thread milling cutter of stock size can be used. This cutter will have a 1 in. hole diameter and an outside diameter of 2⅝ in. The cutter is swiveled to the angle of 2° 52′, and is then centered on the worm blank.

MILLING A HIGH SPEED CARBIDE CUTTER BODY

Carbide face mill cutters differ greatly in diameter, number of teeth, and rake angles. The following specifications are used as a typical example:

1. Diameter of Cutter Body = 8″
2. Number of Teeth = 10
3. Axial Rake Angle = —10°
4. Radial Rake Angle = —10°
5. Carbide Tooth Thickness = 3/16″

Before milling, the following lathe operations should be completed:

1. Turn the periphery to size.
2. Face both sides parallel and square with periphery.
3. Bore the whole which fits over the milling machine spindle nose to a depth of ⅝″ and 5.0620″- 5.0625″ diameter, and square with the face. (Figure 49).
4. Turn a recess in the face of the cutter body to allow for chips.

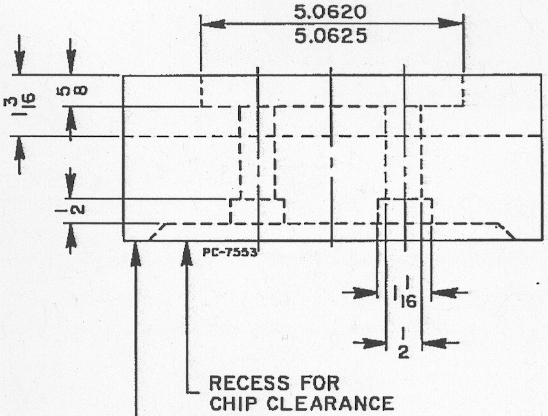


Figure 49

Dimensions of a Typical Cutter Body

Mill Driving Key Slots (Figure 49). This operation is not completed with the aid of the Dividing Head, but we have included the details for sake of completeness in machining the cutter body.

1. Clamp the cutter body face down on the table of the machine and fasten an arbor, fitted with either an inter-locking or stagger tooth cutter of the correct thickness, in the machine spindle. Lock arbor support and overarm in position. Select correct cutter speed and feed.
2. Accurately measure the diameter of the cutter body with a micrometer. Adjust the knee, saddle, and table to bring the side of the cutter tangent to the periphery of the cutter body.
3. Start the spindle and hold a thin piece of paper between rotating cutter and the periphery of the cutter body. Move saddle in slowly until the paper is pulled between the cutter and body.
4. Lower the knee and move the saddle in ½ the diameter of the cutter body plus ½ the thickness of the cutter plus the thickness of the paper. Start the spindle and raise the knee until the rotating cutter contacts the top of the cutter body. Move the table to the right, raise the knee 1 3/16″, and mill the driving key slot.

Mill Carbide Insert Seats.

1. Mount Dividing Head, with four-jaw chuck, in rear T-slot (slot nearest column) of machine. Fasten a 1″ four flute end mill, together with a suitable adaptor, in machine spindle. Select correct speed and feed.

2. Free the Dividing Head spindle by disengaging the worm from worm wheel. Grip the cutter body with Dividing Head chuck by expanding the jaws in the $5\frac{1}{16}$″ bored hole (Figure 49). Protect the bored surface from the hardened steel chuck jaws with shim stock.

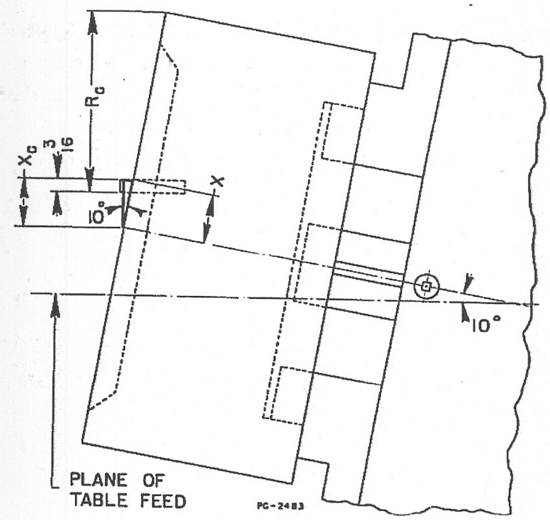


Figure 50A

Sketch Showing Calculation of Distance to Raise Knee

   Test the periphery and face of cutter body with a dial indicator and then eliminate eccentricity by shifting the chuck jaws. When cutter body runs concentric, engage worm with worm wheel.

3. Set the Dividing Head for the axial rake angle of minus 10°. This is accomplished by swiveling the Dividing Head up 10° from the horizontal (Figure 50A). The vernier scale on the Dividing Head may be used to accurately adjust the head.

4. Set the cutter off-center for the radial rake angle of minus 10°. The amount of off-set (Figure 50B) and distance to raise the knee (Figure 50A) can be calculated in the following manner:

$$\text{Sine } 10^\circ = \frac{X}{r}$$

$$X = r \text{ Sine } 10^\circ$$

$$X = 4 \times .17365$$

$$X = .6946$$

Now calculate the corrected X dimension (Xc) and the correct R dimension (Rc) (Figure 50A).

$$\text{Cos } 10^\circ = \frac{Xc}{X}$$

$$Xc = X \text{ Cos } 10^\circ$$

$$Xc = .98481 \times .6946$$

$$Xc = .682$$

$$\text{Cos } 10^\circ = \frac{Rc \times (Xc - \text{tooth thickness})}{4}$$

$$\text{Cos. } .98481 = \frac{Rc + (.6820 - .1875)}{4}$$

$$Rc + (.6820) - .1875 = .98481 \times 4$$

$$Rc + .4945 = 3.93924$$

$$Rc = 3.9392 - .4945$$

$$Rc = 3.444''$$

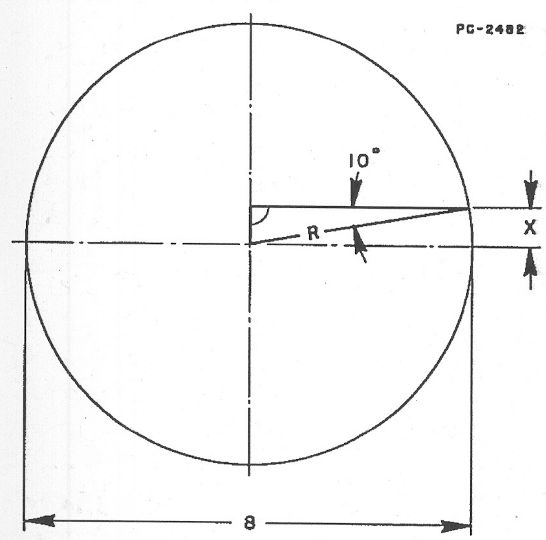


Figure 50B

Sketch Showing Calculation of Amount of Offset

5. Start the spindle, adjust table, knee and saddle to position the rotating cutter directly above the highest point on the periphery of the cutter body. Use a piece of tissue paper for touching up. Back away the saddle and raise the knee Rc dimension.
6. Move in the saddle until the face of the rotating cutter contacts the periphery of the cutter body. Move the table to the right to clear the rotating cutter. Measure the width "W" of the carbide tip, (Figure 51) subtract 1/8" and move the saddle in this amount. If the width of the carbide tip is considerably wide it may be necessary to take several cuts before the desired depth is reached.
7. Engage the table feed lever and mill the carbide tip seat in the cutter body. Turn the crank of the Dividing Head 4 complete turns and return the index pin to the same hole in the index plate. Repeat this operation until all ten carbide tip seats are milled.
8. After the last seat has been milled, lower the knee 3/16" (tooth thickness) and move the saddle in 1/8" (Figure 51). This is done to provide clearance for the grinding wheel when grinding the face of the carbide teeth. Engage the table feed lever and take a cut. Index and repeat this operation on the remaining seats.
9. The chip clearance or gullet is milled next (Figure 51). Scribe a line on the face of the cutter body from "A" to "B" (Figure 51). Position cutter body so line is square with top of table. Start spindle and mill off all the metal outside of this line. Index and repeat this operation. Remove the cutter (not the cutter body).

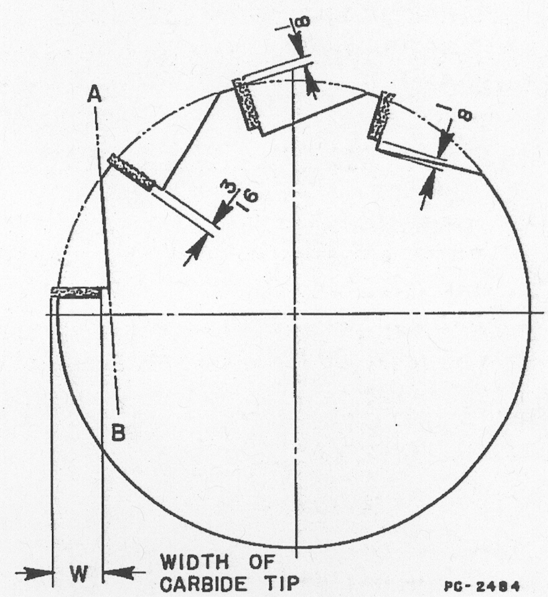


Figure 51

Cutting the Gullets

10. Swivel the Dividing Head spindle to a horizontal position, loosen tee-bolts, and move the Dividing Head to another part of the table. Fasten a Dividing Head angle plate, fitted with tongue strips, to table. Mount Dividing Head on angle plate so face of cutter body is facing the column.
11. Adjust the knee and table to position the cutter body central with the machine spindle. Fasten an indicator to the machine spindle and in contact with the work periphery. Disengage the spindle drive. Rotate the spindle by hand and watch the dial indicator as it revolves around the periphery of the cutter body. Adjust the

table and knee until the indicator shows zero movement during its complete revolution. Remove the dial indicator from machine spindle and engage spindle drive.

12. Disengage the Dividing Head worm from the worm wheel. Rotate the cutter body until the driving key slots are parallel to the machine table. Check the parallelism with an indicator on the table. Lock the Dividing Head spindle and engage the worm with the worm wheel. If the index pin in the Dividing Head crank does not fit into a hole in the index plate, release the stop which locks the index plate and rotate the plate in either direction until pin enters a hole. Relock the index plate stop and release the Dividing Head spindle lock.

13. Mount a suitable adaptor on the spindle nose of the machine. Fasten a 3/16″ center drill and holder in the adaptor. Select the correct spindle speed. Raise the knee 2.000″ and turn the index crank 5 complete revolutions and return the pin to the same hole in the index plate. Start spindle and center drill the face of the cutter body. Turn the index crank 10 complete turns and repeat this operation. After center drilling four holes, drill completely through the cutter body with a 21/32″ drill (Figure 49). Replace the 21/32″ drill with a 1 1/16″ end mill and co-bore the four holes to a depth of 1/2″. Cutter body is now complete and ready for the brazing of carbide tips.

MILLING THE TANG AND CENTER KEY-SLOT ON A TAPER SLEEVE

Milling operations on taper sleeves and similar parts constitute a common Dividing Head setup. Nevertheless, high quality workmanship is difficult to obtain because of the small cutters required for the operation, and the large amount of metal which must be removed. The instructions given briefly outline both tang and key slot operations.

1. Clean milling machine table and bottoms of Dividing Head and tailstock.

2. Clamp Dividing Head in rear T-slot with spindle in horizontal position. Mount a test bar in spindle and check parallelism between spindle and table with a dial indicator.

3. Clamp tailstock to table. An aligning bar and dial indicator may be used for obtaining correct alignment between tailstock center and Dividing Head center.

4. Dog large end of taper sleeve and mount between centers.

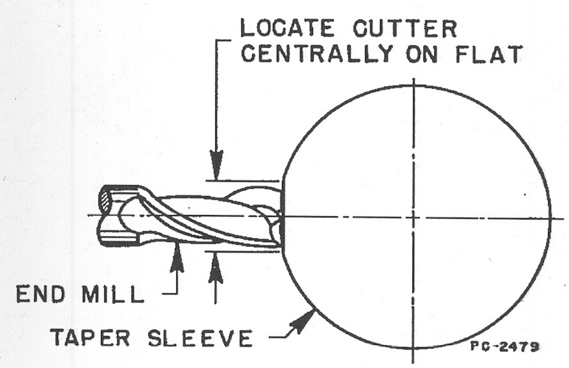


Figure 52
Centering an End Mill

5. Fasten a $\frac{1}{4}$″ two flute straight shank end mill into a holder and mount holder and a suitable adapter in spindle of machine. End mill must have at least $\frac{5}{8}$″ flute length. Select correct cutter speed and feed.

6. Lay off the $1\frac{3}{16}$″ dimension as per Figure 53A. Position table, knee, and saddle so $1\frac{3}{16}$″ dimension is directly in front of cutter. Start machine spindle and move saddle in by hand until cutter starts cutting. Center cutter with flat just milled on taper sleeve (Figure 52).

7. Position table so cutter is at one end of $1\frac{3}{16}$″ dimension. Move saddle in by hand about .250″, engage table feed and mill length of slot. Repeat until flute length is consumed. Back out saddle, turn index crank 20 turns (180°) and return pin to same hole in index plate. Repeat above milling operation until slot is through taper sleeve.

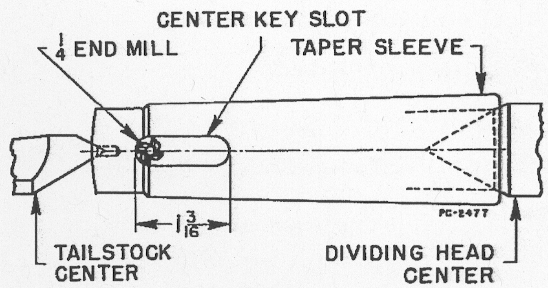


Figure 53A

Milling Center Key-Slot

8. Stop machine, remove two flute end mill and replace it with a $\frac{1}{4}$″ four flute straight shank end mill having a $1\frac{1}{4}$″ flute length or greater.

9. Start machine and move saddle in until cutter extends completely through taper sleeve. Raise knee a few thousandths and take a cut. Move saddle out, return table to its start position, turn index crank 20 turns and take another cut. Measure slot with gage blocks. Raise knee $\frac{1}{2}$ the difference between the gage blocks size and the size of the finished slot. Take another cut, back out saddle, and return table to start position. Turn index crank 20 turns, again move saddle in and take another cut. Measure slot, take another cut if necessary.

10. Turn index crank 10 turns (90°). Stop machine and replace cutter with a $\frac{5}{8}$″ four flute straight shank end mill. It will also be necessary to change the cutter holder, feed and speed.

11. Start machine spindle and position table, knee, and saddle so cutter is directly over small end of taper sleeve.

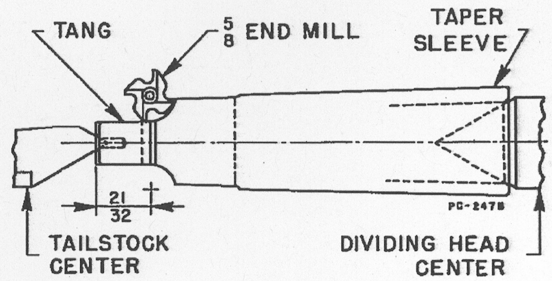


Figure 53B

Milling the Tang

12. Raise knee until cutter contacts work, move table to right and further raise knee about .125″. Lay off the $^{21}/_{32}$″ dimension, Figure 53B. Engage table feed and take first cut. Stop machine, move table to right, and turn index crank 20 turns (180°). Start machine and take a second cut. Measure thickness of tang with micrometer and repeat above milling operation until correct thickness of tang is reached.

CUTTING THE GRADUATIONS ON A MICROMETER DIAL

In experimental work or the making of special attachments a micrometer dial is sometimes needed in connection with a screw having a certain pitch and lead. With the pitch and lead known a dial can be accurately graduated with the aid of a Dividing Head and a small tool which is easily made. The following example will be used for the purpose of explaining the setup and operation of the Dividing Head for this particular job.

Example:

PITCH OF SCREW .... ¼″
LEAD OF SCREW .... ¼″
DIAMETER OF DIAL .... 5″

1. Clean milling machine table and bottoms of Dividing Head and tailstock.

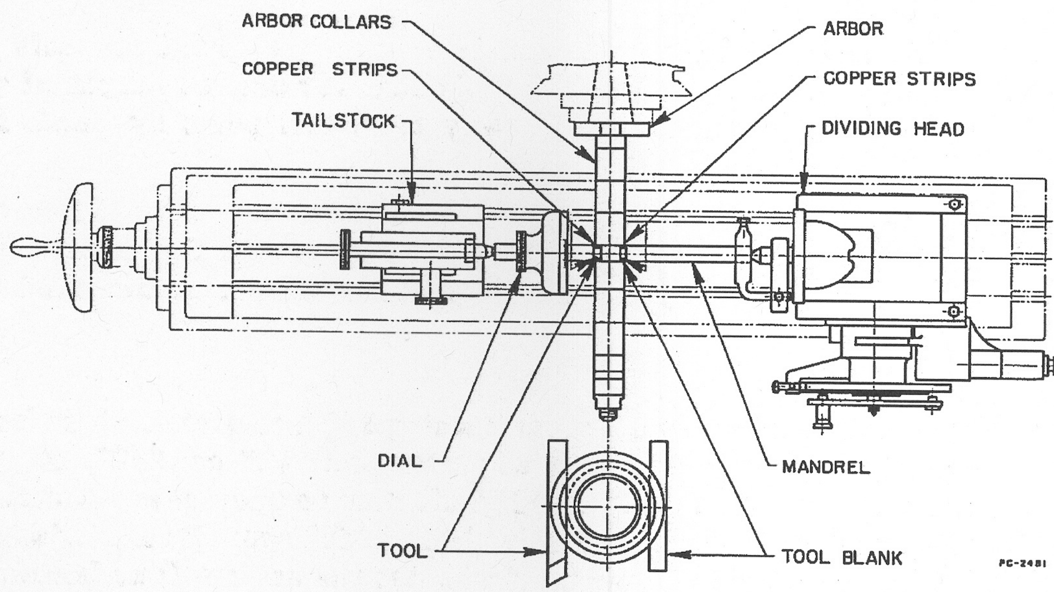


Figure 54
Graduating an Index Dial

2. Clamp Dividing Head in center T-slot with spindle in a horizontal position. Insert a center in spindle of Dividing Head.

3. Align tailstock center with Dividing Head center. Clamp tailstock to table of machine.

4. Grind a piece of tool steel to any desired shape which will be easily read when reproduced on the periphery of the dial.

5. Fasten arbor with arbor collars into spindle of machine. At a convenient distance from the spindle nose separate two of the arbor collars about 1 inch (Figure 54). Place two thin pieces of copper on each side of tool and mount between separated arbor collars. Similarly place a tool blank, with copper strips, between arbor collars directly opposite tool and tighten arbor nut.

6. Manipulate knee, saddle, and table until tool point is in line with tailstock center. Lower knee and set machine to lowest spindle R. P. M. Mount arbor support on overarm and tighten arbor support bushing nut.

7. Dog end of mandrel, preferably a flange type. Fasten work piece on mandrel and mount between centers.

8. Manipulate knee, saddle, and table until tool point contacts periphery of dial blank. Set the table dogs for desired length of graduated line. Move the table away from tool point by hand. Raise knee for desired depth of graduation line.

9. Each graduation is cut by using the longitudinal feed of the machine and indexing the dividing head by means of the hand index crank.

A ¼″ pitch and ¼″ lead indicates a single thread screw. Therefore one complete turn of dial would advance screw ¼″ or .250″. It will be necessary therefore to have 250 graduations on periphery of dial. This can be obtained with the dividing head as follows: Set the index crank so pin enters hole in 25-hole circle. Set the sectors four holes apart. After one graduation mark is cut, move index crank to sector arm (4 holes) swing sector arms around for next index.

MILLING CAMS

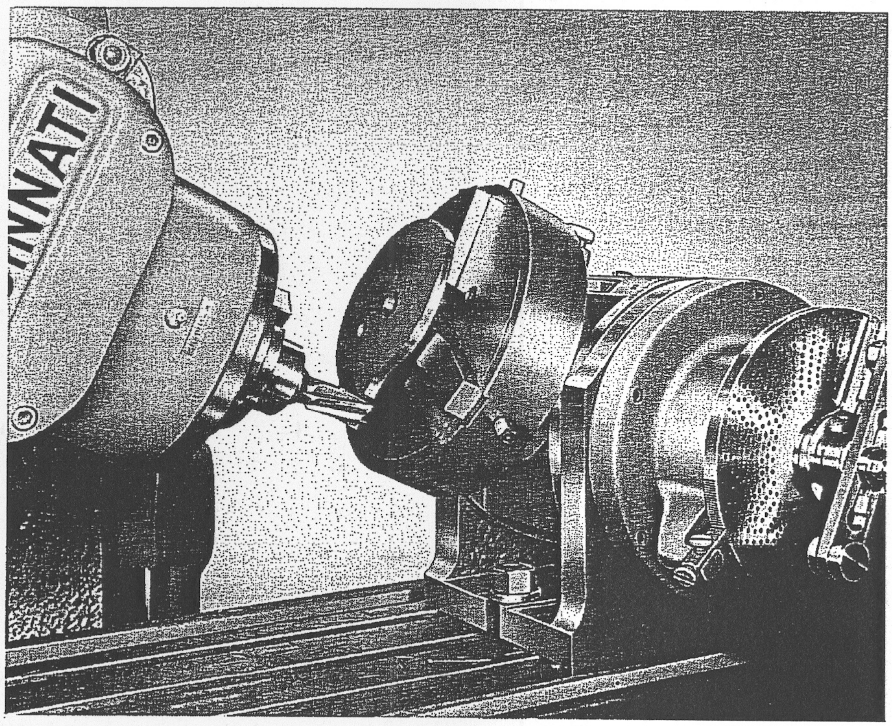


Figure 56

Milling a Uniform Rise Cam

Rise and fall cams having a relatively narrow face may be machined by using the type of setup indicated in Figure 56. The cutter may be supported in any type of swiveling head, such as a Universal Milling Attachment or Vertical Attachment. Almost any cam lead can be machined, and by trying different Dividing Head leads, the angle to which the head must be set can be changed to suit conditions. A table of Sine functions will be required when determining the angle of inclination of the Dividing Head.

The angle of inclination of the Dividing Head and milling cutter can be calculated by means of the following formula.

$$\text{Sine A} = \frac{\text{Lead of Cam}}{\text{Lead of Dividing Head}}$$

Examples:

1. Suppose you want to mill a cam having a .500″ lead. Assume change gears are set up for 2.5″ Dividing Head Lead.

$$\text{Sine A} = \frac{\text{Lead of Cam}}{\text{Lead of Dividing Head}} = \frac{.5}{2.5} = .200 \quad \text{A} = 11^\circ,\ 33'.$$

2. Suppose you want to mill a lead of 6.005″.

(a) Assume change gears are set up for 8″ Dividing Head Lead.

$$\text{Sine A} = \frac{\text{Lead of Cam}}{\text{Lead of Dividing Head}} = \frac{6.005}{8} = .7506 \qquad A = 48°, 39'.$$

(b) Assume change gears are set for 9.935″ Dividing Head Lead instead of 8″ as in example 2 (a), then

$$\text{Sine A} = \frac{\text{Lead of Cam}}{\text{Lead of Dividing Head}} = \frac{6.005}{9.935} = .6044 \qquad A = 37°, 11'.$$

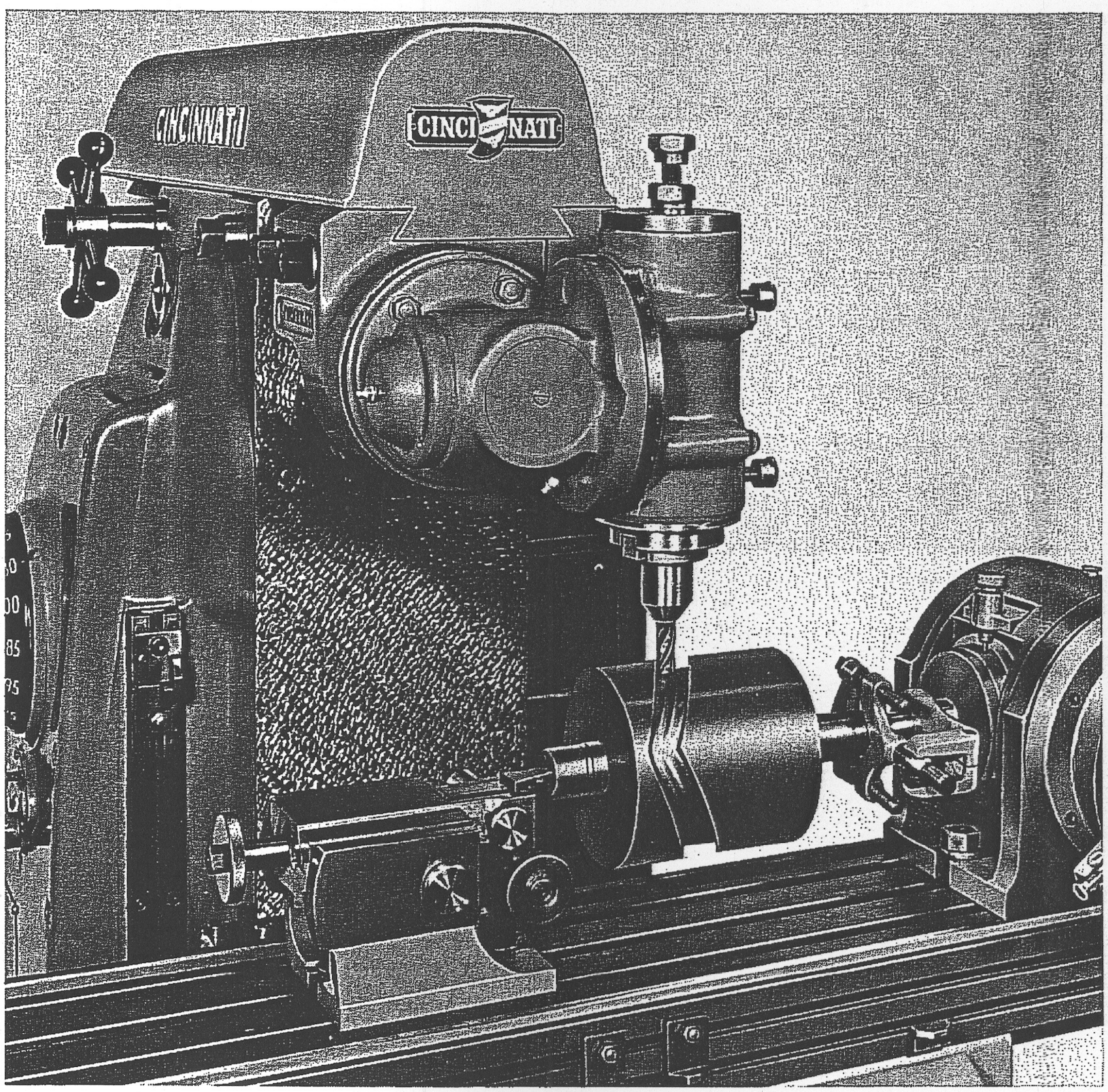


Figure 57

Milling a Reverse Type Drum Cam

DRIVING MECHANISMS

There are three classifications of driving mechanisms for CINCINNATI Universal Dividing Heads. Instructions and tables in this book are for the 2½″ to 100″ Standard Enclosed Driving Mechanism only. The instructions and tables for the Low Lead Attachment and the Short and Long Lead Attachment are contained in separate booklets.

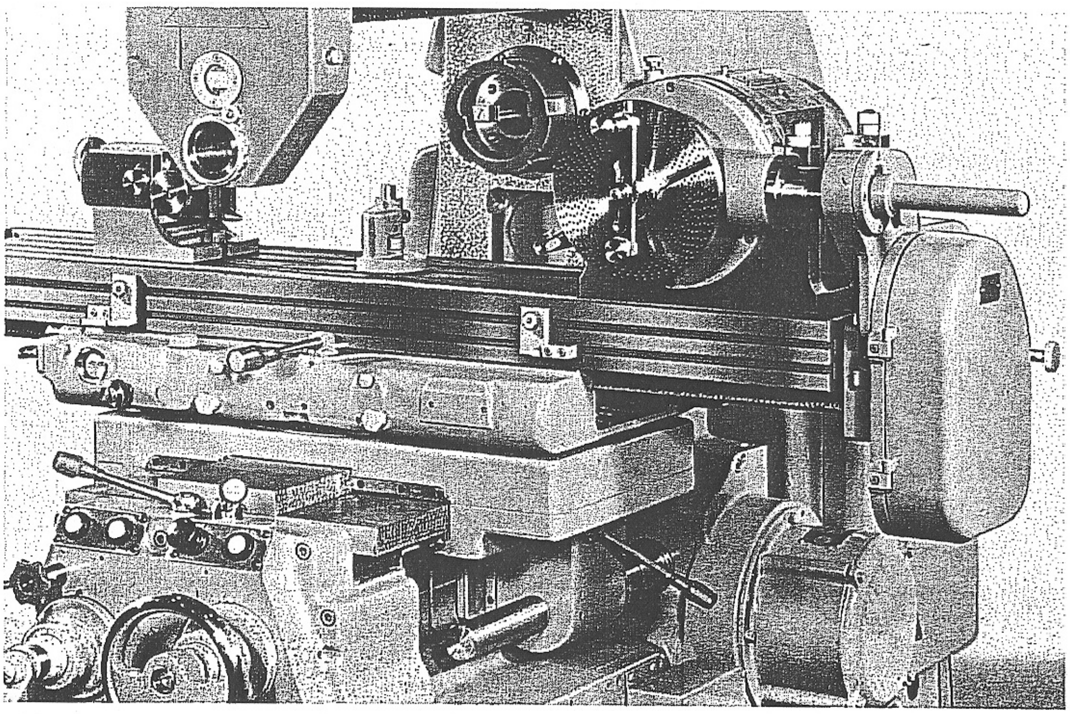


Figure 58

2½″ to 100″ Standard Enclosed Driving Mechanism

2½″ to 100″ Standard Enclosed Driving Mechanism. This driving mechanism is supplied with all CINCINNATI Universal General Purpose Milling Machines as standard equipment (Figure 58). It is available for plain and vertical style machines. The instructions and tables for this attachment are in this book and are also in a separate booklet, "Table of Leads—2½″ to 100″ Standard Enclosed Driving Mechanism."

Note: There is a 2½″ to 150″ Standard Enclosed Driving Mechanism which is available for all general purpose milling machines (plain, universal, and vertical). *The instructions and tables in this book do not apply to this mechanism.* Complete information is contained in the booklet, "Table of Leads—2½″ to 150″ Standard Enclosed Driving Mechanism."

Low Lead Attachment. May be obtained at extra cost for the CINPAK® 45, CINEL® 60, and CINOVA® 80 Universal Machines only (Figure 59A). Complimentary parts must be built into the machine at the factory. It is driven from a splined shaft and has a lead range of ⅛" to 100" (high series same as tables on pages 76 to 92; low series are these leads divided by 20). Complete instructions are contained in a separate booklet "Table of Low Leads—⅛" to 100" Dividing Head Driving Mechanism for CINCINNATI® Milling Machines," a copy of which accompanies each machine equipped with the Low Lead Attachment.

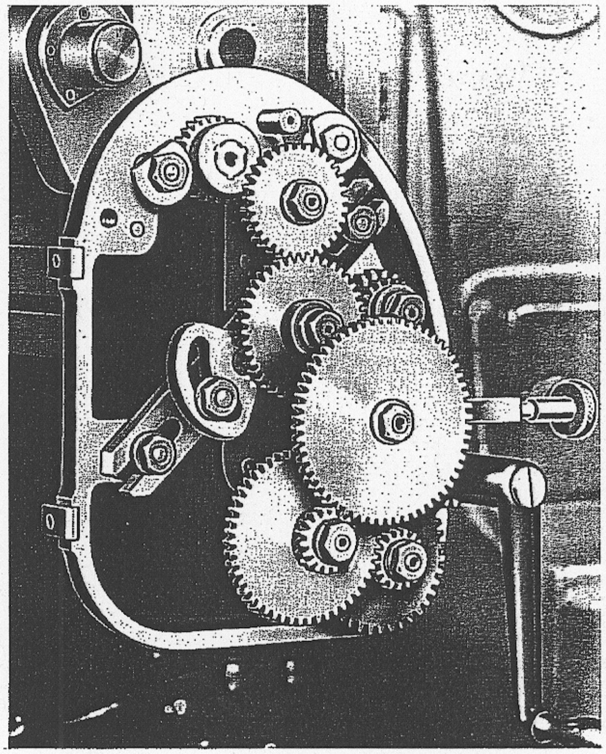


Figure 59A
Low Lead Attachment

Short and Long Lead Attachment. May be obtained at extra cost for all CINCINNATI Universal General Purpose Milling Machines (Figure 59B). Complimentary parts must be built into the machine at the factory. It has a standard range of .010" to 1000" or (on demand) .025" to 3000", with no more than the usual number of change gears. Complete instructions are contained in a separate booklet, "Short and Long Lead Attachment-Table of Leads for CINCINNATI Universal Milling Machines," a copy of which accompanies each machine equipped with this attachment.

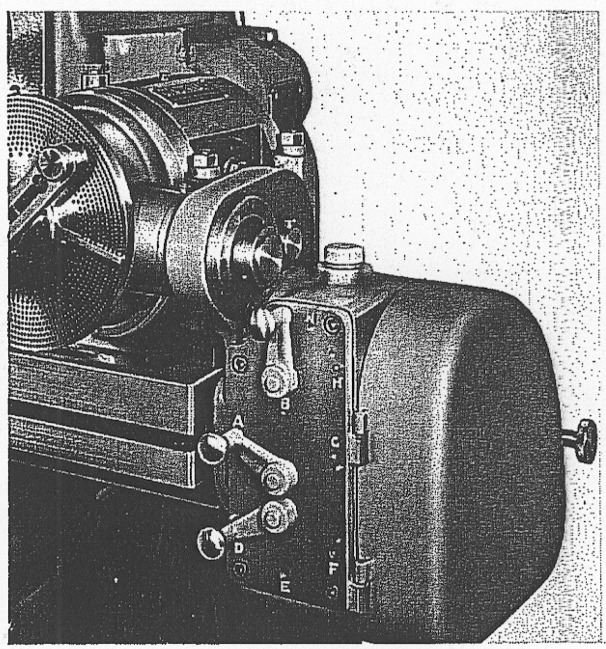


Figure 59B
Short and Long Lead Attachment

$2\frac{1}{2}''$ TO 100″ STANDARD ENCLOSED DRIVING MECHANISM

This Dividing Head driving mechanism is supplied with all CINCINNATI Universal General Purpose Milling Machines as standard equipment. It is available for plain and vertical machines. Driven directly from the lead screw, this attachment provides leads from $2\frac{1}{2}''$ to 100″ (See "Tables of Leads", pages 76-92). For illustrations and operating instructions for this driving mechanism only, see pages 60-63.

Note: This driving mechanism is not interchangeable from one size machine to another.

Calculating the Change Gears Required for a Given Lead. Many leads can be obtained other than those listed in the "Table of Leads". They were omitted because the difference was too small for ordinary requirements; but if you do not find a lead in the table which is close enough to meet your needs, the following formula will enable you to calculate all the possibilities:

$$\frac{\text{Lead}}{10} = \frac{\text{Driven Gears}}{\text{Driver Gears}} = \frac{A \times C}{B \times D}$$

Suppose you want a lead of 35.789″:

$$\frac{35.789}{10} = 3.5789 = \frac{204}{57} = \frac{51 \times 4}{19 \times 3} = \frac{51 \times (4 \times 9)}{19 \times (3 \times 9)} = \frac{51 \times 36}{19 \times 27}$$

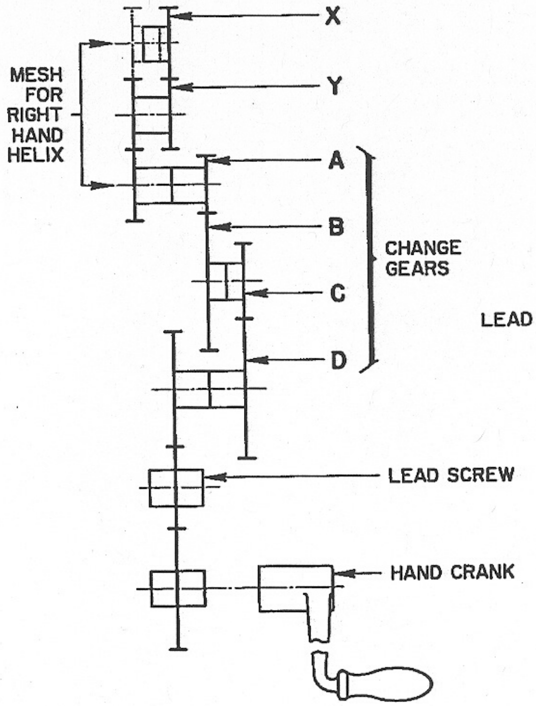
Gear A = 51 teeth
Gear B = 19 teeth
Gear C = 36 teeth
Gear D = 27 teeth

Standard change gears furnished with enclosed driving mechanism:

1 — 17 teeth	2 — 24 teeth	1 — 42 teeth
1 — 18 teeth	1 — 27 teeth	1 — 45 teeth
1 — 19 teeth	1 — 30 teeth	1 — 48 teeth
1 — 20 teeth	1 — 33 teeth	1 — 51 teeth
1 — 21 teeth	1 — 36 teeth	1 — 55 teeth
1 — 22 teeth	1 — 39 teeth	1 — 60 teeth

The "hand" of the lead is fixed by gears "X" and "Y", as shown in the table below:

Right-Hand Helix	Left-Hand Helix
Remove gear Y Reverse gear X	Gears X and Y as shown in Fig. 61B.



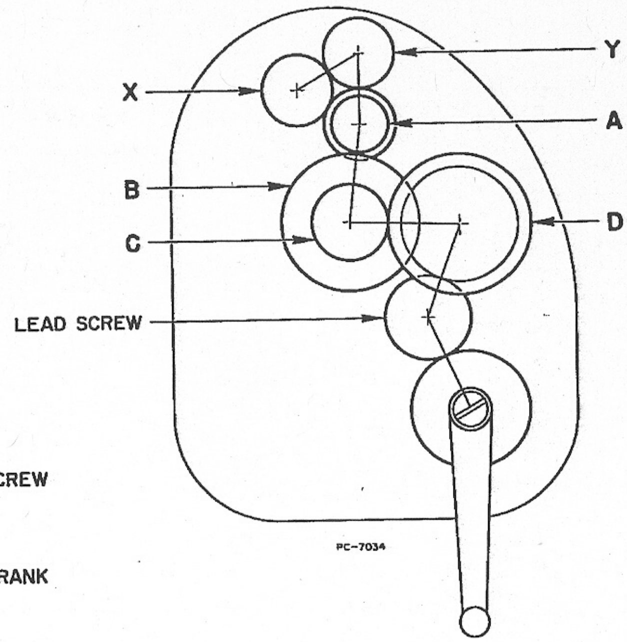


Figure 61A

Arrangement of Change Gears

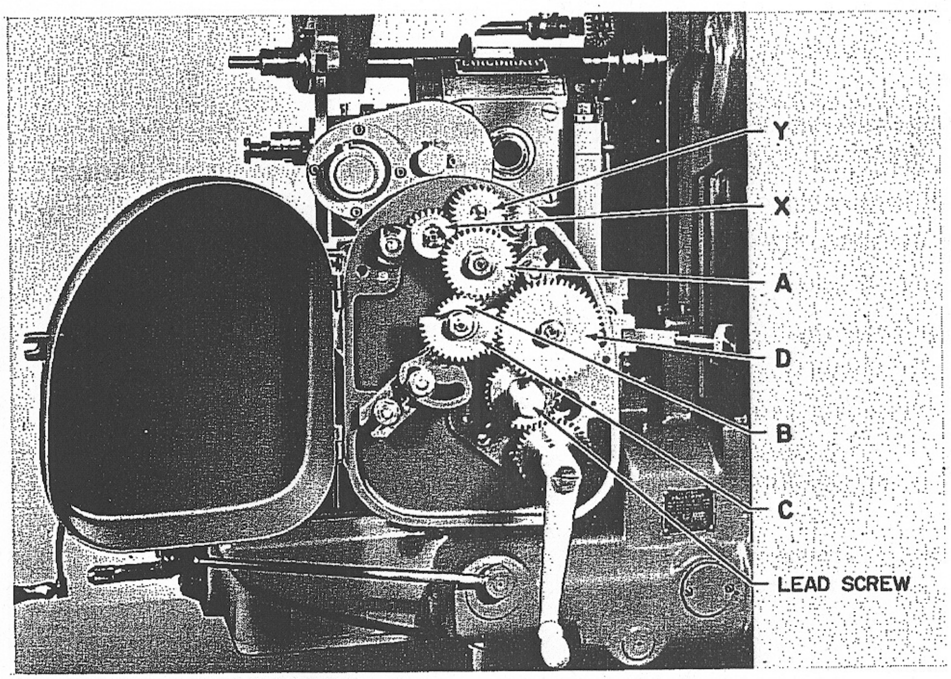


Figure 61B

Arrangement of Complete Gear Train

Setting Up the Change Gears. Remove the circular cover on the apron at the right-hand end of the table. It is held in position with a slotted screw. Then place the change gear driving mechanism on the apron, and fasten securely in position. Place the change gears in the positions indicated for the desired lead, being careful not to get intermediate gears B and C interchanged (Figures 61A and 61B).

After the setup has been completed, move the table by means of the hand feed crank, to insure that the entire mechanism operates freely, before engaging the power feed.

Emergency Conversion to Short Leads. With the 2½″ to 100″ Standard Enclosed Driving Mechanism, illustrated in Figure 61B, leads lower than those listed in the tables, pages 76 to 92, can be obtained, *using hand feed only* (rotating the index crank at the side of the head). To change the gearing for low leads, remove gear "D". A 34-tooth gear is now exposed, meshing with the 34-tooth gear on the lead screw (directly below gear "D"). Remove these two 34-tooth gears, and replace them with the standard 51-tooth change gear on the lead screw and the standard 17-tooth change gear on the stud for gear "D". Instead of a 1 to 1 ratio, we now have a speed-up of 3 to 1. Leads for the change gear combinations listed are now divided by 3. However, some of the change gear combinations are not obtainable because of interference with the segment.

This setup should be used only for occasional jobs. If leads shorter than 2½″ are cut often, we recommend the Low Lead Attachment or the Short and Long Lead Attachment. Of course, these short lead mechanisms can be installed only at our factory.

Leads Near the Low Range. When cutting leads within the low range of the Dividing Head driving mechanism, certain precautions must be observed. If, for example, the gears are set up for a 10″ lead, the ratio of the change gears is 1 to 1, and the table feed (lead) screw rotates 40 revolutions to one revolution of the Dividing Head spindle.

For leads greater than 10″, the Dividing Head spindle runs slower in relation to the speed of the lead screw. Example: 20″ lead, table feed screw rotates 80 revolutions, while the Dividing Head spindle rotates one revolution. This requires a change gear setup which reduces the speed from the lead screw to the Dividing Head, resulting in a mechanical advantage in transmitting power.

For leads shorter than 10", the Dividing Head spindle runs faster in relation to the speed of the lead screw. Example: 5" lead, table feed screw rotates 20 revolutions, while the Dividing Head spindle rotates one revolution. The change gear setup for these low leads increases the speed from the lead screw to the Dividing Head, resulting in a mechanical disadvantage in transmitting power. The slow speed of the lead screw causes a "wind-up", which may produce a slightly jerky motion when milling short leads on large diameters of work. Therefore, conditions should be as nearly correct as possible when cutting short leads, particularly those from 2½" to 5". These conditions may be summarized in a few words: (*a*) the table gib should be correctly adjusted (not too tight), (*b*) the change gears should has a slight amount of backlash, (*c*) the table ways and lead screw should be well oiled, (*d*) the table feed should rotate freely. Also, it might be noted that with a relatively high table feed, say 5¾" per minute, a greater proportion of power is available at the Dividing Head.

When all contributing factors are correct, the machine will pull a reasonable cut with a setup for the lowest lead of 2½". If the cut should be unnecessarily heavy, then it is advisable to feed by hand. This may be done by allowing the table feed engaging lever to remain in neutral position and driving the Dividing Head and table by hand through the index crank in front of the index plate. With a short lead setup, hand feed is very easy, as the mechanical advantage is then in favor of the operator.

If leads lower than 5" must be cut often, we recommend our short lead attachments. (They may be applied to universal machines only.)

Rapid Traverse and High Feed Rates. When the driving mechanism is set up for low leads, *do not* engage the table rapid traverse, or use high feed rates of 11" or 16" per minute. Such rapid rates of table traverse drive the Dividing Head too fast, resulting in rapid wear or perhaps "freezing" of the Dividing Head spindle in the block, as they are fitted very closely to obtain accuracy in spacing.

Rapid Traverse. When using the driving mechanism, reverse the table only when the feed is engaged. Do not reverse it while the rapid traverse is engaged, as entirely too much strain is set up in the mechanism of the machine and attachment. For example, after milling a spiral groove, reverse the table while in feed and then engage the rapid traverse to get back to the starting point.

Lubrication. There are three spring cap oilers on the driving mechanism which should be oiled every day with a good quality paraffinic base, rust and oxidation inhibited oil (P-55).

ACCESSORIES AND ATTACHMENTS

HIGH NUMBER INDEXING PLATES

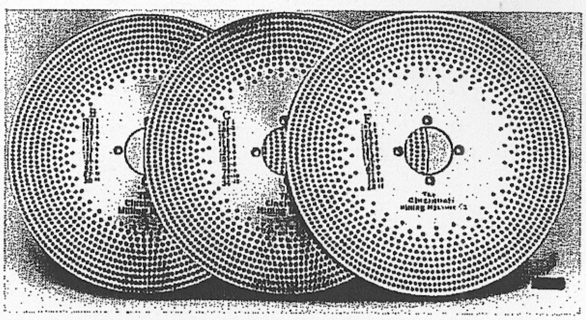


Figure 64

High Number Indexing Plates

This attachment, shown in Figure 64, consists of three plates, drilled on both sides. These plates are interchangeable with the standard index plate on the side of the head.

The index tables shown on pages 74 and 75 apply to this attachment.

Number of Holes Drilled in Each Side of High Number Index Plates

Part Number of Plate					
*Standard 10525 †Wide Range 113505		Standard 10526 Wide Range 113506		Standard 10527 Wide Range 113507	
Side A	Side B	Side C	Side D	Side E	Side F
189	199	197	193	191	187
177	183	181	179	175	173
171	169	167	163	161	159
147	157	153	151	149	143
129	141	139	137	133	131
117	127	123	121	119	113
99	111	109	107	103	101
91	97	93	89	87	83
69	81	79	77	73	71
48	67	46	44	42	38
30	36	34	32	26	28

Note: *Available only for the 10", 12", 14" Universal Dividing Heads.
†Available for the 10", 12", 14" Wide Range Dividers.

For leads shorter than 10", the Dividing Head spindle runs faster in relation to the speed of the lead screw. Example: 5" lead, table feed screw rotates 20 revolutions, while the Dividing Head spindle rotates one revolution. The change gear setup for these low leads increases the speed from the lead screw to the Dividing Head, resulting in a mechanical disadvantage in transmitting power. The slow speed of the lead screw causes a "wind-up", which may produce a slightly jerky motion when milling short leads on large diameters of work. Therefore, conditions should be as nearly correct as possible when cutting short leads, particularly those from 2½" to 5". These conditions may be summarized in a few words: (*a*) the table gib should be correctly adjusted (not too tight), (*b*) the change gears should has a slight amount of backlash, (*c*) the table ways and lead screw should be well oiled, (*d*) the table feed should rotate freely. Also, it might be noted that with a relatively high table feed, say 5¾" per minute, a greater proportion of power is available at the Dividing Head.

When all contributing factors are correct, the machine will pull a reasonable cut with a setup for the lowest lead of 2½". If the cut should be unnecessarily heavy, then it is advisable to feed by hand. This may be done by allowing the table feed engaging lever to remain in neutral position and driving the Dividing Head and table by hand through the index crank in front of the index plate. With a short lead setup, hand feed is very easy, as the mechanical advantage is then in favor of the operator.

If leads lower than 5" must be cut often, we recommend our short lead attachments. (They may be applied to universal machines only.)

Rapid Traverse and High Feed Rates. When the driving mechanism is set up for low leads, *do not* engage the table rapid traverse, or use high feed rates of 11" or 16" per minute. Such rapid rates of table traverse drive the Dividing Head too fast, resulting in rapid wear or perhaps "freezing" of the Dividing Head spindle in the block, as they are fitted very closely to obtain accuracy in spacing.

Rapid Traverse. When using the driving mechanism, reverse the table only when the feed is engaged. Do not reverse it while the rapid traverse is engaged, as entirely too much strain is set up in the mechanism of the machine and attachment. For example, after milling a spiral groove, reverse the table while in feed and then engage the rapid traverse to get back to the starting point.

Lubrication. There are three spring cap oilers on the driving mechanism which should be oiled every day with a good quality paraffinic base, rust and oxidation inhibited oil (P-55).

ACCESSORIES AND ATTACHMENTS

HIGH NUMBER INDEXING PLATES

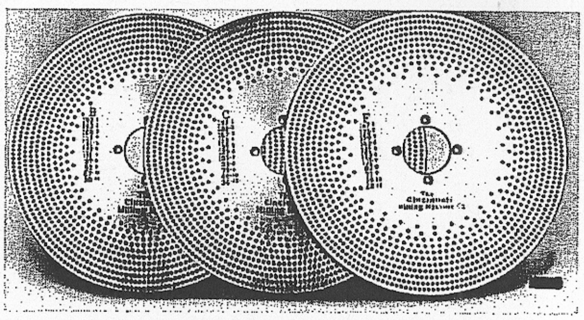


Figure 64
High Number Indexing Plates

This attachment, shown in Figure 64, consists of three plates, drilled on both sides. These plates are interchangeable with the standard index plate on the side of the head.

The index tables shown on pages 74 and 75 apply to this attachment.

Number of Holes Drilled in Each Side of High Number Index Plates

Part Number of Plate					
*Standard 10525 †Wide Range 113505		Standard 10526 Wide Range 113506		Standard 10527 Wide Range 113507	
Side A	Side B	Side C	Side D	Side E	Side F
189	199	197	193	191	187
177	183	181	179	175	173
171	169	167	163	161	159
147	157	153	151	149	143
129	141	139	137	133	131
117	127	123	121	119	113
99	111	109	107	103	101
91	97	93	89	87	83
69	81	79	77	73	71
48	67	46	44	42	38
30	36	34	32	26	28

Note: *Available only for the 10", 12", 14" Universal Dividing Heads.
†Available for the 10", 12", 14" Wide Range Dividers.

COMPENSATING DOG AND DRIVER

The Compensating Dog and Driver, Figure 65 should be used with CINCINNATI Universal Dividing Heads, because the spindle is not fixed in a horizontal plane. With these driving elements, greater accuracy will be obtained on taper work. The tail of the dog has a close fitting roller, which, in turn, fits into the slot of the driver. Various work diameters can be handled, because the roller slides on the tail of the dog a sufficient amount to compensate for the varying difference in the distance from the center of the work to the point of driving contact. The dog has a capacity range from 3/4" to 2 3/4" diameter for 10", 12" and 14" Dividing Heads.

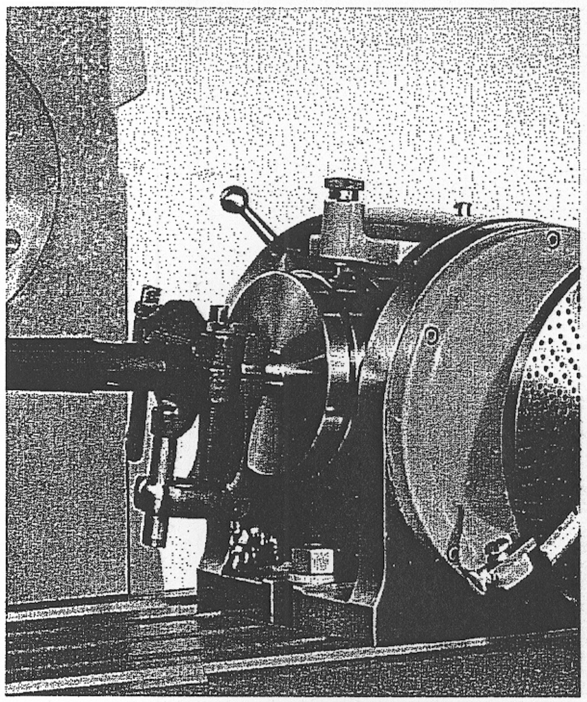


Figure 65
Compensating Dividing Head Dog and Driver

CHUCKS

Many Dividing Head jobs can be more conveniently held in a chuck than between centers. To facilitate this class of work, the 3-Jaw Universal Chuck (Figure 66A) or the 4-Jaw Independent Chuck (Figure 66B) may be obtained.

The chuck bolts to an adapter plate (Figure 66C) designed for the 50 Series spindle nose of the Dividing Head. See specifications (Figure 66D) below for various size chucks and adapters.

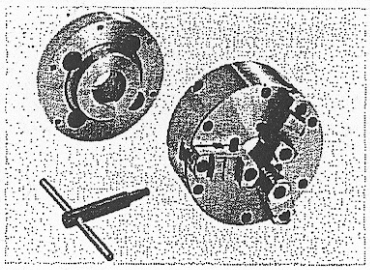


Figure 66A
3-Jaw Universal Chuck, Adapter "A", and T-Wrench

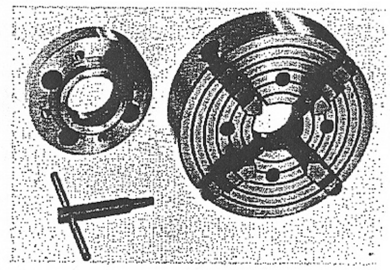
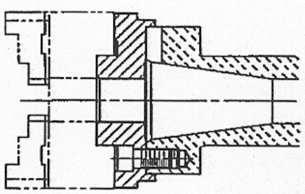
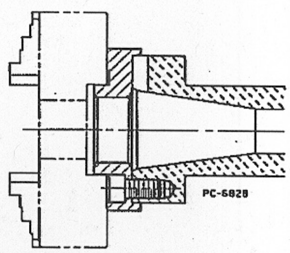


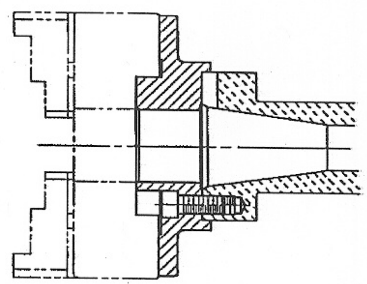
Figure 66B
4-Jaw Independent Chuck, Adapter "B", and T-Wrench



Adapter Style "A"



Adapter Style "B"



Adapter Style "C"

Figure 66C
Chuck Adapters

Size Head	Chuck Size	Style	Capacity	Adapter
10"	6" Universal	3-Jaw	1/8"-7 3/8" O.D. 1 3/4"-5" I.D.	Style A
10"	8" Independent	4-Jaw (light duty)	2 1/8"-7 3/8" O.D. 2"-7 1/4" I.D.	Style B
12"-14"	9" Universal	3-Jaw	1/4"-8 1/2" O.D. 2 1/4"-8 1/2" I.D.	Style C
12"-14"	10" Independent	4-Jaw (light duty)	3 1/8"-9 1/8" O.D. 2"-8 1/4" I.D.	Style B

Figure 66D
Specifications

UNIVERSAL MILLING ATTACHMENT

This attachment is used for helical milling in two cases:

1. If the machine is a plain miller, obviously the table can not be swiveled to bring the work piece to the correct helix angle with the cutter. It then becomes necessary to swivel the cutter. This angular setting is obtained by means of the Universal Milling Attachment (Figure 67).
2. The table of a universal miller can not be swiveled more than 45°. If the helix angle exceeds this range, the attachment must be used, since it allows the cutter to be swiveled through a complete circle.

The Universal Milling Attachment may also be employed for a wide variety of other types of work, such as vertical milling with a shell end mill, rounding out keyways, milling angular surfaces, etc. The attachment spindle runs at the same speed as the machine spindle.

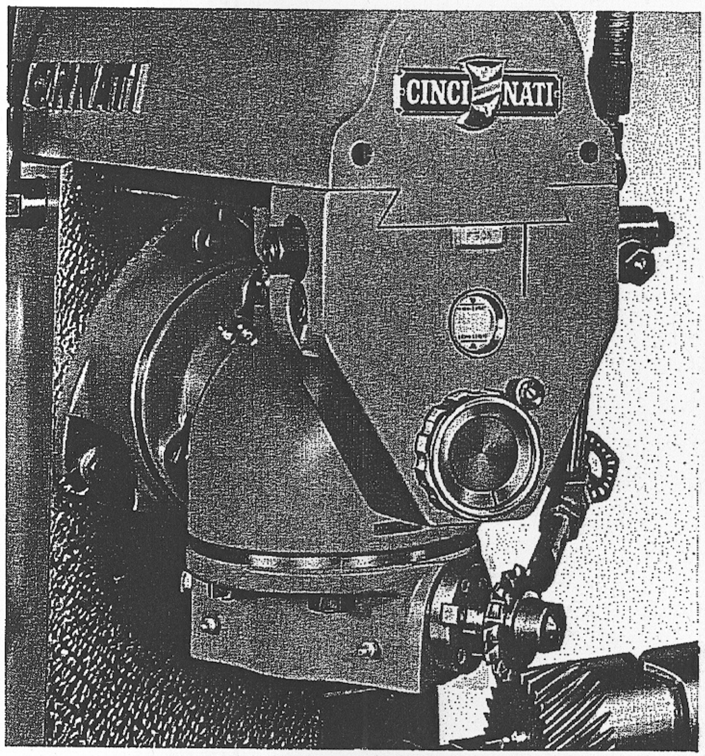


Figure 67
Universal Milling Attachment

GASHING ANGLES FOR WORM WHEELS

Lead of Worm in Inches	No. of Threads per Inch in Worm	PITCH DIAMETER OF WORM															
		5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2
1/10	10	2°55′	2°26′	2° 5′	1°49′	1°37′	1°28′	1°20′	1°13′	1° 7′	1° 2′	58′	55′	52′	49′	46′	44′
1/9	9	3°14′	2°42′	2°19′	2° 1′	1°48′	1°37′	1°28′	1°21′	1°15′	1° 9′	1° 5′	1° 1′	57′	54′	51′	49′
1/8	8	3°38′	3° 2′	2°36′	2°17′	2° 2′	1°49′	1°39′	1°31′	1°24′	1°18′	1°13′	1° 8′	1° 4′	1° 1′	58′	54′
1/7	7	4°10′	3°28′	2°58′	2°36′	2°19′	2° 5′	1°54′	1°44′	1°36′	1°29′	1°23′	1°18′	1°14′	1° 9′	1° 6′	1° 3′
1/6	6	4°51′	4° 3′	3°28′	3° 2′	2°42′	2°26′	2°13′	2° 1′	1°52′	1°44′	1°37′	1°31′	1°26′	1°21′	1°17′	1°13′
1/5	5	5°49′	4°51′	4°10′	3°39′	3°14′	2°55′	2°39′	2°26′	2°15′	2° 5′	1°57′	1°49′	1°43′	1°37′	1°32′	1°27′
1/4	4	7°16′	6° 4′	5°12′	4°33′	4° 3′	3°39′	3°19′	3° 2′	2°48′	2°36′	2°26′	2°17′	2° 9′	2° 2′	1°55′	1°49′
2/7	3 1/2	8°17′	6°55′	5°56′	5°12′	4°37′	4°10′	3°47′	3°28′	3°12′	2°58′	2°47′	2°36′	2°27′	2°19′	2°12′	2° 5′
1/3	3	9°38′	8° 3′	6°55′	6° 3′	5°23′	4°51′	4°25′	4° 3′	3°44′	3°28′	3°14′	3° 2′	2°52′	2°42′	2°33′	2°26′
4/11	2 3/4	10°30′	8°46′	7°32′	6°36′	5°52′	5°17′	4°49′	4°25′	4° 4′	3°47′	3°32′	3°19′	3° 7′	2°57′	2°47′	2°39′
3/8	2 2/3	10°49′	9° 3′	7°46′	6°48′	6° 4′	5°27′	4°58′	4°33′	4°12′	3°54′	3°39′	3°25′	3°13′	3° 2′	2°53′	2°44′
2/5	2 1/2	11°31′	9°38′	8°17′	7°15′	6°27′	5°49′	5°17′	4°51′	4°29′	4°10′	3°53′	3°39′	3°26′	3°14′	3° 4′	2°55′
4/9	2 1/4	......	......	......	8° 3′	7°10′	6°27′	5°52′	5°23′	4°59′	4°37′	4°19′	4° 3′	3°46′	3°36′	3°25′	3°14′
1/2	2	......	......	......	......	......	7°15′	6°36′	6° 3′	5°36′	5°12′	4°51′	4°33′	4°17′	4° 3′	3°50′	3°39′
4/7	1 3/4	......	......	......	......	......	......	......	6°55′	6°23′	5°56′	5°32′	5°12′	4°54′	4°37′	4°23′	4°10′
2/3	1 1/2	......	......	......	......	......	......	......	......	......	......	6°27′	6° 3′	5°42′	5°23′	5° 6′	4°51′
3/4	1 1/3	......	......	......	......	......	......	......	......	......	......	......	......	6°25′	6° 3′	5°44′	5°27′
4/5	1 1/4	......	......	......	......	......	......	......	......	......	......	......	......	......	......	6° 7′	5°49′
1	1	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1 1/3	3/4	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1 1/2	2/3	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

GASHING ANGLES FOR WORM WHEELS

(Continued)

Lead of Worm in Inches	No. of Threads per Inch in Worm	PITCH DIAMETER OF WORM															
		2⅝	2¾	2⅞	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6
1/10	10	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1/9	9	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
1/8	8	52′	50′	48′	46′	42′	39′	36′	34′	32′	......	......	......	......	......	......	......
1/7	7	1°	57′	54′	52′	48′	45′	42′	39′	37′	35′	33′	......	......	......	......	......
1/6	6	1° 9′	1° 6′	1° 3′	1° 1′	56′	52′	48′	46′	43′	40′	38′	36′	35′	......	......	......
1/5	5	1°23′	1°20′	1°16′	1°13′	1° 7′	1° 3′	58′	55′	52′	49′	46′	44′	42′	40′	38′	......
1/4	4	1°44′	1°39′	1°35′	1°31′	1°24′	1°18′	1°13′	1° 8′	1° 4′	1° 1′	58′	55′	52′	50′	48′	46′
2/7	3½	1°59′	1°54′	1°49′	1°44′	1°36′	1°29′	1°23′	1°18′	1°14′	1° 9′	1° 6′	1° 3′	1° 1′	57′	54′	52′
1/3	3	2°19′	2°13′	2° 7′	2° 2′	1°52′	1°44′	1°37′	1°31′	1°26′	1°21′	1°17′	1°13′	1° 9′	1° 6′	1° 3′	1° 1′
4/11	2¾	2°31′	2°25′	2°18′	2°13′	2° 2′	1°54′	1°46′	1°39′	1°34′	1°28′	1°24′	1°20′	1°16′	1°12′	1° 9′	1° 6′
3/8	2⅔	2°36′	2°29′	2°23′	2°17′	2° 6′	1°57′	1°49′	1°43′	1°37′	1°31′	1°26′	1°22′	1°18′	1°15′	1°11′	1° 8′
2/5	2½	2°47′	2°39′	2°32′	2°26′	2°14′	2° 5′	1°57′	1°49′	1°43′	1°37′	1°32′	1°28′	1°23′	1°20′	1°16′	1°13′
4/9	2¼	3° 5′	2°57′	2°49′	2°42′	2°30′	2°19′	2°10′	2° 2′	1°54′	1°48′	1°42′	1°37′	1°33′	1°28′	1°24′	1°21′
1/2	2	3°28′	3°19′	3°10′	3° 2′	2°48′	2°36′	2°26′	2°17′	2° 9′	2° 2′	1°55′	1°49′	1°44′	1°39′	1°35′	1°31′
4/7	1¾	3°58′	3°47′	3°37′	3°28′	3°12′	2°59′	2°47′	2°36′	2°27′	2°19′	2°12′	2° 5′	1°59′	1°54′	1°49′	1°44′
2/3	1½	4°37′	4°25′	4°13′	4° 3′	3°44′	3°28′	3°14′	3° 2′	2°52′	2°42′	2°33′	2°26′	2°19′	2°13′	2° 7′	2° 1′
3/4	1⅓	5°12′	4°58′	4°45′	4°33′	4°12′	3°54′	3°39′	3°25′	3°13′	3° 2′	2°53′	2°44′	2°36′	2°29′	2°23′	2°17′
4/5	1¼	5°32′	5°17′	5° 4′	4°51′	4°20′	4°10′	3°53′	3°39′	3°26′	3°14′	3° 4′	2°55′	2°47′	2°39′	2°32′	2°26′
1	1	6°55′	6°36′	6°19′	6° 3′	5°36′	5°12′	4°51′	4°33′	4°17′	4° 3′	3°50′	3°39′	3°28′	3°19′	3°10′	3° 2′
1⅓	¾	......	......	8°24′	8° 3′	7°26′	6°54′	6°27′	6° 4′	5°42′	5°23′	5° 6′	4°51′	4°37′	4°25′	4°13′	4° 2′
1½	⅔	......	......	......	9° 3′	8°22′	7°46′	7°15′	6°49′	6°26′	6° 4′	6°44′	5°27′	5°12′	4°58′	4°45′	4°33′

TABLE OF IMPORTANT DIMENSIONS OF WORM THREAD PARTS

No. of Threads per In.	Circular or Linear Pitch, Inches	Cir. or Linear Pitch, Decimal Equivs.	Height of Tooth above Pitch Line	Depth of Space below Pitch Line	Whole Depth of Tooth	Thick-ness of Tooth on Pitch Line	Width of Thread Tool at End	Width of Thread at Top
1/2	2	2.0000	0.6366	0.7366	1.3732	1.0000	0.6200	0.6708
4/7	1 3/4	1.7500	0.5570	0.6445	1.2015	0.8750	0.5425	0.5869
2/3	1 1/2	1.5000	0.4775	0.5524	1.0299	0.7500	0.4650	0.5031
4/5	1 1/4	1.2500	0.3979	0.4603	0.8582	0.6250	0.3875	0.4192
1	1	1.0000	0.3183	0.6383	0.6866	0.5000	0.3100	0.3354
1 1/3	3/4	0.7500	0.2387	0.2762	0.5149	0.3750	0.2325	0.2515
1 1/2	2/3	0.6667	0.2122	0.2455	0.4577	0.3333	0.2066	0.2236
2	1/2	0.5000	0.1592	0.1841	0.3433	0.2500	0.1550	0.1677
2 1/2	2/5	0.4000	0.1273	0.1473	0.2746	0.2000	0.1240	0.1341
3	1/3	0.3333	0.1061	0.1228	0.2289	0.1667	0.1033	0.1118
3 1/2	2/7	0.2857	0.0909	0.1053	0.1962	0.1429	0.0886	0.0958
4	1/4	0.2500	0.0796	0.0920	0.1716	0.1250	0.0775	0.0838
4 1/2	2/9	0.2222	0.0707	0.0810	0.1526	0.1111	0.0689	0.0745
5	1/5	0.2000	0.0637	0.0736	0.1373	0.1000	0.0620	0.0670
6	1/6	0.1667	0.0531	0.0613	0.1144	0.0833	0.0516	0.0559
7	1/7	0.1429	0.0455	0.0526	0.0981	0.0714	0.0443	0.0479
8	1/8	0.1250	0.0398	0.0460	0.0858	0.0625	0.0387	0.0419
9	1/9	0.1111	0.0354	0.0409	0.0763	0.0556	0.0344	0.0373
10	1/10	0.1000	0.0318	0.0369	0.0687	0.0500	0.0310	0.0335
12	1/12	0.0833	0.0265	0.0307	0.0572	0.0416	0.0258	0.0279
14	1/14	0.0714	0.0227	0.0263	0.0490	0.0357	0.0221	0.0239
16	1/16	0.0625	0.0199	0.0230	0.0429	0.0312	0.0194	0.0209
18	1/18	0.0556	0.0177	0.0205	0.0382	0.0278	0.0172	0.0186

TABLE OF ANGULAR DIVISIONS

Obtainable With Standard Dividing Head and Wide Range Divider

(Use 54-hole circle on large plate)

DEGREES

Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B	Degrees	Turns of Crank B	Spaces Crank B
1	....	6	41	4	30	81	9	....	121	13	24	161	17	48	201	22	18	241	26	42	281	31	12	321	35	36
2	....	12	42	4	36	82	9	6	122	13	30	162	18	....	202	22	24	242	26	48	282	31	18	322	35	42
3	....	18	43	4	42	83	9	12	123	13	36	163	18	6	203	22	30	243	27	....	283	31	24	323	35	48
4	....	24	44	4	48	84	9	18	124	13	42	164	18	12	204	22	36	244	27	6	284	31	30	324	36	....
5	....	30	45	5	....	85	9	24	125	13	48	165	18	18	205	22	42	245	27	12	285	31	36	325	36	6
6	....	36	46	5	6	86	9	30	126	14	....	166	18	24	206	22	48	246	27	18	286	31	42	326	36	12
7	....	42	47	5	12	87	9	36	127	14	6	167	18	30	207	23	....	247	27	24	287	31	48	327	36	18
8	....	48	48	5	18	88	9	42	128	14	12	168	18	36	208	23	6	248	27	30	288	32	....	328	36	24
9	1	....	49	5	24	89	9	48	129	14	18	169	18	42	209	23	12	249	27	36	289	32	6	329	36	30
10	1	6	50	5	30	90	10	....	130	14	24	170	18	48	210	23	18	250	27	42	290	32	12	330	36	36
11	1	12	51	5	36	91	10	6	131	14	30	171	19	....	211	23	24	251	27	48	291	32	18	331	36	42
12	1	18	52	5	42	92	10	12	132	14	36	172	19	6	212	23	30	252	28	....	292	32	24	332	36	48
13	1	24	53	5	48	93	10	18	133	14	42	173	19	12	213	23	36	253	28	6	293	32	30	333	37	....
14	1	30	54	6	....	94	10	24	134	14	48	174	19	18	214	23	42	254	28	12	294	32	36	334	37	6
15	1	36	55	6	6	95	10	30	135	15	....	175	19	24	215	23	48	255	28	18	295	32	42	335	37	12
16	1	42	56	6	12	96	10	36	136	15	6	176	19	30	216	24	....	256	28	24	296	32	48	336	37	18
17	1	48	57	6	18	97	10	42	137	15	12	177	19	36	217	24	6	257	28	30	297	33	....	337	37	24
18	2	....	58	6	24	98	10	48	138	15	18	178	19	42	218	24	12	258	28	36	298	33	6	338	37	30
19	2	6	59	6	30	99	11	....	139	15	24	179	19	48	219	24	18	259	28	42	299	33	12	339	37	36
20	2	12	60	6	36	100	11	6	140	15	30	180	20	....	220	24	24	260	28	48	300	33	18	340	37	42
21	2	18	61	6	42	101	11	12	141	15	36	181	20	6	221	24	30	261	29	....	301	33	24	341	37	48
22	2	24	62	6	48	102	11	18	142	15	42	182	20	12	222	24	36	262	29	6	302	33	30	342	38	....
23	2	30	63	7	....	103	11	24	143	15	48	183	20	18	223	24	42	263	29	12	303	33	36	343	38	6
24	2	36	64	7	6	104	11	30	144	16	....	184	20	24	224	24	48	264	29	18	304	33	42	344	38	12
25	2	42	65	7	12	105	11	36	145	16	6	185	20	30	225	25	....	265	29	24	305	33	48	345	38	18
26	2	48	66	7	18	106	11	42	146	16	12	186	20	36	226	25	6	266	29	30	306	34	....	346	38	24
27	3	....	67	7	24	107	11	48	147	16	18	187	20	42	227	25	12	267	29	36	307	34	6	347	38	30
28	3	6	68	7	30	108	12	....	148	16	24	188	20	48	228	25	18	268	29	42	308	34	12	348	38	36
29	3	12	69	7	36	109	12	6	149	16	30	189	21	....	229	25	24	269	29	48	309	34	18	349	38	42
30	3	18	70	7	42	110	12	12	150	16	36	190	21	6	230	25	30	270	30	....	310	34	24	350	38	48
31	3	24	71	7	48	111	12	18	151	16	42	191	21	12	231	25	36	271	30	6	311	34	30	351	39	....
32	3	30	72	8	....	112	12	24	152	16	48	192	21	18	232	25	42	272	30	12	312	34	36	352	39	6
33	3	36	73	8	6	113	12	30	153	17	....	193	21	24	233	25	48	273	30	18	313	34	42	353	39	12
34	3	42	74	8	12	114	12	36	154	17	6	194	21	30	234	26	....	274	30	24	314	34	48	354	39	18
35	3	48	75	8	18	115	12	42	155	17	12	195	21	36	235	26	6	275	30	30	315	35	....	355	39	24
36	4	....	76	8	24	116	12	48	156	17	18	196	21	42	236	26	12	276	30	36	316	35	6	356	39	30
37	4	6	77	8	30	117	13	....	157	17	24	197	21	48	237	26	18	277	30	42	317	35	12	357	39	36
38	4	12	78	8	36	118	13	6	158	17	30	198	22	....	238	26	24	278	30	48	318	35	18	358	39	42
39	4	18	79	8	42	119	13	12	159	17	36	199	22	6	239	26	30	279	31	....	319	35	24	359	39	48
40	4	24	80	8	48	120	13	18	160	17	42	200	22	12	240	26	36	280	31	6	320	35	30	360	40	....