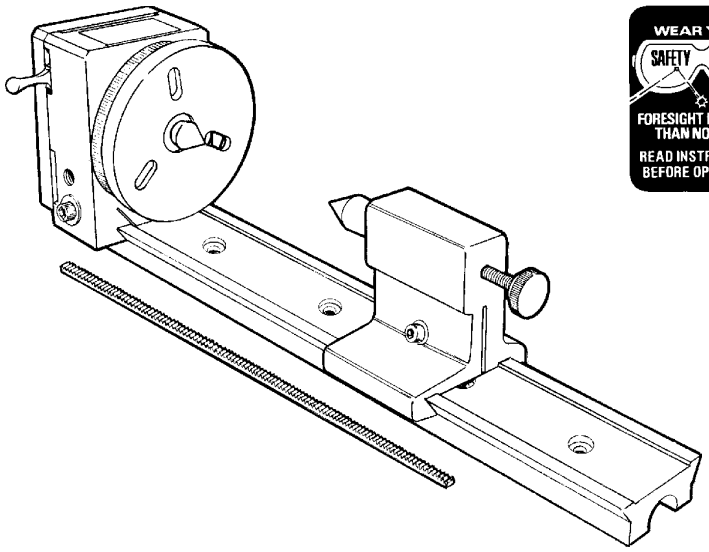


SHERLINE PRODUCTS

INCORPORATED 1974

INDEXING ATTACHMENT

P/N 3200

OPERATING INSTRUCTIONS

This indexing attachment has been designed to give the average hobbyist an all-purpose method of dividing circles into an equal number of segments to aid in cutting gears or any other repetitive, circular machining operation. It is of a price and size which makes it ideal for use with miniature machines. The dividing head can be used in both horizontal and vertical modes.

Although it has been designed to be used with the Sherline vertical mill, it can be adapted for use with other types of equipment or used for different purposes described in this booklet.

Before attempting any machining operation, be sure your set-ups use good machining principles and practices. Work in a careful, professional, craftsmanlike manner, and ALWAYS wear SAFETY GLASSES.

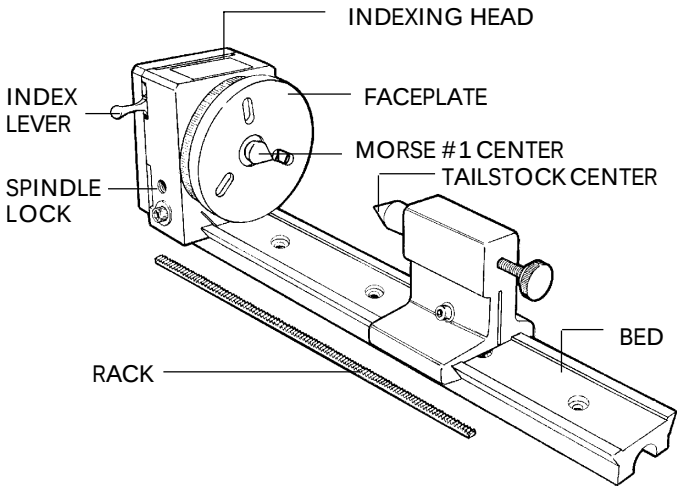


FIGURE 1—Parts of the Indexing Attachment

LUBRICATION AND MAINTENANCE

Like any fine machine tool accessory, care should be taken to keep your indexing attachment clean and free from rust. Moving parts should be oiled periodically with sewing machine oil. The indexing head can be easily taken apart for cleaning when necessary.

ADJUSTMENTS

End play can be removed from the head spindle by unlocking set screw #3214 (Ref #16 on exploded view) and turning clockwise to remove "play". Turning the set screw counter-clockwise reduces drag on the spindle.

TWO METHODS OF DIVIDING

1. INDEXED METHOD. This method is quite simple and uses the indexing lever and the graduated scale on the spindle. Internally the indexing lever engages with a 72-tooth gear, and each tooth equals 5° of movement. Obviously this method will only allow indexing of simple hole patterns since you can only work in multiples of 5°; however, this is usually sufficient for most jobs with the exception of cutting gears. Since very few gears will work out in even multiples of 5°, a second method of dividing called the "calculated method" can be used. It is described below.

It is important to remember to lock the spindle before attempting any machining. The indexing lever is NOT a lock and is not intended for any use other than to locate the index (See Figure 2).

2. CALCULATED METHOD. This method will yield an infinite number of divisions but takes considerably more time. To set up the head in this mode, the indexing lever must be raised to its uppermost position. The rack gear is then inserted from either side with the teeth towards the spindle under the lever. It is important that the spindle lock is loose so the spindle is free to move as the rack is inserted. The theory behind the calculated method should be apparent now. As the spindle is rotated, the rack moves in a linear

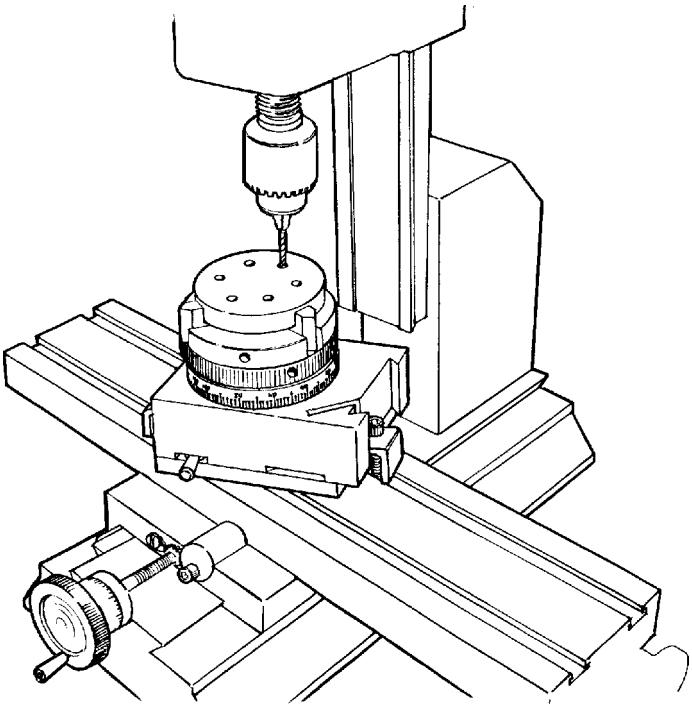


FIGURE 2—INDEXED METHOD, Drilling a precise hole pattern.

motion which can be easily measured. If the total movement of the rack for one revolution is known, any number of divisions can be made by dividing this dimension by the number of divisions required.

The calculated linear dimension for one complete revolution is 4.712 inches (119.685mm), but this dimension may vary slightly from one indexing attachment to the next. For utmost precision, it is suggested that you accurately measure your particular indexing head and note the dimension for future use. Use a precise vernier or dial caliper of at least 5 inches in length (6 inches is preferable) equipped with a depth rod (See Figure 3).

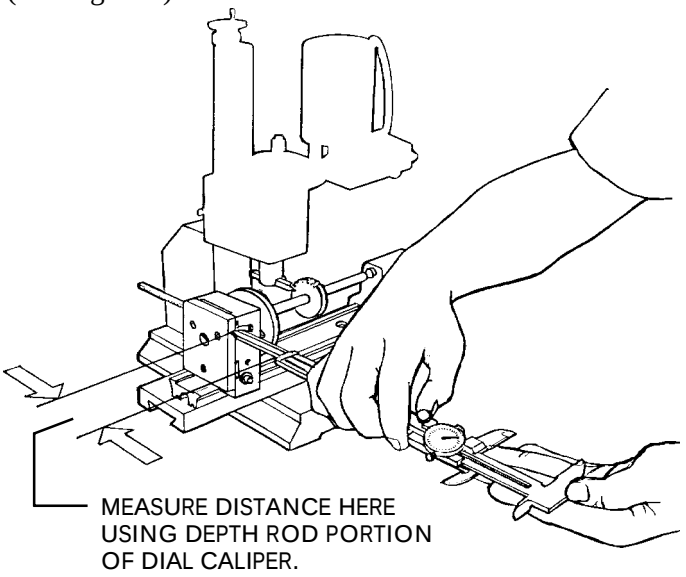


FIGURE 3— Calculated Method, measuring the rack position.

For a free gear tooth calculator in Microsoft Excel® see our web site at
www.sherline.com/gear cutting.xls

To determine this dimension for your particular indexing head, drill a small hole with a center drill on the very top edge of the faceplate with the indexing head mounted on its bed. Before drilling be sure the rack is positioned in such a way that one complete revolution can be turned and still have the rack properly engaged. Make sure to lock the spindle and accurately measure from the end of the rack to the indexing head. After drilling, unlock the spindle and rotate it one revolution using the hole and center drill to index the spindle. Measure the rack again and subtract the smaller number from the larger. The difference should come out quite close to 4.712" or 119.685mm. Since the accuracy of all your machining is dependent on the precision of this measurement, it is suggested that you DOUBLE CHECK your work!

Once you have this dimension, dividing a part into any number of divisions is easy. Just divide 4.712" (or the dimension for your attachment if different) by the number of divisions you wish to make. This will give you the distance the rack must move for each division. The math is simple, but a small pocket calculator saves a lot of time.

EXAMPLE:

Say you want to cut an 83-tooth gear, 56 pitch (The size of the blank can be arrived at from *Machinery's Handbook* and a similar type gear can be used to arrive at the cutter shape). The blank can be mounted on an arbor and held between centers. The dog is clamped on the arbor in such a way that it engages with the faceplate. Care must be taken to eliminate all "play" where the dog engages with the faceplate. Grind a tool bit that will give the desired tooth shape and use this tool like a fly cutter. Cutters can be purchased that will generate an accurate shape, but the are very expensive and hard to find. With a little practice excellent results can be obtained with the "fly cutter method" (See figure 4).

Once the cutter is properly held in a holder and has been located on center using the tailstock center for a reference point, the indexing attachment is properly clamped to the machine table and aligned with an indicator, and the rack gear is located in such a way a complete revolution can be turned, you are ready to begin.

MAKING THE FIRST CUT

Before you begin "making chips", look again at your set-up; is it really SAFE? Also make sure you're wearing safety glasses. Remember, that cuts of this type require very rigid set-ups because of the intermittent cutting action. If the gear blank is thin it may require additional support by sandwiching the gear blank between support pieces shaped like a large washer and of a material which is easily machined.

Turn on the machine spindle and move the Y-axis toward the cutter while moving the X-axis back and forth until the cutter just starts to touch the blank. Write down the dial setting and calculate the total depth of the cut. (The information to calculate this can be found also in *Machinery's Handbook*.) The first cut should be less than .010" (.20mm) deep. Observe the cutting action carefully. Is the cutter cutting properly? Is there excessive vibration in the set-up? Is the cutting speed proper? There is no book written that can give you the answer to these questions; this is where

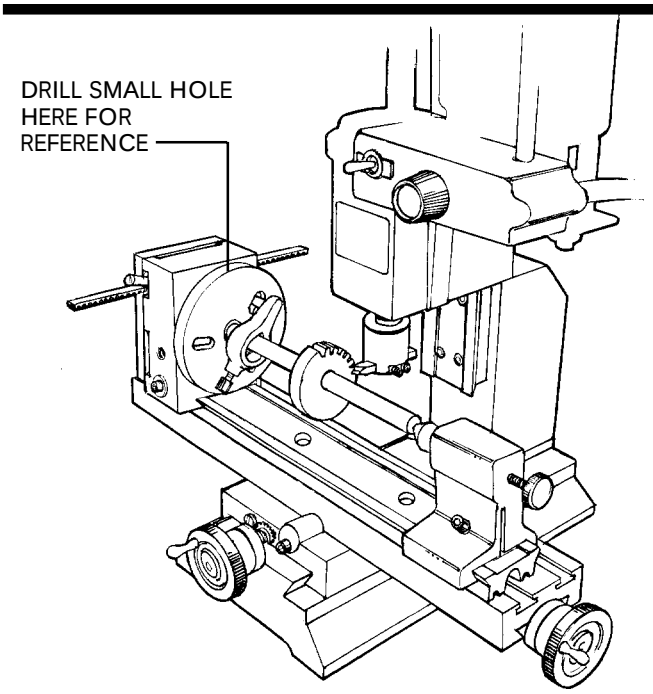


FIGURE 4— Typical setup for cutting gear teeth.

experience and craftsmanship come into play. The best way to make good parts is to work VERY CAREFULLY! To cut an 83-tooth gear means you have to do 83 successive machining operations correctly to make a good part...82 out of 83 is a waste of time!

Once your cutting speed and feed are to a point you're sure you can repeat the same operation over and over again with excellent results, finish out your first cut to its final depth. Now it is time to index for the next cut. Measure the distance from the end of the rack to the index head carefully before unlocking the spindle. Write down this dimension (it will be referred to as "A"). From previous instructions you have already figured the total throw of your indexing head—say it is 4.712". You now divide this number by the number of divisions, in this case 83 to get: 4.712 x 1/83 = .056771", or rounding off, .057". This is now added to or subtracted from dimension "A". At first glance it would appear that all you need to do is add .057" for each cut because an error of only .000229" is so small it can be discounted. But if you multiply this error by the total number of teeth (in this case 83) you would end up with an error of .019" which would make the last tooth you cut a very "interesting" shape. This is what is known as "tolerance buildup" and is the reason you must use your basic formula at each step to calculate the next dimension rather than simply adding rounded off dimensions. The second cut and each succeeding cut are calculated as follows: 4.712 x 2/83 = .113542 or .114". Add this to or subtract from dimension "A", index and cut.

Most modern electronic calculators have a "memory" function which can make your job easier. Although the calculator may only read out 6 to 8 decimal places, the figure is actually held in the calculator's memory to far greater accuracy than the readout shows. To make these calculations using the calculator's memory function you would proceed as follows:

1. Measure the distance from the end of the rack gear to the body of the indexing head (dimension "A") at the first cut.

2. The first calculation (2nd cut) is 4.712 x 1/83 = .056771" Hit the memory key to store this number (usually [M+] or [M] on most calculators). Add the rack length (dimension "A") to this number and write it down rounded off to 3 decimal places. This is the length of the rack for the 2nd cut.

3. To figure the setting for the 3rd cut you will add the total on the calculator from step 2 to the number in memory as follows:

   A. Hit the [+] key
   B. Hit the [MR] or [MRC] key (Memory Recall)
   C. Hit the [=] key and write down the total rounded off to 3 places

4. To figure the setting for the 4th cut you will add the total on the calculator from step 3 to the number in memory using the same sequence: [+][MR][=].

5. Continue this sequence until you have written down the settings for each of the 83 teeth. Using the memory's ability to store a number to many decimal places, your 83rd calculation should come so close to dimension "A" plus 4.712 that the error is insignificant. (On my calculator the 83rd calculation was off by .000007".)

With each cut your understanding of the techniques involved will increase. By working and thinking in a careful manner you should be successful on the first attempt.

Although the instructions given here have been related to cutting a gear, the same approach must be used for any type of indexed machining.

FIVE BASIC RULES TO REMEMBER

1. Work ACCURATELY.
2. Determine the best possible way of holding the part to be machined. This type of machining requires a very secure set-up.
3. Carefully align the set-up with the machine.
4. Take cuts that the set-up you are using can easily withstand.
5. Don't try to rush the job! Successive machining operations make some people lax; therefore, it is wise to consider the amount of time and effort you will lose if you destroy your part rather than how much is left to do.

DESIGN UPDATE

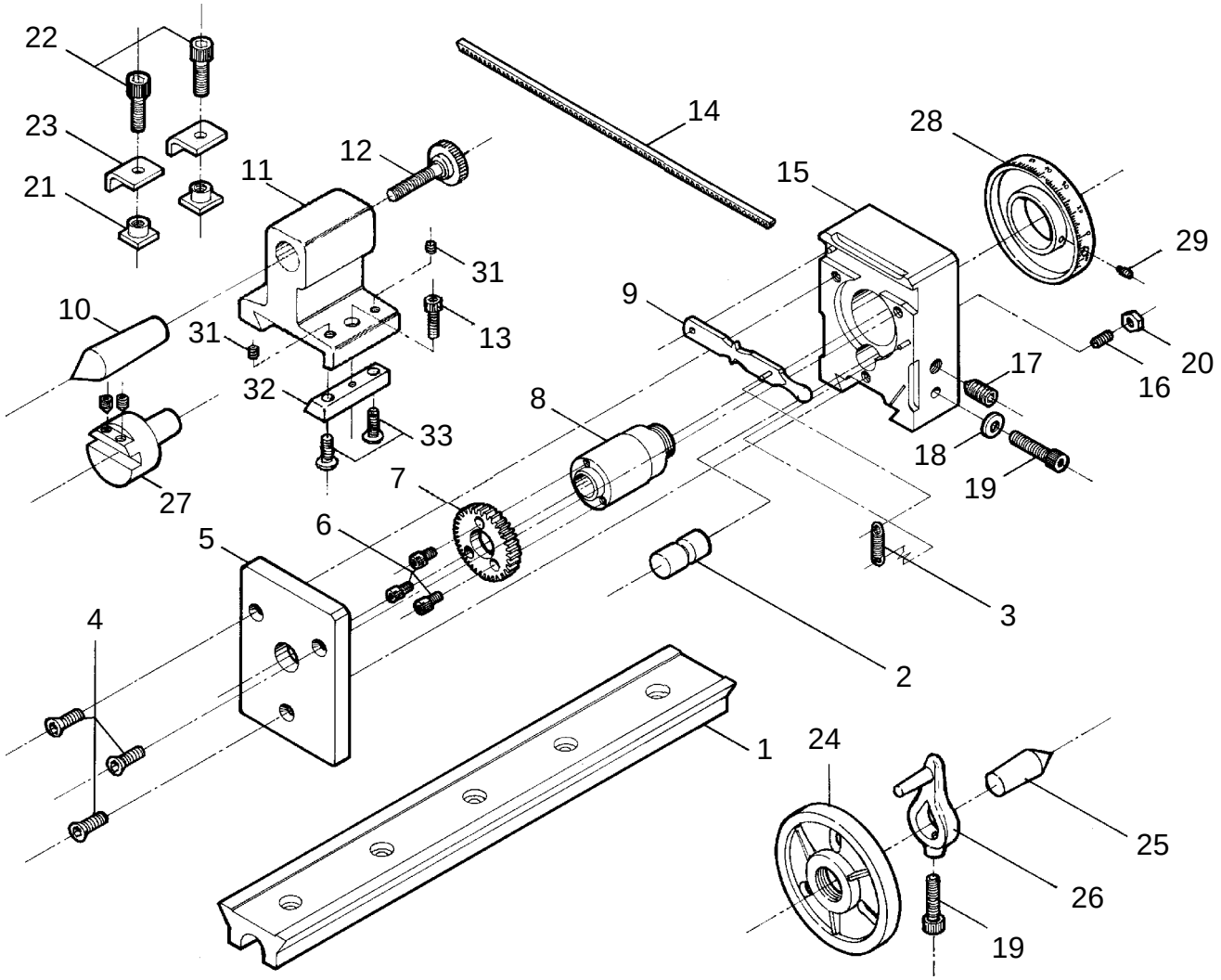
Note that the index tailstock has been updated to include a gib similar to that used on the lathe. See exploded view.

INDEXING ATTACHMENT SPECIFICATIONS

Overall Length	12.0" (304.8mm)
Distance Between Centers	7.0" (177.8mm)
Max. Diameter Horizontally	3.50" (88.9mm)
Graduations	5° Increments
Spindle Thread	3/4-16 TPI

SHERLINE INDEXING ATTACHMENT, P/N 3200

EXPLODED VIEW



PARTS LISTING

NOTE: WW collets can be held in the #1 Morse spindle by using a WW collet adapter P/N 11580. This will also require a special short collet drawbar P/N 11682 made for use with the indexer.

REF #	PART #	DESCRIPTION
1	32010	Bed
2	32020	Locking Pin
3	32030	Spring
4	32190	10-32 X 1/2" Skt. Hd. Flat Screw
5	32200	Indexing Case Cover
6	32210	6-32 x 3/8" Skt. Hd. Cap Screw
7	32220	Indexing Gear, 72 Tooth, 48 Pitch
8	32230	Spindle
9	32240	Stepping Lever
10	32250	Tailstock Center
11	32261	Tailstock Case
12	32180	10-32 x 1" Tailstock Thumbscrew
13	40330	10-32 x 5/8" Skt. Hd. Cap Screw
14	32120	Rack, 48 Pitch
15	32130	Indexing Case
16	32140	10-32 X 1/2" Cup Point Skt. Hd. Set Screw
17	40540	5/16-18 X 3/4" Cone Point Skt. Hd. Set Screw
18	40660	3/16" I.D. Washer
19	40340	10-32 X 1" Skt. Hd. Cap Screw
20	32100	10-32 Hex Nut
21	30561	10-32 Tee Nut
22	40330	10-32 X 5/8" Skt. Hd. Cap Screw
23	35580	Hold Down Clamp
24	40070	Faceplate
25	40380	Morse #1 Center
26	40090	Drive Dog
27	32170	Gear Tooth Cutter Holder
28	32500	Indexing Collar
29	32510	6-32 x 1/8" Nylon tip Skt Hd Set Screw
30	30050	High Speed Tool Blank (Not Shown) for P/N 3217
31	40520	10-32 x 3/16" Cup Point Set Screw
32	32262	Brass Indexing Tailstock Gib
33	40501	10-32 x 1/2" Button Head Socket Screw