Universal Cutter *and* Tool Grinder

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U.S.A.

IMPROVED

UNIVERSAL CUTTER AND TOOL GRINDER.

Manufactured by

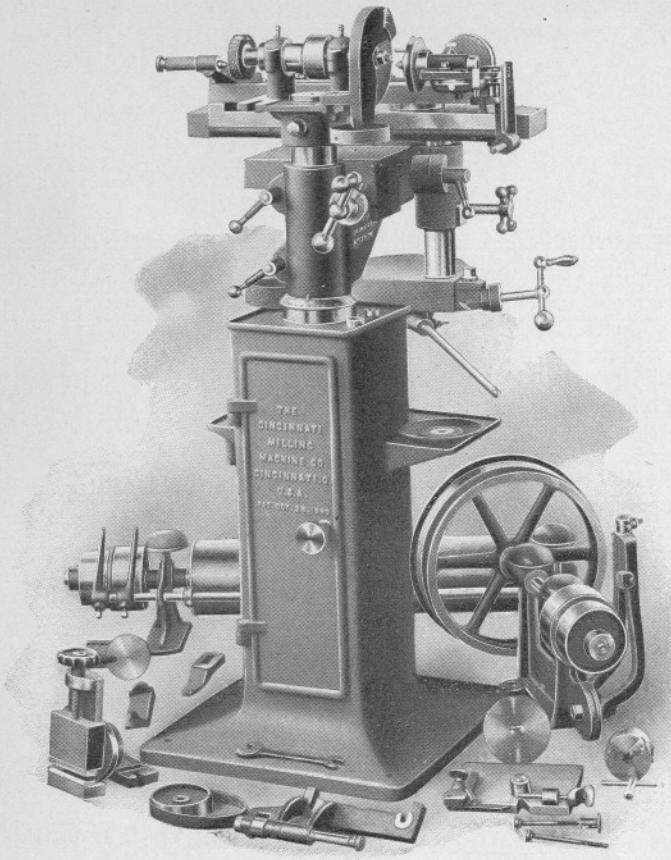
THE CINCINNATI
MILLING MACHINE CO.
CINCINNATI, O.
U. S. A.

Cable Address:
Milling Cincinnati.

Lieber and
A B C Codes.

JUNE, 1901.

INDEX.



Improved Universal Cutter and
Tool Grinder.

Improvements.

THE improvements embodied in this machine to date are as follows: A revolving knee with a dovetailed cross slide has been substituted for the cylindrical shaft and sleeve, thus making a very rigid construction.

A two-step cone has been put on the emery-wheel spindle so as to secure a high speed for internal grinding, and for emery wheels reduced in diameter by wear.

A self-adjusting center takes the place of the fixed center so as to allow for expansion of work.

A new high-speed internal grinding attachment.

A graduated scale and an adjusting screw have been added to the table so as to give the taper per foot, when grinding taper reamers, mandrels, etc.

A screw feed is provided in addition to the hand and lever feeds of the table, so that there are three modes of operation.

The work spindle in universal head is made tapering to secure compensation for wear.

A graduated dial for cross-slide screw, reading to thousandths of an inch.

Two bolts instead of one are used for clamping table to long slide.

Safety guards are provided for emery wheels.

Kinds and Dimensions of Work

For which This Grinder is Designed.

THIS machine has a horizontal range of 12 inches at right angles with the knee, a transverse movement to and from column of 6½ inches, a vertical movement of 3¾ inches and is designed to grind with accuracy and dispatch work of the following kinds and sizes:

Milling machine cutters 12 inches in diameter when not more than 1 inch wide.

Work 14 inches long held between centers when the diameter of rotation is not more than 8 inches. These dimensions are given as the limit for irregular pieces and not for heavy, solid cylinders.

Work 14 inches long can be ground by using an emery wheel on each side of the head.

Slitting saws for cold sawing up to 24 inches in diameter can be sharpened.

Reamers and shell counter bores of large or small sizes.

Gear cutters and formed cutters of every description.

Flat surfaces, such as shear plates, dies and gauges.

Hardened bushing and other pieces to be ground internally.

Conical surfaces, such as taper bearings and mandrels, and small cylindrical machine parts which are to be finished with extreme accuracy.

The foregoing list does not give the limit of the capacity of machine, but rather indicates in a general way what is possible in its use.

For a more particular presentation of the kinds of work which can be and are actually ground on machines in our shop, reference is made to the following pages.

SUMMARY OF DIMENSIONS.

Net weight, complete,	600 pounds
Shipping weight, about	850 pounds
Length of table,	20¾ inches
Horizontal range,	12 "
Transverse movement,	6½ "
Vertical movement,	3¾ "
Centers take in length,	14 "
Will grind cutters on cutter head,	12 inches diameter
Will grind cutters between centers,	8 " "
Will grind saws on end of table,	24 " "

Special Features.

THIS machine is perfectly universal, and differs from other machines in that it will grind the teeth on all milling cutters and reamers without the use of special attachments.

Those familiar with grinding the side teeth of side milling and angular cutters are aware that the tooth rest must be set to the exact height so as to bring the cutting edge of the tooth to be ground in an exact parallel line with the slide. In some machines this adjustment of the tooth rest for this grinding is complicated. The difficulty, however, is overcome in this machine, as no attention is required to adjust the tooth rest, since it is centrally fixed for all diameters of cutters. The tooth rest travels with the cutter, except in the grinding of spiral mills and large saws.

The side teeth of angular and side milling cutters are ground off with practically a straight line clearance. This is done with a cup-shape emery wheel 3 inches in diameter on the left side of the machine. The advantages of grinding side teeth with a fair size emery wheel, and at the same time grinding a straight line clearance with an accompanying strong cutting edge, is known to those who have heretofore been compelled to use a small wheel grinding a hollow clearance and weak-cutting edge. (See Fig. A, page 7.)

To prevent the drawing of the temper from cutting edges of side mills and the side teeth of angular cutters, etc., which have a broad surface, it is important that the heel of the tooth be stocked out first at a sharper angle and only a small portion left to be ground at a different angle. The change from stocking out to the grinding of the cutting edge is quickly made by moving the knee a few degrees around the column.

This feature of revolving the knee around the column has also the following advantages:

Work can be brought in contact with the emery wheels on either side of the machine without rechucking.

Work can be brought in contact with the emery wheels in the most favorable position to either wheel for rapid grinding. For an example, a side milling cutter may have the outer teeth ground off on the straight-face emery wheel on the right side of the machine, and the side teeth on the cup-shape wheel at the left side of the machine, without taking the cutter off the arbor or disturbing the tooth guide.

Cutters of small diameters and sharp angles can be ground without the cutter, mandrel or centers striking the belt or emery wheel head.

In grinding the shoulders, on work revolved between centers, the periphery instead of the side of a flat wheel can be used.

SPECIAL FEATURES — Continued.

The table is moved forward and back either by hand, a lever, or screw. The lever can be placed to suit position or convenience of the operator. The table is adjusted to and from the emery wheels by means of a screw which carries a graduated dial reading in thousandths of an inch.

Adjustable stops on each end of table are furnished.

The table makes a complete revolution on slide and can be set at an angle for taper work. The angle of taper is read both in degrees and inches per foot.

The universal head has vertical and horizontal adjustments which are graduated to read in degrees. This simple arrangement does away with special and complicated fixtures employed to grind angular cutters, side mills, etc.

The tail stock has a compensating center to allow for the expansion of work during grinding.

The emery wheel spindle is provided with two speeds. It is made of high-grade tool steel, hardened, ground and lapped, and runs in phosphor-bronze bearings. Dust caps are provided to keep the emery from the bearings. Both emery wheels are kept close to the bearings of the spindle, thereby avoiding the trembling incident to high-speed machines where an extended spindle is used.

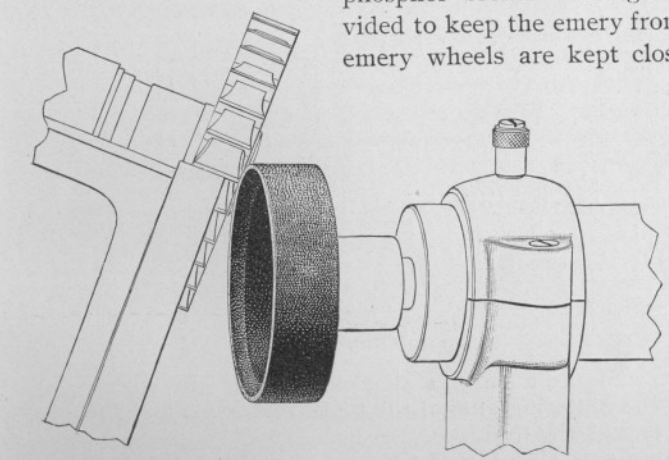


Fig. A.

Endless belts may be used, as the emery wheel head has a vertical adjustment to keep them at the proper tension.

A hand rest is furnished for turning off the emery wheels and grinding other work by hand.

The countershaft furnished for driving the emery wheel spindle is complete, including a novel device for shifting the belt. The loose pulley is made smaller in diameter than the tight pulley, to relieve the belt when the machine is not being used.

To Grind a Spiral Mill.

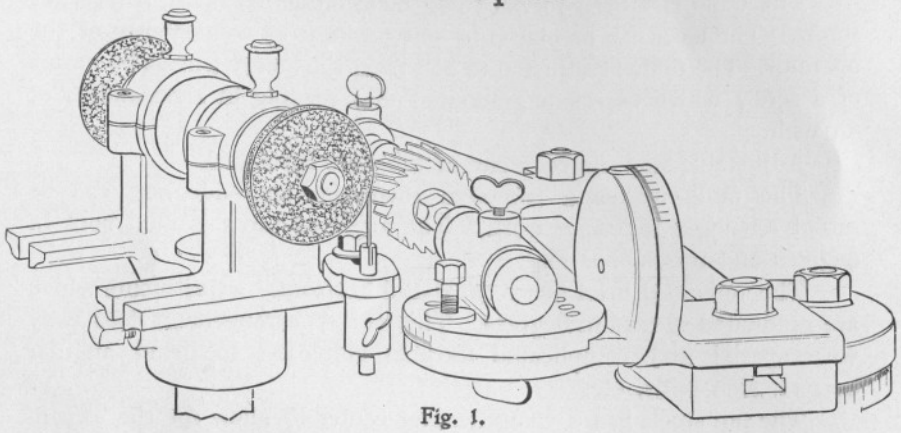


Fig. 1.

Figure 1 shows the long slide at the rear of the column and nearly parallel to the emery wheel spindle, the two swivels set at zero, a flat wheel on the right of the emery wheel head and the mill on the mandrel held between centers.

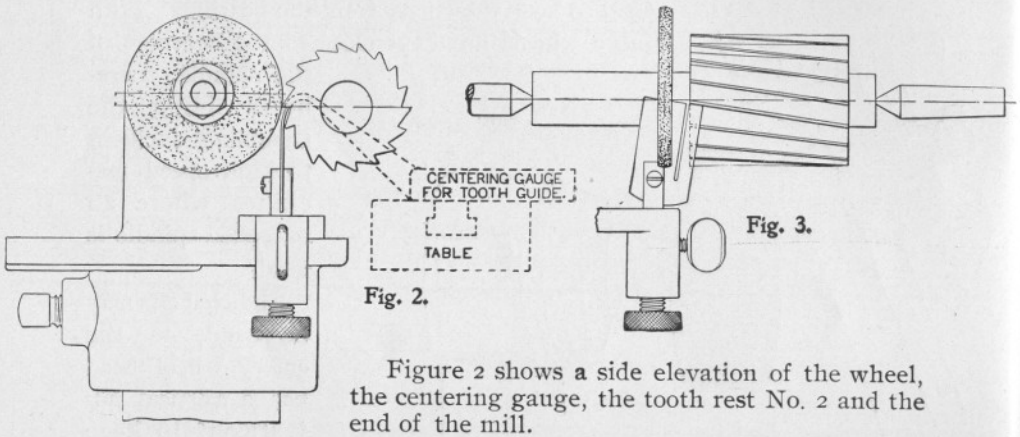


Fig. 2.

Fig. 3.

Figure 2 shows a side elevation of the wheel, the centering gauge, the tooth rest No. 2 and the end of the mill.

Figure 3 is an elevation showing the rim of the wheel, the face of the mill and the tooth rest in the position required when the mill is turned for grinding the next tooth.

DIRECTIONS.—Adjust the plane of centers below the plane of the spindle the distance required for clearance (see table, page 30). If the mill is cylindrical, set the table at zero; and if not, set it for the required taper. Set the stops on the long slide so that the mill having passed, the cutter will still be held by the flexible part of the tooth rest, which will then act as a spring pawl when turning the mill to bring the next tooth into position for grinding. In setting tooth rest the centering gauge must come directly opposite to part of the wheel which strikes the cutter.

(*Observe general directions, page 28.*)

To Grind Angular Cutters.

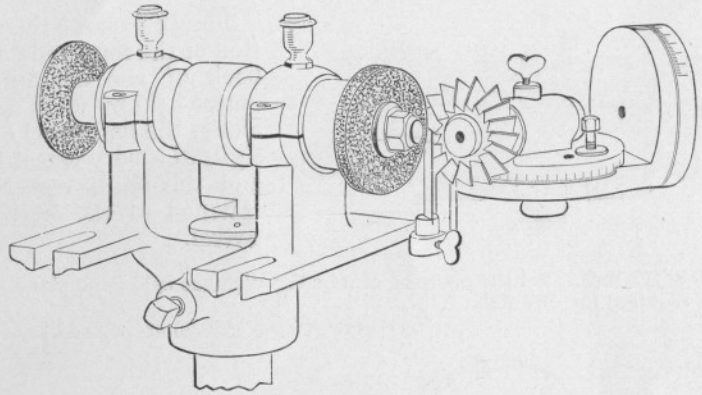


Fig. 4.

Figure 4 illustrates the grinding when the cutter is left-hand.

The flat wheel is on the right-hand end of spindle, the long slide is at the rear and right-hand, the cutter is held on work spindle and the tooth rest No. 4 is on the horizontal swivel.

DIRECTIONS.—Set the plane of centers below plane of spindle the distance required for clearance. Set the long slide at a convenient angle, and then adjust the horizontal swivel to the angle required for the cutter.

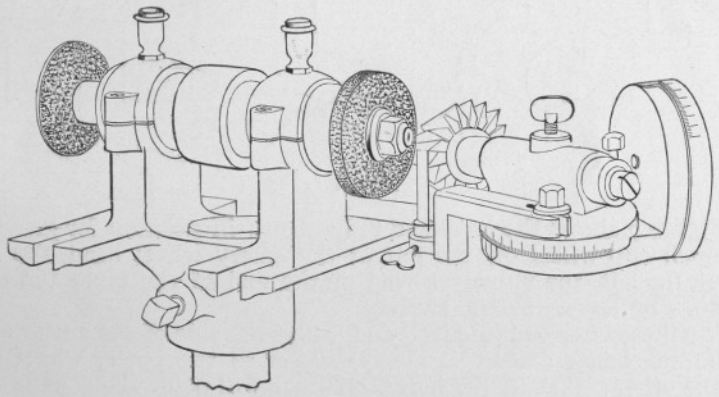


Fig. 5.

Figure 5 illustrates the grinding when the cutter is left-hand.

The explanations and directions for Figure 4 are sufficient for Figure 5.

(*Observe general directions, page 28.*)

To Grind Side Milling Cutters.

There Are Three Operations.

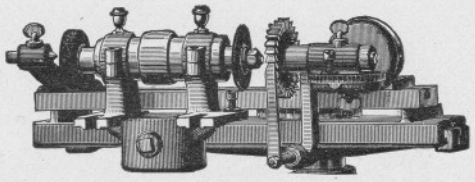


Fig. 6.

Figure 6 shows the situation of the long slide at the back of the column, the cutter held by work spindle alone, the flat wheel on the right of emery wheel head, and the tooth rest No. 3 fastened to the horizontal swivel.

DIRECTIONS.— Set the plane of centers the distance below the plane of the spindle required for clearance.

(*Observe general directions, page 28.*)

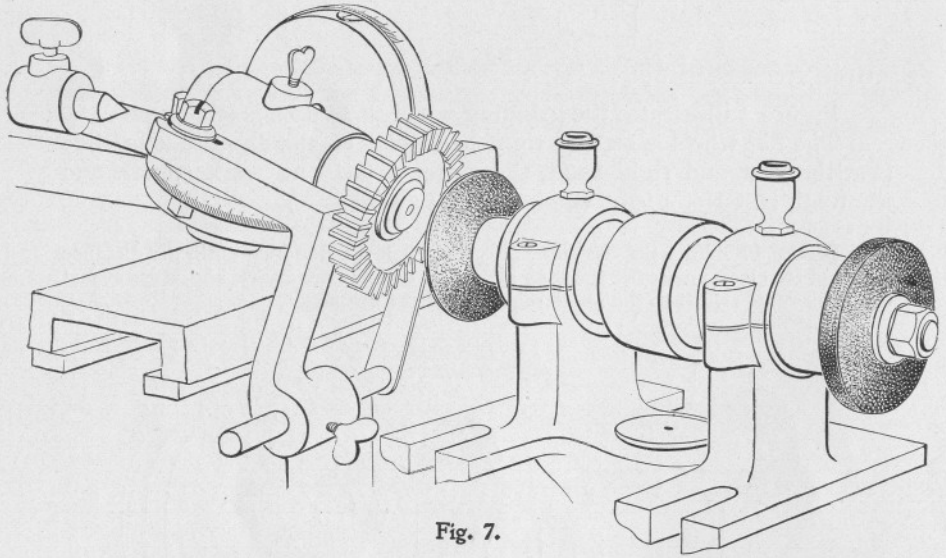


Fig. 7.

Figure 7 shows the left-hand radial teeth in position for grinding, the 3-inch cup wheel on the left of the emery wheel head, the long slide on the left, the universal head on the end of the table and tooth rest No. 3 on the horizontal swivel.

It will be observed in cuts 7 and 8 that the side of the cutter opposite the one being ground is always closer to the emery wheel head than the other; that is, the index on knee will point about 5° beyond the 90° point.

DIRECTIONS.— Set the vertical swivel so as to depress the outer end of work spindle the number of degrees required for clearance. This ranges from 5° to 20°, depending upon the clearance required.

(*Observe general directions, page 28.*)

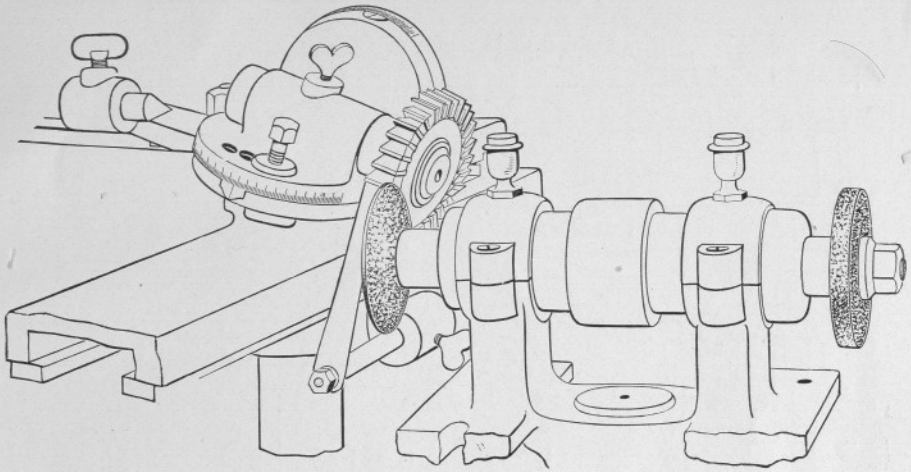


Fig. 8.

Figure 8 shows the same cutter in position for grinding the right-hand radial teeth. The explanations and directions for Figure 7 are sufficient for Figure 8.

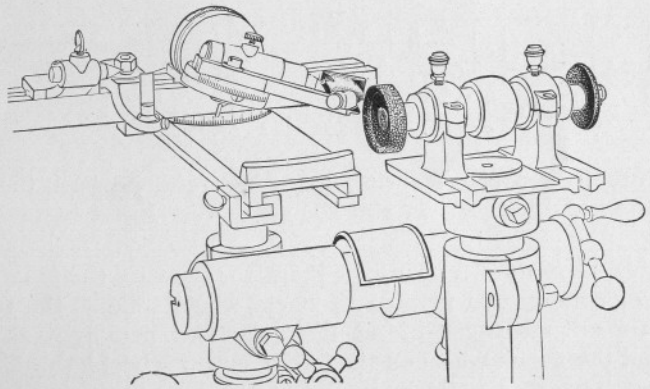


Fig. 9.

Shell counter bores are ground in same manner by having a stud which fits taper hole in work spindles and hole in counter bore, using tooth rest No. 4.

To Grind Milling Cutters or Metal Slitting Saws

From 8 to 12 Inches in Diameter.

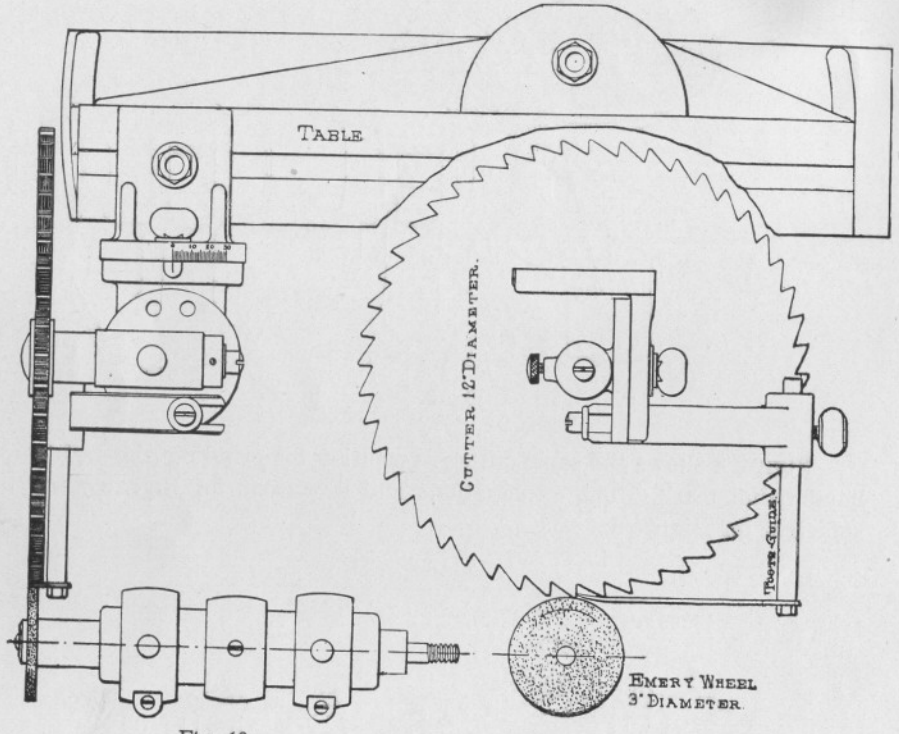


Fig. 10. Fig. 11.

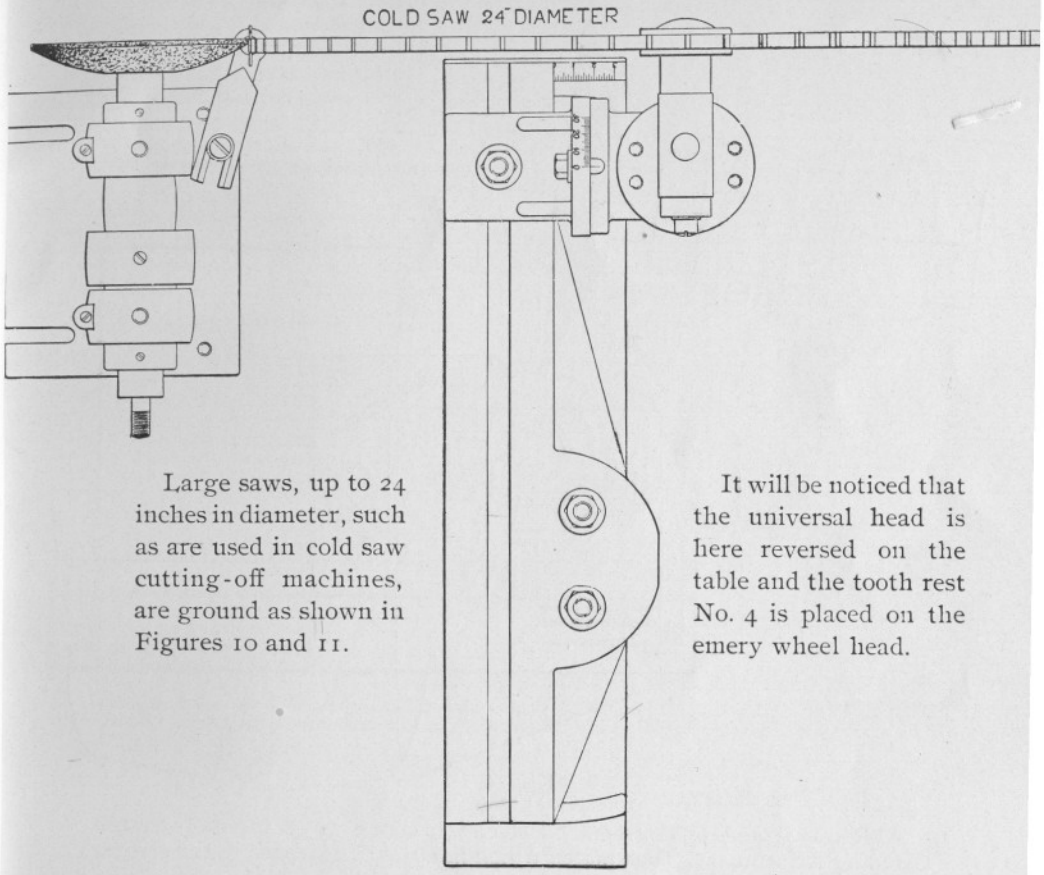
Figure 10 is a plan showing the 3-inch emery wheel, the saw or cutter, the horizontal swivel and the tooth rest No. 3 in position for grinding.

Figure 11 is an elevation of Figure 10, showing the long slide at the rear of column end parallel to emery wheel spindle, the universal head at the tail stock end of the table, the saw held by work spindle alone, and the 3-inch wheel on the left of emery wheel head. The saw is clamped to work spindle by means of the long screw with nut and collar furnished for this purpose.

DIRECTIONS.—Set the plane of centers below the spindle plane the distance required for clearance. Set both swivels and table at zero.

(*Observe general directions, page 28.*)

To Grind Metal Saw, 24-inch Diameter.



Large saws, up to 24 inches in diameter, such as are used in cold saw cutting-off machines, are ground as shown in Figures 10 and 11.

It will be noticed that the universal head is here reversed on the table and the tooth rest No. 4 is placed on the emery wheel head.

Fig. 12.

Gear-Cutter Grinding.

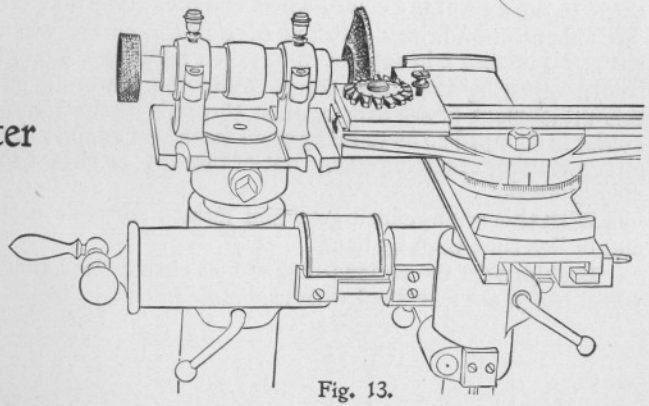


Fig. 13.

Gear-Cutter Grinding.

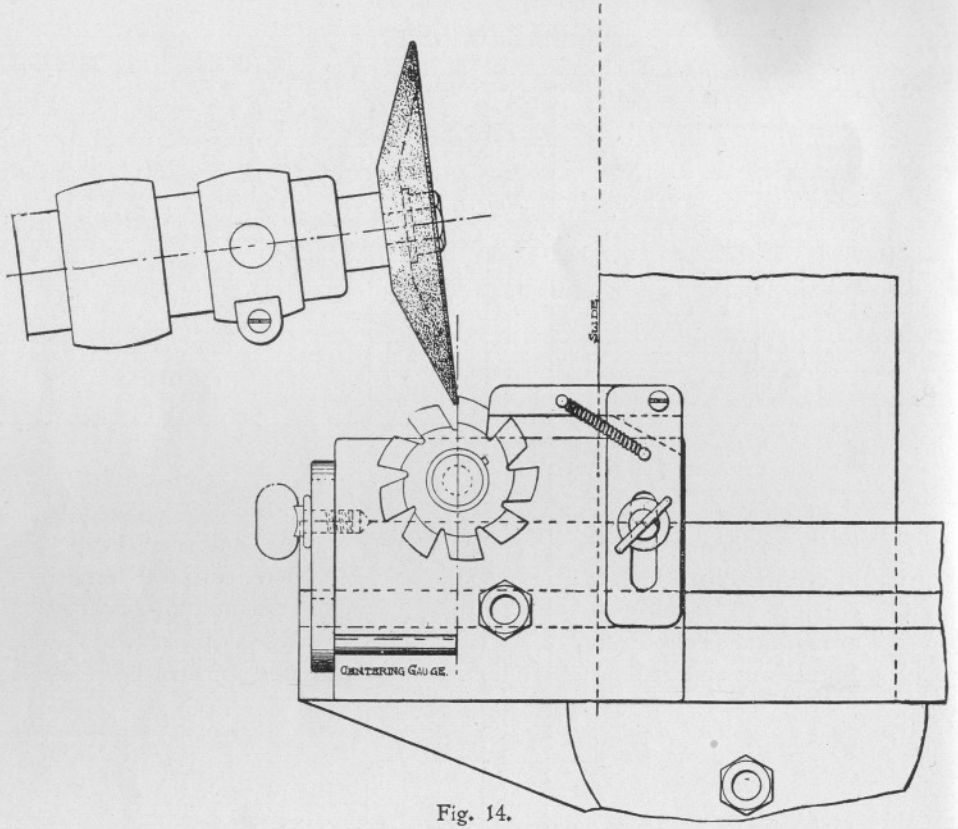


Fig. 14.

Figures 13 and 14 represent an elevation and plan of the Gear-Cutter Grinding Attachment. The platen which holds cutter is fitted to the slot in the table and clamped to it by bolt and nut.

The table should be set right angular to the slide and the slide at a slight angle to the axis of the emery wheel spindle. (See dotted lines.)

This position brings only the edge of the emery wheel in contact with work, permitting a heavy cut to be taken without danger of heating.

In adjusting the cutter for grinding the centering gauge belonging to this attachment is set over against the face of the tooth. Then the pawl holder is clamped so as to bring pawl tooth rest against the heel of the tooth, after swinging centering gauge out of the way, as shown in cut, the grinding may proceed.

With this arrangement gear and formed cutters can be ground correctly and in less time than by hand.

Bushings for the various sizes of holes in standard gear cutters and emery wheel No. 3, are furnished with this attachment.

To Grind Formed Cutters.

Figure 15 shows the table and long slide on the right of the column, the dish-shape wheel on the right-hand end of the spindle, the two arms by means of which the center of the cutter may be held below the top of the table and the tooth rest No. 5 which engages with the heel of the tooth to be ground.

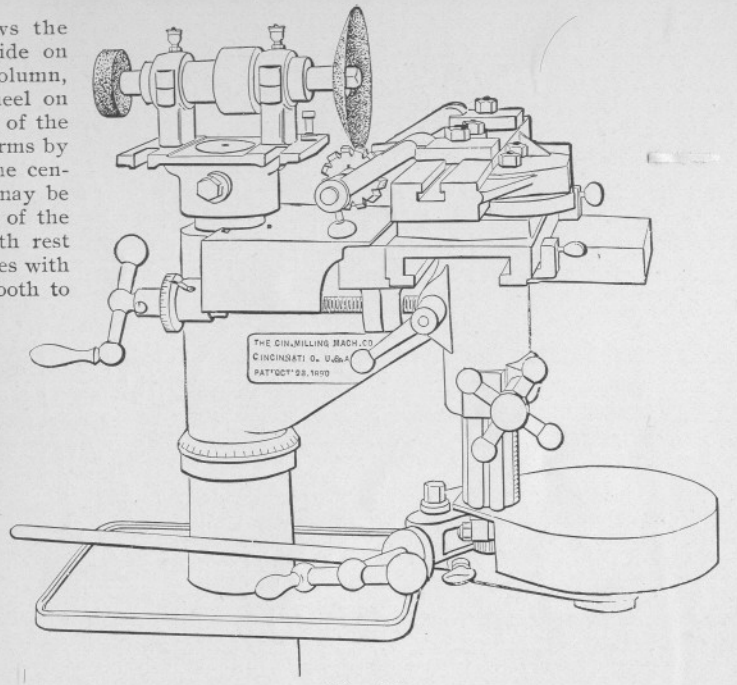
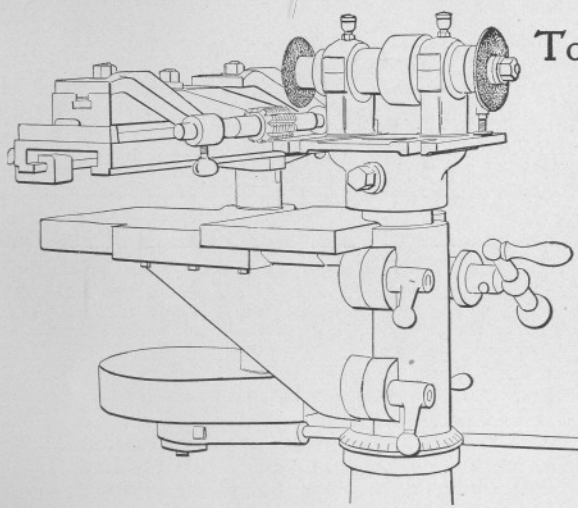


Fig. 15.

Directions.— Set the axis of long slide at right angle to that of the spindle by means of dial on column. Set the lower line of centers so that it will intersect the vertical diameter at the side of the wheel. This adjustment can be readily effected by bringing the point of the tail stock center nearly into line with the side of a straight edge held vertically against the flat side of the wheel. Put the cutter on a mandrel between the centers and set the face of a tooth against the side of the wheel, making allowance for amount to be ground off. To hold the face in this position adjust tooth rest No. 5 to the heel of the tooth. Determine depth of cut by short slide.



To Grind a Hob For Worm Wheel.

Figure 16 shows the long slide on the left of the column, the special attachment on the table for holding mandrel, the dish-shape wheel No. 3 on the left-hand end of the spindle and the table in line with the long slide.

Directions.— See those given for grinding formed cutters, Figure 15.

(Observe general directions, page 28.)

Fig. 16.

To Grind a Hand Reamer.

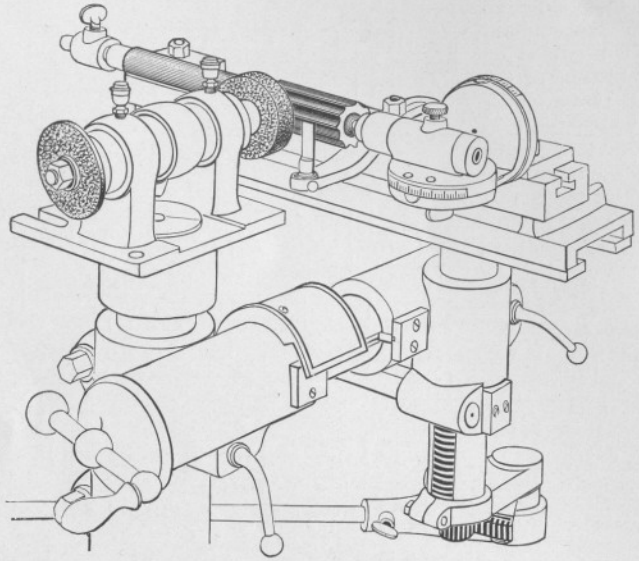


Fig. 17.

Figure 17 shows the long slide on the left, the cup-shape wheel on the left-hand end of the spindle and the tooth rest No. 1 fastened to the top of the table.

DIRECTIONS.—Set tooth rest below plane of centers a sufficient amount for clearance when grinding straight reamers. Set the table to grind straight. To grind bevel on end of reamer set table to angle required, or as shown in Figure 18.

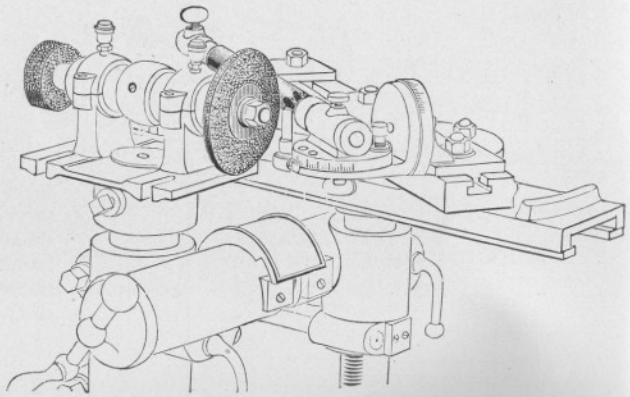


Fig. 18.

(*Observe general directions, page 28.*)

To Grind a Taper Reamer.

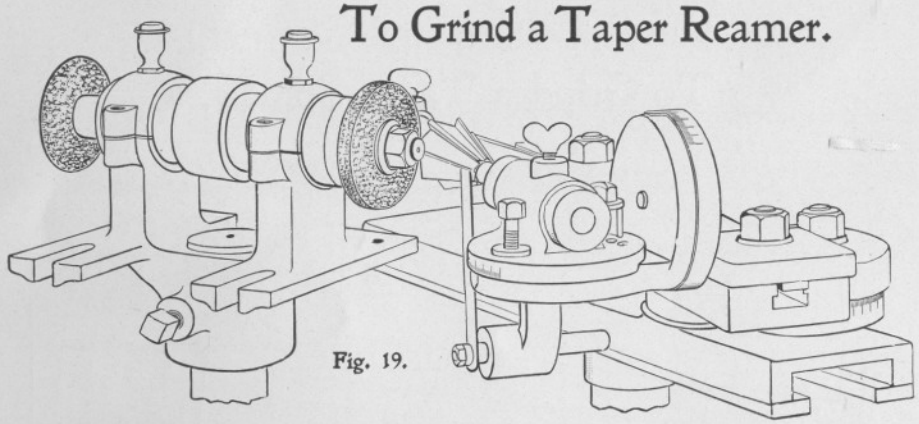


Fig. 19.

Figure 19 shows the long slide at the rear right of the emery wheel head, the table set obliquely to the slide, the swivels at zero, the reamer between dead centers, a flat wheel on the right-hand end of the spindle and the tooth rest No. 3 fastened to the swivel.

DIRECTIONS.—Set the tooth rest in the plane of centers. Set the plane of centers below the plane of the spindle the distance required for clearance. Set the table at the angle required for taper. (*Observe general directions, page 28.*)

To Grind a Hardened Drilling Jig Bushing.

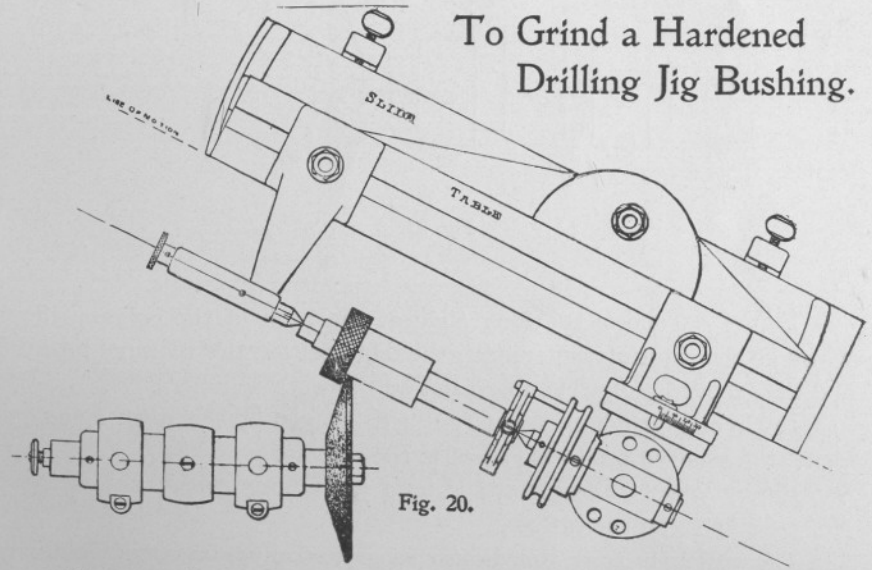


Fig. 20.

Figure 20 shows the emery wheel spindle with flat wheel on the right, the long slide on the right to the rear of machine, the table set at zero, the grooved pulley running loose on the work spindle, which is locked by a knurled screw, the jig bushing on a mandrel held between dead centers and turned by a dog engaging with the grooved pulley.

To Grind a Taper Spindle.

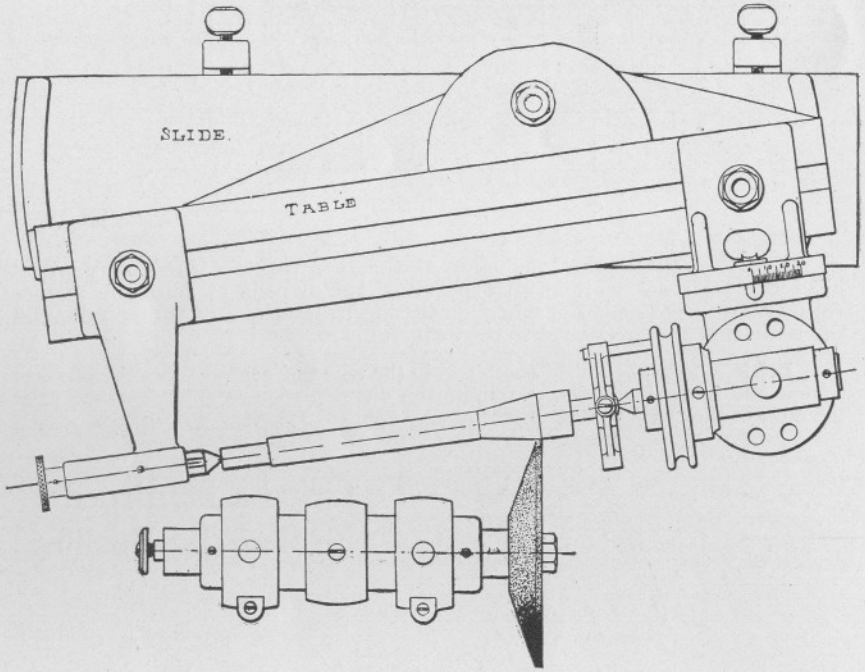


Fig. 21.

Figure 21 shows the long slide at the back of the column, the wheel on the right of the spindle, the table set for the required taper, and the grooved pulley running loose on the work spindle.

In circular grinding, when the piece is held by the work spindle alone, the grooved pulley is locked to the spindle.

Emery wheel shape No. 3 is used for taking deep cuts; shape No. 5 for finishing the surface.

The centers in work that has to be ground must be very carefully made and held to proper shape. Hardened pieces must have centers lapped as nearly round as possible in order to obtain good results.

(*Observe general directions, page 28.*)

To Grind Milling Cutters and Metal-Slitting Saws Straight or Concave.

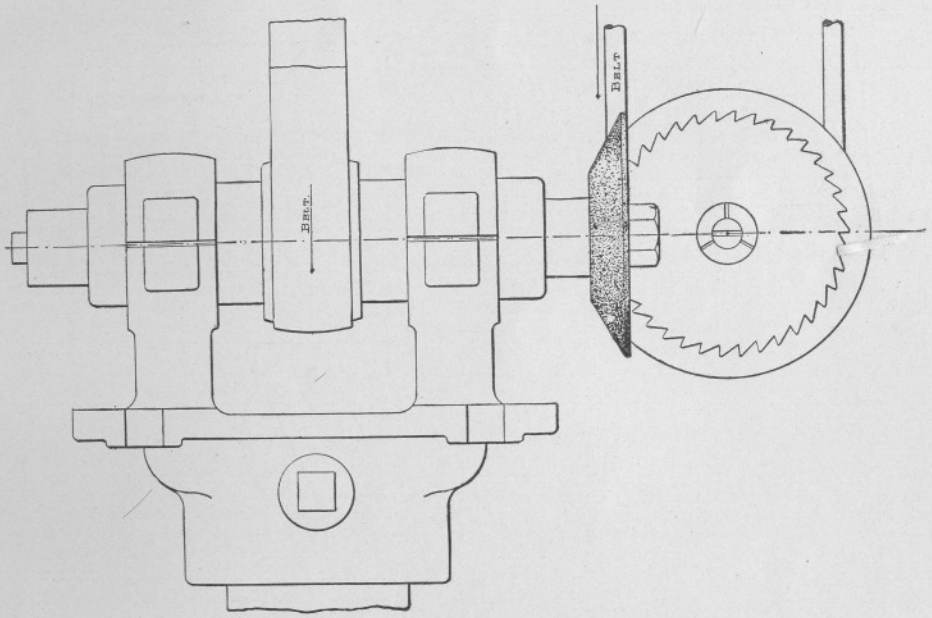


Fig. 22.

Figure 22 shows the emery wheel head with a wheel on the right, the long slide and table parallel to the emery wheel spindle, the horizontal swivel set at 90, and the saw fastened to work spindle by the saw-grinding disk furnished for this purpose with Circular Grinding Attachment.

The round belt should be as loose as possible.

(*Observe general directions, page 28.*)

To Grind a Slitting Knife with Beveled Edges.

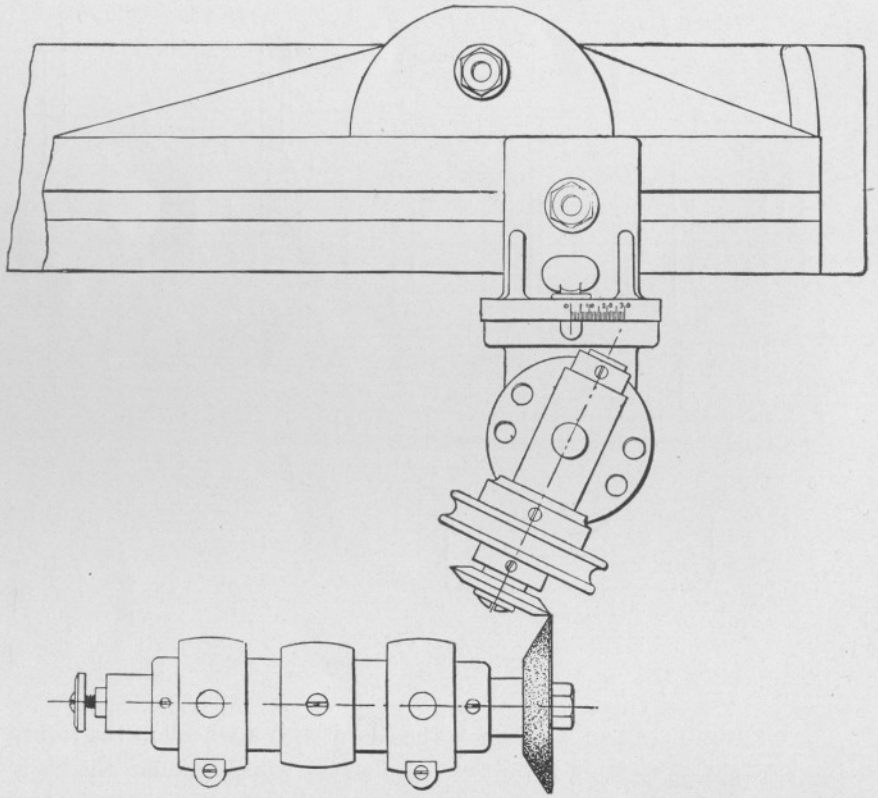


Fig. 23.

Figure 23 shows the wheel on the right of emery wheel head, the long slide and table at the back of the column, the horizontal swivel set at the angle required by the face of the knife, the grooved pulley locked to the work spindle which holds the knife by bushing and long screw.

Internal Grinding.

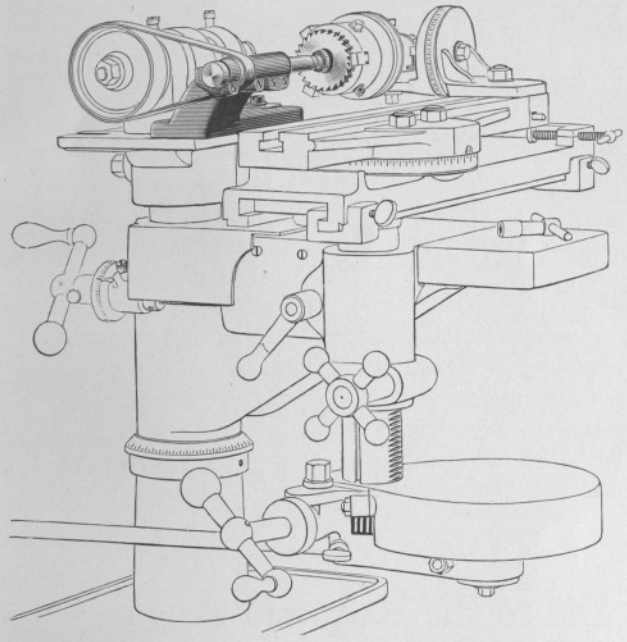


Fig. 24.

Figure 24 shows the long slide and table at the rear of the column and parallel to the spindle of the emery wheel; the piece to be ground is fastened to the work spindle; the internal grinding attachment is fastened to the emery wheel head, with its pulley belted to the pulley on the right of the column.

To Grind a Straight Edge.

Figure 25 shows the long slide on the left and parallel to the table, the straight edge clamped to its place, and a cup-shape wheel on the left of the spindle.

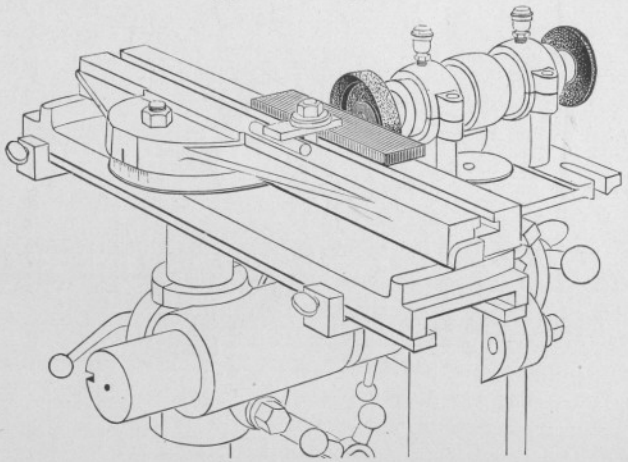


Fig. 25.

To Grind a Shear Plate.

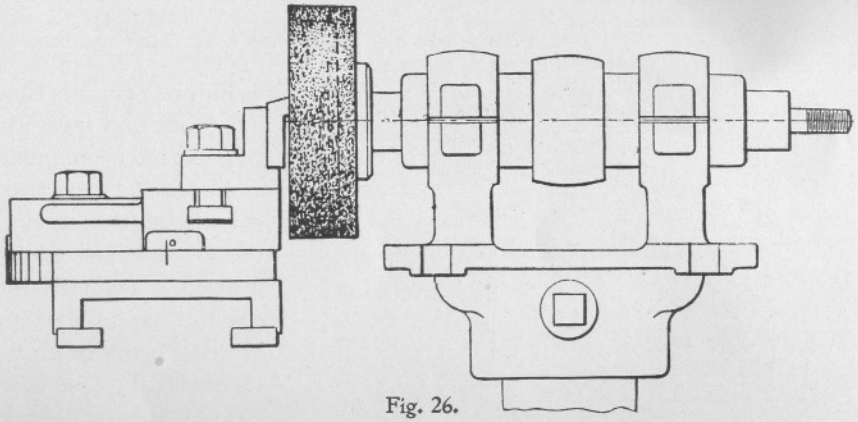


Fig. 26.

Figure 26 is an elevation showing the long slide on the left parallel to the table, the cup-shape wheel on the left and the shear plate clamped to the table.

To Grind a Die to the Required Angle.

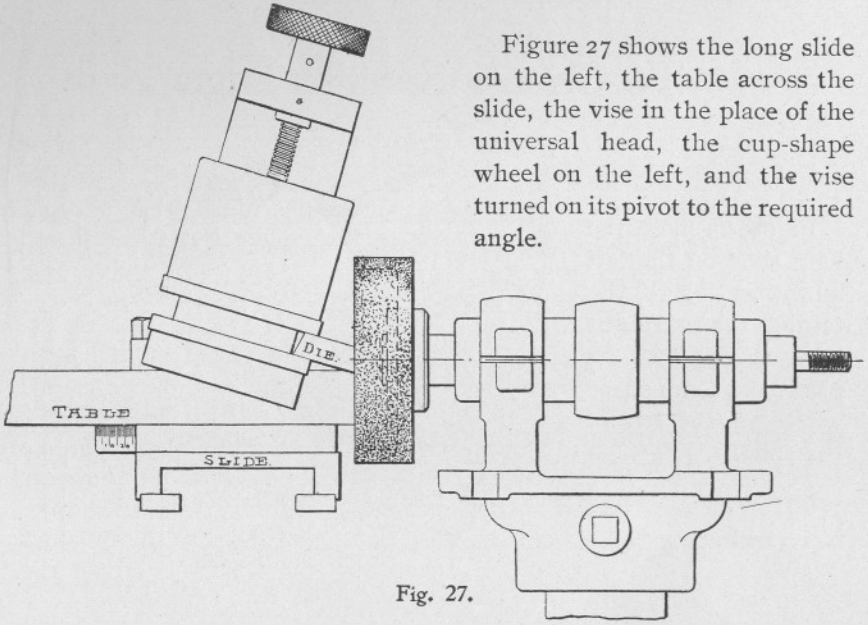


Fig. 27.

Figure 27 shows the long slide on the left, the table across the slide, the vise in the place of the universal head, the cup-shape wheel on the left, and the vise turned on its pivot to the required angle.

To Grind a Formed Tool on its Face.

Figure 28 shows the long slide on the left, the table set at zero, the cup-shape wheel on the left of emery wheel head, the vise set at 90 degrees for convenience in holding a screw machine form tool when grinding its face.

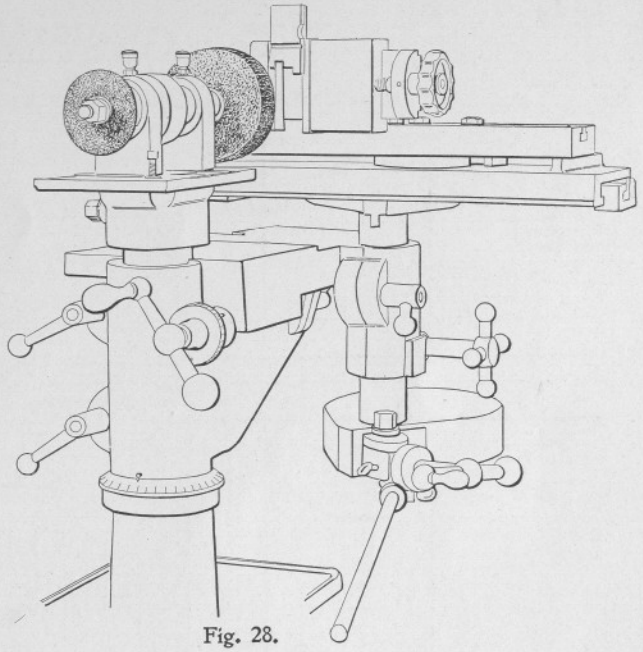


Fig. 28.

The Emery Wheel Used as a Metal Saw.

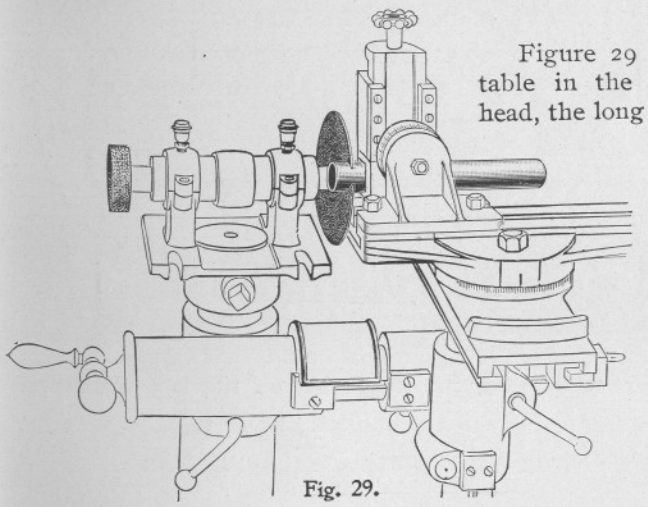


Fig. 29.

Figure 29 shows the vise on the table in the place of the universal head, the long slide at the right of the column, the table across the slide, and a wheel on the right of the spindle $\frac{1}{16}$ inch thick and 8 inches in diameter. Brass tubing and small steel bars can be readily and smoothly cut into pieces by means described.

To Grind a Gauge To a Given Dimension.

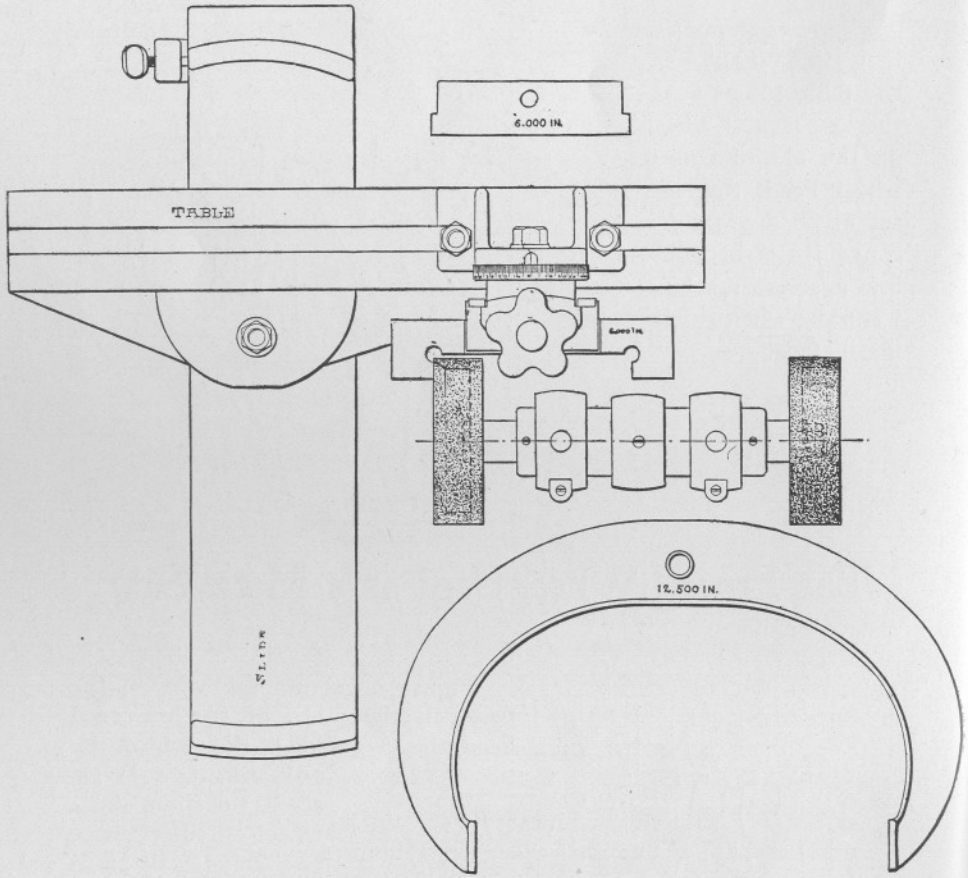


Fig. 30.

Figure 30 is a plan view showing the long slide on the left, the table across the slide, the vise in place of the universal head, the gauge with one of its faces against the cup-shape emery wheel on the left.

New Attachment For Internal Grinding.

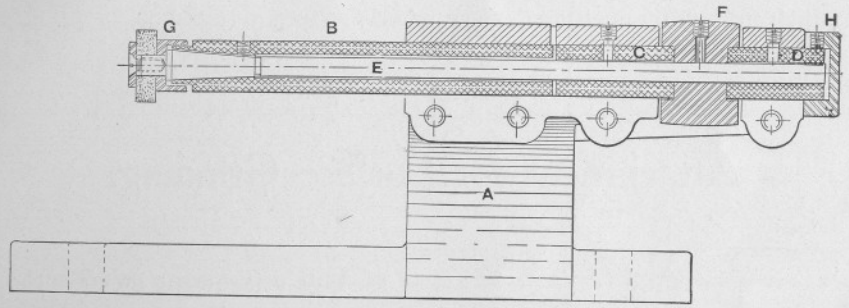


Fig. 31.

THE internal grinding attachment consists of the part shown in cut, the emery wheel shape No. 6, a driving pulley, and belt. The spindle has its bearings at *B*, *C*, and *D*, which are firmly supported in body *A*, which in turn is fastened to back side of emery wheel head. The spindle is locked to pulley *F* by a set-screw.

The parts *G* and *H* are dust caps.

The bearings *B*, *C*, and *D* are made of genuine Babbitt metal.

To adjust the spindle for a proper bearing in its box near *G*, loosen the screw in *F* and press the spindle into its taper bearing, then lock the pulley to the spindle by the set-screw.

This is the most rigid construction which can be obtained, and does away with the usual three shells or boxes placed inside the sleeve *B*.

Attachment for Circular Grinding.

THIS attachment includes a secondary drum countershaft, as shown in cut on page 3, and used for revolving the work to be ground, a pulley and collar on work spindle, a set of dogs with wrench and tray for same, a disk or saw grinding chuck and internal grinding arbor, a 3-inch universal chuck and emery wheels shapes 3, 5 and 6.

Attachment for Surface Grinding.

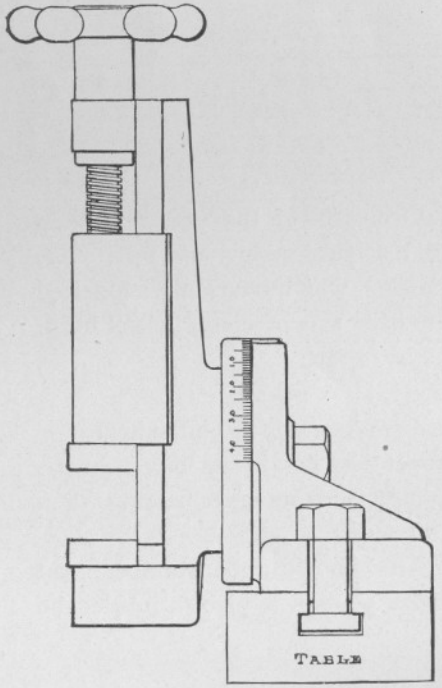


Fig. 32.

This attachment includes the vise shown, with angle, and emery wheel No. 4.

The vise may be clamped to the table at any point in its length.

Work held in its jaws can be presented at any angle whatever in regard to the axis of the emery wheel head, by making suitable adjustment of the swivel vise, the table and the long slide.

It has a graduated arc to measure the angle of elevation or depression at which the work is presented to the side of the emery wheel.

The Emery-Wheel Head.

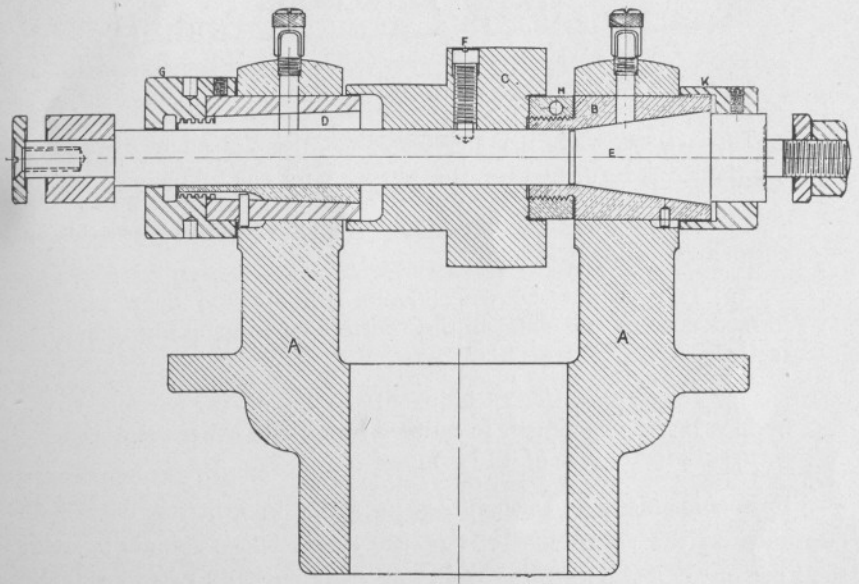


Fig. 33.

The Emery-Wheel Head includes the cast-iron stock which is fixed at the top of the column, the wheel spindle with its bearings, and the cone pulley.

It is set so that the axis of the spindle is parallel to a line which passes through the 90° points of the dial on the column. The front of the emery-wheel head, or what is the same, the front of the grinder, corresponds to the zero point on the dial, and may also be distinguished by the slots for clamping hand rest.

DETAILS OF THE EMERY-WHEEL HEAD.

The spindle *E* is made of tool steel hardened, ground and lapped.

The cone-pulley *C* is locked to the spindle by the set-screw *F* so that the two rotate together on the bearings *B* and *D*. Both bearings are made of phosphor bronze. The one on the right is solid, the one on the left is split.

In adjusting the spindle to prevent end play, screw nut *H* gently against the cone-pulley *C*.

The back bearing is adjusted by turning nut against head *A*.

The bearings *B* and *D* are protected against dust by the caps *G* and *K* and by the projections of the cone pulley.

General Directions

1. Hold the cutter to the tooth rest by hand.

2. In all cases, when it is possible, limit the movement of the long slide by the stops furnished for the purpose, for the following reasons:

1. It prevents the wheel from striking the head stock or cutter in concave grinding.

2. It prevents the wheel from running too deep into formed cutters and side milling cutters when grinding radial teeth.

3. It prevents the cutter from passing off the tooth rest, besides being convenient in quite a number of other instances occurring in the use of the grinder.

It is convenient and sometimes necessary in grinding cutters for clearance on the right-hand end of the emery wheel spindle, to swing the knee on the column to the right at an angle of from 5 to 15. This applies especially in angle cutters and small cylindrical cutters, when the belt is liable to strike the cutter or center.

After cutters have been reground once or twice the land becomes thick; it is very convenient under these conditions to swing the knee slightly around column 2° or 3°, and grind with a heavy broad cut between the teeth so as to reduce the amount of the land.

After the land is reduced to the proper width a slight movement of the knee back about 1° will alter the angle of the cut in such a way as to produce a narrow land with a keen cutting edge without danger of drawing temper.

The life of a cutter by this means is very much prolonged.

In using the lever or screw feed handles, adjust them by means of the clamp screws at bottom of long slide holder to the most convenient position.

Use the centering gauge shown in cut on page 36, for determining the relative height of center of emery wheel spindle and tail stock center.

(Consult Tables A and B, page 30.)

Tables A and B on the following page give the largest wheel practicable for grinding each of the given cutters as nearly as possible to a 9-degree clearance, and also the drop required for the wheel and the clearance.

The use of these tables may be illustrated by the example on page 5, Fig. 2.

Suppose the spiral mill to be 2 inches in diameter, to have 18 teeth, and that a 9-degree clearance is required.

Looking in the column 2, 18, 5, 9°, $\frac{25}{64}$, it appears that a 5-inch wheel is the largest which can be used in this case without scoring the next tooth, and that the "drop" or the distance between the plane of the centers and the plane of the spindle (which is represented in Fig. 2 by the lines which cross the emery wheel) is $\frac{25}{64}$ of an inch.

If now, by chance, there is not at hand a 5-inch wheel, then a smaller wheel can be tried with the "drop" given for that wheel in Table B, for a clearance of 9 degrees.

TABLE A.

Diameters of Cutters.	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 1/2	1 3/4	2	2 1/8	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4
Number of Teeth.	8	8	8	8	10	10	10	12	14	16	18	19	20	20	20	22	22	24	26	26
Diameters of Emery Wheel.	6	6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5
Angle of Clearance.	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°
Distance for Centers below Emery Wheel Spindle.	15/32	15/32	15/32	15/32	15/32	15/32	15/32	15/32	15/32	15/32	25/64	25/64	25/64	25/64	25/64	25/64	25/64	25/64	25/64	25/64

TABLE B.

Diameters of Emery Wheel, . .	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5	5 1/4	5 1/2	5 3/4	6
Distance for Centers below Spindle,	5/32	11/64	13/64	7/32	15/64	1/4	9/32	19/64	5/16	21/64	11/32	3/8	25/64	13/32	7/16	29/64	15/32
Angle of Clearance. . . .	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°	9°

Cleaning and Oiling.

THE durability and service of every machine are increased by proper attention to cleaning and oiling; but grinders which are exposed to emery dust, and have parts running at high speeds, require special care in these respects. Proper cleaning does not mean merely wiping with a handful of waste, but the careful removal of all oily gum and grit which may have collected on any wearing part.

The machine is provided with dust caps, covering especially-exposed bearings; but when these are removed for cleaning, extreme care should be exercised in replacing them so that emery dust will be effectually excluded. *Good mineral oil is suitable for all parts of the machine*, but the high speed of the internal grinding attachment requires coal oil.

Ordinarily all bearings are provided with dust-proof oil covers, but in case of long and short slides it will be necessary to put the oil directly onto the bearing. The long slide should be cleaned and oiled frequently, as on this depends in a large measure the successful working of the grinder.

The taper bearings of the emery-wheel spindle, the work spindle of the universal head and the spindle of the internal grinding attachment should be carefully adjusted so as to be neither too loose nor too tight, a condition which can be discovered by the resistance their movements offer to the touch.

Emery Wheels.

THE Emery Wheel consists of grains of emery and a composition called the texture which binds these grains together.

In regard to the size of the grains the wheel is said to be fine or coarse in grade. In regard to its texture it is called hard or soft.

To distinguish the grades they are numbered from the dimensions of the meshes through which the grains pass.

Thus grade 10 means that the distance between the wires of the mesh is 10 to the inch.

Some of the substances used to hold the grains of emery together are hard rubber, shellac, ordinary glue and a mixture of linseed oil and litharge.

The relative hardness of the texture is indicated by letters. Thus *A* indicates a soft wheel, *B* a harder wheel, *M* a medium wheel and so on.

The vitrified emery wheel is made with a cement which contracts slightly while cooling, leaving small pores, or cells through which water introduced at the center is thrown to the surface by centrifugal force. This flow of water operates to carry off the cuttings and the detached emery.

The grade and texture of the wheel to be used in certain kinds of work is fairly within the following limits:

Wheels of coarse grain and hard texture are suitable for rough grinding, such as the smoothing down of protuberances and in other rough work in which accuracy and finish are not required.

Wheels having medium grain and hard texture are serviceable in grinding lathe tools, for gumming saws, etc.

Wheels with medium grains and soft texture are suitable for free cutting on broad surfaces of iron, steel or brass.

Wheels with fine grain and soft texture are suitable for grinding fine tools, such as milling machine cutters for which the duty is light, but the demand for accuracy imperative.

One of the important conditions of accuracy is that the wheel vary in the least possible degree in shape or diameter from start to finish in a series of cuts.

The wheel with fine grain and hard texture is suitable for smooth grinding on soft metals such as cast iron or brass.

A wheel glazes or gums if its grains are held too long by its texture.

The ideal duty of a wheel consists in having its grains displaced as soon as they become unfit for further service.

EMERY WHEELS—Continued.

As the wheel by use wears out of true, it can be trued by a little black diamond point, and if very accurate grinding or a fine finish is required, the diamond should be carried across the surface of the wheel by the long slide.

If it is required to do heavy cutting the emery wheel should be trued at a comparatively slow speed.

If the wheel becomes glazed, its surface may be improved by a coarse file or a piece of pumice stone.

Emery wheels should be kept clean and free from oil, and should not present more than $\frac{1}{16}$ to $\frac{1}{8}$ of an inch to the surface of the work. This provision is particularly applicable to cup-shape wheels.

If it is desired to put an exceedingly fine finish on such work as arbors, spindles, standards, etc., after they have been ground true, a wheel of 80 or 100 grade emery, with not more than $\frac{1}{8}$ inch face, should be used for taking this finishing cut.

However, very finely finished surfaces can be obtained with a wheel as coarse as 40 grade emery, if the work is passed very slowly across the face of the wheel and the wheel allowed to cut but slightly.

In regard to finish, it is to be observed that the harder the substance to be ground the coarser must be the grade of the wheel.

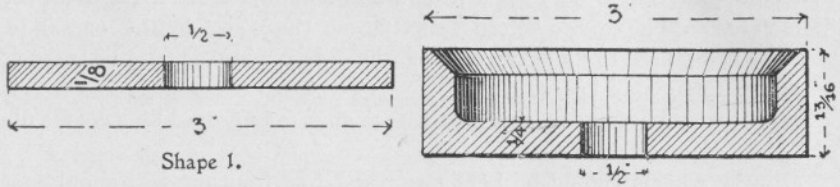
Thus the finish of steel requires a coarser grade of wheel than the finish of copper.

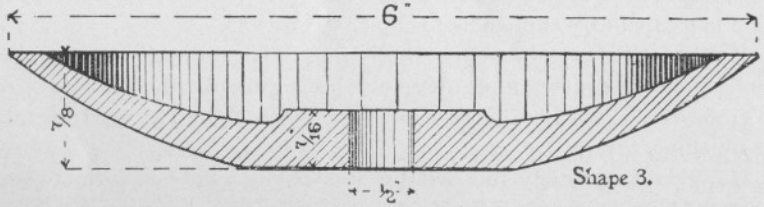
If a wheel is too hard for the substance it is cutting, it may heat or chatter; this can be obviated somewhat by diminishing the width of the cutting surface, but it is much better to use a softer wheel and full width of cutting surface.

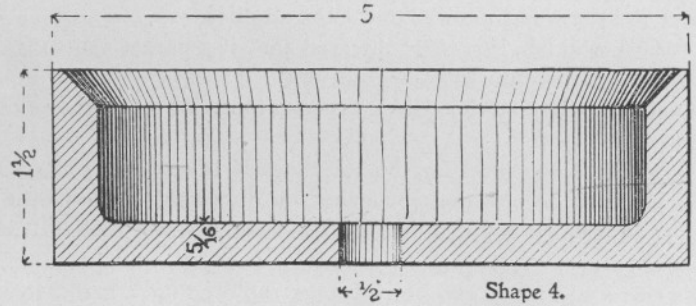
As a rule a soft wheel can be run more rapidly than a hard one without changing the temperature of the work. Accordingly there is an advantage in two speeds for the emery wheel spindle.

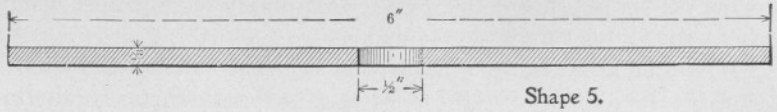
For internal grinding the wheel should be softer than for external grinding, and the work should revolve so as to give the wheel opportunity to do its work.

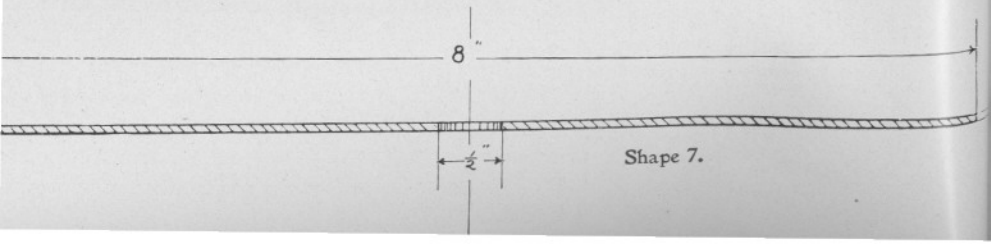
EMERY WHEELS.—The emery wheels shown have been carefully selected as to shape, grade and mixture of emery for obtaining the best possible results on work for which this machine is adapted. They are kept in stock, and should be ordered by number.











The Universal Cutter and Tool Grinder

Is Furnished as Follows:

For Cutter and Reamer Grinding, the machine is furnished with the following outfit:

One universal head and tail stock complete with centers.
Tooth rest and holder No. 3 for large cutters.
Tooth rest and holder No. 4 for small cutters and counter bores.
Tooth guide and holder No. 2 for spiral cutters.
Tooth rest holder No. 1 for reamers.
Centering gauge for setting height of tooth guide.
Two long screws and one nut for holding cutters on universal head spindle.
Two stops on slide.
One ⅞ x 1 inch bushing for cutters.
Hand rest.
One wrench.
Emery wheel, shape 1.
Emery wheel, shape 2.
Code word — Laban. Price . . . . . .

For Circular Grinding, the following additional parts are furnished:

Drum, with secondary countershaft, complete.
Pulley and collar on cutter head spindle.
Disk or saw-grinding chuck, fitted to universal head spindle.
Internal grinding arbor with emery wheel, shape 6.
Three-inch universal chuck, fitted.
One set of fifteen dogs, from ¼″ to 1¼″, with wrench and tray for same.
Emery wheel, shape 3.
Emery wheel, shape 5.
Code word — Lewis. Price . . . . . .

For Surface Grinding, the following additional parts are furnished:

Swivel vise, with angle and two clamping bolts.
Emery wheel, shape 4.
Code word — Lot. Price . . . . . .

For Gear-Cutter Grinding, are furnished:

Gear-cutter attachment.
Two bushings.
Emery wheel, shape 3.
Code word — Lucian. Price . . . . . .

For Grinding the Face of Teeth in Taps, Hobs and Formed Cutters, etc.:

One pair drop centers, complete with hardened and ground centers.
One tooth rest No. 5.
Two bolts.
Code word — Lug. Price . . . . . .

For Internal Grinding:

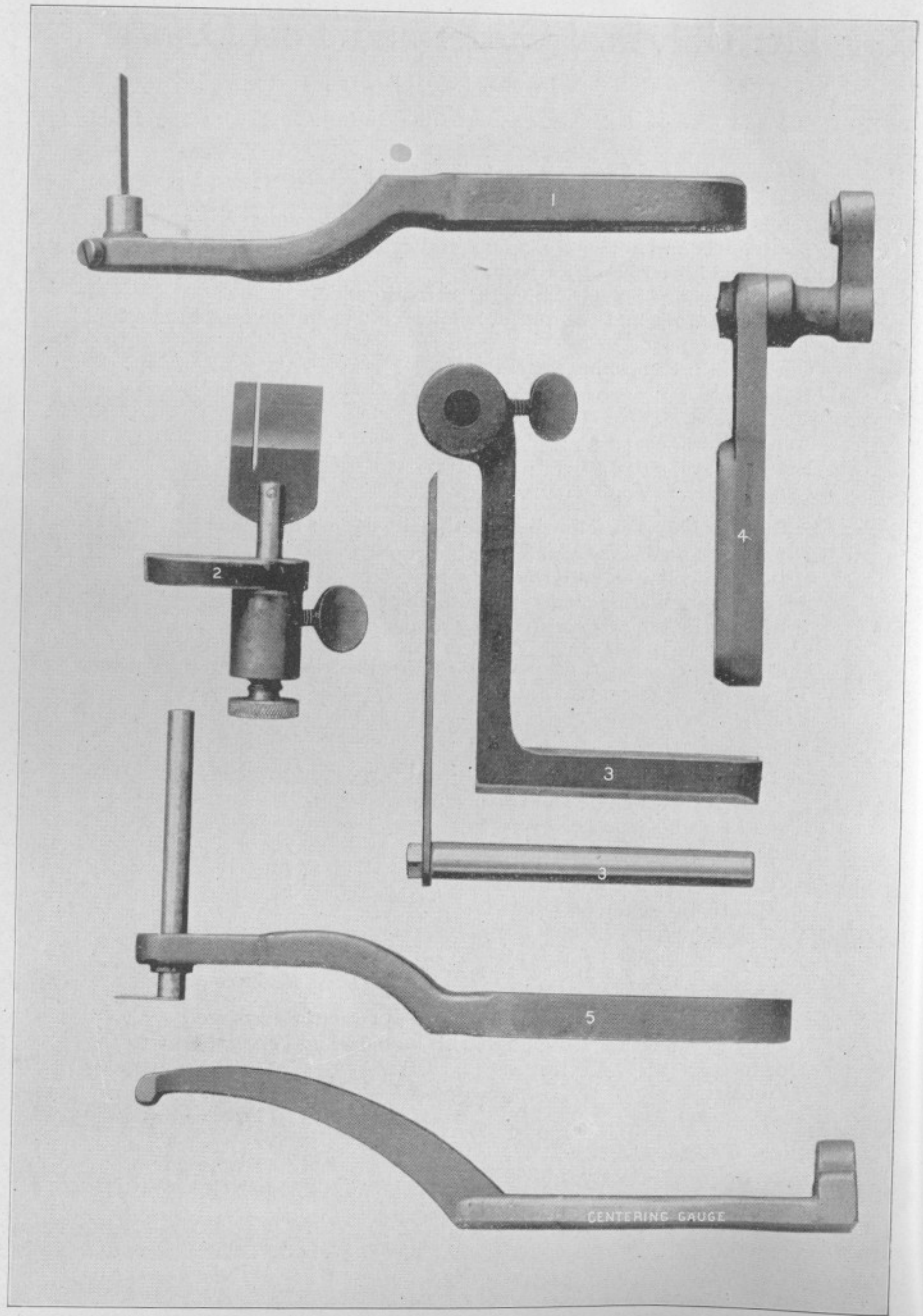
Internal grinding attachment.
Pulley.
Belt.
Emery wheel, shape 6.
Code word — Lip.

This attachment can be used only when the Circular Grinding Outfit is furnished.

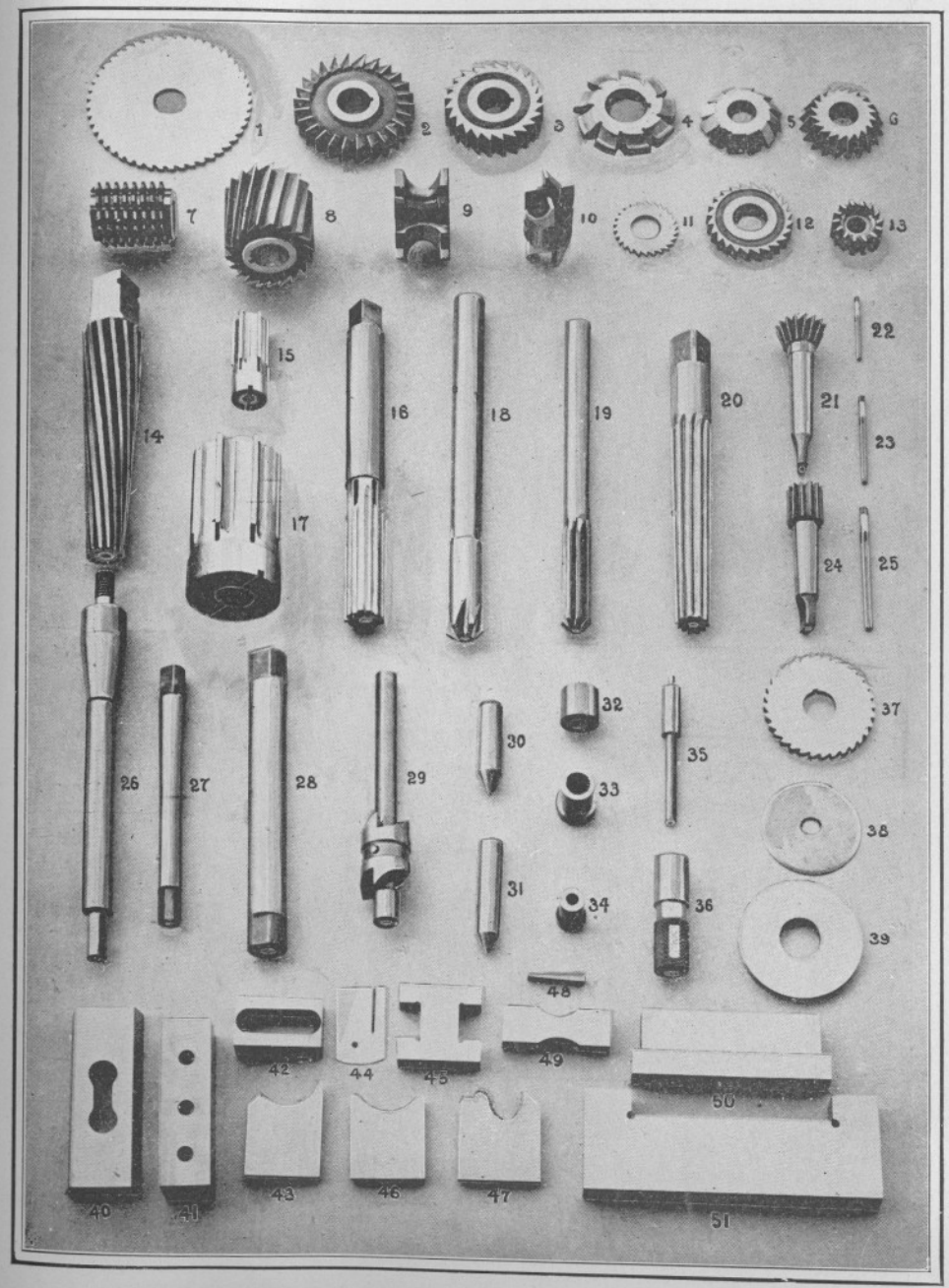
Price . . . . . .

Universal Cutter and Tool Grinder, Complete:

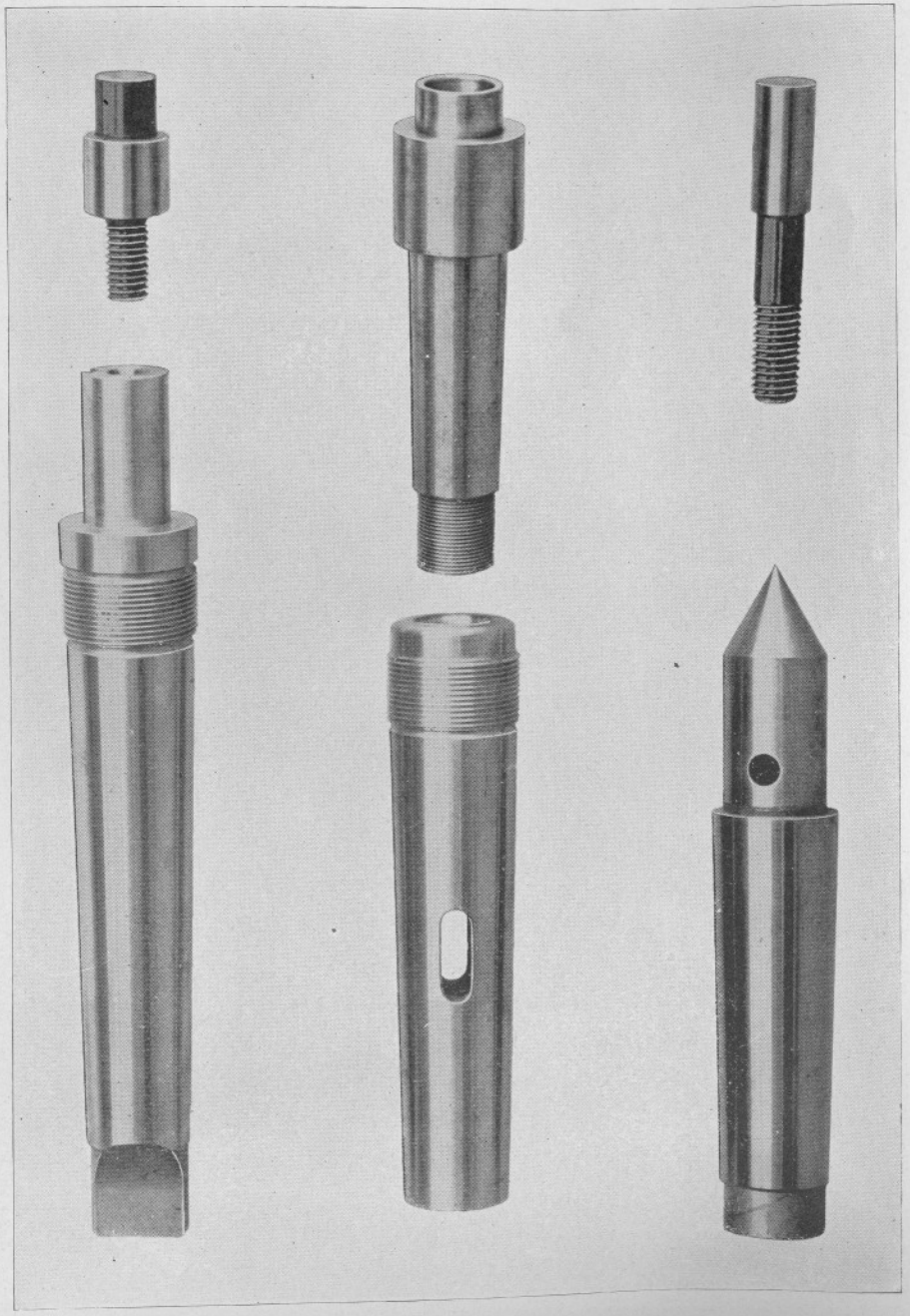
Code word — Luxus. Price . . . . . .



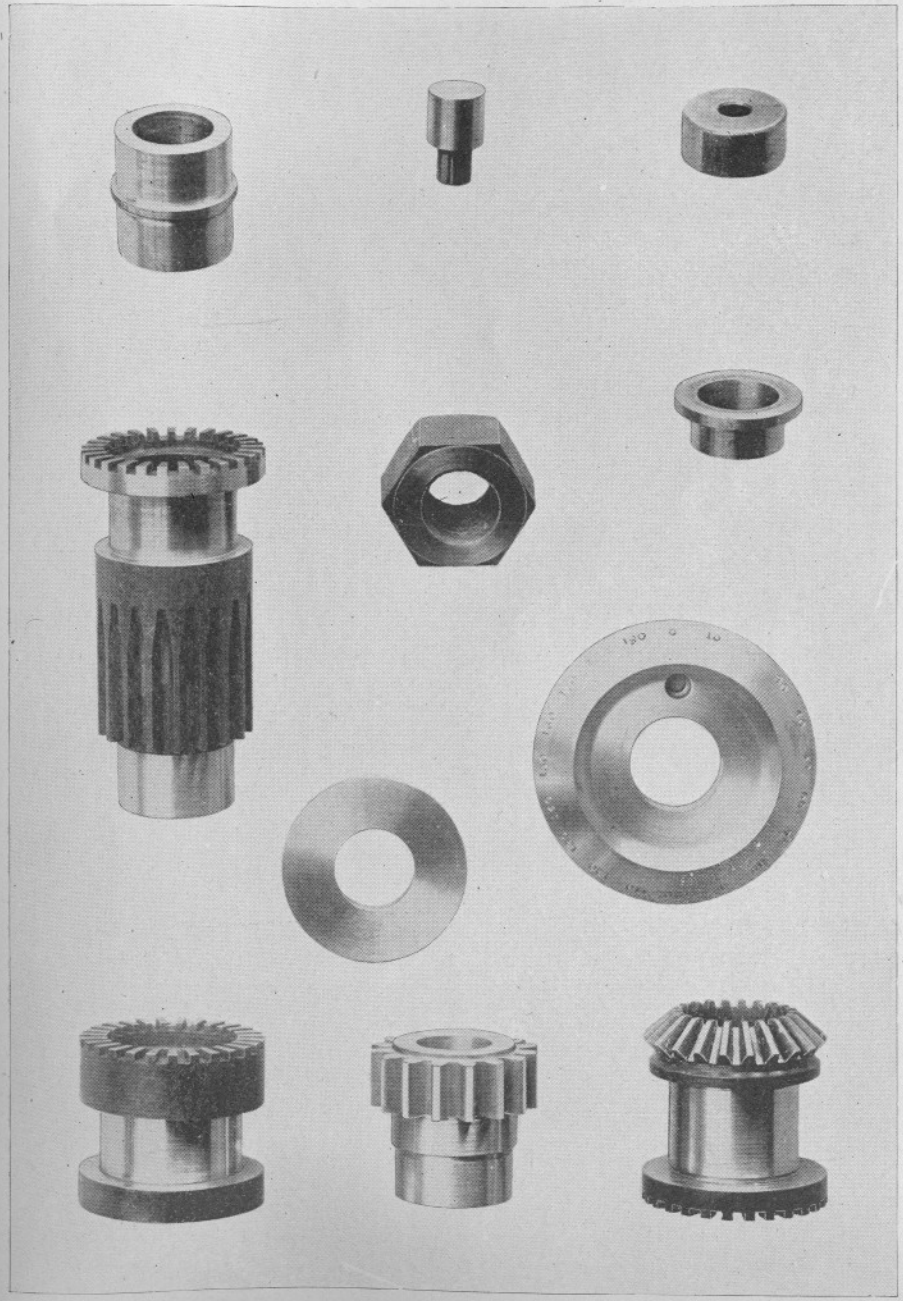
TOOTH RESTS AND CENTERING GAUGE.



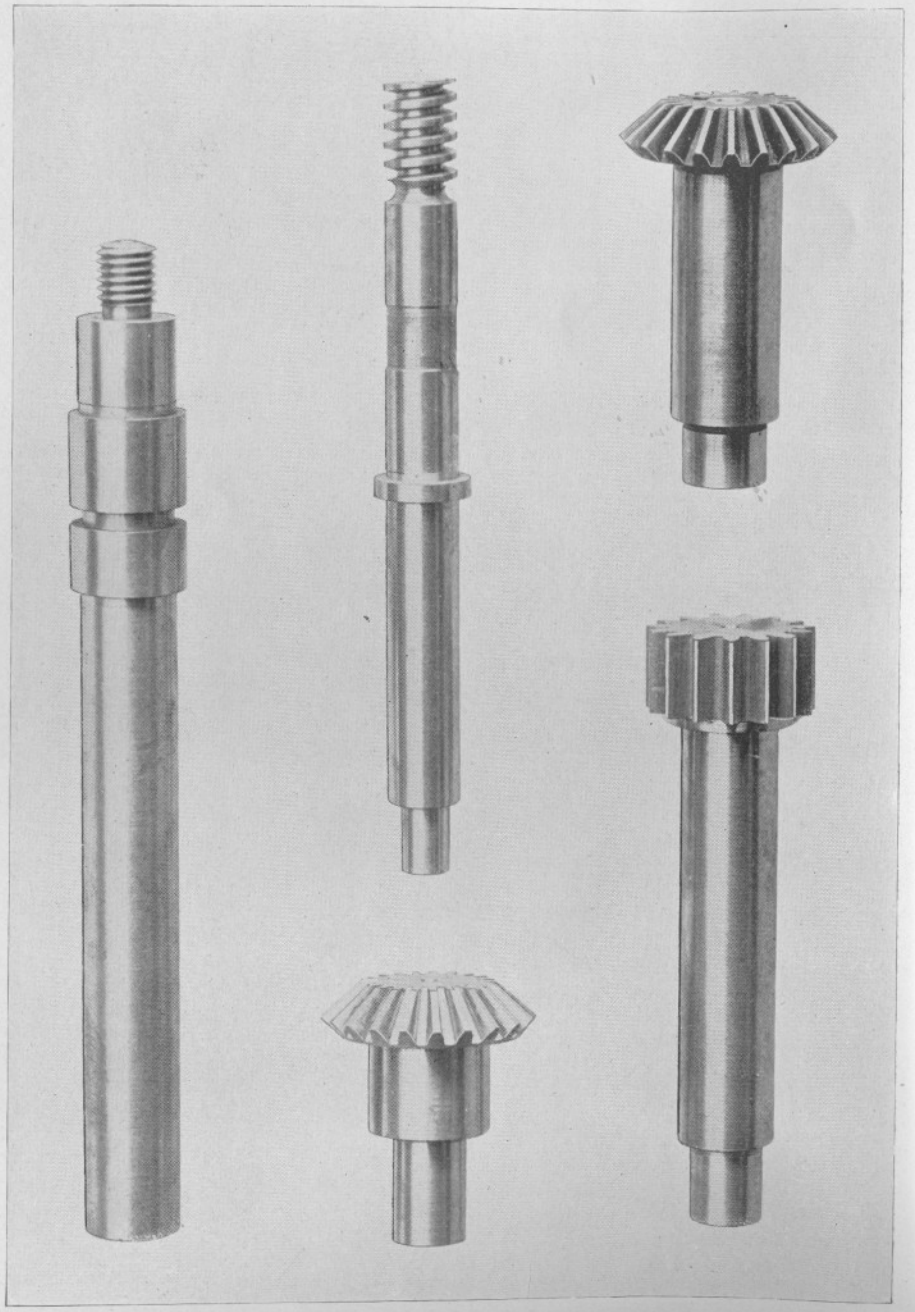
WORK GROUND ON THIS MACHINE.



WORK GROUND ON THIS MACHINE.



WORK GROUND ON THIS MACHINE.



WORK GROUND ON THIS MACHINE.

TESTIMONIALS.

Durbrow & Hearne.

THE CINCINNATI MILLING MACHINE CO. NEW YORK.

Gentlemen —We have your favor of the 17th inst., and in reply will say that we are perfectly satisfied with the Universal cutter and tool grinder which we bought from you about one year ago. So far we have never come across a piece of work that required grinding which we could not get at in some way with your machine. Before purchasing your machine we examined very thoroughly the other machines on the market, and we are satisfied that not only is your machine the best for all around work, but it seems to be practically the only one of its kind.

Yours Truly, DURBROW & HEARNE.

Fitchburg Machine Works.

THE CINCINNATI MILLING MACHINE CO. FITCHBURG, MASS.

Gentlemen – In reply to yours of the 17th, we have used one of your Universal cutters and tool grinders in our tool room for about five years, upon a large variety of work, and it has given entire satisfaction. We found we were able to do a much larger variety of work on this machine than we anticipated. A tool room is not complete without it.

Yours respectfully,

J. L. CHAPMAN, Supt. and Treas.

Delaware & Hudson Canal Co.

THE CINCINNATI MILLING MACHINE CO. CARBONDALE, PA.

Gentlemen — In answer to yours of the 17th inst., to Mr. R. C. Blackall, as regards the merits of your Universal cutter and tool grinder. As we have been using one for the past ten months at the Carbondale Locomotive Shops, would say in reply that, as for special features, I consider them all special, as the machine is the best that I have ever seen, being the result of good workmanship, and a tool, after being ground with it, is as near perfect as it can be.

Yours truly,

C. E. RETTEW, Master Mechanic.

The Sinker-Davis Co.

THE CINCINNATI MILLING MACHINE CO. INDIANAPOLIS, IND.

Gentlemen — Regarding your Universal cutter and reamer grinder purchased of you some time ago, will say that it meets our requirements in every particular, and we consider it by far the best grinder in the market, and recommend it without any hesitation to any factory needing a machine of that kind. It is an A No. 1 machine.

Yours truly, THE SINKER-DAVIS CO.

J. H. HOOKER.

St. Louis Southwestern Railway Co.

THE CINCINNATI MILLING MACHINE CO. PINE BLUFF, ARK.

Gentlemen — Replying to your favor of the 17th inst., will say that the Universal cutter and tool grinder purchased from your Company a year or more since has given us splendid satisfaction. We consider it a first-class machine, and think that it does all that is claimed for it. The results obtained from using the machine lead me to endorse it as perfect in its work, and I commend it highly to those needing such a tool.

Yours truly,

R. M. GALBRAITH, General Master Mechanic.

Some of the Users of The Universal Cutter and Tool Grinder.

Arkansas Indust. University,	Fayetteville,	Arkansas
St. Louis S. W. Ry.,	Pine Bluff,	"
Sterne Bros.,	San Diego,	California
Geo. E. Dow Pumping Engine Co.,	San Francisco,	"
California Fuse Works,	"	"
Raymond Mfg. Co.,	Guelph,	Ont. Canada
David Maxwell & Son,	St. Mary's,	"
Polson Iron Works,	Toronto,	"
Chemical Laboratory, University of Toronto,	"	"
Nock & Garside,	Denver,	Colorado
S. O. & C. Co.,	Ansonia,	Connecticut
Kinsley Mfg. Co.,	Bridgeport,	"
Eaton, Cole & Burnham Co.,	"	"
W. & B. Douglas,	Middletown,	"
Stanley Works,	New Britain,	"
E. A. Burgess,	New Haven,	"
New Haven Car Register Co.,	"	"
Boardman Manual Training School,	"	"
Griest Manufacturing Co.,	"	"
Oakville Co.,	Oakville,	"
Blickensderfer Mfg. Co.,	Stamford,	"
Eagle Bicycle Co.,	Torrington,	"
Randolph & Clowes,	Waterbury,	"
E. J. Manville Machine Co.,	"	"
American Well Works,	Aurora,	Illinois
National Sewing Machine Co.,	Belvidere,	"
March-Davis Cycle Co.,	Chicago,	"
Walburn-Swenson Co ,	"	"
M. D. Ewell,	"	"
Fulton Machine Works,	"	"
Challenge Machinery Co.,	"	"
Geo. E. Lloyd & Co.,	"	"
Remington & Sholes Typewriter Co.,	"	"
Illinois Central Ry.,	"	"
Grant Locomotive Works,	"	"
C. H. Hanson,	"	"
Weir & Craig Manufacturing Co.,	"	"
Goss Printing Press Co.,	"	"
L. Wolf Manufacturing Co.,	"	"
Mackie-Lovejoy Manufacturing Co.,	"	"
Gormully & Jeffery Co.,	"	"
Excelsior Supply Co.,	"	"
Eaton, Prince & Co.,	"	"
Deering Harvester Co.,	"	"
Chicago City Railway Co.,	"	"
Cobden Machine Works,	Cobden,	"
H. Mueller Manufacturing Co.,	Decatur,	"
Illinois Watch Case Co.,	Elgin,	"
Chicago, Peoria & St. L. Ry.,	Jacksonville,	"
Humphrey & Sons,	Joliet,	"
C. C. C. & St. Louis R. R.,	Mattoon,	"
Deere & Mansur Co.,	Moline,	"
F. C. Tichenor,	Peoria,	"

Some of the Users of the Universal Cutter and Tool Grinder—Continued.

B. Barmeier,	Quincy,	Illinois
Burson Knitting Co.,	Rockford,	"
Connersville Blower Co.,	Connersville,	Indiana
S. F. Bowser & Co.,	Fort Wayne,	"
Indiana Bicycle Works,	Indianapolis,	"
Greenleaf Turntable Mfg. Co.,	"	"
Indianapolis Chain & Stamping Co.,	Indianapolis,	"
Sinker-Davis Co.,	"	"
Bellis Cycle Mfg. Co.,	"	"
Indianapolis Elbow Co.,	"	"
Mohawk Cycle Co.,	"	"
Industrial Manual Training School,	"	"
Flint & Walling Mfg. Co.,	Kendallville,	"
Rockford Bit Co.,	Kokomo,	"
Lindsay Bicycle Mfg. Co.,	La Fayette,	"
A. D. Cook,	Lawrenceburg,	"
Speeder Cycle Co.,	New Castle,	"
Henley Bicycle Works,	Richmond,	"
Gaar-Scott & Co.,	"	"
Vandergrift Mfg. Co.,	Shelbyville,	"
Prox & Brinkman Mfg. Co.,	Terre Haute,	"
J. G. Cherry & Co.,	Cedar Rapids,	Iowa
Duplex Typewriter Co.,	Des Moines,	"
McDonald & Morrison Mfg. Co.,	Dubuque,	"
State College of Kentucky,	Lexington,	Kentucky
Sulzer Machine Co.,	Louisville,	"
Drummond Mfg. Co.,	"	"
E. Crawley & Co.,	Newport,	"
Harry Guenther & Bro.,	Owensboro,	"
Bath Iron Works,	Bath,	Maine
J. W. Penny & Sons,	Mechanics Falls,	"
Henry McShane Mfg. Co.,	Baltimore,	Maryland
Maryland Mfg. Co.,	"	"
Crown Cork & Seal Co.,	"	"
Baltimore Sugar and Refinery Co.,	Curtis Bay,	"
Maryland Mfg. & Construction Co.,	"	"
L. S. Starrett Co.,	Athol,	Mass.
J. F. Sturdy's Sons,	Attleboro Falls,	"
Boston Ball-Bearing Co.,	Boston,	"
Massachusetts Institute of Technology,	"	"
Fitchburg Machine Works,	Fitchburg,	"
C. H. Brown & Co.,	"	"
Millers Falls Co.,	Millers Falls,	"
Locke Regulator Co.,	Salem,	"
J. Duckworth,	Springfield,	"
Warren Steam Pump Co.,	Warren,	"
Draper Machine Tool Co.,	Worcester,	"
G. L. Brownell,	"	"
Julius Collignon,	Guadalajara,	Mexico
Monterey Foundry & Machine Co.,	Monterey,	"
Fletcher Paper Co.,	Alpena,	Michigan
Duplex Printing Press Co.,	Battle Creek,	"
National Cycle Mfg. Co.,	Bay City,	"
Lee & Porter,	Buchanan,	"
Detroit Screw Works,	Detroit,	"
American Blower Co.,	"	"
Penberthy Injector Co.,	"	"
Detroit Automobile Co.,	"	"
Decker Mfg. Co.,	"	"
Perkins & Co.,	Grand Rapids,	"
Baldwin-Tuthill & Bolton,	"	"

Some of the Users of the Universal Cutter and Tool Grinder—Continued.

Wisconsin Land & Lumber Co.,	Hermansville,	Michigan
Wm. E. Hill & Co.,	Kalamazoo,	"
Detroit Ship-Building Co.,	Wyandotte,	"
Michigan Mfg. Co.,	Ypsilanti,	"
Northern Pacific Ry. Co.,	St. Paul,	Minnesota
Soule Steam Feed Works,	Meridian,	Mississippi
Caps Bros. Special Printers Mch. Co.,	Kansas City	Missouri
Armour Packing Co.,	"	"
Pleuger & Henger Mfg. Co.,	St. Louis,	"
James Whitelaw,	"	"
St. Louis S. W. Ry. Co.,	"	"
Landis Machine Co.,	"	"
St. Louis Terminal R. R. Association,	"	"
Lansberg Brake Co.,	"	"
Curtis & Co. Mfg. Co.,	"	"
Union Depot Ry. Co.,	"	"
St. Louis Screw Co.,	"	"
Emerson Elec. Mfg. Co.,	"	"
H. Stanley Mill Furnishing Co ,	"	"
St. Louis Iron & Mach. Works,	"	"
St. Louis City Water Works Department,	"	"
Medart Patent Pulley Co.,	"	"
Montana College of Agric. & Mech. Arts,	Bozeman,	Montana
Underwood Typewriter Co.,	Bayonne,	New Jersey
Ferracute Machine Co ,	Bridgeton,	"
Camden Iron Works,	Camden,	"
Warren-Webster Co.,	"	"
F. A. Verdon & Co.,	Hoboken,	"
Manhattan Oil Motor Co.,	Jersey City,	"
Geo. White,	"	"
Foster Engineering Co.	Newark,	"
Manhattan Typewriter Co.,	"	"
R. C. Jenkinson & Co.,	"	"
Hasbrouck Motor Co.,	"	"
Manhattan General Construction Co.,	"	"
Fredericke Manufacturing Co.,	"	"
G. A. Meyer & Co.,	Paterson,	"
Delaware & Hudson Canal Co.,	Albany,	New York
Zenith Cycle Co.,	Binghamton,	"
M T. Davidson Pump Works	Brooklyn,	"
Riker Electric Motor Co.,	"	"
Colby & Co.,	"	"
Krajewski & Pesanct,	"	"
Hart-Ayres Plumbing Co.,	"	"
Chas. Ross & Son Co.,	"	"
Buffalo Gasoline Motor Co.,	Buffalo,	"
Conrad Carriage Works,	"	"
American Radiator Co.,	"	"
Howard Iron Works,	"	"
Buffalo Meter Co.,	"	"
West Manufacturing Co.,	"	"
Cataract Tool & Optical Co.,	"	"
Sherwood Manufacturing Co.,	"	"
Sheridan Iron Works,	Champlain,	"
Gould Coupler Co.,	Depew,	"
Elmira Knitting Mills,	Elmira,	"
J. A. Roebling & Sons Co.,	New York,	"
General Manufacturing Co.,	"	"
U. S. Friede,	"	"
Pettee & McCutcheon,	"	"
Flint, Eddy & Co.,	"	"

Some of the Users of the Universal Cutter and Tool Grinder—Continued.

Chas. Gantz,	New York,	New York
The Primus Co.,	"	"
J. L. Mott Iron Works,	"	"
Self-Threading Sewing Machine Co.,	"	"
A. F. Brombacher & Co.,	"	"
Durbrow & Hearne,	"	"
Western Elec. Co.,	"	"
L. F. Winter,	"	"
House of Refuge, Randall's Island,	"	"
J. T. Pedersen,	"	"
Century Machine Co.,	"	"
Imperial Engine Co.,	Painted Post,	"
Knowlton & Beach,	Rochester,	"
Eastman Kodak Co.,	"	"
Ritter Dental & Mfg. Co.,	"	"
Yawman & Erbe Co.,	"	"
Baker & Shevlire,	Saratoga Springs,	"
Goulds Manufacturing Co	Seneca Falls,	"
American Fire Engine Co.,	"	"
O. Milton Gale,	Syracuse,	"
The Bradley Co.,	"	"
Troy Laundry Machinery Co ,	Troy,	"
Morse Chain Co.,	Trumansburg,	"
Addyston Pipe & Steel Co ,	Addyston,	Ohio
Akron Elec. Mfg. Co.,	Akron,	"
Diamond Match Co.,	Barberton,	"
Canton Saw Co.,	Canton,	"
Wm. Powell Co.,	Cincinnati,	"
Laidlaw-Dunn-Gordon Co.,	"	"
J. M. Robinson & Co.,	"	"
J. A. Fay & Egan Co ,	"	"
Cincinnati Screw & Tap Co.,	"	"
Bradford Machine Tool Co.,	"	"
Miller-DuBrul & Peters Mfg. Co.,	"	"
The Lunkenheimer Co.	"	"
Crane & Breed Mfg. Co ,	"	"
R. K. LeBlond Machine Tool Co.,	"	"
H. F. Schlueter Bicycle Mfg. Co.,	"	"
Bullock Elec. Mfg Co.,	"	"
M. & M Machine Co.,	"	"
Chris. Erhart,	"	"
Krippendorf-Dittmann & Co.,	"	"
Wolf Promoting Elec. Co.,	"	"
Lane & Bodley Co.,	"	"
Bickford Drill & Tool Co.,	"	"
Lodge & Shipley Machine Tool Co.,	"	"
J. H. Day & Co.,	"	"
Dreses, Mueller & Co.,	"	"
Cincinnati Consolidated Street Ry. Co.,	"	"
Schumacher & Boye,	"	"
Cincinnati Shaper Co.,	"	"
Cincinnati Machine Tool Co.	"	"
American Tool Works,	"	"
Greaves & Klusman,	"	"
Hilbert, Freiberg Machine Co.,	"	"
Cincinnati Radial Drill Co.,	"	"
Jantz-Leist Electric Co.,	"	"
Dietz Machine Co.,	"	"
Brown Hoisting & Conveying Co.,	Cleveland,	"
West Manual Training School,	"	"
Lucas Machine Tool Co.,	"	"

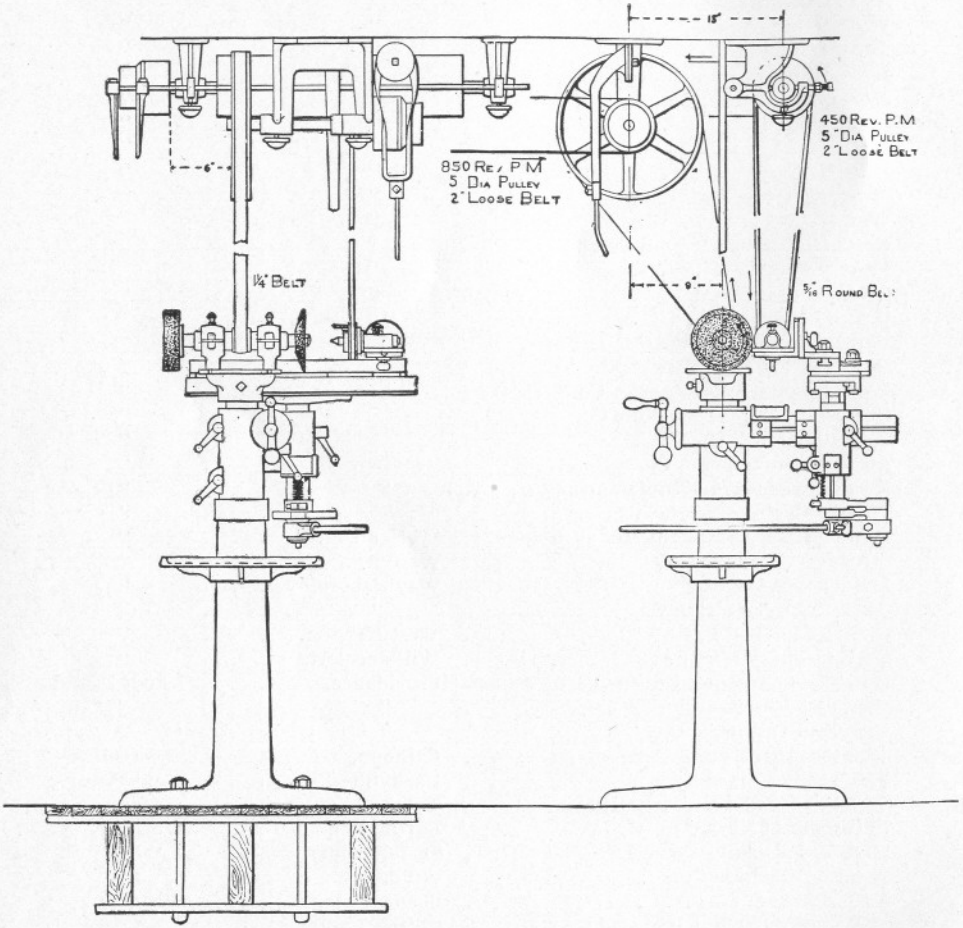
Some of the Users of the Universal Cutter and Tool Grinder—Continued.

The Long Arm System Co.,	Cleveland,	Ohio
Bishop & Babcock Co.,	"	"
Standard Lighting Co.,	"	"
Peerless Mfg. Co.,	"	"
Chandler & Price,	"	"
Lamson & Sessions Co.,	"	"
Central Manual Training School,	"	"
Cleveland Machine Screw Co.,	"	"
E. Konigslow & Bro.,	"	"
Kinnear Gager Co.,	Columbus,	"
Columbus Bicycle Co.,	"	"
Jeffry Mfg. Co.,	"	"
Columbus Brass Co.,	"	"
Brownell & Co.,	Dayton,	"
Computing Scale Co.,	"	"
Seybold Machine Co.,	"	"
W. P. Callahan & Co.,	"	"
Hamilton Machine Tool Co.,	Hamilton,	"
Fred. J. Meyers Mfg. Co.,	"	"
Ohio Machine Tool Co.,	Kenton,	"
Peters Cartridge Co.,	King's Mills,	"
Ohio Brass Co.,	Mansfield,	"
Monarch Stove Co.,	"	"
Miamisburg Electric Co.,	Miamisburg,	"
McSherry Mfg Co.,	Middletown,	"
Drew, Selby & Co.,	Portsmouth,	"
Deming Co.,	Salem,	"
Wagner Machine Co.,	Sidney,	"
Springfield Machine Tool Co.,	Springfield,	"
Springfield Gas Engine Co.,	"	"
Thomas Mfg. Co.,	"	"
Jos. M Normand,	"	"
Mast, Foos & Co.,	"	"
Hoppes Mfg. Co.,	"	"
Warder, Bushnell & Glessner Co.,	"	"
Foos Gas Engine Co.,	"	"
The Gendron Wheel Co.,	Toledo,	"
Snell Cycle Fittings Co.,	"	"
Toledo Metal Wheel Co.,	"	"
Toledo Machine & Tool Co.,	"	"
Acme Sucker Rod Co.,	"	"
Toledo Manual Training School,	"	"
Garfield Injector Co.,	Wadsworth,	"
Wm. Tod & Co.,	Youngstown,	"
Oklahoma Agricultural & Mech. College,	Stillwater,	Oklahoma
Allentown Spinning Co.,	Allentown,	Pennsylvania
Apollo Iron & Steel Co.,	Apollo,	"
Union Bridge Co.,	Athens,	"
R. Hermann,	Crafton,	"
Ingersoll-Sargent Drill Co.,	Easton,	"
Metric Metal Works,	Erie,	"
Keystone Elec. Co.,	"	"
Black Manufacturing Co.,	"	"
Jeanesville Iron Works,	Jeanesville,	"
Champion Blower & Forge Co.,	Lancaster,	"
W. L. Brubaker & Bros.,	Millersburg,	"
Pierce-Crouch Engine Co.,	New Brighton,	"
McMichael & Wildman,	Norristown,	"
A. & P. Roberts Co.,	Pencoyd,	"

Some of the Users of the Universal Cutter and Tool Grinder—Continued.

John Epplers Machine Works,	Philadelphia,	Pennsylvania
National Automatic Knitter Co.,	"	"
Wm Cramp & Sons,	"	"
Thos. Devlin & Co.,	"	"
J. W. Hepworth Machine Works,	"	"
Morse, Williams & Co.,	"	"
Acme Staple Co.,	"	"
J. E. Lonergan & Co.,	"	"
John H. Clay,	"	"
Moore & White Co.,	"	"
Wm. S. Cooper Brass Works,	"	"
National Pneumatic Tool Co.,	"	"
Pratt & Whitney,	"	"
Oil Well Supply Co.,	Pittsburg,	"
C. L. Hussey & Co.,	"	"
Westinghouse Machine Co.,	"	"
Union Boiler Tube Cleaner Co.,	"	"
Westinghouse Elec. & Mfg. Co.,	"	"
Fisher Foundry & Machine Co.,	"	"
Bailey-Farrell Mfg. Co.,	"	"
Acme Manufacturing Co.,	Reading,	"
Reading Standard Manufacturing Co.,	"	"
Textile Machine Works,	"	"
Penn. Soldiers' Orphans' Indus. School,	Scotland,	"
Struthers, Wells & Co.,	Warren,	"
Landis Tool Co.,	Waynesboro,	"
Geiser Manufacturing Co.,	"	"
U. S. Radiator Co.,	West Newton,	"
Darling Pump Mfg Co.,	Williamsport,	"
Hotchkiss Ordnance Co.,	Providence,	Rhode Island
Diamond Machine Co.,	"	"
American Ordnance Co.,	"	"
Clemsen Agricultural College,	Calhoun,	S Carolina
Vanderbilt University,	Nashville,	Tennessee
St Louis Southwestern Railway,	Tyler,	Texas
University of Vermont,	Burlington,	Vermont
E & T. Fairbanks Co.,	St. Johnsbury,	"
Windsor Machine Co.,	Windsor,	"
A. K. Rarig & Co.,	Buena Vista,	Virginia
Chesapeake & Ohio Railroad Co.,	Clifton Forge,	"
Miller Manual Training School of Albemarle,	Crozet,	"
Glamorgan Pipe and Foundry Co.,	Lynchburg,	"
Richmond & Danville R. R.,	Manchester,	"
United States Navy Yard,	Portsmouth,	"
West Virginia University,	Morgantown,	West Virginia
Beloit Iron Works,	Beloit,	Wisconsin
Fairbanks, Morse & Co.,	"	"
Berlin Machine Works,	"	"
Sterling Cycle Works,	Kenosha,	"
Lippitt Iron Works,	"	"
The Vilter Manufacturing Co.,	Milwaukee,	"
Perry Ransom,	Oshkosh,	"

Countershaft Connections with Grinder.



The Grinder in position for service shows on the left a front view elevation of its countershafts and belts, and on the right a side view elevation of the same objects.

The overhead works include a secondary countershaft with a long drum for the round belt to grooved pulley used in circular grinding.

Endless belts are preferable.

Width of belt from line shaft to countershaft,	2 inches
Width of down belt,	1¼ "
Revolutions of countershaft for emery wheel spindle,	850 per min.
Diameter of tight and loose pulleys,	5 inches
Revolution of drum countershaft for circular grinding,	450 per min.
Diameter of tight and loose pulleys	5 inches