with a projection on the lower face of the forming slide. Lever O_2 is fulcrumed at O_4, and on its lower end carries a roll which, as shown in Fig. 8, runs in the groove formed by the forming cam O_5 and the return cam O_6. The forming slide is returned by the lever O_2 coming in contact with bracket O_7 attached to the side of the slide. The forming slide can be adjusted to the lever O_2 by means of an adjusting screw O_3 as shown, in order to bring the forming tool into the required relation to the work. The forming tools used on this machine, which are generally of the dovetail type, are held in a forming-tool holder, fastened to the top face of the forming slide.

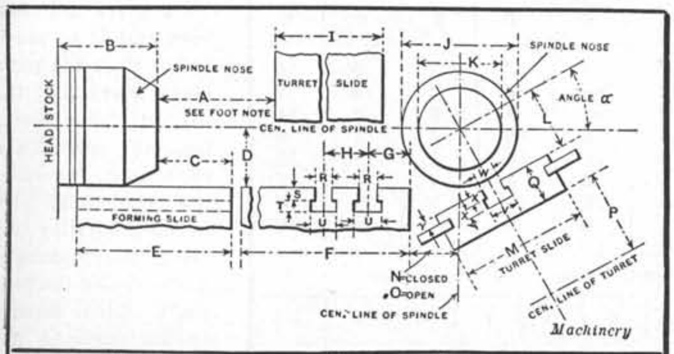
The cutting-off slide is in the form of a bellcrank lever *P*, which is fulcrumed on a stud P_1. The lower end of this lever carries a roll that contacts with a cam on the inner side of cam disk *O;* whereas the upper end has a machined face in which there is a T-slot for carrying the tool-holder P_2. This tool-holder carries a blade type cutting-off tool P_3. The tool-holder proper can be adjusted longitudinally in relation to the axis of the work to bring the cutting-off tool into the correct position, but for diameter adjustment it is necessary to move the blade in or out as required. One cutting-off cam generally covers a large range of work and can be used in all cases where it is not necessary to bring in the cutting-off tools more than once for the completion of a certain part.

Cams and Dogs

The main cam drum, located at the left-hand end of the main cam-shaft, carries cams for operating the closing and opening of the chuck, withdrawing the stock pusher or feed tube and operating the turret slide through the medium of the draw-bar previously mentioned. The cam drum located in the center of the machine, which is also mounted on the main cam-shaft, carries cams for shifting the belt, dogs held in the T-slot in its rim for indexing the turret and cams for moving the high-speed lever which operates the quick and slow speed movements of the cam-shaft. These are held in circular T-slots at the ends of the operating cam drum E_2.

The cam-shaft has a quick and slow movement in a ratio of 70 to 1. The cam disk held on the extreme right-hand end of the main cam-shaft carries cams having several angles for operating the cutting-off and forming tools. The various cams, dogs and trips used on this machine are shown in the illustrations. The cams regularly furnished with the machine for operating the turret have three angles, giving fine, medium and coarse feeds. These cams, as has been previously mentioned, are easily located on the drum and can be changed to the desired position. For special work, of course, these cams are cut to suit the conditions, as in some cases it is necessary to start with a fairly coarse feed and then gradually slow down when approaching the end of the cut, as in counterboring or facing operations. The same remarks also apply to the forming cams which, in some cases, have to be changed to suit the conditions of the work.

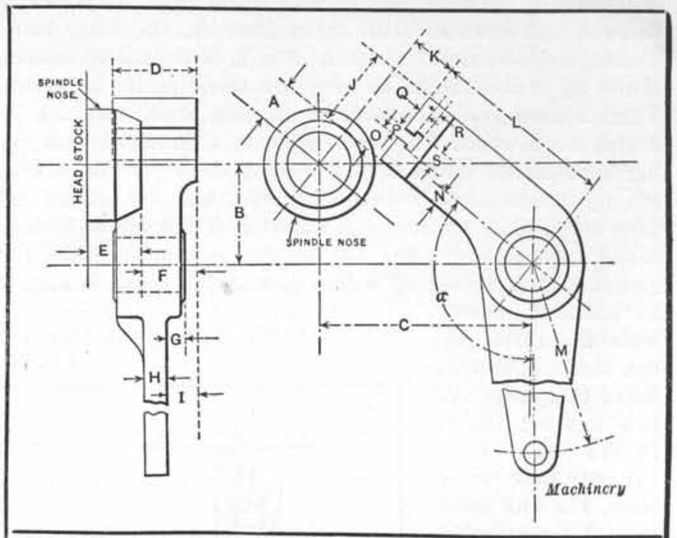
TABLE 2. TURRET SLIDES, FORMING SLIDE AND SPINDLE NOSE DIMENSIONS AND RESPECTIVE RELATIONS



Dimensions, Inches	Rated Chuck Capacity of Machine, Inches			Dimensions, Inches	Rated Chuck Capacity of Machine, Inches		
	2¼	3¼	4¼		2¼	3¼	4¼
A	5 1/8	5	5 1/4	N	2 1/4	2 1/4	2 7/8
B	5 1/8	5 1/4	5 3/8	O	6	6	6 1/2
C	3 5/8	3 1/2	4 1/4	P	4	4	4
D	2 3/4	3 5/16	5 3/16	Q	2	2	2
E	7 1/2	7 1/2	8 1/4	R	3/4	3/4	3/4
F	10 1/4	10 1/4	10	S	5/8	5/8	5/8
G	2 1/16	2 1/16	2 1/16	T	1/2	1/2	1/2
H	2 1/16	2 1/16	2 1/16	U	1 3/8	1 3/8	1 3/8
I	21	21	21	V	1 3/8	1 3/8	1 3/8
J	5 3/8	6 7/8	7 7/8	W	7/8	7/8	7/8
K	3 7/8	5	5 7/8	X	1/2	1/2	1/2
L	3	3 1/2	4	Y	1/2	1/2	1/2
M	6	6	6	Angle α	29° 45′	28′ 10″	33° 7′

Dimension A gives the position of the tool-slide in the position it occupies when the turret is being revolved. The slide has a total movement of 8½ inches when using the regular cams, although for most work 6-inch cams only are required or used.

TABLE 3. DIMENSIONS OF CUTTING-OFF ARM AND RELATION TO NOSE OF SPINDLE



Dimensions, Inches	Size of Machine, Inches			Dimensions, Inches	Size of Machine, Inches		
	2¼	3¼	4¼		2¼	3¼	4¼
A	1 9/32	1 13/32	2 13/16	K	3	3 11/16	3
B	6	6 9/16	6 9/16	L	11 1/4	11 1/4	12 3/8
C	12.968	13 1/2	14.463	M	18	18	18 1/4
D	5 3/4	5 3/4	5 3/4	N	5/8	5/8	1 1/8
E	3 1/2	3 5/8	3 3/4	O	1 1/2	1 1/2	2
F	4 1/8	4	3 7/8	P	3/4	3/4	3/4
G	1 3/8	1 3/8	1	Q	13/16	13/16	13/16
H	1 1/4	1 1/4	1 1/2	R	1/2	1/2	1/2
I	2 1/4	2 1/4	2 1/8	S	1 3/8	1 3/8	1 3/8
J	4 5/8	4 5/8	5 1/2	α	120°	120°	130°

Sizes of Gridley Single-spindle Turret Lathes

The Gridley single-spindle turret lathe is built in four sizes, which, rated according to the largest chuck capacities, are as follows: 2¼, 3¼, 4¼ and 5 inches. Turret-slides are made for a feed of 8½ inches, but on most work only 6-inch feed-cams are necessary. These are preferable, since they allow more room on the cam drum for other operations. The spring collets or chucks, as well as the stock pushers or feeding fingers, are provided with pads suitably shaped to accommodate the work being handled. These pads are hardened and are changed when a different size of bar is to be handled. The illustration accompanying Table 1 shows the belting arrangement on the belt-driven type of Gridley turret lathe for the 4½- and 5-inch sizes. In the 2¼- and 3¼-inch machines, the belt to pulley *A* is open instead of crossed. Hence in these machines pulley *A* revolves in a direction opposite to that shown by the arrow. The countershaft speed on the 2½- and 3¼-inch machines is 300 R. P. M., and on the 4¼- and 5-inch machines it is 275 R. P. M. Table 1 gives the principal dimensions, including sizes of overhead pulleys, floor plan, countershaft, etc. It should be noted that, although the 5-inch machine is not listed in Tables 2 and 3, this machine is the same as the 4¼-inch size, with the exception of its greater chuck capacity.

The machine shown in Fig. 1 is a belt-driven machine. Fig. 2 shows the Gridley automatic turret lathe equipped with motor drive. When motor-driven, the machine is provided with two variable-speed motors, each having its own controller, resistance, etc. Motor *A* drives the work-spindle through the back-gears, and is provided with a controller *B* for producing the desired speed. The other motor, which is located at the rear of the machine and is geared to the power feed shaft, has a controller *C*.

Table 2 includes all the tooling dimensions of the 2¼-, 3¼-, 4¼- and 5-inch sizes of Gridley single-spindle automatic turret lathes. These dimensions include the spindle nose, turret slide and forming slide and show the relation of the forming slide to the spindle nose and turret slide; referring to the illustration accompanying this table, it will be noticed that dimensions *N* and *O*, respectively, represent the relative positions of the forming slide when at its extreme forward and return strokes. These dimensions must be taken into consideration when designing special tools for use on the turret slides.

Table 3 gives the principal dimensions of the cutting-off arm and its relation to the nose of the spindle.

GRIDLEY TURRET LATHE EQUIPMENT

CHUCKS, FORMING AND CUTTING-OFF TOOLS, DRILL-HOLDERS, KNURLING TOOL-HOLDERS, TURNERS, BACK-RESTS, ETC.

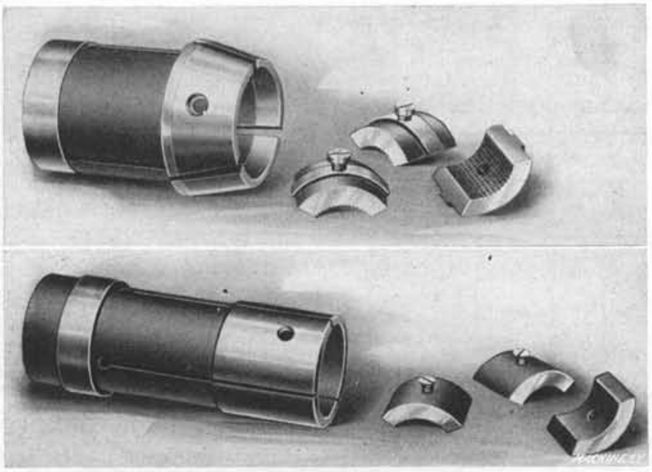


Fig. 1. Master Spring Chuck and Feed Chuck with Gripping Jaws removed

THE tool equipment and attachments used on the Gridley single-spindle automatic turret lathes do not differ essentially from those used on the multiple-spindle type of machine. The tool-holders, however, are held on flat slides instead of on the corner of the turret, as in the multiple-spindle machines. The standard tool equipment consists of spring chucks, feed chucks, vertical and flat forming tools, blade-type cutting-off tools, drill-holders, facing tools, knurling tools, internal necking tools, turners, high-speed drilling attachments, automatic die attachments, releasing tap-holder attachment, and taper turning attachment. Other special tools, of course, can be designed when the character or shape of the work necessitates the performance of operations that cannot be handled with the standard equipment.

Fig. 2. Standard Type of Tool-holder used on Turret Slide of Gridley Automatic Turret Lathe

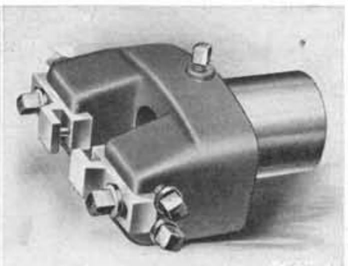
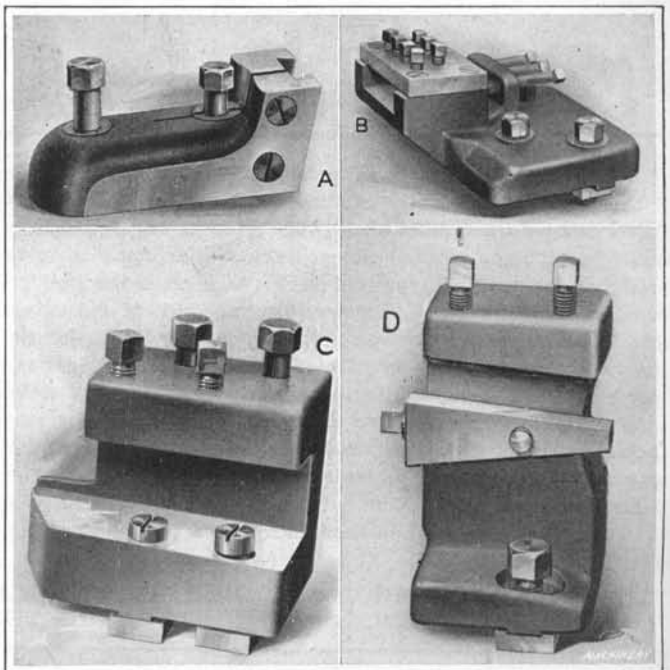


Fig. 3. Standard Type of Knurling Tool-holder for Use on Turret Slide of Gridley Automatic Turret Lathe

Spring Chuck and Feed Chuck

The spring chuck and the feed chuck used in the single-spindle turret lathe are exactly the same as those used on the multiple-spindle machines; in fact, the chucks used on the 2¼-inch sizes are interchangeable. On the single-spindle turret lathes, of course, the smallest capacity of the machine is such that the master spring chuck and feed chuck are used exclusively, and these are fitted with bushings to suit the size and shape of the work being handled. The illustration accompanying Table 1 shows the design of the spring chuck, and the principal dimensions are given for the 2¼-, 3¼-, and 4½-inch machines. It will be noticed in this connection that the taper on the front end of the chuck is only 14½ degrees on the 2¼-inch size, whereas it is 15 degrees on the 3¼- and 4¼-inch sizes. Another difference that should be noticed is that the chucks used on the 3¼- and 4¼-inch sizes have four slots and four bushing sections, instead of three, as on the 2¼-inch size.

The illustration accompanying Table 2 shows the type of master feed chuck used and the table gives the principal dimensions. These chuck are also interchangeable with those on the same size of multiple-spindle machines, and the number of slots and bushing sections vary on the 3¼- and 4¼-inch sizes, as mentioned in connection with the spring chuck. On the 3¼- and 4¼-inch feed chucks, the diameter is not reduced at *L*, but the diameter *A* extends from the front back to the shoulder at *J*; otherwise the feed chucks used on the various sizes of machines are identical in shape. Fig. 1 shows a master spring chuck and a feed chuck with the bushings removed and illustrates clearly the shape of the bushings and the method of holding them.



Filg. 4. Forming and Cutting-off Tool-holders used on Gridley Single-spindle Automatic Turret Lathe

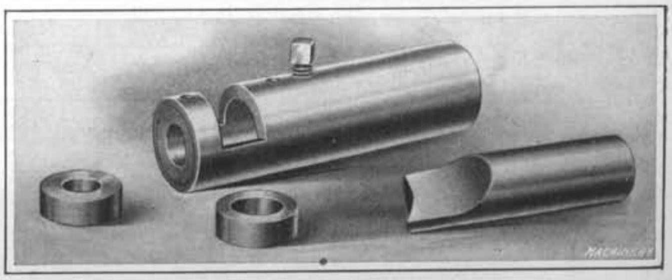
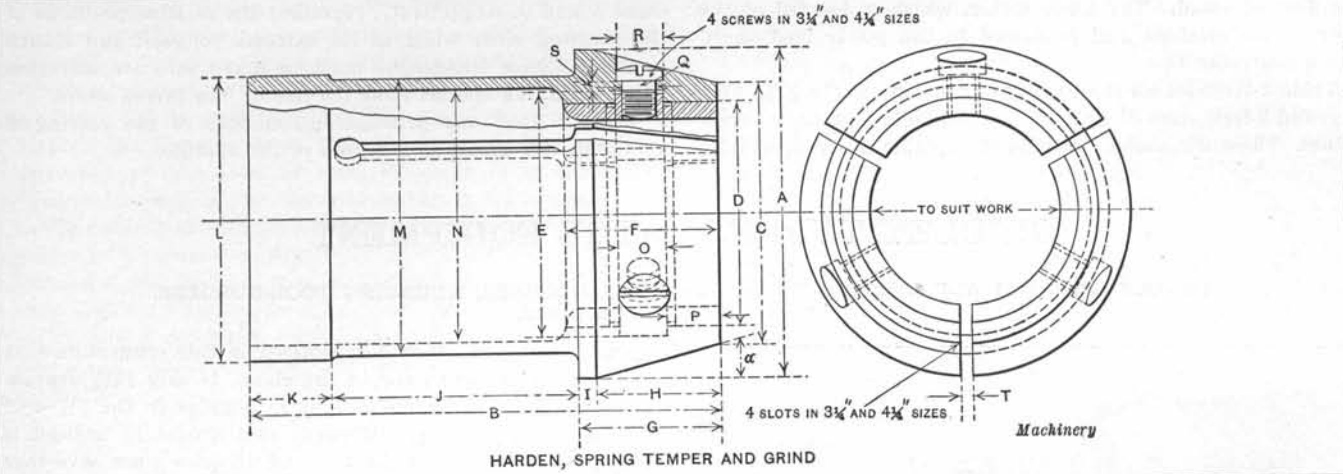


Fig. 5. Facing Tool and Holder used in Standard Tool-holder

TABLE 1. PRINCIPAL DIMENSIONS OF MASTER SPRING CHUCKS FOR GRIDLEY SINGLE-SPINDLE TURRET LATHES



Size of Machine	Dimensions, Inches																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	a, Degrees
$2\frac{1}{4}$	$3\frac{1}{2}$	$5\frac{1}{32}$	2.7966	$2\frac{3}{8}$	$2\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{1}{2}$	$1\frac{5}{16}$	$\frac{3}{16}$	$2\frac{21}{32}$	$\frac{7}{8}$	3	$2\frac{15}{16}$	$2\frac{11}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{32}$	$14\frac{1}{2}$
$3\frac{1}{4}$	$4\frac{11}{16}$	$5\frac{5}{8}$	3.9173	$3\frac{3}{8}$	$3\frac{9}{16}$	$1\frac{3}{4}$	$1\frac{5}{8}$	$1\frac{7}{16}$	$\frac{3}{16}$	3	1	$4\frac{5}{16}$	$4\frac{1}{8}$	$3\frac{3}{4}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{16}$	15
$4\frac{1}{4}$	$5\frac{3}{4}$	7	4.8625	$4\frac{3}{8}$	$4\frac{9}{16}$	$1\frac{7}{8}$	$1\frac{3}{4}$	$1\frac{21}{32}$	$\frac{3}{32}$	$4\frac{1}{4}$	1	5.495	$5\frac{3}{8}$	$4\frac{7}{8}$	$\frac{1}{2}$	$\frac{11}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	15

Forming and Cutting-off Tools

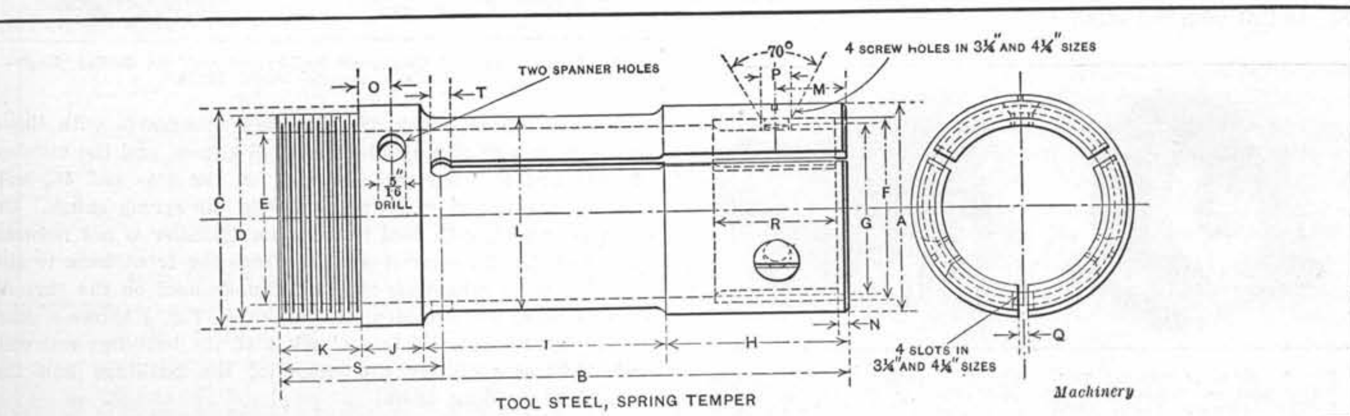
The forming and cutting-off tools used on the single-spindle turret lathe do not differ materially from those used on the multiple-spindle machine. When an irregular form is to be produced the vertical type of forming tool gives the best results. When the several diameters are to be formed and only a small number of parts are to be turned out, individual forming tools consisting simply of blades for covering each diameter are satisfactory. It should be stated, however, that when a large number of parts are to be produced a tool covering the entire form, if possible, is better than a tool made up in separate parts, as it is easier to set up the tool again after it has been sharpened. The cutting-off tools are generally of the blade type, except when they do some part of the forming.

Forming and Cutting-off Tool-holders

Fig. 4 shows types of forming and cutting-off tool-holders used on the single-spindle turret lathe. That shown at *A* is known as the vertical tool-holder and is the type generally used, because the cutting tool can be held much more rigidly than in the other designs. The tool also can be ground on its top face without changing the form on the work, and it has a longer life than the straight forming tool.

When the piece to be formed has several plain diameters, the flat forming tool-holder shown at *B* is sometimes found convenient. This tool-holder, of course, is only used when there are a small number of pieces to be made and when the expense of making a vertical forming tool would not be warranted. It is also used when several narrow forming tools are

TABLE 2. PRINCIPAL DIMENSIONS OF MASTER FEED CHUCKS FOR GRIDLEY SINGLE-SPINDLE TURRET LATHES



Size of Machine	Dimensions, Inches																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
$2\frac{1}{4}$	2.560	7	2.620	$2\frac{1}{2}\times24$ P. L. H.	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{1}{8}$	$2\frac{1}{4}$	3	$\frac{3}{4}$	1	$2\frac{3}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$
$3\frac{1}{4}$	$3\frac{5}{8}$	$7\frac{1}{8}$	3.745	3.580 ×18 F R. H	$3\frac{5}{16}$	$3\frac{1}{4}$	$3\frac{1}{8}$	—	—	$\frac{3}{4}$	1	$3\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$
$4\frac{1}{4}$	$4\frac{11}{16}$	$7\frac{1}{4}$	4.808	$4\frac{5}{8}\times18$ P. L. H.	$4\frac{3}{8}$	$4\frac{1}{4}$	$4\frac{1}{32}$	—	—	$\frac{7}{8}$	1	$4\frac{11}{16}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$

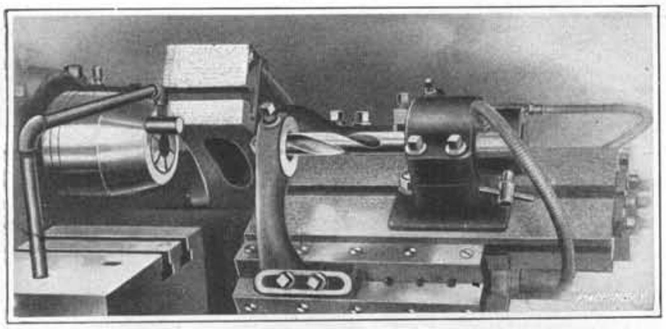


Fig. 6. Standard Type of Drill-holder and Drill-support in Operation

required, spacing pieces being put in between the tools and the entire number clamped in the holder. Three adjusting screws are provided, as shown, so that three separate tools can be independently adjusted; they are then clamped by the other set screws.

The plain forming tool-holder shown at *C* is sometimes used for forming back of the head of a screw or for similar work, so that the cutting-off tool is relieved of considerable work. It is also used for beveling the end of the bars before it is fed out, and thus assisting the turner in starting, especially in giving the back-rests a chance to support the work when the turning cut starts.

D shows the standard type of cutting-off tool-holder used on the single-spindle machine. This holder, as shown, is fitted

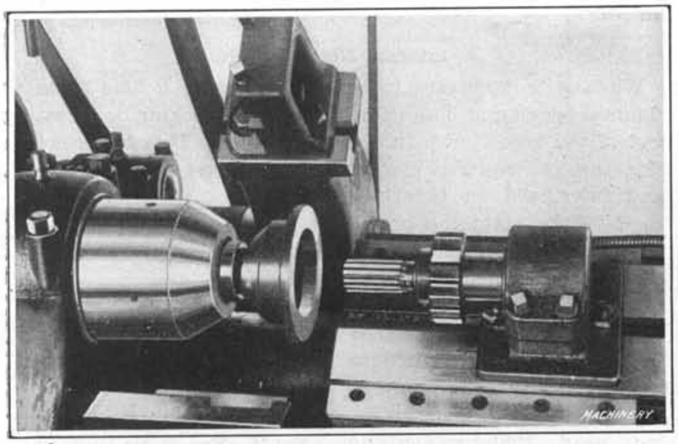


Fig. 7. Standard Tool-holder carrying Reamer

with an adjustable taper wedge so that the cutting-off blade can be easily adjusted to correspond with the center of the work. Ordinary forged tools can be held in this holder or almost any type of blade inserted. When a large number of pieces are to be made it is advisable to use a blade-type of cutting-off tool and holder. This simplifies the sharpening of the tool, as a blade-type tool has clearance all the way back and to sharpen it is simply ground on the front end to the required cutting angle.

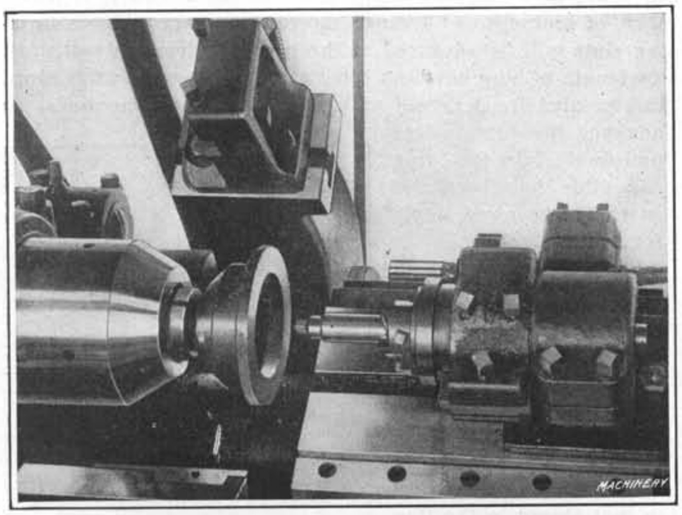


Fig. 8. Standard Holder carrying Reamer and Counterboring Tool

Tool-holders

The standard type of tool-holder used on the Gridley single-spindle turret lathe is shown in Fig. 2. This tool-holder is bolted directly to the turret slide and is bored out when in place on the machine so that the hole is in direct alignment with the spindle. It is held in place on the slide by means of two T-bolts, which are threaded; an adjusting screw laid in the T-slot in the slide can then be used for accurately adjusting the tool-holder longitudinally along the slide. This

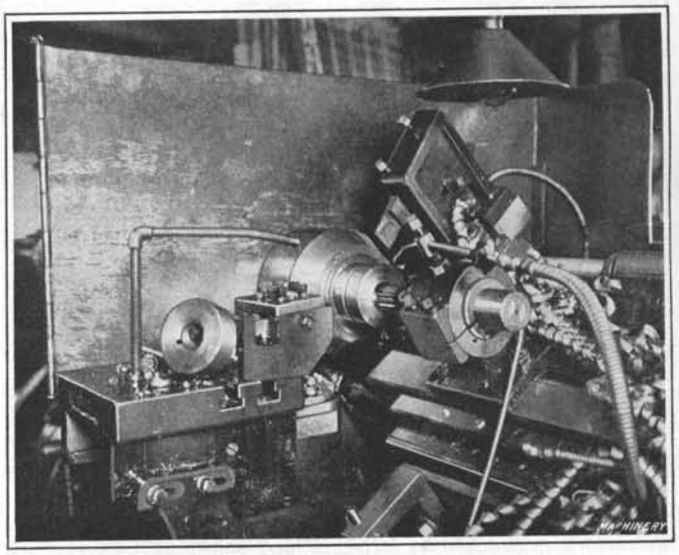


Fig. 9. Standard Type of Reamer-holder at Work

screw, of course, is provided with a collar head, and a plate attached to the rear end of the slide acts as a stop for adjusting purposes. The various tool-holders are numbered to correspond with the number of the tool-slide to which they are fastened when finished, and should be used only on the tool-slide having that number. They can be used, of course, by the substitution of bushings and other independent holders for carrying facing tools, drills, pointing tools, etc. Fig. 5 shows a tool-holder arranged to hold a pointing tool. A separate bushing is provided for guiding the bar, and the pointing tool is held in another sleeve, the latter being retained in the holder.

Drill-holder and Support

In Fig. 6 is shown the standard tool-holder carrying a twist drill, which is held in a bushing fitting in the holder, so

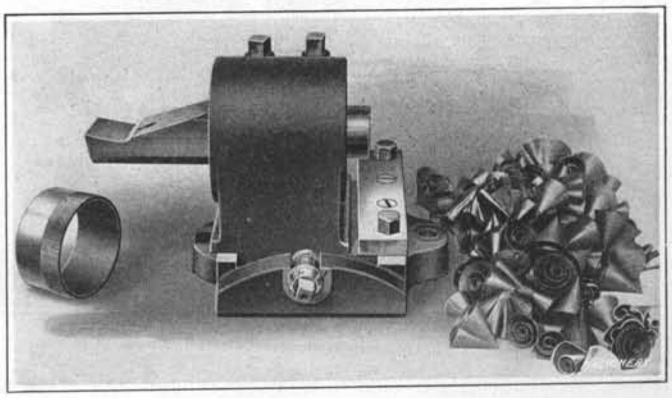


Fig. 10. Set-over Tool and Holder and Chip produced by it

constructed that an oil-tube can be inserted for supplying a coolant to the drill. In drilling deep holes, the drill should be of the oil-tube type in order that the oil can flow directly to the cutting point. In addition, the drill is supported close to the cutting point, by means of an arm which is fastened to the turret in such a position that it is close to the end of the piece being drilled. The arm holds a bushing which fits the drill and accurately guides it in line with the work. This insures the tool starting concentrically and obviates the necessity of using a starting drill.

Fig. 9 shows a standard tool-holder carrying a reamer. The reamer is mounted so that it can float and is carried in a separate bushing in the tool-holder. In this illustration the screw for adjusting the main tool-holder longitudinally can be plainly seen, as well as the forged type of cutting-off tool, and the tool-holder for carrying separate forming tool blades. In Fig. 8 is illustrated another application of a reamer-holder, which is used in conjunction with a facing and counterboring tool. The reamer is of the shell type. The job shown is a

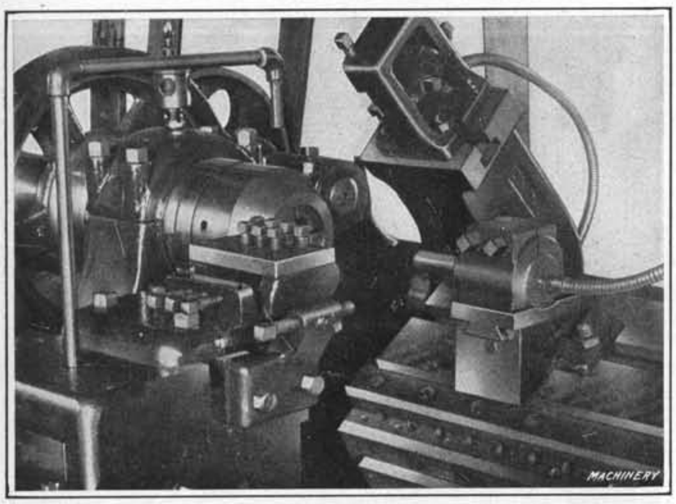


Fig. 11. Internal Necking or Recessing Tool

hub which is chucked by hand. Fig. 7 shows still another application of the standard holder. In this case it is used for carrying a reamer, operating on a chucking job.

Knurling Tool-holder

The standard type of knurling tool-holder used on the Gridley automatic turret lathe is shown in Fig. 3. This has a shank which can be held in the standard tool-holder and carries two adjustable slides that hold the spiral knurls. Two straight knurls can be used when it is necessary to produce a straight knurled effect on the work.

Set-over Tool and Holder

An interesting type of tool which takes the place of a drill for producing shallow holes (not more than one and one-half

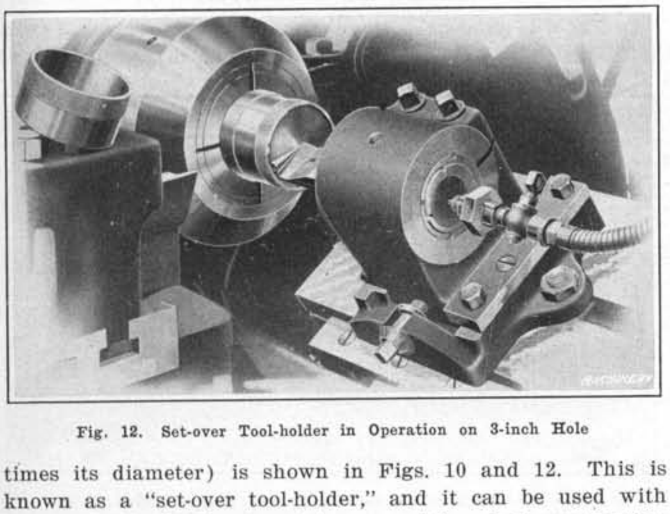


Fig. 12. Set-over Tool-holder in Operation on 3-inch Hole

times its diameter) is shown in Figs. 10 and 12. This is known as a "set-over tool-holder," and it can be used with success on the Gridley turret because of the rigid construction of the latter. The cutting tool works the same as a forming tool, but instead of cutting on the outside surface of the bar, as the forming tool does, it cuts into the end of the bar, and as the holder which supports the tool has a set-over adjustment, the same cutting tool can be used for making holes of various diameters. It is not necessary to use a starting drill with this tool and the use of a counterbore can also be dispensed with in most cases when the bottom of the hole in the piece is flat.

The cutting tool proper is made from high-speed steel with

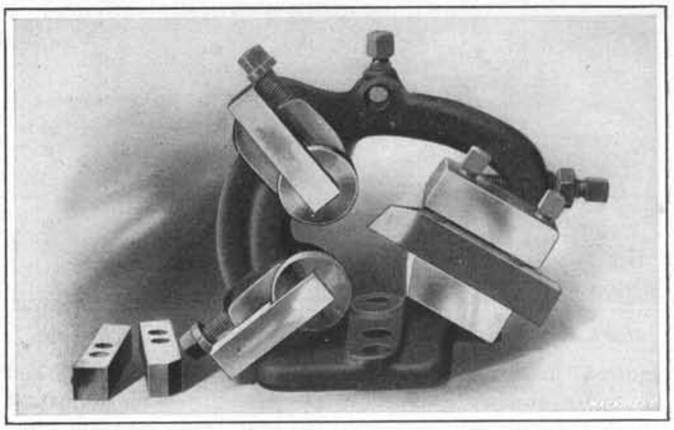


Fig. 13. Standard Type of Turner for Use on Gridley Automatic Turret Lathe

oughly flooded with cutting oil or compound. This tool is cheaper to make than a drill and can be used for making different sizes of holes, and also as a reamer. Fig. 12 shows the tool in operation, producing a hole that is three inches in diameter. Fig. 10 shows the kind of chips produced with this tool, and the set-over arrangement is also clearly shown. The holder carrying the cutting tool is mounted on a slide which is adjustable at right angles to the axis of the spindle by means of a collar-head screw, as illustrated. This adjustment is made to secure the desired diameter of the hole in the work.

Internal Necking Tool

When it is necessary to make a recess in a hole so as to obtain a bearing at both ends, an internal necking or recessing tool of the type shown in Fig. 16 is used. This tool consists of a base *A*, which is clamped to the turret slide, as shown, and fulcrumed on this base at *B* is the main tool-holder *C*. This holder carries the recessing tool, which is held by a bushing and a clamping screw, as shown. The recessing tool is centered with the hole by means of the adjusting screw *D*, which has a collar head that comes up against the bracket *E* of the holder, and it also is provided with a nut for locking purposes. The shoulder of screw *D* is kept against the bracket by means of coil spring *F*, and after the tool has finished cutting, and the pressure is removed from the holder, the spring returns the tool to the central position. The recessing tool is fed to depth by means of a roller pusher *G* mounted in a bracket *H* attached to the edge of the forming slide, as illustrated. The roller bears against a hardened block that is held by screws to the side of the internal necking tool-holder proper. In using this tool for enlarging, or boring a hole, it is necessary, of course, to so arrange the forming cam that the forming slide will be advanced at the proper moment, dwell until the length of bore has been completed, and then be withdrawn. In recessing for a thread or internal form, it is necessary to advance the turret slide and dwell until the forming slide has been fed in to the required depth for taking the cut.

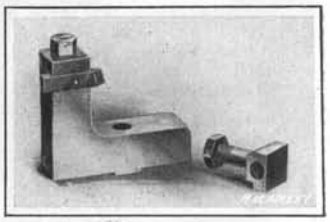


Fig. 14. Knee Turner for Roughing and Finishing Cuts

An internal forming or recessing tool that differs slightly from that shown in Fig. 16 is illustrated in Fig. 11. The design in this case is not quite so elaborate; the tool is operated from the forming slide in a similar manner to that shown in the line

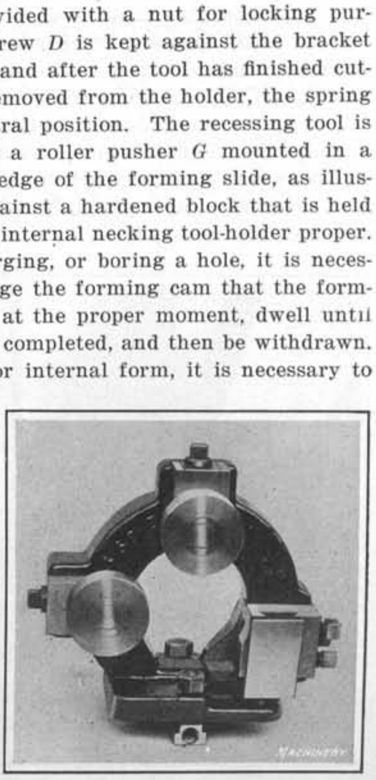


Fig. 15. Standard Turners used on

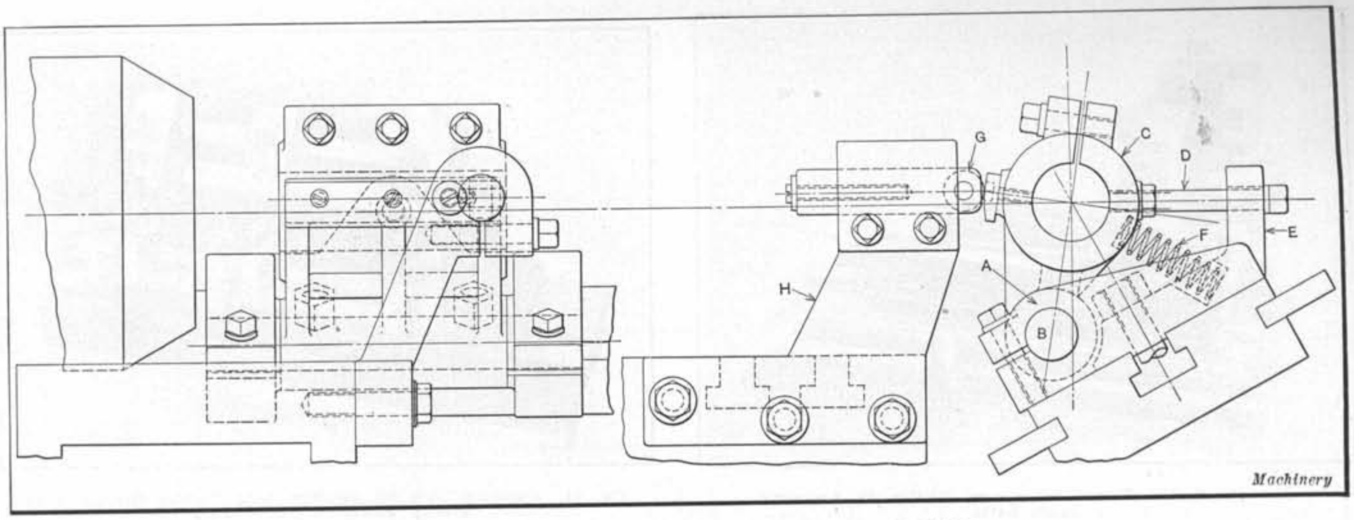


Fig. 16. Another Type of Internal Necking or Recessing Tool-holder

Turners and Back-rests

A noticeable feature of the standard turning tool shown in Fig. 13 is the absence of a shank. This holder is in the form of a yoke having a base that rigidly clamped to the turret slide. At the front it carries a turning tool and at the rear two supports; the latter can be either of the plain type or of the roller type, as shown. The cutting tool in the turner for the 2¼-inch machine is 1 by ½ inch and is ground on the end, as shown. The roller rests permit the use of heavier cuts and coarser feeds, and a cutting speed of two or three times that which can be maintained when the common type back-rest is used. These back-rests may be used either ahead of or behind the cutting tool, depending upon the character of the work and the cut being taken.

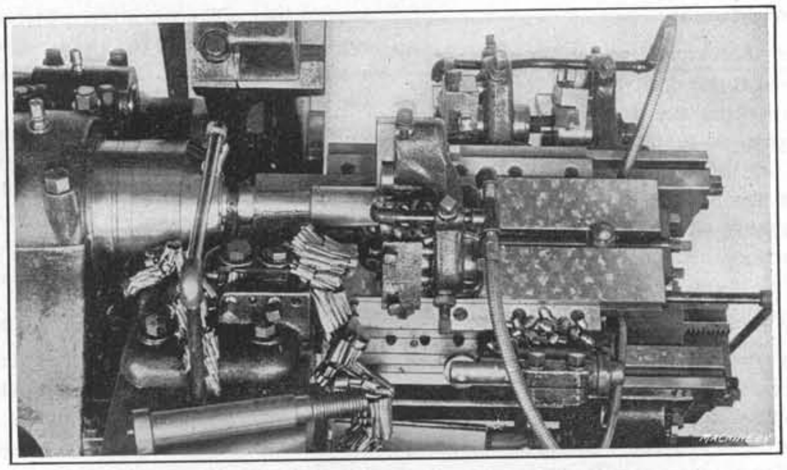


Fig. 17. Standard Turner and Flat Forming Tool working together on Shoulder Screw

Fig. 17 shows one of these standard turners at work producing a shoulder screw with the forming tool at work at the same time. Forming and turning can be done simultaneously with good results, as the desired rigidity can easily be obtained. This particular setting was used to save time on the single-spindle machine, but if the same job were done on the multiple-spindle machine, two or more turning cuts would be made, thus obviating the necessity for the wide forming cut in the first operation. The same illustration also shows the adjusting screw for moving the standard tool-holders in a longitudinal direction along the turret slide, to which reference has been made in the foregoing.

In Fig. 15 is shown the type of standard turner used on the 4¼-inch automatic turret lathe. This uses a dovetail turning tool and roller back-rests.

Another type of standard turner, known as an "adjustable stud turner," is shown in Fig. 18. This turner is so arranged that three different diameters can be finished at the same time. It consists of a holder proper, which is clamped to the turret slide and carries individual units, one unit for holding the cutting tool and the other for the back-rest or support. Usually the first support of the group is provided with rollers because of the heavier duty required in this position. The turning tools are adjusted by means of a collar-head screw, as illustrated, and adjustment is also provided for the back-rests.

Fig. 19 shows a special stud turner. This is almost of the same design as the adjustable stud, turner, except that it is made for a given piece of work and is not adjustable for shoulder distances, that is, longitudinally. The tool-holder proper is solid, as illustrated, and carries, in this case, five turning tools. The supports are held so that they can be adjusted

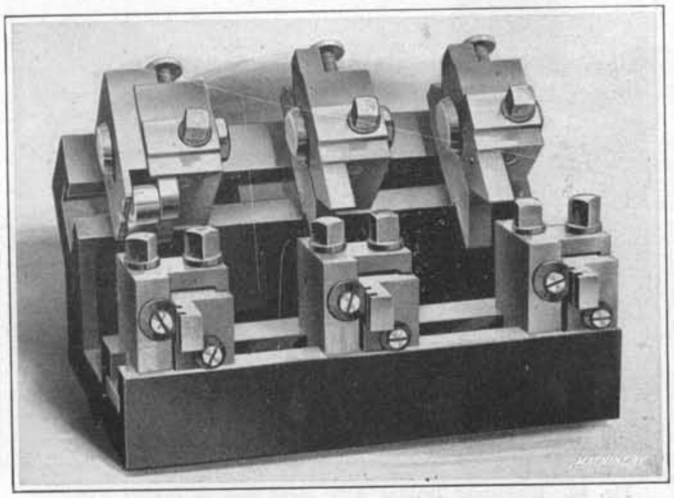


Fig. 18. Standard Type of Adjustable Stud Turner

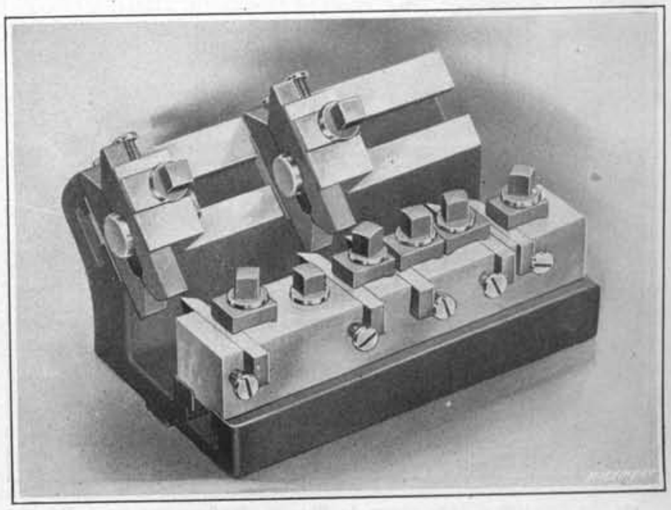


Fig. 19. Special Type of Adjustable Stud Turner

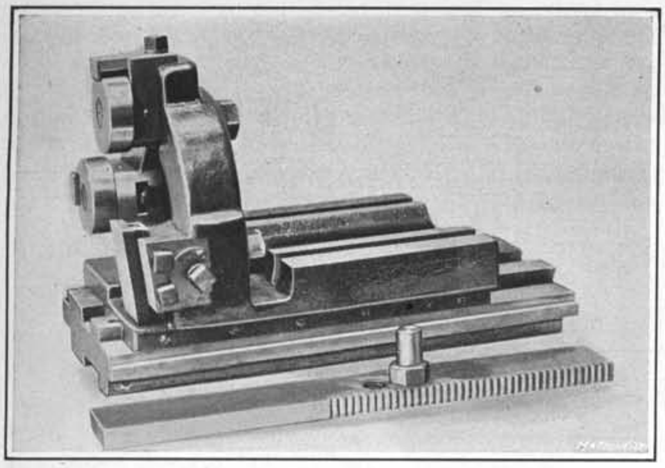


Fig. 20. Special Turner for use on Gridley 4¼-Automatic Turret Lathe

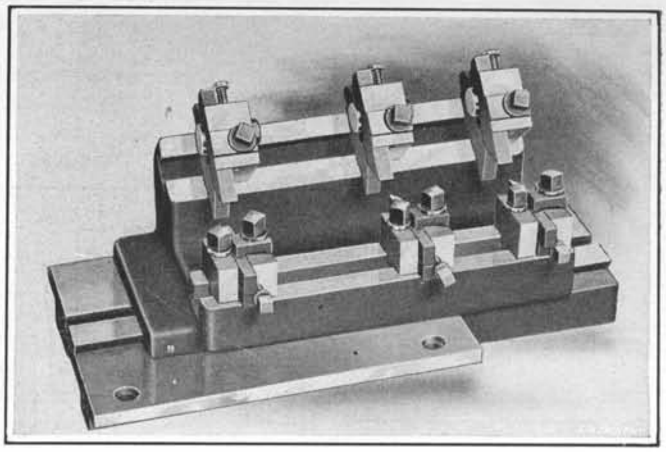


Fig. 21. Finishing Slide for handling Long Turning Operations on Gridley Automatic Turret Lathe

along the slide or holder to bring them in the most convenient position relative to the work, that is, where they can give the best support. When the required number of pieces have been made, this tool is put away without disturbing the cutting tools and can be kept until the same piece is to be produced again. In the arrangement shown, it is possible to put the cutting tools much closer together than in the holder shown in Fig. 18.

Knee Turner

Fig. 14 shows a type of tool known as a "knee turner," which can sometimes be used to good advantage for removing scale from the work by preceding the drill, reamer or other tool being used. It is narrow, so that it takes up very little space, and can be used in conjunction with some other tool. It cuts on the back side of the bar, so that the forming tool can be operated without backing off the knee turner from the work to get it out of the way.

Feeds and Speeds for Turning

The feeds and speeds used on the Gridley turret lathe when using the standard turners vary considerably and are governed entirely by the material and nature of the cut. Because of the rigidity of the machine, it is generally advisable to use a coarse feed and a comparatively slow speed. This statement applies especially in the production of studs or other work when the amount of metal to be removed is considerable. When only light cuts are to be taken, however, it is preferable to increase the speed and decrease the feed, although, as a general rule, the speed can be increased without decreasing the feed and still give satisfactory results, owing to the elimination of chatter. A careful analysis of each piece must be made, however, to determine what feed and speed should be used.

Special Turner for Use on 4 1/4-inch Machine

A special turner for handling long work is shown in Fig. 20. This turner, it will be noticed, is provided with two slides. One slide occupies the same groove in the turret face as the regular tool-slide, the latter being removed when using this special tool. The top slide, which carries the turning tool and supports, is attached to the turret face, and is operated through a pinion and rack; the latter is shown in the foreground of the illustration. The rear part of the top slide has two grooves in it. These are for attaching auxiliary turning tools, when such are necessary. The turning tool used is of the dovetail type, working on the end instead of the side of the bar. This tool is held in a slide, which provides for adjusting for diameter. Roller supports are used, and these are also held in the adjustable slide, as illustrated.

Finishing Slide

Another type of turning tool, known as a 12-inch finishing slide, is shown in Figs. 21 and 22. This slide will handle a turning operation of 12½ inches. It is not constructed for taking heavy roughing cuts, as these can be more satisfactorily handled with the regular turners placed one behind the other on the turret slide. This slide is operated in a similar manner to that shown in Fig. 20, but differs slightly in construction. With the arrangement shown in Fig. 20, the tool-holders and supports can be independently adjusted to the desired position. This feature is of especial advantage when finishing shafts having a series of shoulders of various diameters.

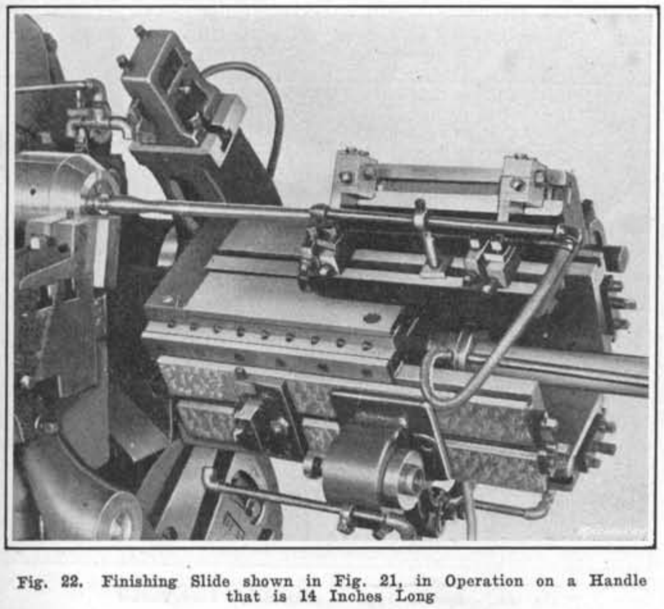


Fig. 22. Finishing Slide shown in Fig. 21, in Operation on a Handle that is 14 Inches Long

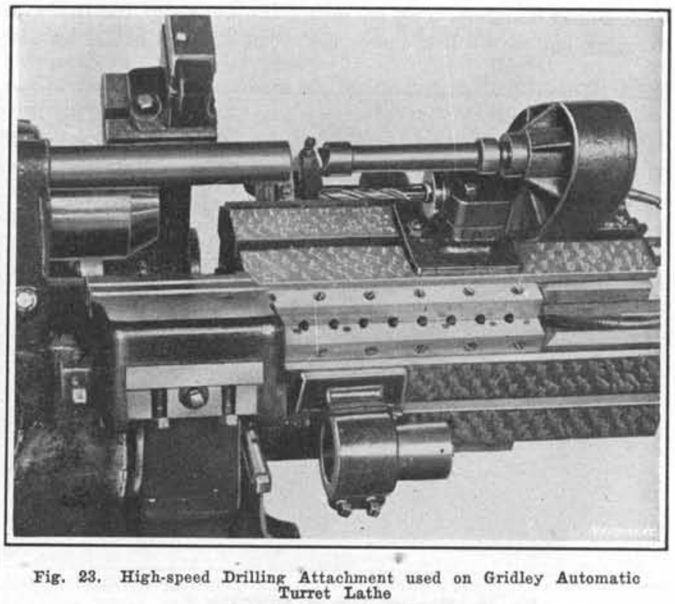


Fig. 23. High-speed Drilling Attachment used on Gridley Automatic Turret Lathe

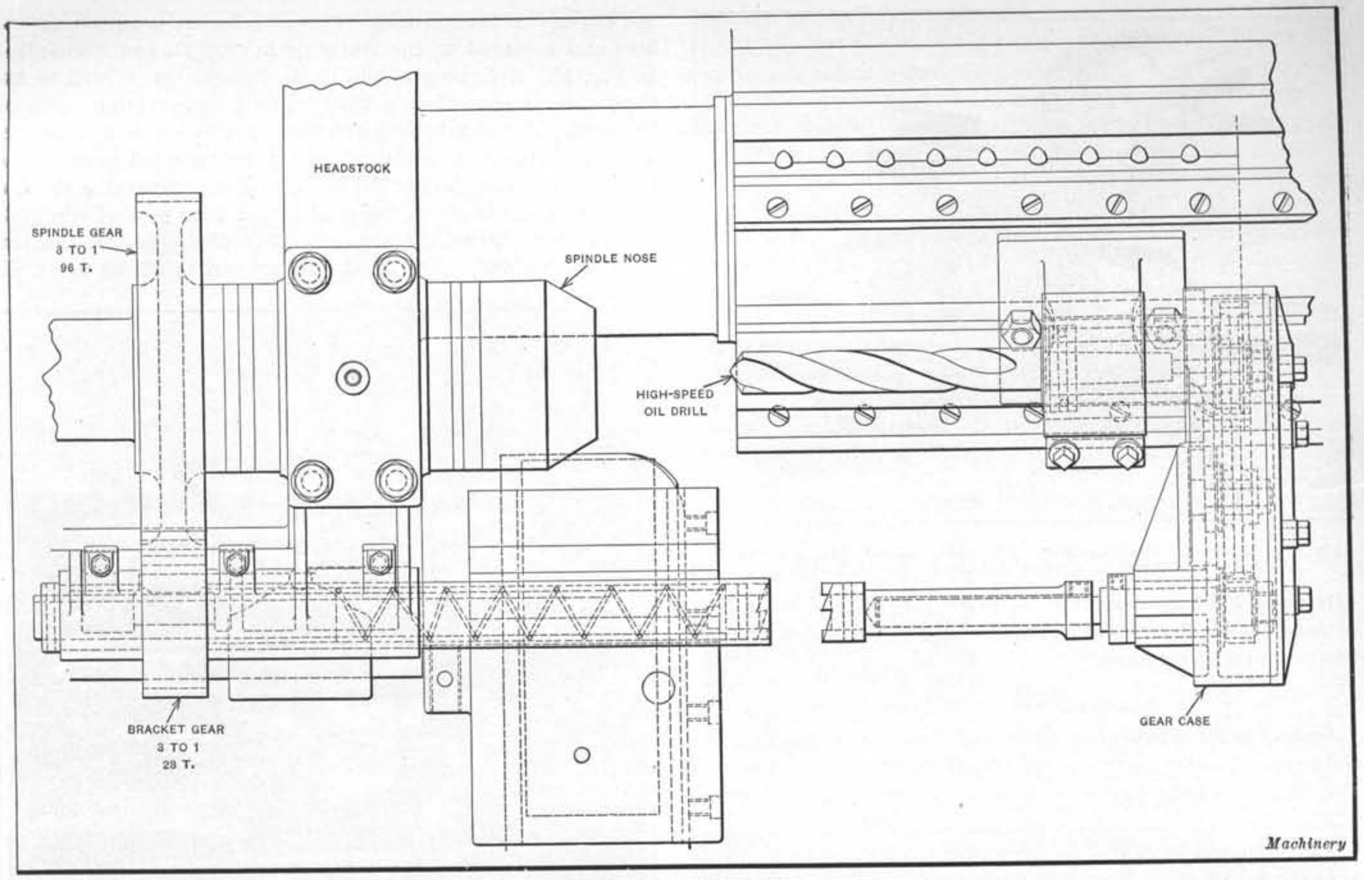


Fig. 24. Detail View of High-speed Drilling Attachment shown in Fig. 23

Fig. 22 shows the 12-inch finishing slide in operation on a handle, 14 inches long. In this case, the work is of such shape that only two turning tools can be used to advantage. The rear tool is used for reducing the end of the handle, whereas the forward tool finishes the straight portion.

High-speed Drilling Attachments

When it is necessary to drill a small hole in a large diameter bar, the best results can be secured by driving the drill at its proper cutting speed. This, of course, cannot be done without arranging a special driving mechanism for the drill, as the tools on the Gridley turret lathe are not rotated, but are held stationary. Fig. 23 shows the standard high-speed drilling attachment on the machine, and Figs. 24 and 25 show a plan and an end elevation view, respectively, of the same device. This attachment is designed for use on the different sizes of automatic turret lathes. Reference to the illustrations will show that it consists chiefly of a bracket, which is clamped to the front of the machine and carries a gear meshing with the spindle gear. The spindle gear has ninety-six teeth and the gear on the drill-driving spindle, twenty-eight teeth. The driving spindle is provided with a jaw clutch, as may be seen in Fig. 24, which is pinned to it and is kept out by means of an open-wound spring. When the turret slide advances to the drilling position, this clutch engages with a similar clutch member on the drill-driving mechanism proper, which is fastened to the holder carried on the tool-slide. As the turret-slide advances, the clutch on the main driving shaft is forced back into the sleeve against the tension of the open-wound spring previously mentioned.

The driving mechanism in the attachment held on the tool-slide consists of three gears, the driver, intermediate and driven gear, running inside an enclosed case. The driven gear is held on the spindle that carries the drill, the latter being supported in a regular tool-holder on the tool-slide. The arrangement of the driver, driven and intermediate gears can be more clearly seen in Fig. 25, where a sectional view of the driving spindle and drill-holder is shown; this view also indicates the relation of these members to the holder and the tool-slide.

The ratio between the number of teeth in the main spindle gear and the gear on the clutch shaft is 3 to 1. As shown in Fig. 25, the

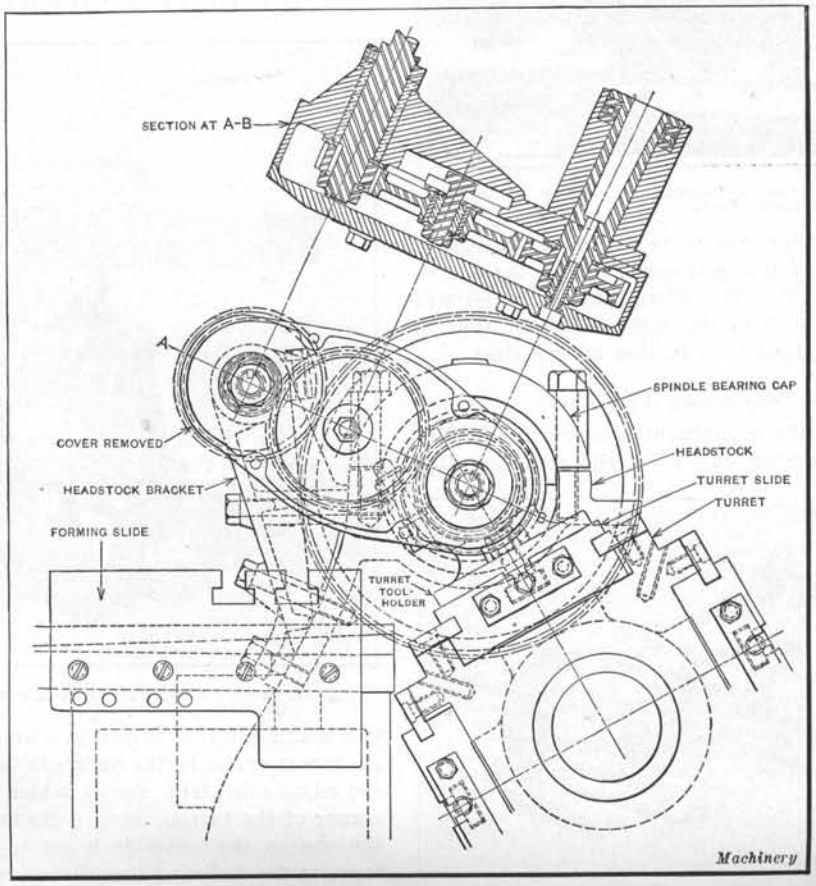


Fig. 25. End Elevation and Sectional View of Attachment shown in Fig. 23

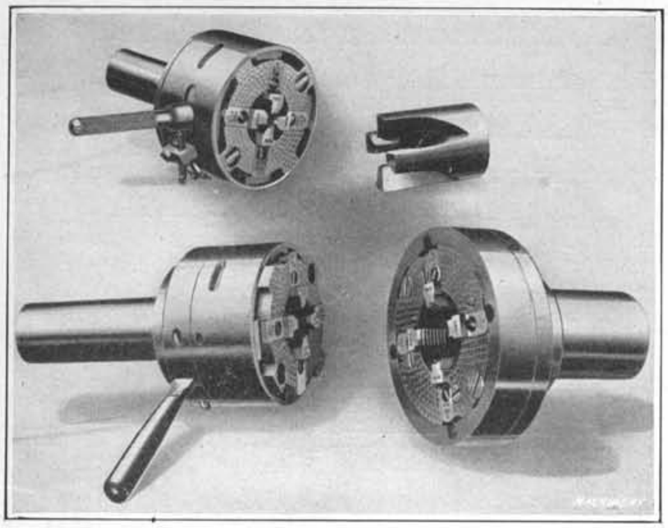


Fig. 26. Automatic Opening Dies, Adjustable Chaser Die and Spring Screw Die used on Gridley Automatic Turret Lathes

driving and driven gears can be interchanged, and when this is done four different drill speeds can be obtained with only two work-spindle speeds.

Automatic and Solid Dies

Several different types of automatic dies can be used on the Gridley automatic turret lathe. Some of these are shown in Fig. 26. As a general rule, it is advisable to use an automatic

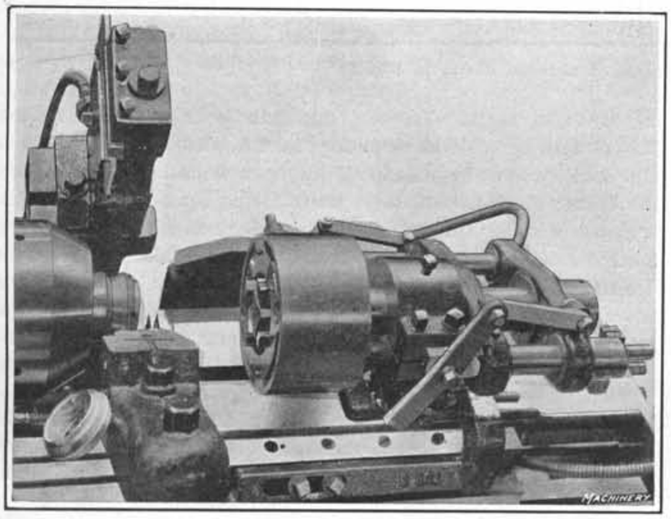


Fig. 27. Automatic Die Fixture in Operation on Gridley Automatic Turret Lathe

opening die on this machine, but there are cases, of course, when it is necessary to use the solid spring die or the adjustable chaser die shown in Fig. 26. These particular dies will be described in connection with the multiple-spindle type of machine and will not be dealt with further at this time.

Automatic Die-opening Attachment

The automatic die-opening attachment used on the Gridley automatic turret lathe consists of a lever and cam operating

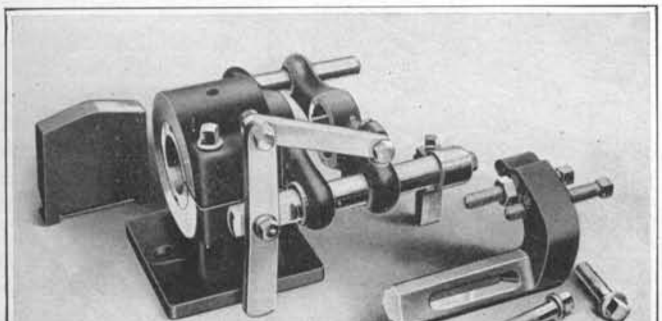


Fig. 28. Details of Automatic Die Fixture shown in Fig. 27

the chasers in the die-head. This attachment is shown assembled and mounted on the tool-slide in Fig. 27, and dismantled in Fig. 28. Referring to the latter illustration, it will be noticed that it comprises a holder and two operating cams or brackets. The arm to which the bellcrank lever is attached is, in turn, fastened to a rod, which can be operated upon by the front bracket attached to the turret-slide for returning the die-head; whereas the cam fastened to the rear part of the slide is used for closing the chasers. The die opens on the forward stroke, and closes on the return stroke of the tool-slide.

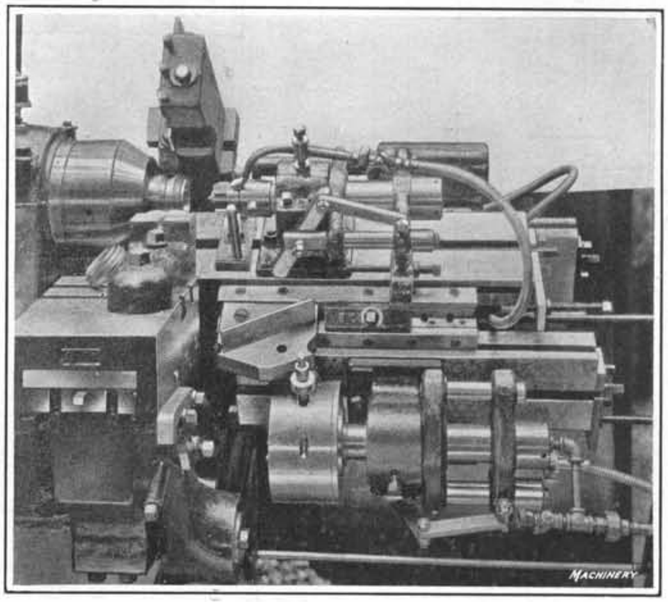


Fig. 29. Collapsing Tap Fixture in Operation on Gridley Turret Lathe

Releasing Tap-holder Attachment

When using a tap of the collapsible type on the Gridley automatic turret lathe, it is necessary to use a special attachment in connection with it, as shown in Fig. 29. This attachment does not differ materially from that used for the self-opening die, except in the method of operating the tap. As shown in the illustration, the chasers are collapsed by means of the operating handle on the collapsing tap-holder coming in con-

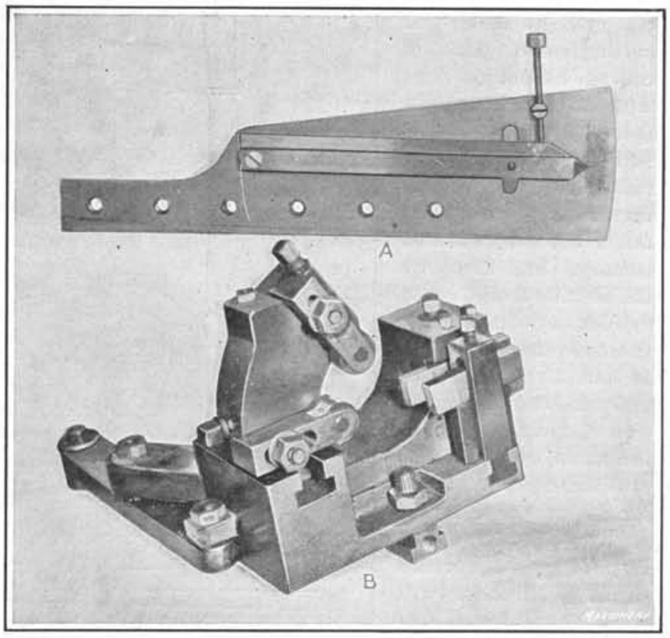


Fig. 30. Taper-turning Tool and Guide used on a Gridley Turret Lathe

tact with a pin that is held in a bracket on the tool-slide. The chasers are reset by the bellcrank lever coming in contact with the adjustable screw shown, which is held on a bracket on a corner of the turret. Both these brackets are adjustable, and the one on the tool-slide is set so that the chasers will collapse at the desired point, that is, when the tap has advanced to the desired depth. This illustration also shows a good

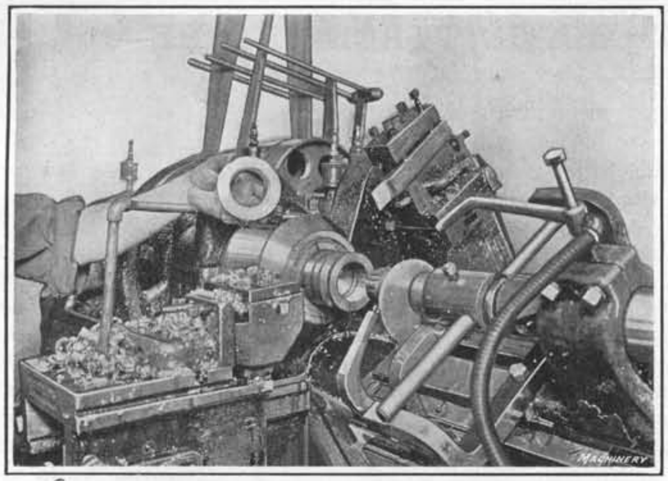


Fig. 31. A Different Design of Tap Fixture from that shown in Fig. 29

view of the opening cam for operating the automatic die-head.

Fig. 31 shows a tapping attachment for carrying a tap that is not of the same design as the one illustrated in Fig. 29. In this case the tap floats and is held in a collapsing holder in which a large collar is used for collapsing the chasers. This collar comes into contact with the arm fastened to the corner of the turret, and is so placed that the rod illustrated prevents the tap-holder from rotating with the work. The holder used is of the releasing type, and is drawn out against the tension of a spring when it advances into the work.

Taper-turning Attachments

Taper turning can be accomplished on the Gridley automatic turret lathe by the use of a simple attachment, shown at *A* and *B* in Fig. 30. The taper guide, which is capable of being adjusted as shown, is fastened by screws to the turret, whereas the turner proper is fastened to the tool-slide. A rod passing through the tool-holder and connected to a bellcrank lever, which carries a hardened slotted stud on its rear end, is operated by the adjustable taper guide. This particular taper turner carries two turning tools, and roller supports which can be set either ahead of or behind the front turning tool.

Fig. 32 shows a special taper-turner, turning two tapers on the same piece at the same time. The roller supports are between the front and back tools, and are on a straight diameter while the taper is being turned. In this particular case the taper away from the chuck is turned by a tool and slide operated directly from a guide similar to the guide shown in Fig. 30. The tool for turning the taper next to the chuck is held in a slide operating directly under the work. This slide is operated by a rocker-shaft, having a lever attached which fits into a cored hole in the tool-slide and is operated by an adjustable taper guide, attached to the turret as shown. These tools are all held in a special slide which takes the place of the regular slide similar to the tools shown in Figs. 20 and 21.

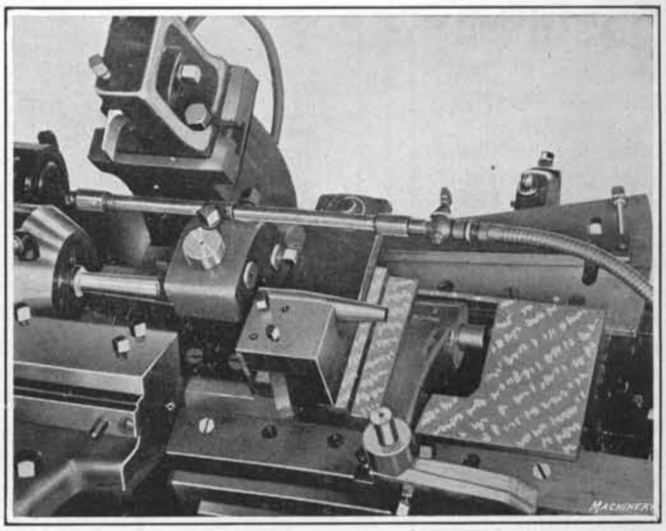


Fig. 32. Two Taper-turning Tools in Operation at the Same Time

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—1[1]

COMPLETE INSTRUCTIONS FOR TOOLING, SETTING-UP, AND OPERATING

THE Gridley automatic turret lathe is of the single-spindle type. It has three cam-drums for operating the various mechanisms. The main drum, which is located at the left-hand end of the machine, carries cams for operating the work-holding and feeding chucks and the tool-slides on which the end-working tools are held. The turret has four slides, and hence can be indexed four times for each revolution of the camshaft. When the corner stop is used, a fifth indexing is necessary. The indexing of the turret is accomplished by dogs carried on a drum located near the center of the main camshaft; this drum also carries dogs for operating the fast and slow feeds. The third cam-drum, located at the right-hand end of the camshaft, carries the cams for operating the forming slide and the cutting-off slide.

As each tool-slide is operated by a separate cam and as the travel of each slide is governed by the length to be turned, drilled, etc., it is necessary to select suitable cams, and in some cases to cut the standard cams or make special ones. It is, therefore, necessary for the operator to understand how to lay out these cams in order to operate the machine at its highest efficiency. The cams are laid out with relation to the main cam-drum, which makes one revolution in forty-two minutes on the slow feed, and one revolution in thirty-six seconds on the fast feed, the latter being used for the idle movements. The cams are laid out so that they advance the slides a certain specified distance per inch of circumferential travel of the drum on which they are held. In laying out any particular job, however, the first question to settle is the speed at which the work is to be rotated; this is governed by the diameter of the work, nature of the material, and character of the operation. In order to illustrate the procedure, a practical example will be taken and each step described.

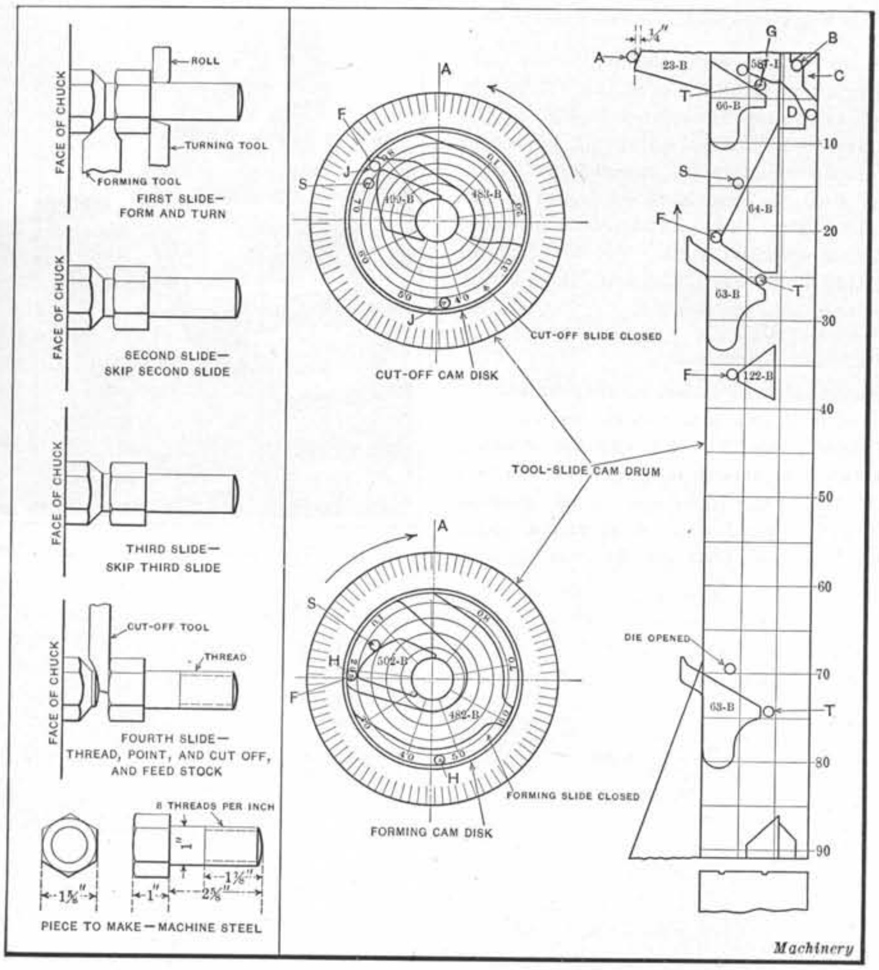


Fig. 1. Order of Operations and Lay-out of Cams for making Cap-screw

Method of Tooling

The shape and size of the part to be made largely govern the method of tooling that should be employed; the type of tools used also must be considered. In making a cap-screw of the form shown in Fig. 1, the forming tool is used for breaking down and chamfering the head, the box-turner on the turret-slide is used for turning, and the cutting-off tool cuts off and points the next screw. The threading, as a rule, is done with an opening die, which eliminates backing off the die.

After having decided on the order of operations and the tools to be used, it is necessary to determine the number of revolutions required to complete the cut and to select the cam to use. When the part to be made is to be threaded, two spindle speeds are usually necessary, especially for steel parts, so that all the other operations are performed at one spindle speed. As a general rule, the speed at which the forming cut can be satisfactorily taken may be considered the deciding factor. It is then necessary to determine the spindle speed required, which is governed by the diameter of the bar and the material. As most screw-machine tools are made from high-speed steel, a speed at least 25 per cent greater than would be possible with ordinary carbon tools may be employed.

The screw shown in Fig. 1 is to be made of hexagonal machinery steel, 1 5/8 inch across the flats, or 1 25/32 inch across the corners; hence the screw will be produced on a 2 1/4-inch machine. A surface speed for the work of 100 feet per minute will require a spindle speed of approximately 215 revolutions per minute.

Selecting Turret Feed Cam

The drum that carries the cams for operating the tool-slide has a circumference of 91 inches; and as it makes one complete revolution, on the slow feed, in forty-two minutes, it evidently travels $91 \div 42 = 2.166$ inches per minute. As shown in Table 1, several cams having different angles of rise are provided, so the problem is to select a cam having a rise sufficient to give the desired feed with a certain spindle speed. Fig. 1 shows that the turning tool must take a heavy cut, and so the cam having the slowest feed will be selected. The cam designated by the manufacturers as 64-B, Table 1, advances the tool-slide 0.4663 inch per each inch of circumferential travel of the drum; or, in other words, it advances the tool-slide at the rate of 1.01 inch per minute. The rise of the cam, in inches, per inch of travel of the drum is equal to the tangent of the angle on the cam; so the rise or advance per minute is found by multiplying the advance per inch of circumferential travel by 2.166.

It is next necessary to see if cam 64-B will give a suitable feed with the work rotating at 215 revolutions per minute. The feed of the tool per revolution of the work is found by dividing the feed of the cam per minute by the number of revolutions of the work; thus, $1.01 \div 215 = 0.0047$ inch. As the length to be turned is 2⅝ inches, with a feed of 0.0047

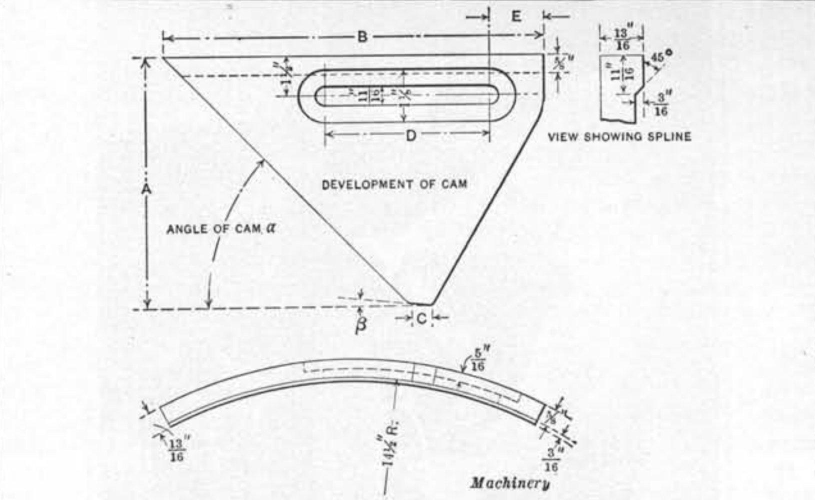
[1]For previous articles on Gridley multiple-spindle automatic screw machines, see "Operating the Gridley Multiple-spindle Screw Machine," May, 1918, and articles there referred to.

inch per revolution, it will require 458 revolutions to make the complete cut.

Selecting Forming Cam

Reference to Fig. 1 will show that the forming tool is not required to take a wide cut; hence it will stand a comparatively heavy feed. Table 2 shows that there are three forming cams provided; so the one giving the coarsest feed, or that designated as 502-B, will be taken. The forming tool is required to travel a distance equal to 1/2 (1 25/32—1), or 0.391 inch. Cam 502-B has a total rise of 2½ inches and will more than cover the distance. As this cam advances the forming slide at the rate of 0.3384 inch per minute, and as the work is rotating at 215 revolutions per minute, the feed per revolution is evidently 0.00157 inch. This is satisfactory under the conditions, and as the time required to take the forming cut is much less than that required for turning and the operation is accomplished at the same time, it need not be taken into consideration in determining the time required to complete the part.

TABLE 1. DIMENSIONS OF STANDARD TURRET FEED-CAMS USED ON GRIDLEY 2¼-, 3¼-, AND 4¼-INCH AUTOMATIC TURRET LATHES



Number of Turret Cam	Angle α of Cam, Degrees	Angle β Deg.	Advance of Slide, Inches per Minute	Advance of Slide per Inch of Drum Travel	Principal Dimensions of Cams, Inches				
					A	B	C	D	E
64-B	25	..	1.0100	0.4663	6	16¾	¾	4 13/16	2 11/32
154-B	25	..	1.0100	0.4663	8	18	..	5 5/16	2 23/32
278-B	28	5	1.1516	0.5317	9	19	⅜	7	2 1/16
62-B	30	..	1.2504	0.5773	6¼	14⅜	¾	5 5/16	2 3/16
61-B	38	..	1.6923	0.7813	6¼	11½	¾	4 1/16	1 27/32
122-B	40	..	1.8175	0.8391	3⅞	5¾	7/16	..	1 11/16
60-B	45	..	2.1666	1.0000	6	10	¾	3 9/16	2 3/32
65-B	45	..	2.1666	1.0000	6¼	13¼	4¼	5 5/16	1⅞
329-B	45	5	2.1666	1.0000	9	13¾	⅜	6	1 15/16

Threading

As all the tool-slides are not necessary to complete this screw, blocks are inserted in the index-plate, and the second and third slides skipped, bringing the turret around from the first to the fourth position for threading. This procedure saves considerable time, when only one tool is necessary on the tool-slide, with the exception of the die.

The time required for threading depends upon the pitch and length of the thread and on the material being threaded. Brass can be threaded, as a rule, at a speed of from 50 to 60 feet per minute, whereas the surface speed for soft steel should not exceed 30 feet per minute. Assuming in this case that the threading is to be done at 107 revolutions per minute, and figuring on a basis of 15 threads, 15 revolutions must be made to advance the die to the required distance. This will require 30 revolutions when figured on the basis on which the turning and forming is done because, for threading, the spindle is only operated at one-half the speed of that used for turning.

As the cam for operating the slide carrying the opening die should never follow the die up on the work, it is possible to use almost any cam, the one requirement being that the rise or advance per revolution of the work does not exceed the lead of the thread. Cam 122-B, according to Table 1, advances the slide at the rate of 1.817 inch per minute and as the spindle is rotating at 107 revolutions per minute, the advance per revolution is approximately 0.017 inch. As the pitch of the thread is 0.125 inch, the cam will not follow up the die.

TABLE 2. RISE OF STANDARD FORMING AND CUT-OFF CAMS AND ADVANCE OF SLIDE

Cam Number	Total Rise of Cam, Inches	Rise of Cam per Inch Travel of Drum	Advance of Slide per Inch Travel of Drum	Travel of Slide, Inches per Minute
Forming Cams				
502-B, coarse	2.500	¼	5/32	0.3384
501-B, medium	1.500	5/32	3/32	0.2033
503-B, fine	0.750	5/64	1/32	0.0676
Cut-off Cams				
499-B, coarse	2.500	¼	7/32	0.4737
500-B, fine	1.500	5/32	9/64	0.3046

Machinery

Selecting Cutting-off Cam

The cutting-off tool is required to take only a comparatively light cut and hence the coarsest feed-cam will be used. As shown in Table 2, cam 499-B advances the cutting-off slide at the rate of 0.4737 inch per minute, and at 215 revolutions per minute gives a feed per revolution of the work of 0.0022 inch. As the cutting-off tool has to travel approximately 0.520 inch, the number of revolutions required will be 236.

Summary of Operations

As it requires 36 seconds for the camshaft to make one complete revolution on the fast feed, this gives 9 seconds to index from one position to the next, and approximately 1 second to withdraw the plunger, making a total of 10 seconds for indexing. The tool-slides have a total travel of 8½ inches when the standard return cams are used, so it takes 3 seconds for the tool-slides to be returned the full distance. Allowing 3 seconds to feed the stock and close the chuck, the time required to complete the screw can be determined, as the spindle is operating at 215 revolutions per minute, or approximately 3.6 revolutions per second.

Operation	Time, Seconds	Number of Revolutions
Feed stock to stop and chuck............	3	10.8
Index turret..............................	10	36.0
Advance turner and turn.................	127	458.0
Return turner and index two spaces......	21	75.6
Thread and withdraw die from work.....	10	36.0
Cut-off and index turret..................	66	236.0
Withdraw cut-off and feed stock..........	15	54.0
Total..................................	252	906.4

It is thus found that approximately 4.2 minutes will be required to complete this screw.

Setting Cams and Tools

When setting up the Gridley automatic turret lathe to produce any piece of work, all the cams, dogs, etc., should be set before the tools are set or adjusted. The arrangement of the various cams for producing the hexagon-head screw is shown in Fig. 1. As only two turret-slides are used, the first step is to insert blocks in the turret index slots that will not be used. Then, when the turret is indexed, it jumps from the first to the fourth slide, skipping the second and third. The stop is held on the corner of the turret, and so the next step is to set the cam for the stop. The high point of the stop cam and the high point of the chuck-closing cam should be equal. When roll *B* is on the high point of the chuck-opening cam *C* and roll *G* is on the stock-stop cam 587-B, roll *A* should have a quarter-inch lead on cam 23-B in order to release the chuck. Cam 587-B should be relieved according to the amount that the collet feeds forward when gripping the stock. To return the stock stop, cam 66-B should be set with clearance for the roll to pass between it and cam 587-B. When the roll is flush with the high point of the return cam, the indexing dog should be set on the cam-operating drum against the revolving lever at this point, as shown in Fig. 3. Indexing should be done only on the fast speed. The turret is now indexed to the first slide and the machine stopped at this point. In all the examples given in the illustration the indexing points are marked *T* and the points where changes in speed occur are marked *S* and *F*, which designate slow and fast speeds.

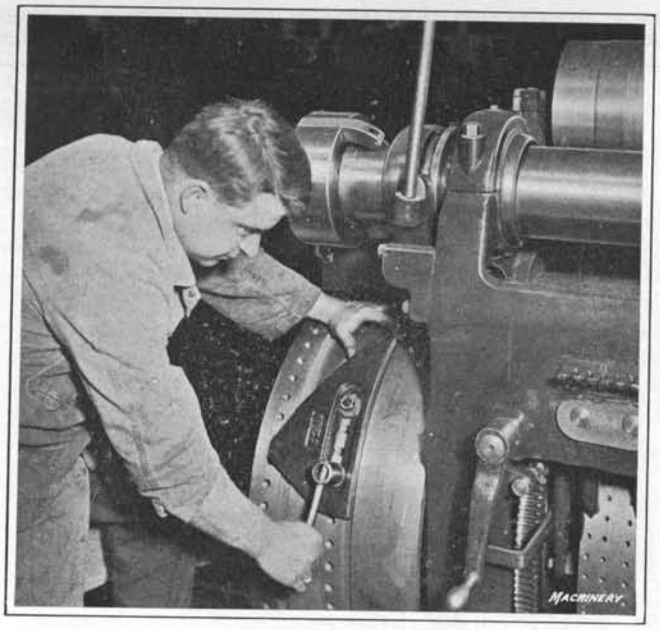


Fig. 2. Clamping Cams on Main Cam-drum

Setting Turret Feed-cam

As the cam to be used for operating the turning tool has been selected, the next step is to clamp this to the drum, as illustrated in Fig. 2. Cam 64-B is now set up against roll *G* and the slow-feed dog, shown in Fig. 4, should be set on the cam-operating drum at this point for safety in setting up the machine; the dog is properly located later. Crank the machine forward, by hand, until the roll *G*, Fig. 1, is at the high point of cam 64-B; then set the forming cam 502-B, which was previously selected for operating the forming slide, at the high point of the roll *H*. Also set the fast-feed dog on the operating drum at this point as illustrated in Fig. 4. Now set the forming slide return cam 482-B and the tool-slide return cam 63-B, allowing clearance for rolls *G* and *H*. Then crank the machine forward until roll *G* is at the high point of the return cam 63-B and set the indexing dog, as shown in Fig. 3, at this point. Index the turret from the first to the fourth position or slide, where the threading is to be accomplished. The die is to be operated at a slower spindle speed than the other tools so that the belt should be shifted from the fast to the slow spindle speed as soon as the drum shaft start to rotate at the fast feed. As soon as the turret has indexed to the fourth slide, stop the machine and set the roll *G* at the high point of the die cam 122-B. The drum rotates on the fast feed until the die opens. The return cam for the die slide should now be set as shown in Fig. 1; then crank the machine until the roll *G* is on the high point of the cam 63-B, and measure down on the cut-off cam 499-B a distance slightly greater than the amount of travel actually required to cut off the piece. Set roll *J* at this point and clamp cam 499-B in position. Crank the machine, by hand, until roll *J* reaches the high point of the cam and set the cut-off cam 499-B and the return cam 483-B so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Set the dog on the operating drum to change from slow to fast feed when roll *J* is on the high point of the cut-off cam 499-B; also set the dog to index from the fourth slide to the stop. This completes the rough setting of the cams.

Setting the Tools

Before proceeding to set any of the tools, it is a good plan to give attention to points that have not been mentioned; one is the placing of the weights, see Fig. 5, on the chain that operates the stock-feeding mechanism. The number of weights to use is governed by the weight and size of the bar being handled, so that it is sometimes necessary to add weights after the machine has been set up. Usually, after the operator has had some experience, he can tell how many weights are required without trial.

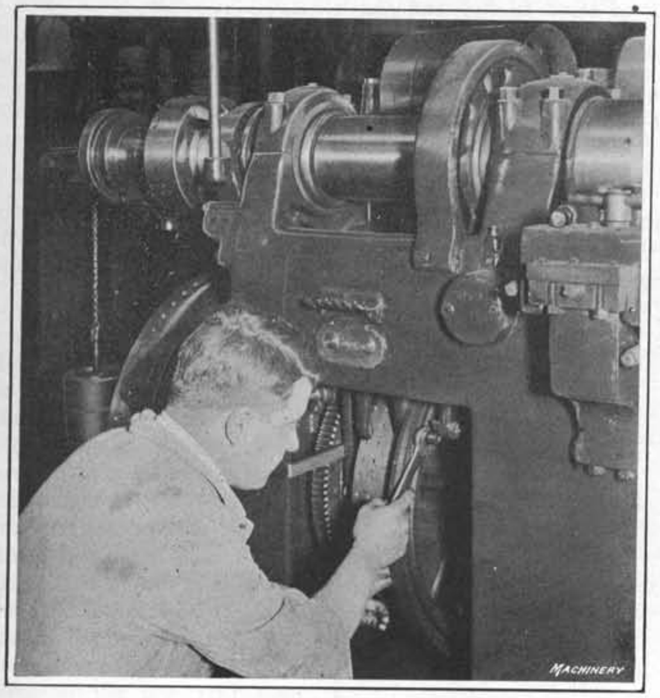


Fig. 3. Adjusting Dog for indexing Turret

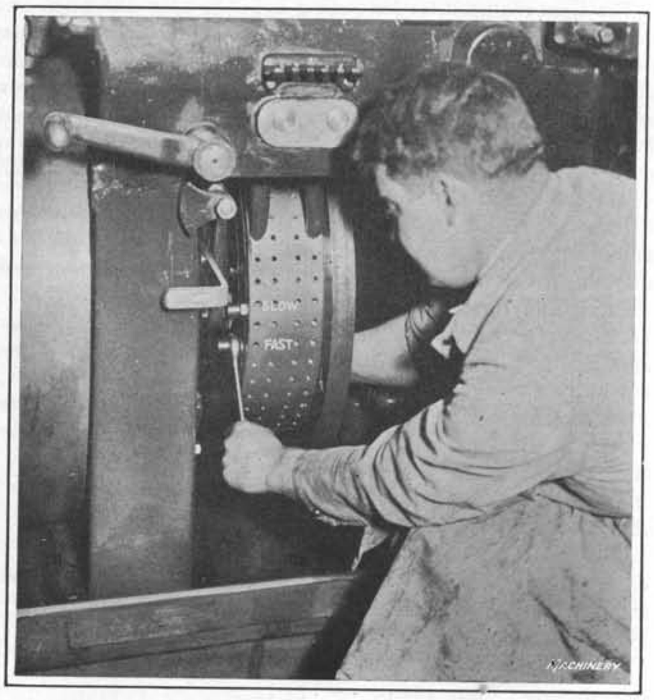


Fig. 4. Adjusting Dog for changing from Slow to Fast Feed

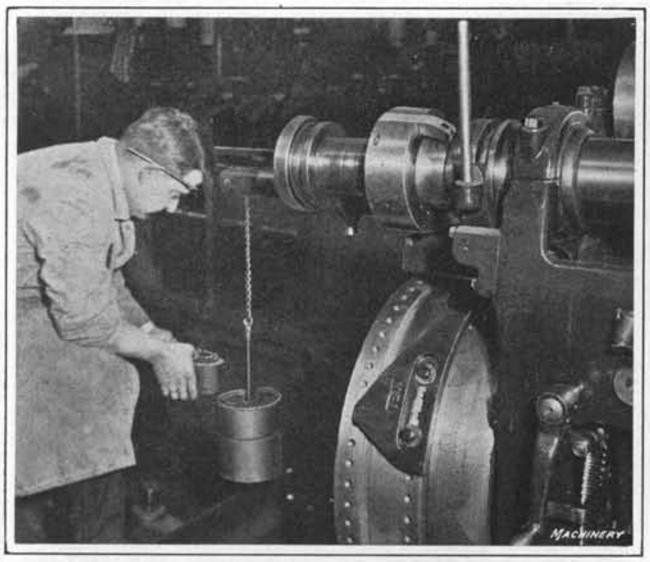


Fig. 5. Changing Weights on Stock-feeding Mechanism

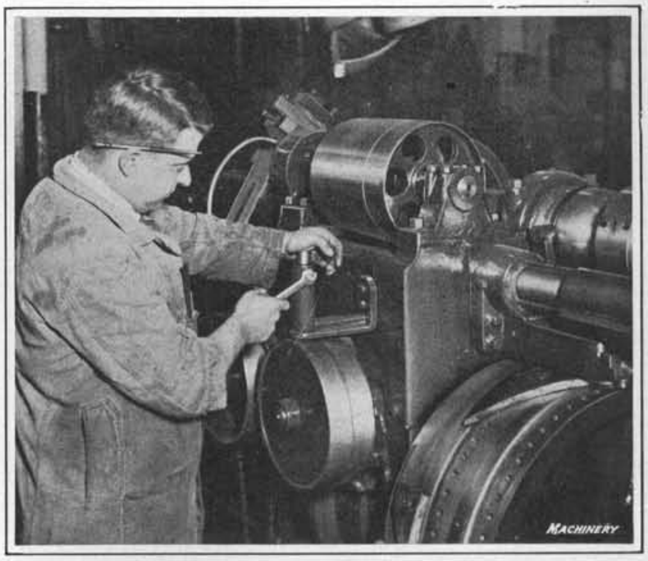


Fig. 6. Adjusting Friction for Fast-feed Pulley

Another point that should receive attention is the setting of the friction on the pulleys that control the operation of the fast and slow feeds of the camshaft; this is set as shown in Fig. 6. The set-screw is released and the plunger forced down by hand sufficiently to exert the required friction on the pulley, after which the set-screw is tightened. If this friction is not tight, and the tools are set close to the work before changing to the slow feed, a slight slippage of the belt is likely to cause the tools to dig into the work, with the result that they may be broken. Many operators do not give this friction any attention until they experience trouble; it should be adjusted each time the machine is set up, and, on a long run of work, it should be frequently inspected.

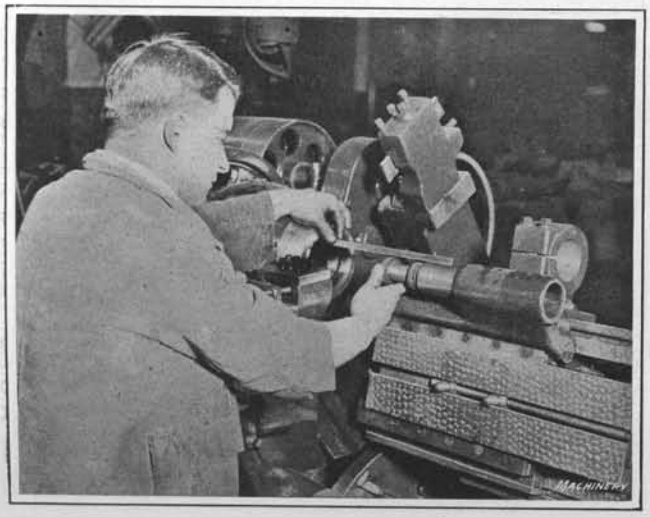
Setting the Stop

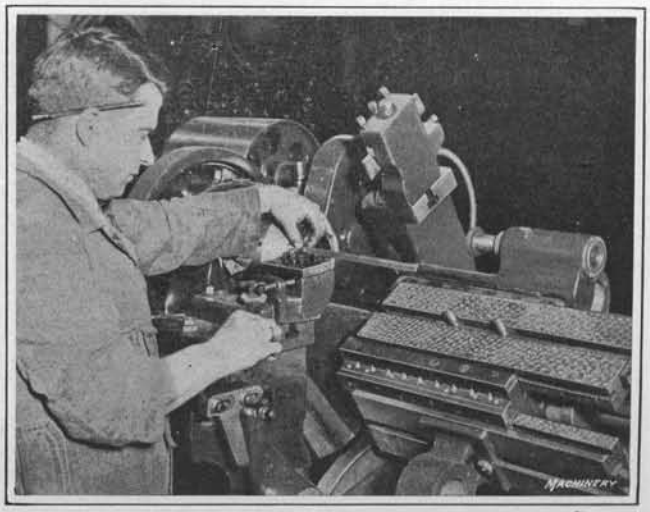
The first tool to set is the stop; as a general rule, the corner stop is used. The machine is cranked by hand until the roll is at the high point of the stop cam 587-B, Fig. 1; then the stop is placed in position on the corner of the turret and moved into the approximate position. A scale is used to measure from the face of the chuck, as shown in Fig. 7, allowance being made for clearance for the forming and cutting-off tools and for the thickness of the cutting-off tool. When the stop has once been properly set, it is locked in position. The stop cam should be relieved according to the amount that the collet feeds forward when gripping the stock. This relieves the pressure of the stock on the stop caused by the chuck closing on the work. Then the return cam should be set for the stop, so as to come into action just as the roll leaves the high point of the cam that advances it. The draw-bar roll at this time should be flush with the high point of the stop return cam. Now the dog on the operating drum, Fig. 3, should be brought up to the lock-pull lever and the machine indexed by power on the fast feed of the camshaft by setting the dog for shifting the belt on the pulleys shown in Fig. 6. The belt shifter should be so set that it throws the belt over the full distance and does not allow it to drag on the slow-feed pulley; then, as the lock-bolt drops into place, the machine should be stopped by pulling over the belt shifter by hand and the dog placed for shifting to the slow feed at this point.

Setting Forming Tool and Turner

As the forming cam has been set in position, the next step is to set the forming tool to the spindle nose, and not for turning to the correct diameter. The forming tool to use is clamped in the proper holder, and the latter located on the forming slide, as shown in Fig. 8, by means of a scale, measuring from the face of the chuck to the rear of the forming tool. In setting this tool, it is necessary to take into consideration the amount that was allowed for clearance and, in some cases, the amount used up by the tool in cutting off the piece from the bar. Then set the turning tool relative to the face of the chuck, as shown in Fig. 9. In this particular case a single turner is being used, which is placed on the first slide and moved into the approximate position; then, by means of a scale, measure from the face of the chuck to the front edge of the turning tool, making allowance for clearance for the forming tool and the distance that the turning tool has to travel on the work.

The next step is to set the turning tool to approximately the correct diameter. First open the chuck by hand and insert a bar of stock, letting it project from the face of the chuck the required distance. Then close the chuck by hand and pull over the belt shifter to start the spindle rotating. Before starting to turn the crank handle, release the roller-rests and withdraw them so that they will not come into





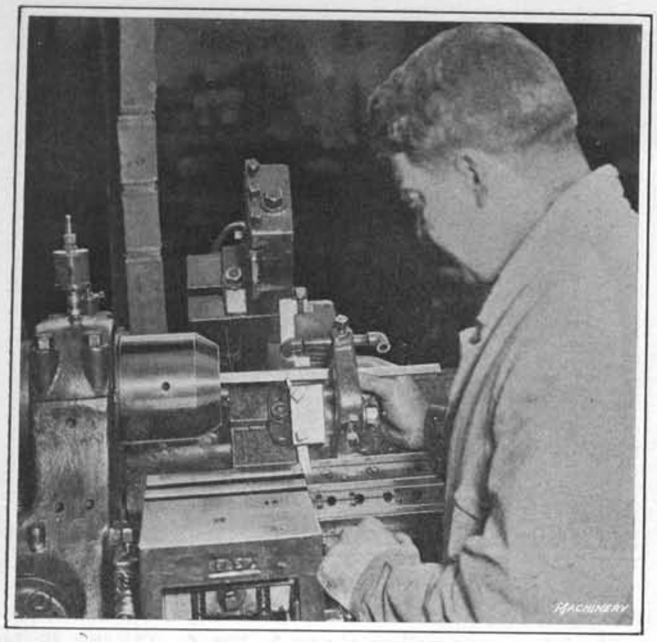


Fig. 9. Setting Turning Tool Relative to Spindle Nose

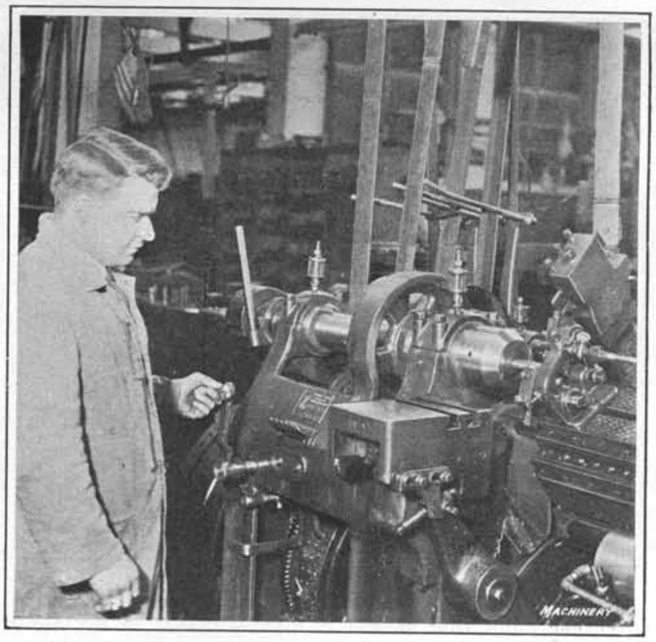


Fig. 10. Setting Turning Tool to partly turned down Work

contact with the work. Then set the turning tool to approximately the center of the bar, clamp the holder and the tool in position, and turn the bar down for a distance of about 1/4 inch, cranking the machine by hand. Now stop the spindle and measure the work; if it is not correct, crank the machine backward until the tool is free from the work and adjust it. Continue in this manner until the tool has been properly set. Then, with the tool still in contact with the work and the spindle stopped, set the roller-supports to the work. Crank the machine by hand, see Fig. 10, until the roll is at the high point of the cam and the tool set so that it will turn to the required length.

Before setting the dog to shift to the fast speed, set the forming tool in the correct position and adjust the forming cam, if necessary, so that the roll is at the high point of the cam when the forming tool just clears the work. Start the spindle rotating and feed in the forming tool, by operating the screw that adjusts the slide, until the forming tool has turned the bar down to the correct diameter. Then set and lock the stop in the forming slide, so that the forming tool will always advance to the same position. It is a good idea to put a slight spring or tension in the lever operating the forming slide, so that the forming tool will finish up with a light cut. Set the dog so that it will shift to the fast feed on the high point of the cam, and set the return cams, 63-B and 482-B, leaving sufficient space for the rollers to pass between them and the advancing cams. Clamp the cams in position and crank the machine until the roll is on the high point of the return cam 63-B. Then set the dog as required for indexing the turret.

Setting Die and Die-operating Attachment

As soon as the turret has been indexed to the point where the fourth slide is in line with the chuck, stop the machine and set the die attachment. Rotate by the hand-crank until the roll is on the high point of the threading cam 122-B. Then move the die attachment up on the slide, bringing the die up against the end of the work. Exert pressure on the die-holder to compress the spring, Fig. 11, and at the same time tighten the screws that clamp the die attachment to the slide. Set the cams to shift the belt from the fast to the slow or threading spindle speed. This cam should be set so that the belt is shifted before the roll reaches the high point of the threading cam. The dog for shifting from the fast to the slow feed is not set, as the screw is threaded on the fast feed.

After the tension on the die has been set with the die closed, open the die and move it out of the holder to the desired distance for the length of thread. If threading to a shoulder, set the die 1/16 inch away from the shoulder. Place the stop on the corner of the turret-slide, as shown in Fig. 12, so that the die will be opened at this point, and later adjust the stop so that the die is advanced to the exact position before opening. Crank the machine backward so that the roll is free from the die cam, and adjust the screws in the stop on the corner of the turret, as shown, in Fig. 13, to close the die when it returns. Then bring the die forward by cranking the machine and note that the spindle shifts from the fast to the slow spindle speed before the die comes into contact with the work. Allow the die to thread or advance on the work by power until the die is opened; then place the return cam one inch from the roll, placing the high-speed cams so as to shift

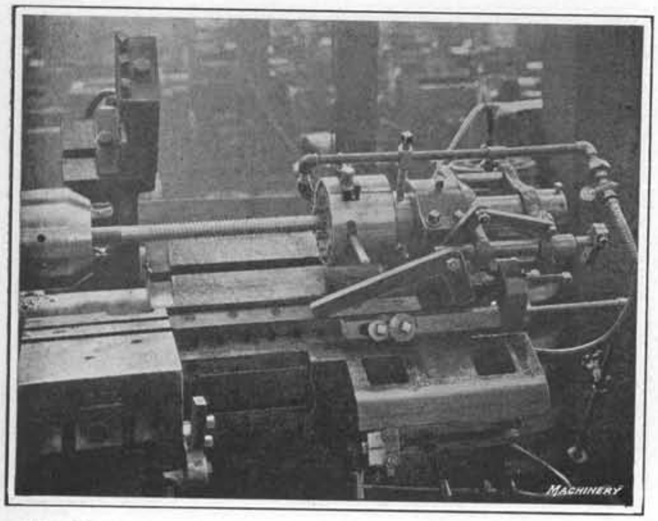


Fig. 11. Setting Opening Die with Roll on High Point of Cam

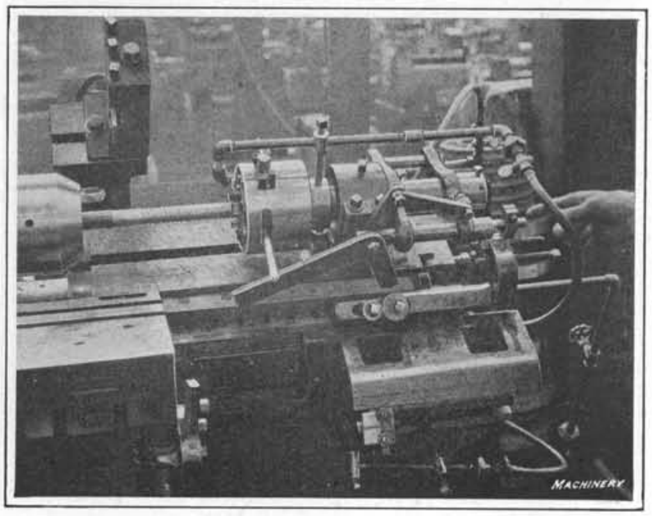


Fig. 12. Setting Stop for threading to Length with Die Open

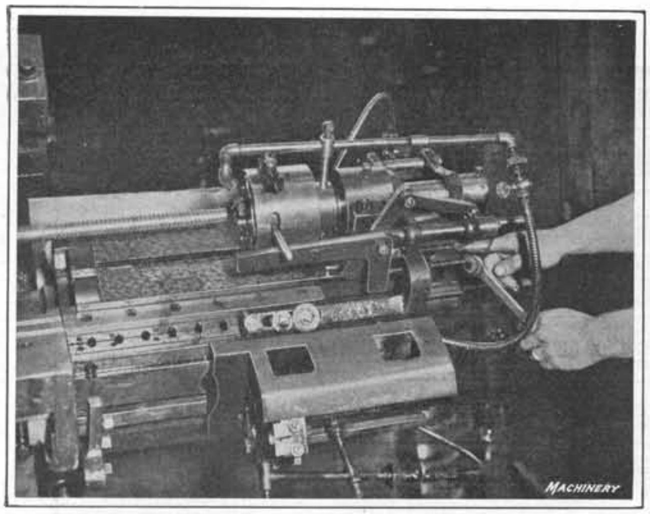


Fig. 13. Setting Stop for closing Die

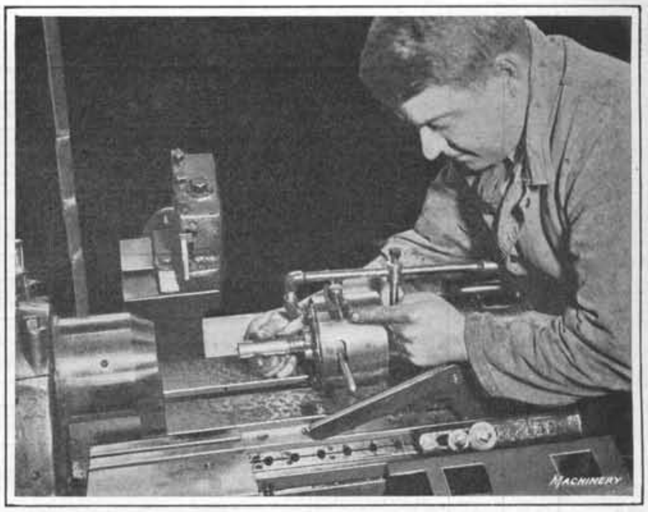


Fig. 14. Setting Die for Size to Plug Gage

the machine to the fast spindle speed. To set the die so that it will cut a thread of the correct diameter, it is advisable to set the chasers to a plug gage, as shown in Fig. 14. The dies is closed by operating the closing lever and then the chasers are adjusted to the plug gage.

Setting Cutting-off Tool

Now set the cut-off cam 499-B, Fig. 1, as shown in Fig. 15, so that the cut-off tool will start to work by the time the spindles have changed to the fast speed. This cam should be set so that when the spindle is changed to the fast speed, the roll will be on a point of the cam that measures an amount equal to the distance that the slide has to travel from the high point of the cam to cut off the piece.

The chuck can now be opened (if the cut-off tool has not previously been set), the bar pulled back, and the cut-off tool set relative to the center of the Chuck, as shown in Fig. 16. To do this, it is necessary to crank the machine by hand until the roll is on the high point of the cut-off cam; then set the cut-off tool and clamp it in position. Now crank the machine back to the point where it will start to cut off, push out the stock, set it, and close the chuck; set the slow-feed dog at this point. The piece is now cut off by cranking the machine by hand, and, as the tool passes the center, set the dog to shift to the fast feed; also, set the dog to index from the die slide to the stop. Set the return cam 483-B, Fig. 1, to return the cut-off slide, leaving space for the roll to pass between the two cams. As a rule, the cut-off cams are set so as to return the cut-off clear of the spindle just before the chuck is opened. Therefore it is not necessary to change the position of these cams in most cases. Leave the machine running on the fast feed until the first tool is in position to start on the work; then set the slow-feed dog. This is all that is required in the setting of the cut-off tools.

Fig. 14A. Standard Cams used on Gridley Automatic Turret Lathes

In Fig. 14A are shown the standard cams used on the Gridley automatic turret lathes. The number of the cams and their description are as follows: (A) 10282, turret feed cam, 45 degrees 6 inches; (B) 10278, turret feed-cam, 45 degrees 6¼ inches; (C) 10280, turret feed-cam, 30 degrees 6¼ inches; (D) 10326, turret feed-cam for starting die; (E) 10327, corner stock stop-cam, (F) 10279, turret feed-cam, 25 degrees 6 inches; (G) 10299, turret feed-cam, 45 degrees 9 inches; (H) 10281, turret feed-cam, 38 degrees 6¼ inches; (I) 10306, turret feed-cam, 28 degrees 9 inches; (J) 10287, turret feed-cam, 25 degrees 8 inches; (K- 10413, stock feed-cam extension; (L) 10412, stock feed-cam; (M) 10268, turret return cam, 60 degrees 9 inches; (N) 10305, return cam, 45 degrees 9 inches; (O) 10303, cut-off cam, fine feed; (P) 10304, cut-off cam, coarse feed; (Q) 10312, return cut-off cam; (R) 10301, forming cam, medium feed; (S) 10313, return forming cam; (T) 10302, forming cam, coarse feed; (U) 10300, forming cam, fine feed.

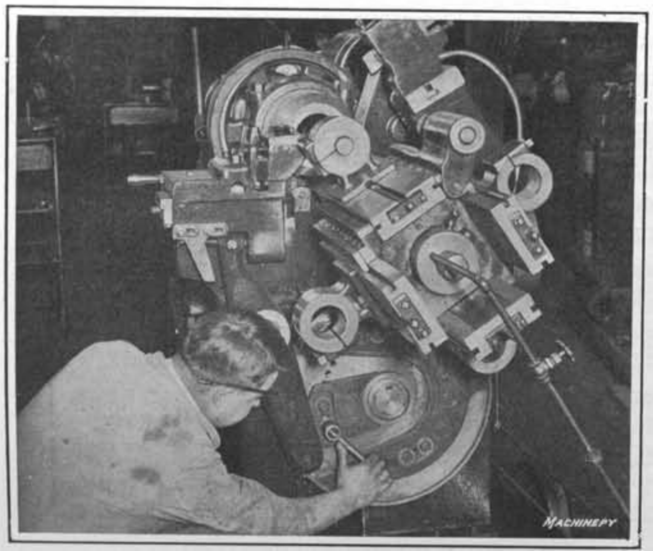


TABLE OF SURFACE SPEEDS IN FEET PER MINUTE

REVOLUTIONS PER MINUTE

Feet Per Minute / Diam.	15	20	25	30	35	40	45	50	55	60	65	70
1/16	917	1223	1528	1834	2140	2445	2751	3057	3363	3668	3974	4280
1/8	459	611	764	917	1070	1222	1375	1528	1681	1834	1986	2139
3/16	306	408	509	611	713	815	917	1019	1121	1222	1325	1426
1/4	229	306	382	458	535	611	688	764	851	917	994	1070
5/16	183	245	306	367	428	489	550	611	672	733	794	856
3/8	153	204	255	306	357	408	458	509	560	611	662	713
7/16	131	175	218	262	306	349	393	437	481	524	568	611
1/2	115	153	191	229	268	306	344	382	420	459	497	535
9/16	102	136	170	204	238	272	306	340	373	407	441	475
5/8	91.8	123	153	184	214	245	276	306	337	367	398	428
11/16	83.3	111	138	167	194	222	249	273	300	333	360	389
3/4	76.3	102	127	153	178	203	229	254	279	306	330	357
13/16	71.1	94.8	119	142	166	190	213	237	261	284	308	332
7/8	65.5	87.3	109	131	153	175	196	219	241	262	285	306
15/16	61.0	81.4	101	122	142	163	183	204	224	244	265	285
1	57.3	76.4	95.5	115	134	153	172	191	210	229	258	267
1 1/16	53.9	71.8	89.8	108	126	144	162	180	197	215	233	251
1 1/8	51.0	68.0	85.0	102	119	136	153	170	187	204	221	238
1 3/16	48.3	64.4	80.5	96.6	113	129	145	161	177	193	209	225
1 1/4	45.8	61.2	76.3	91.8	107	123	137	153	168	183	199	214
1 5/16	43.6	58.2	72.8	87.3	102	116	131	146	160	175	189	204
1 3/8	41.7	55.6	69.5	83.3	97.2	111	125	139	153	167	180	195
1 7/16	39.8	53.0	66.3	79.5	92.8	106	119	133	146	159	172	186
1 1/2	38.2	50.8	63.7	76.3	89.2	102	115	127	140	153	165	178
1 9/16	36.6	48.8	61.0	73.2	85.4	97.6	110	122	134	146	159	171
1 5/8	35.0	47.0	58.8	70.5	82.2	93.9	106	117	129	141	152	165
1 11/16	33.9	45.2	56.5	67.8	79.1	90.4	102	113	124	136	147	158
1 3/4	32.7	43.6	54.5	65.5	76.4	87.3	98.2	109	120	131	142	153
1 13/16	31.7	42.2	52.8	63.3	73.9	84.4	95.0	106	116	127	137	148
1 7/8	30.6	40.7	50.9	61.1	71.3	81.5	91.9	102	112	122	133	143
1 15/16	29.6	39.4	49.3	59.1	69.0	78.8	88.7	98.5	108	118	128	138
2	28.7	38.2	47.8	57.3	66.9	76.4	86.0	95.5	105	115	124	134
2 1/8	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0	99.0	108	117	126
2 1/4	25.4	34.0	42.4	51.0	59.4	68.0	76.2	85.5	93.5	102	111	119
2 3/8	24.2	32.2	40.3	48.3	56.4	64.4	72.5	80.5	88.6	96.6	105	113
2 1/2	22.9	30.6	38.2	45.8	53.5	61.2	68.8	76.3	84.2	91.7	99.5	107
2 5/8	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.5	79.8	87.0	94.3	102
2 3/4	20.8	27.8	34.7	41.7	48.6	55.6	62.5	69.5	76.5	83.4	90.4	97.2
2 7/8	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0	72.6	79.2	85.8	92.4
3	19.1	25.5	31.8	38.2	44.6	51.0	57.3	63.7	69.9	76.4	82.6	89.1
3 1/8	18.3	24.4	30.5	36.6	42.7	48.8	54.9	61.0	67.1	73.2	79.3	85.4
3 1/4	17.6	23.4	29.3	35.1	41.0	46.8	52.7	58.5	64.4	70.2	76.1	81.9
3 3/8	17.0	22.6	28.3	33.9	39.6	45.2	50.9	56.5	62.2	67.8	73.5	79.1
3 1/2	16.4	21.8	27.3	32.7	38.2	43.6	49.1	54.5	60.0	65.5	70.8	76.4
3 5/8	15.8	21.0	26.3	31.5	36.8	42.0	47.3	52.5	57.8	63.0	68.3	73.5
3 3/4	15.3	20.4	25.5	30.6	35.7	40.8	45.9	51.0	56.1	61.2	66.3	71.4
3 7/8	14.8	19.7	24.6	29.6	34.5	39.4	44.3	49.3	54.2	59.1	64.0	69.0
4	14.3	19.1	23.9	28.7	33.4	38.2	43.0	47.8	52.6	57.3	62.1	66.9
4 1/4	13.5	18.0	22.5	26.9	31.4	35.9	40.4	44.9	49.4	53.9	58.4	62.9
4 1/2	12.7	16.9	21.2	25.4	29.6	34.0	38.2	42.4	46.6	51.0	55.1	59.4
4 3/4	12.1	16.1	20.1	24.1	28.1	32.2	36.2	40.2	44.2	48.2	52.3	56.3
5	11.5	15.3	19.1	22.9	26.7	30.6	34.4	38.2	42.0	45.9	49.7	53.5
5 1/4	10.9	14.5	18.2	21.8	25.4	29.1	32.7	36.4	40.0	43.6	47.3	50.9
5 1/2	10.4	13.9	17.4	20.8	24.3	27.8	31.3	34.7	38.2	41.7	45.1	48.6
5 3/4	10.0	13.3	16.6	19.9	23.2	26.6	29.9	33.2	36.5	39.8	43.2	46.5
6	9.6	12.7	15.9	19.1	22.3	25.5	28.7	31.8	35.0	38.2	41.3	44.6
6 1/4	9.2	12.2	15.3	18.3	21.4	24.4	27.5	30.6	33.6	36.7	39.7	42.8
6 1/2	8.8	11.7	14.7	17.6	20.5	23.5	26.4	29.4	32.3	35.2	38.2	41.1
6 3/4	8.5	11.3	14.2	17.0	19.8	22.6	25.5	28.3	31.1	34.0	36.8	39.6
7	8.1	10.9	13.6	16.4	19.1	21.8	24.6	27.3	30.0	32.7	35.5	38.2
7 1/4	7.9	10.5	13.2	15.8	18.4	21.1	23.7	26.4	29.0	31.6	34.3	36.9
7 1/2	7.6	10.2	12.7	15.3	17.8	20.4	22.9	25.4	28.0	30.5	33.1	35.6
7 3/4	7.4	9.8	12.3	14.8	17.2	19.7	22.1	24.6	27.1	29.5	32.0	34.4
8	7.2	9.6	11.9	14.3	16.7	19.1	21.1	23.9	26.3	28.7	31.0	33.4

Feet Per Minute / Diam.	75	80	85	90	95	100	110	120	125	130	140
1/16	4586	4891	5197	5502	5800	6114	6725	7337	7643	7948	8560
1/8	2292	2445	2598	2750	2903	3056	3362	3667	3820	3973	4278
3/16	1529	1630	1732	1834	1936	2038	2242	2446	2548	2649	2853
1/4	1147	1222	1300	1376	1453	1528	1681	1734	1910	1986	2139
5/16	917	978	1039	1100	1161	1222	1344	1466	1527	1589	1711
3/8	764	815	865	916	967	1018	1121	1222	1273	1323	1425
7/16	656	699	743	786	830	874	961	1049	1093	1136	1224
1/2	573	611	649	688	726	764	840	917	955	993	1070
9/16	509	543	577	611	645	679	747	813	869	883	951
5/8	459	489	520	552	581	612	673	736	765	796	857
11/16	416	444	472	500	527	555	611	666	692	722	770
3/4	381	409	432	458	483	508	559	610	635	661	711
13/16	356	379	403	427	450	474	521	569	593	616	664
7/8	329	349	372	392	416	438	482	526	548	569	613
15/16	305	326	346	366	387	407	448	488	509	529	570
1	287	306	325	344	363	382	420	458	478	497	535
1 1/16	269	287	305	323	341	359	395	431	449	467	503
1 1/8	255	272	289	306	324	340	374	408	425	442	476
1 3/16	242	258	274	290	306	322	354	386	403	419	451
1 1/4	230	245	260	274	291	306	337	367	383	398	428
1 5/16	218	233	247	262	276	291	320	349	351	378	407
1 3/8	208	222	236	250	264	278	306	334	348	361	389
1 7/16	199	212	225	239	272	265	292	318	331	345	371
1 1/2	191	204	216	230	241	254	279	305	318	330	356
1 9/16	183	195	207	220	232	244	268	293	305	317	342
1 5/8	176	188	199	212	222	234	257	281	293	304	328
1 11/16	170	181	192	203	215	226	249	271	283	294	316
1 3/4	164	175	185	196	207	218	240	262	273	283	305
1 13/16	158	169	179	190	200	211	232	253	264	274	295
1 7/8	153	163	173	184	194	204	224	244	255	265	286
1 15/16	148	158	167	177	187	197	217	236	246	256	276
2	143	153	162	172	181	191	210	229	239	248	267
2 1/8	135	144	153	162	171	180	198	216	225	234	252
2 1/4	128	136	145	153	162	170	187	204	213	221	238
2 3/8	121	129	137	145	153	161	177	193	201	209	225
2 1/2	114	122	130	138	145	153	168	184	191	199	213
2 5/8	109	116	123	131	138	145	160	174	181	189	203
2 3/4	104	111	118	125	132	139	153	167	174	181	195
2 7/8	99.0	106	112	119	125	132	145	158	165	172	185
3	95.3	102	108	114	121	127	140	152	159	165	178
3 1/8	91.5	97.6	104	110	116	122	134	146	153	159	171
3 1/4	87.8	93.6	99.5	105	111	117	129	140	146	152	164
3 3/8	84.8	90.4	96.1	102	108	113	124	136	141	147	158
3 1/2	81.8	87.4	92.7	98.1	104	109	120	131	136	142	153
3 5/8	78.8	84.0	89.3	94.5	99.8	105	116	126	131	137	147
3 3/4	76.5	81.6	86.7	91.8	96.9	102	112	122	128	133	143
3 7/8	73.8	78.8	83.7	88.6	93.6	98.5	108	118	123	128	138
4	71.7	76.4	81.3	86.0	90.8	95.6	105	115	120	124	134
4 1/4	67.4	71.8	76.3	80.8	85.3	89.8	98.8	108	112	117	126
4 1/2	63.6	67.9	72.1	76.3	80.6	84.8	93.3	102	106	110	119
4 3/4	60.3	64.3	68.3	72.4	76.4	80.4	88.4	96.9	101	105	113
5	57.3	61.1	64.9	68.8	72.6	76.4	84.0	91.7	95.5	99.3	107
5 1/4	54.5	58.2	61.8	65.4	69.1	72.7	80.0	87.2	90.9	94.5	102
5 1/2	52.0	55.6	59.0	62.5	65.9	69.4	76.3	83.3	86.8	90.2	97.2
5 3/4	49.8	53.1	56.4	59.8	63.1	66.4	73.0	80.0	83.0	86.3	93.0
6	47.7	51.0	54.0	57.2	60.5	63.6	70.0	76.3	79.5	82.7	89.0
6 1/4	45.8	48.9	51.9	55.0	58.0	61.1	67.2	73.3	76.4	79.4	85.5
6 1/2	44.0	47.0	49.9	52.8	55.8	58.7	64.6	70.4	73.4	76.3	82.2
6 3/4	42.5	45.3	48.1	50.9	53.8	56.6	62.3	67.9	70.8	73.6	79.2
7	41.0	43.7	46.0	49.1	51.9	54.6	60.1	65.5	68.3	71.0	76.4
7 1/4	39.5	42.2	44.8	47.4	50.1	52.7	58.0	63.2	65.9	68.5	73.8
7 1/2	38.2	40.7	43.3	45.8	48.4	50.9	56.0	61.1	63.6	66.2	71.0
7 3/4	36.9	39.4	42.8	44.3	46.7	49.2	54.1	59.0	61.5	64.0	68.9
8	35.9	38.2	40.6	43.0	45.4	47.8	52.6	57.4	59.8	62.1	66.9

Feet Per Minute / Diam.	150	160	170	175	180	190	200
1/16	9171	9782					
1/8	4584	4890	5195	5348	5501	5806	6112
3/16	3055	3261	3465	3567	3668	3872	4076
1/4	2292	2445	2598	2674	2750	2903	3056
5/16	1833	1955	2077	2139	2200	2322	2444
3/8	1527	1629	1731	1782	1832	1934	2036
7/16	1311	1398	1486	1530	1573	1661	1748
1/2	1146	1222	1299	1337	1375	1452	1528
9/16	1019	1086	1154	1188	1222	1290	1358
5/8	918	979	1040	1071	1102	1163	1224
11/16	833	888	944	971	999	1054	1110
3/4	762	813	864	889	914	965	1016
13/16	711	758	806	830	853	901	948
7/8	657	701	745	767	788	832	876
15/16	611	651	692	712	733	773	814
1	573	611	649	669	688	726	764
1 1/16	539	579	610	628	646	682	718
1 1/8	510	544	578	595	612	646	680
1 3/16	483	515	547	564	580	612	644
1 1/4	459	490	520	536	551	581	612
1 5/16	437	466	495	509	524	553	582
1 3/8	417	445	472	487	500	528	556
1 7/16	398	424	451	464	477	504	530
1 1/2	381	406	432	445	457	483	509
1 9/16	366	390	415	427	439	464	488
1 5/8	351	374	398	410	421	445	468
1 11/16	339	362	384	396	407	429	452
1 3/4	327	349	371	382	392	414	436
1 13/16	317	338	359	369	380	401	422
1 7/8	306	326	347	357	367	388	408
1 15/16	296	315	335	345	355	374	394
2	287	306	325	334	344	363	382
2 1/8	270	288	306	315	324	342	360
2 1/4	255	272	289	298	306	313	340
2 3/8	242	258	274	282	290	306	322
2 1/2	230	245	260	268	275	291	306
2 5/8	218	232	247	254	261	276	290
2 3/4	209	222	236	242	250	264	278
2 7/8	198	211	224	231	238	251	264
3	191	203	216	222	228	241	254
3 1/8	183	195	207	214	219	232	244
3 1/4	176	188	199	205	211	222	234
3 3/8	170	181	192	198	203	215	226
3 1/2	164	174	186	191	196	207	218
3 5/8	158	168	179	184	189	200	210
3 3/4	153	163	175	179	184	194	205
3 7/8	148	158	167	172	177	186	197
4	143	153	163	167	172	182	191
4 1/4	135	144	153	157	162	171	180
4 1/2	127	136	144	148	153	161	170
4 3/4	121	129	137	141	145	153	161
5	115	122	130	134	138	145	153
5 1/4	109	116	124	127	131	138	145
5 1/2	104	111	118	121	125	132	139
5 3/4	99.6	106	113	116	120	126	133
6	95.4	102	108	111	114	121	127
6 1/4	91.7	97.7	104	107	110	116	122
6 1/2	88.1	93.9	100	103	106	112	117
6 3/4	84.9	90.6	96.2	99.0	102	108	113
7	81.9	87.4	92.8	95.6	98.3	104	109
7 1/4	79.1	84.3	89.6	92.2	94.9	100	105
7 1/2	76.4	81.4	86.5	89.1	91.6	96.7	102
7 3/4	73.8	78.7	83.6	86.1	88.6	93.5	98.4
8	71.7	76.5	81.3	83.7	86.0	90.8	95.6

Machinery

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—2

EXAMPLES OF CAMMING AND SETTING OF TOOLS

In the first installment of this article, published in the June number of Machinery, the general directions for setting up and operating the Gridley automatic turret lathe were given. The present installment will take up some specific examples of work done on the machine and will show the camming required and the tool set-up necessary.

Tooling Lay-out for Making Counterbored Bushing

The counterbored bushing illustrated in Fig. 17 has been selected to show the working relations of the forming slide to the turret-slide, when working at the same time; and also of the cutting-off and counterboring tools when working at the same time. This part is to be made from 2½-inch cold-rolled steel, and hence will be handled on a 3¼-inch machine. The operations required to complete this part are:

Position	Operation
First.........	Form and drill large hole
Second.......	Drill small hole
Third.........	Skip
Fourth.......	Combination ream and counterbore, and cut off

The procedure to follow in setting the various cams, dogs, tools, etc., to complete this part is given in the following; the method of selecting the came has been fully explained in the preceding article.

Assuming that the proper spring chuck and feed-chuck have been put into place and all the tools and cams used for a previous job have been removed, proceed in the following manner to set the cams, dogs, etc., for producing the part shown: First, crank the machine by hand, and when roll *B* is on the high point of cam *D*, roll *G* should be on the high point of cam 587-B. This cam should be relieved, depending on the amount that the collet feeds forward in closing on the work. To return the stop, return cam 66-B should be set to allow clearance for roll *G* to pass between it and cam 587-B. When roll *G* is flush with the high point of the return cam, the indexing dog should be set to index the turret. Indexing should only be done when the machine is operating on the fast feed. Now revolve the turret to bring the first slide into position, and set cam 64-B against roll *G*. The slow-feed dog should be set at this time for safety sake when setting up the machine. Crank the machine forward until roll *G* is on the high point of cam 64-B and set the forming cam to the high point of roll *H*, allowing clearance for the roll; also set the fast-feed dog on the cam-operating drum. Set the forming slide return cam 482-B and tool-slide return cam 63-B, allowing clearance for the rolls. Now crank the machine forward until roll *G* is flush with the high point of return cam 63-B and set the dog for indexing the turret; revolve the turret to the second slide, stopping the machine at this point.

Setting Drilling Cam

The next operation is drilling the small hole, which is to be performed from the second slide; came 62-B is selected for this operation. Set this cam and the slow-feed dog and crank the machine forward until roll *G* is on the high point of the cam 62-B; then locate the fast-feed dog. Set return cam 63-B, allowing clearance for the roll to pass, and crank the machine forward until roll *G* is flush with the high point of the return cam; then set the indexing dog. Plug up the indexing slot in the third position and index to the fourth position.

Setting Cut-off and Counterboring Cams

We are now ready to set the cams for the cut-off tool and counterbore, which, as shown in Fig. 17, work at the same time. Crank the machine to the high point of the cut-off cam 499-B, which, with the return cam 483-B, should be set so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Crank the machine backward to the high point of the cut-off cam and locate return cam 155-B, so as to return the tool-slide far enough to allow the piece to drop off the counterbore when it is cut off. Again crank the machine backward and set cam 62-B for the counterbore, allowing clearance for the roll; set the slow-feed dog at the low point of cam 62-B, where the counterbore starts to work. The fast-feed dog should be set at the high point of the cut-off cam 499-B, and the revolving dog should be set after the machine has been shifted to the fast feed. This completes the preliminary setting of the cams.

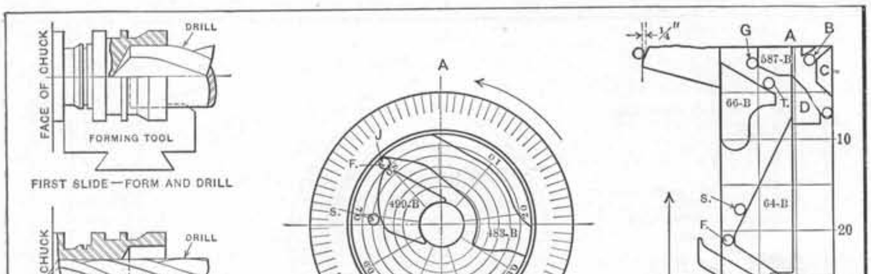


Fig. 17. Tooling Lay-out for Work in which Drilling and Forming Operations are performed at Same Time

Setting the Tools

The vertical forming tool and holder should be set to clear the spindle nose at the high point of the cam, and, at the same time, the large drill should be set at the required distance from the spindle nose. Set the stop for the stock at the required distance from the spindle nose; then place sufficient weights on the chain to feed the stock out to the stop and index from the corner stop position to the first slide. Crank the machine forward to the high point of the cam, watching the fast-feed dog, and adjust the forming tool for the height and diameter and set the stop for the slide. Index the turret to the second slide and drill the small hole. It is advisable in all cases to set the various tools with relation to the face of the chuck before placing the bar of stock in the chuck, as in this way the setting of the tools can be approximately located without wasting any stock. After setting the small drill, index to the fourth slide, skipping the third slide, and set the counterbore. Next set the cut-off tool to cut off the piece and travel only into the small drill hole, not to the center of the chuck. This completes the setting of the tools, but it is necessary to make a few pieces, adjusting the slow- and fast-feed dogs on the operating drum so as to reduce the non-cutting movements and thus produce the part in the shortest possible time. It is also necessary in some cases to make minor adjustments of the cutting tools.

Making a Thin Washer

The thin washer shown in Fig. 18 is to be made from 4⅝-inch stock, and hence will be handled on the 5-inch machine. It should be noted that the corner stop cannot be used because it will not clear. This example shows drilling, counterboring, and reaming operations with the cut-off tool working continuously. As shown, the operations are accomplished in the following order:

Position	Operation
First	Form, bore with set-over tool, and cut off 5/8 inch
Second	Drill, turn, and cut off 3/8 inch
Third	Ream with strippers on reamer and finish cutting off 1/2 inch
Fourth	Feed stock to stop

The procedure to follow in setting the various cams, dogs, tools, etc., does not differ materially from the preceding, and is, briefly, as follows: The cams are set in the following order: Set cam 65-B, for counterboring, against roll *G*, and set the slow-feed dog on the operating drum for safety. Crank forward to the high point of the cam and set the continuous cut-off cam 229-B, which is made special for this job, to the high point of roll *J* on the first rise; also set forming cam 502-B to the high point of forming-cam roll *H*. Set the return cam 482-B, allowing clearance for the roll to pass. Set the fast-feed dog on the cam operating the drum at this point.

Set the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank forward until the roll *G* is flush with the high point of the return cam, setting the revolving dog on the operating drum at this point. Index the turret to the second slide and stop the machine. Crank forward to the high point of the cut-off cam—the second rise—and then set the cam 64-B to the high point of the turret tool-slide roll *G*, and set the fast-feed dog on the drum. Crank backward to the low point of the cut-off cam 229-B—the second rise—and set the slow-feed dog for safety. Now locate the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. Index to the third slide and set the high point of the tool-slide cam 61-B to the high point of the third rise on the cut-off cam, and set the fast-feed dog at this point. Crank backward to set the slow-feed dog at the low point of cam 61-B and set the tool-slide return cam 155-B, allowing clearance for the roll; also set the special return cam for the cut-off arm, allowing for clearance. The next step is to crank backward until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. When laying out the special continuous cut-off cam 229-B, the first rise on the cam is made to give 5/8 inch travel of the slide; the second rise gives 3/8 inch travel, and the third, 1/2 inch travel. These rises are laid out so that they occupy about the same time as the opreations performed from the tool-slides. The concentric portions of the cam are laid out to stop the travel of the slide while the turret is indexing. On the third slide, the piece is cut off and the work is removed from the reamer by the strippers when the tool-slide returns; the stock is then fed out to the stop in the fourth position. The tools are set in the manner previously described, and the final setting of the indexing, fast-feed, and slow-feed dogs is made after the machine is operating under power.

Producing a Long Shaft

The third example is a long shaft, which illustrates a long forming operation, shown in Fig. 19. Owing to the length of this form, it is impossible to operate the forming tool at the same surface speed as the turning tool, so the order of the operations is as follows:

Position	Operation
First	Turn
Second	Form and support, using two rolls
Third	Skip
Fourth	Thread and cut off

This part is made from 1⅞-inch cold-rolled steel, and is handled on a 2¼-inch machine. As the corner stop is used, the fifth turret index-hole is not blocked. The first operation is to turn the bar for a distance of 4⅜ inches; then the turret is indexed to the second position, and the speed of the spindle changed to one-half the spindle speed used for turning. The bar is formed at the points indicated, and rolls held in special supports are brought in from the turret. In order that the rolls will remain stationary while the forming tools are at work, a special cam is used on the main drum; this cam is as long as the amount of circumference of the drum occupied by the forming operation. The third index-hole is plugged and the turret is indexed to the fourth position with the spindle still operating at the same speed as that used for forming.

The machine is run on the fast feed until the die has approached the work, when it is shifted to the slow feed, at which speed it is run until the die opens, when the spindle is

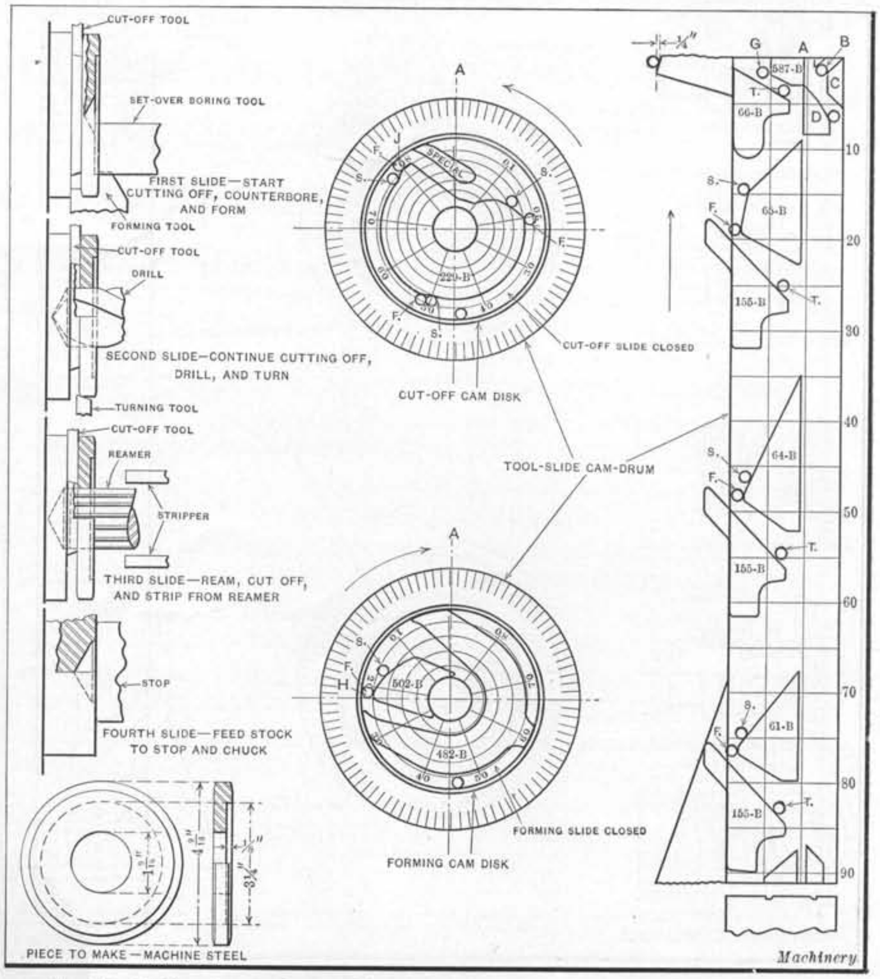


Fig. 18. Tooling Lay-out for a Thin Washer in which Cut-off Tool works continuously

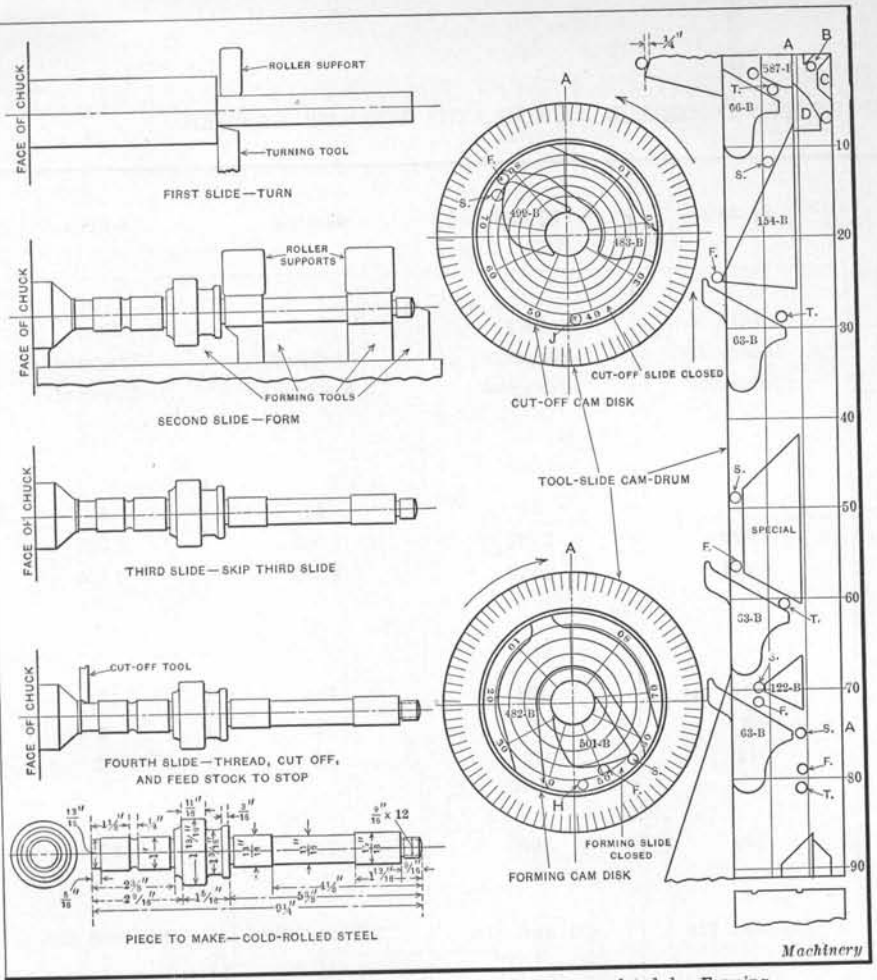


Fig. 19. Tooling Lay-out for a Long Shaft largely completed by Forming

changed to the fast speed again. The cut-off tool is now brought in on the slow feed and the piece cut off. As soon as the piece is cut off, the dogs are set to change to the fast feed and to index the turret. This series of operations is repeated on the next piece.

Producing a Long Sleeve with a Tapered Hole

The long sleeve with a tapered hole shown in Fig. 20 illustrates how drilling and turning operations can be accomplished at the same time, also reaming and cutting-off operations. The part is made from 4-inch cold-rolled steel, and hence will be handled on a 4¼-inch machine. The operations necessary to complete this piece are:

Position	Operation
First	Drill and turn
Second	Rough-ream
Third	Form and support
Fourth	Finish-ream and cut off

The drill is the first tool brought into position, as it has to travel slightly farther than the turning tool, which is held on the same tool-slide. Cam 329-B is selected to give a feed that is suitable for both tools. The turret is now indexed to the second position and the work rough-reamed. It is next indexed to the third slide, where the work is formed from the forming slide and is supported from the turret by a special internal support. In order that the support will remain in position while the forming tool is at work, a special cam 65-B is necessary on the main drum. The turret is now indexed to the fourth slide, where the hole is finish-taper-reamed, and cut off. It will be noticed that the reamer is required to take a long taper cut to finish, so that the feed of the tool will be reduced at the end of the cut. This is accomplished by a special cam 278-B, which is cut away to give a fast feed to start, and to reduce the feed when the taper part of the reamer comes into action. The cut-off tool comes into action after the reamer has been fully withdrawn from the work. A fast-feed dog is set when the piece has been cut off and the turret is indexed and the series of operations is completed on the next piece. The full procedure to follow in setting the various cams and tools has not been included in the last two examples for the reason that it does not differ materially from that previously described.

Conclusion

The preceding articles describing the construction and operation of the single-spindle Gridley automatic turret lathe make it possible for the operator to become thoroughly acquainted with the design of the machine and its tool equipment, and to obtain the thorough knowledge that is required for tooling, setting up, and operating the machine so that he should have no difficulty in obtaining the maximum production and the high degree of accuracy of which the machine is capable. Whatever facilitates production at the present time is a distinct service not only to the machine industry, but to the nation as a whole. The one important question with every manager is production, and as only the operator who understands his machine and knows how to apply and adjust the tooling equipment properly and how to operate the machine can be expected to reach maximum production, specific instruction treatises, such as the one presented here, are of the greatest importance.

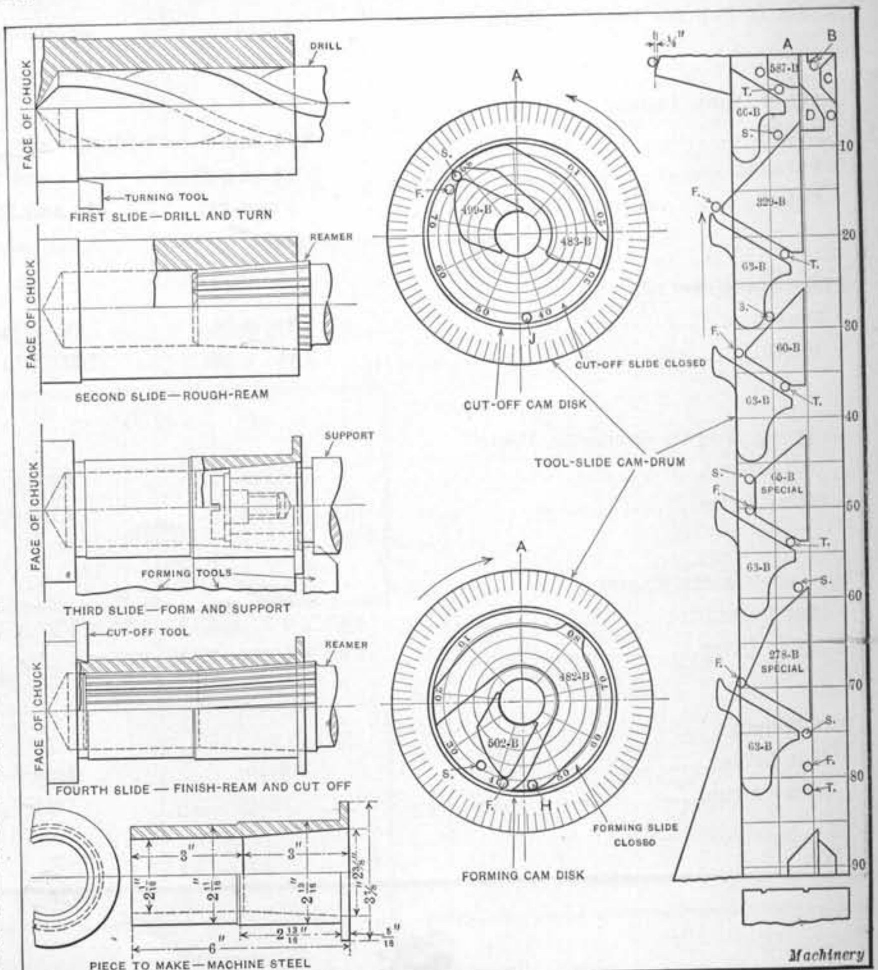
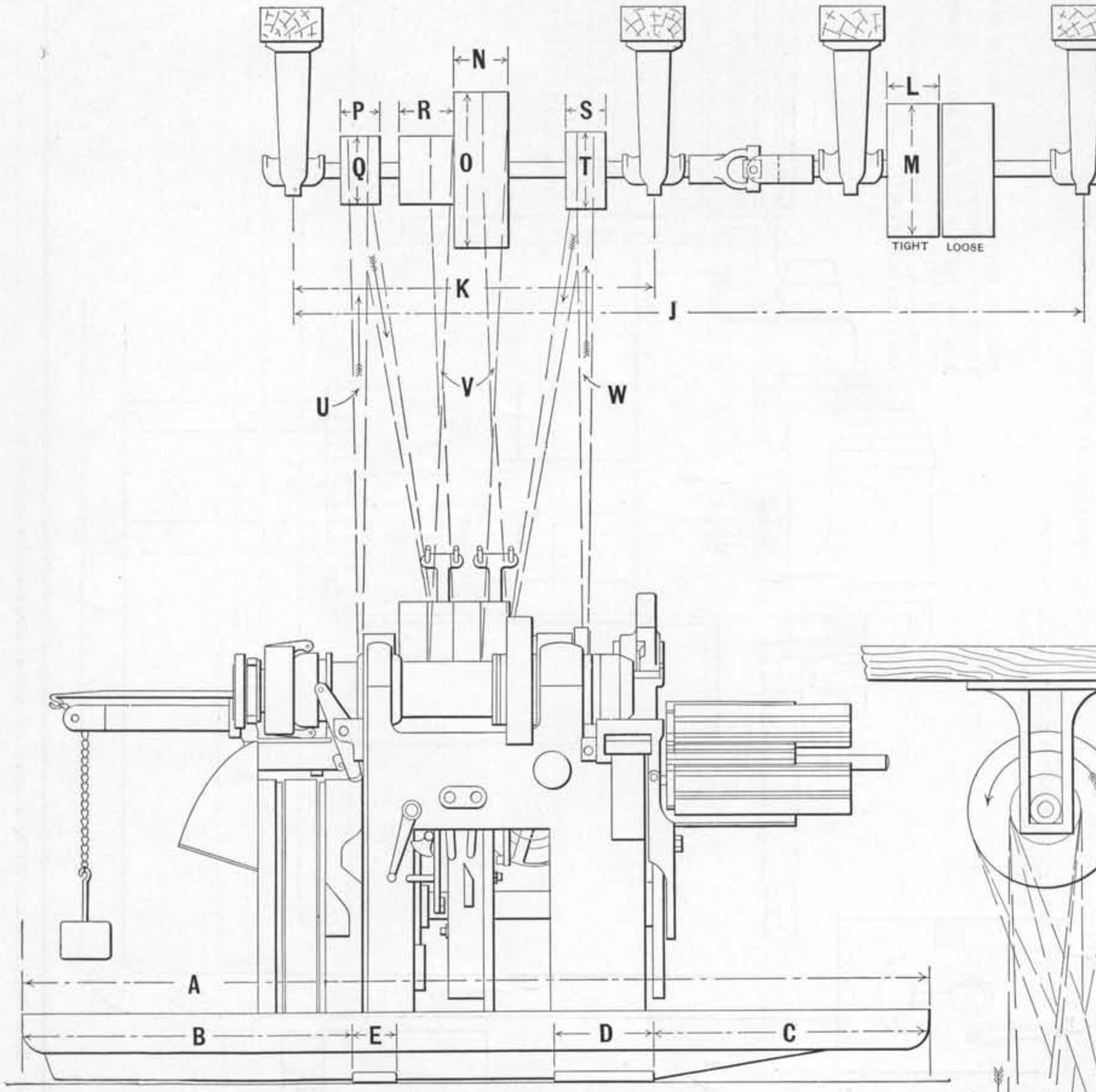


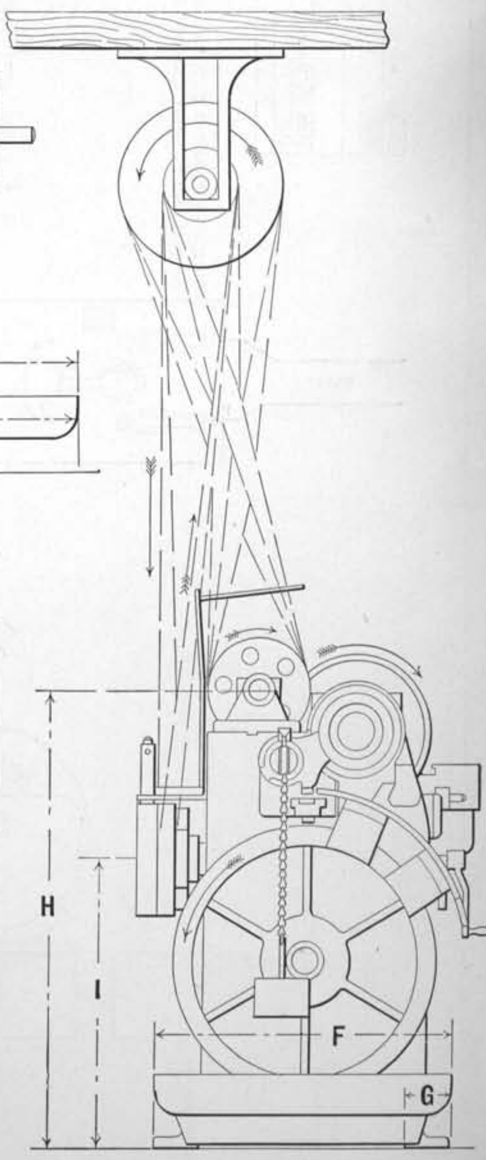
Fig. 20. Tooling Lay-out for a Bushing with Long Tapered Hole

COMPOSITE LIST OF GRIDLEY SINGLE AUTOMATIC TURRET LATHES

Standard Size Machine	2¼-inch	3¼-inch	4¼-inch	5-inch
Code: Belt Drive	*Idol*	*Jury*	*Keel*	*Leaf*
Motor Drive	*Idolmod*	*Jurymod*	*Keelmod*	*Leafmod*
Motor Drive—without motor	*Idolmol*	*Jurymol*	*Keelmol*	*Leafmol*
Capacity of Chuck, Inches:				
Round	2¼	3¼	4¼	5
Square	1.590	2.298	3.005	3.535
Hexagon	1.948	2.814	3.680	4.330
Maximum Length, Inches:				
Of Feed	13½	13½	13½	13½
With Regular Turners	8	8	8	8
With Finishing Slide	12	12	12	12
Speed of Countershaft, R. P. M.:	300	300	275	275
Speed of Driving Pulley, R. P. M.:	491 and 218	491 and 218	375 and 250	375 and 250
Diameter of Driving Pulley, Inches:	11	11	11	11
Width of Belt for Spindle Shaft, Inches:	2¾ double	2¾ double	2¾ double	2¾ double
Sizes of Cams, Inches:				
Lead	6, 8 and 9	6, 8 and 9	6, 8 and 9	6, 8 and 9
Forming	¾, 1½ and 2½	¾, 1½ and 2½	¾, 1½ and 2½	¾, 1½ and 2½
Cut-off	1½ and 2½	1½ and 2½	1½ and 2½	1½ and 2½
Floor Space over all:				
Length	7 ft., 9 in.	7 ft., 9 in.	8 ft., 8 in.	8 ft., 8 in.
Width	3 ft., 6 in.	3 ft., 6 in.	3 ft., 6 in.	3 ft., 6 in.
Shipping Weight—Domestic, Pounds:				
Belt Drive	6000	6200	7000	7000
Motor Drive	6400	6800	8300	8300
Size of Box for Export:				
Belt Drive	8′6″ × 5′2″ × 3′11″	8′6″ × 5′2″ × 3′11″	9′4″ × 5′4″ × 3′11″	9′4″ × 5′4″ × 3′11″
Motor Drive	8′6″ × 5′2″ × 3′11″	8′6″ × 5′2″ × 3′11″	9′4″ × 5′4″ × 3′11″	9′4″ × 5′4″ × 3′11″
Net Weight:				
Belt Drive	6150	6350	6950	6950
Motor Drive	6850	7050	7650	7650

PRINCIPAL DIMENSIONS FOR GRIDLEY SINGLE-SPINDLE AUTOMATIC TURRET LATHES



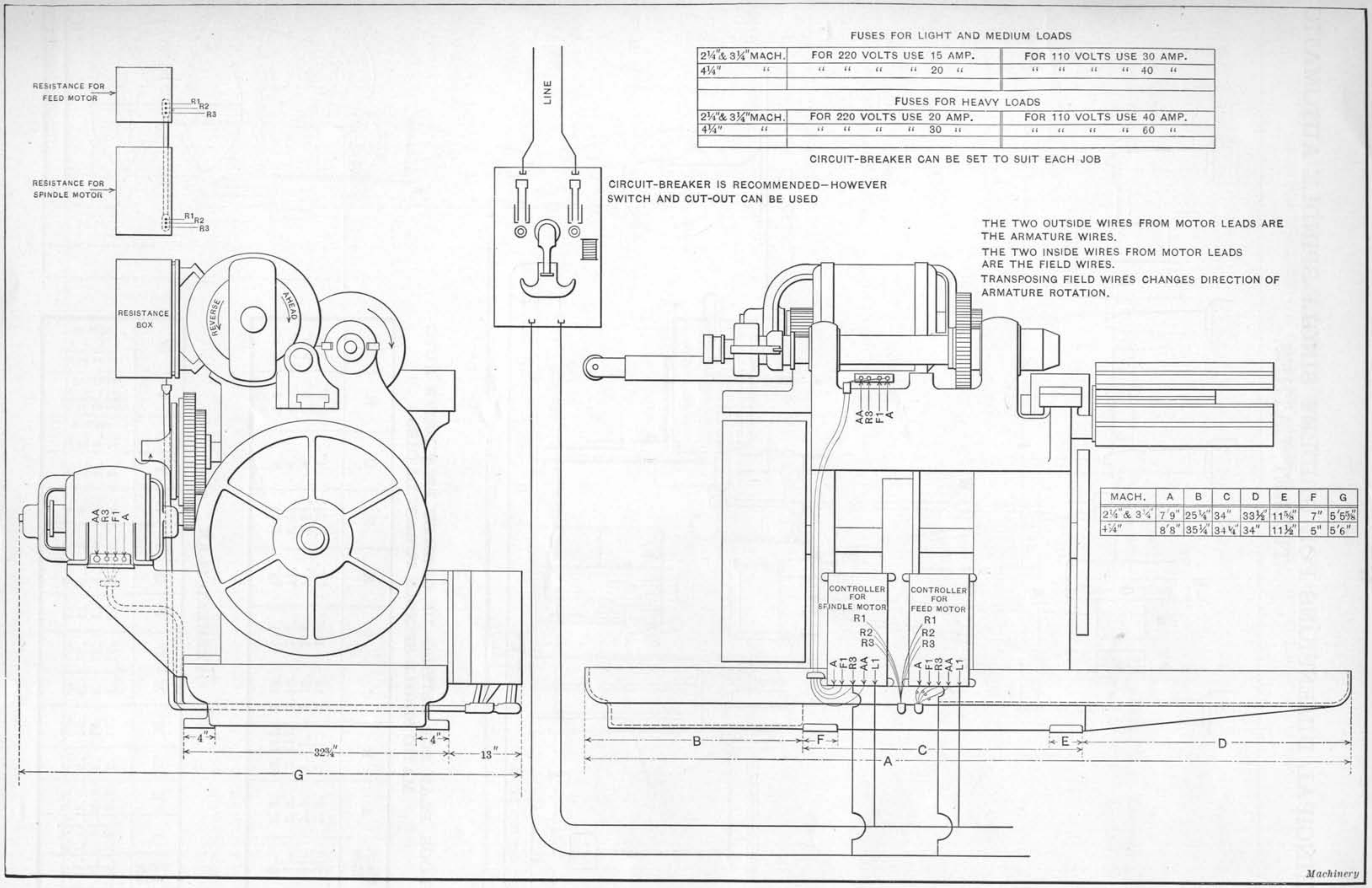


FLOOR PLAN FOR SETTING UP GRIDLEY BELT DRIVE AUTOMATIC SINGLE-SPINDLE TURRET LATHES

Mach. Size	A	B	C	D	E	F	G	H	I
2¼″	7′ 9″	2′ 1″	2′ 10″	11½″	7½″	2′ 8½″	4″	3′ 9″	2′ 8″
3¼″	7′ 9″	2′ 1″	2′ 10″	11½″	7½″	2′ 8½″	4″	3′ 9″	2′ 8″
4¼″	8′ 8″	2′ 11¼″	2′ 10″	11½″	7½″	2′ 8¾″	4″	4′ 2″	2′ 8″
5″	8′ 8″	2′ 11¼″	2′ 10″	11½″	7½″	2′ 8¾″	4″	4′ 2″	2′ 8″

OVERHEAD PLAN

Mach. Size	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
2¼″	7′ 6½″	3′ 5″	5″	14″	6″	18″	4″	8″	6″	4″	9″	2″ Single	2¾″ Double	2½″ Single
3¼″	7′ 6½″	3′ 5″	5″	14″	6″	18″	4″	8″	6″	4″	9″	2″ Single	2¾″ Double	2½″ Single
4¼″	7′ 6½″	3′ 5″	6″	16″	6″	15″	4″	6″	6″	4″	9″	2″ Single	2¾″ Double	2½″ Single
5″	7′ 6½″	3′ 5″	6″	16″	6″	15″	4″	6″	6″	4″	9″	2″ Single	2¾″ Double	2½″ Single



FUSES FOR LIGHT AND MEDIUM LOADS

2¼" & 3¼" MACH.	FOR 220 VOLTS USE 15 AMP.	FOR 110 VOLTS USE 30 AMP.
4¼" "	" " " " 20 "	" " " " 40 "

FUSES FOR HEAVY LOADS

2¼" & 3¼" MACH.	FOR 220 VOLTS USE 20 AMP.	FOR 110 VOLTS USE 40 AMP.
4¼" "	" " " " 30 "	" " " " 60 "

CIRCUIT-BREAKER CAN BE SET TO SUIT EACH JOB

MACH.	A	B	C	D	E	F	G
2¼" & 3¼"	7'9"	25¼"	34"	33½"	11⅝"	7"	5'5⅝"
4¼"	8'8"	35¼"	34¼"	34"	11½"	5"	5'6"

Motor Drive Equipment and Wiring Diagram for Gridley Single-spindle Automatics