Maintenance Operations on Turret Lathes

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The author has seen thousands of turret lathes limping along, increasing the users cost and helping to fill the scrapbox. Since a relatively small repair often corrects the major source of trouble, this article tells how to make the most common of these repairs.

Maintenance Operations on Turret Lathes

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THERE are still in use throughout the United States more than 38,000 turret lathes that are 10 years old or older.

It is clearly evident from the flood of mail coming to the desks of machine tool builders' service managers that most of these 10 to 25-year-old machines are failing to produce work of the desired accuracy. This does not mean, however, that all these machines are hopelessly worn out and incapable of ever again accurately and efficiently cutting metal. All or part of the original accuracy of many of these old turret lathes could, with proper reconditioning, be re-established and the present production of the machines materially increased.

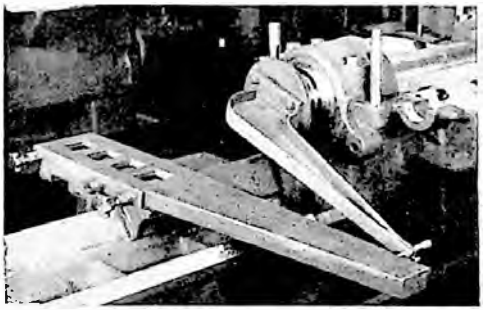

Fig. 1—Fixture for Aligning Cross Slide Carriage with Spindle

In the belief that the average owner would be interested in determining to what extent his old machine could be reconditioned in his own shop, this diagnosis of major turret lathe troubles is presented, together with an outline of the procedure to be followed in repairing them.

It must be pointed out, however, that the reconditioned machine will never be equivalent to a present model turret lathe. The speed, power and accuracy of a reconditioned machine will always be limited by its original design.

Re-establishing original performance in a machine tool that has seen many years of service means, of course, a thorough repairing and reconditioning based on sound engineering analysis. Hasty, superficial, haphazard fix-ups do not solve the problem, since they do not get to the fundamental source of trouble.

The complete reconditioning or rebuilding of a turret lathe needed to restore its original accuracy and ability to produce, requires the skill, experience and equipment of the original builder and should be done in his plant. However, much can be done effectively and efficiently in the owner's own plant and the work can be done by the first class mechanics and tools available in first class repair departments.

Classification of Repairs

Repairs required on turret lathes due to normal wear, over a period of years, are of two classes:

mechanical repairs required to keep a machine in operation, and the more difficult repairs required to re-establish accuracy.

We will not be concerned here with mechanical repairs. Adjustment of slipping clutches, replacement of worn gears or shafts, or the correction of troubles that may develop in a machine suddenly as the result of the failure of some part, are readily handled by mechanics and repair men in the course of their normal days' work. We will rather be concerned with those problems that develop in a machine slowly over a long period of time as the result of constant wear.

Such problems and the procedure for correcting them are basically the same for every old turret lathe regardless of make. The procedure for reconditioning them may, however, vary in detail. When the directions must necessarily be specific and detailed I can best proceed with these particular points by considering the Warner & Swasey machine—the machine with which I am most familiar.

Trouble that may likely develop in an old turret lathe as a result of long wear can be tabulated in six major categories, outlined here in question form.

1. Will the machine duplicate sizes?
2. Does the machine produce chatter?
3. Do the finished surfaces show gear tooth marks?
4. Does the cross slide face and cut off square?
5. Do reamers and counterbores cut properly?
6. Does the machine cut taper with tools held in the hexagon turret?

Although the solution to some of these problems, to repeat, may require factory skill and experience, most of them can be readily solved by good repairmen right in your shop. Most manufacturers can supply you with any repair parts needed to complete the job; and their service repre-

Fig. 2—Straight-Edge Used in Re-Scraping Turret Lathe Bed

sentatives are at all times equipped to lend reliable advice and instruction.

1. **Will the Machine Duplicate Sizes?** In other words, at one setting of the machine will it cut the same diameter on successive pieces or does the size of cut vary? The failure of a machine to duplicate size on successive pieces indicates quite definitely that there is trouble in the lockbolt mechanism of either the hexagon or the square turret, depending on where the trouble develops.

In either case the finding of the trouble and the procedure for its elimination is generally the same, as follows: Remove the turret causing the trouble and inspect. (a) the strength of the lockbolt spring, (b) the condition of the tapered end of the lockbolt, (c) the fit of the lockbolt in its sleeve, (d) the condition of the lockbolt bushings, and (e) the fit of the center pilot about which the turret revolves.

A pressure of at least 25 pounds should be required to compress the lockbolt spring of small ram-type machines. This minimum may be as high as 150 pounds on the larger saddle-type machines. There is no important part in the turret lathe that costs less than this spring, yet many cases of failure to duplicate size can be corrected by the installation of a new spring which will force the tapered end of the lockbolt to a proper seat in the lockbolt bushings.

If the end of the lockbolt is so worn or damaged that it does not present a smooth, tapered surface, or if the lockbolt shows any appreciable play in its sleeve, it should be replaced.

The new lockbolt must be very carefully fitted in the sleeve. This work is usually done with a cast iron or brass lap driven by a slow-speed electric motor and with a fine grade of emery as the lapping compound. The usual procedure is to suspend the electric motor from overhead by means of a large coil spring, so that while the motor is driving the lap, both motor and lap can be moved up and down.

The lockbolt bushings which are pressed into the bottom of the turret should present a smooth tapered hole for the lockbolt. If these bushings are not in good condition, they should be replaced. It is good practice to install new lockbolt bushings whenever a new lockbolt has been installed.

After the lockbolt, spring, and bushing have been inspected and any necessary repairs or replacements have been made, the turret should be re-installed. The bottom of the turret and the bearing surface on the slide, or on the saddle, should be rescraped until a good bearing is indicated. Care should be taken that the center pilot about which the turret revolves is in good condition, and that there is no more play in this unit than is necessary to allow the turret to revolve freely.

After a good complete repair job has been made, the turret should repeat its index in either direction within plus or minus 0.0005 in. as measured at the turret face.

2. **Does the Machine Produce Chatter?** Chatter is caused by vibration, and usually results from loose bearings at some point. It should be distinguished from gear tooth marks, which are discussed in question 3.

If a tool on the rear of the cross slide chatters, it indicates looseness of the cross slide bearing, but if a tool on the front of the cross slide chatters, looseness of the spindle bearing is indicated. Chatter developed from cutters in the hexagon turret may indicate loose spindle bearings or, under heavy cuts, loose turret slide bearings. In this connection it should be remembered that a tool placed below center or ground without the proper top rake is apt to produce

chatter in any machine at any time.

Elimination of wear on cross slide bearings by adjusting the gib is not discussed here in detail because all good repair men are well experienced in tightening bearings. It should be remembered, however, that if wear is sufficient to require new tapered gibs to be fitted, it is often necessary to rescrape the complete unit. Usually the wear is not uniform at all points but is greater in the position where the slide has been used the most.

Rescraping of the complete cross slide unit should not be attempted unless repair men are available who have had experience in this line of work. The brief discussion under question 4 will indicate the care that must be taken with this job. New tapered gibs should be longer than standard and cut to proper length only after they have been properly fitted over the entire length of the bearing. New gibs furnished for replacement purposes are ordinarily long enough to compensate for wear when fitted to old machines.

Loose spindle bearings—that is, of course, plain type bearings and not roller or ball bearings—can be tightened by removing the top bearing cap and filing the surface that bolts to the head. After the bearing has been brought down tight against the spindle, the bearing surface should be very carefully scraped to insure long life and prevent possible overheating.

If side play is also found in the bearing, the bottom half should first be scraped until the spindle drops to a point where the bearing is obtained on the side as well as on the bottom. Then the same procedure should be followed with the top half of the bearing. Care must be taken not to throw the spindle out of alignment with the turret holes.

To eliminate chatter from the hexagon turret, usually the result of loose bearings, all gibs should be refitted and adjusted or new gibs installed.

3. Do the Finished Surfaces Show Gear Tooth Marks? These marks, which are often mistakenly called chatter marks, can be distinguished from chatter by the fact that on different diameters cut at the same speed the same number of marks will be produced. The actual depth of the gear tooth mark is usually very slight but may at times be sufficient to prevent the obtaining of a satisfactory finish.

This trouble is always caused by the improper meshing of the gear teeth at some point in the train of gears in the head of the machine, and is usually the result of wear on the gear teeth. The gears responsible are usually those that actually drive the spindle and the number of marks on the work will always correspond with the number of teeth in either the driving or driven gears that is causing the trouble. Loose spindle bearings will make this condition worse, but tightening the spindle bearings will not permanently correct the trouble.

Gear tooth marks are eliminated by replacing worn gears. The only real problem, therefore, is in locating the proper gears to be replaced and this can be done only by the trial-and-error method. Very often this trouble becomes apparent when one new gear has been installed and is meshed with an old gear. For this reason it is always advisable to replace mating gears in the all-geared heads of turret lathes.

4. Does the Cross Slide Face and Cut Off Square? That is; does a facing cutter held on the cross slide produce a flat surface? If it does not, you have a definite indication that the cross slide is not traveling at right angles to the spindle. The cause may be either wear in the cross slide bearings or wear in the spindle bearings.

Refitting cross slide bearings so worn that the cross slide is out of square requires a more careful procedure than that outlined in question 2. To merely install a new gib will not, of course, eliminate the trouble. On saddle or "A" type machines the problem now is to first refit or scrape the side of the cross slide carriage bearing which is away from the gib so that it is straight and at right angles to the spindle. The method used at the factory for checking this is illustrated in Figure 1.

In plants where this job is done only occasionally, equipment similar to that shown in the illustration can be readily made up. A long straight piece of round stock may be laid in the dovetail of the carriage and an indicator may be clamped to a bent bar held in the spindle chuck. Indicator readings at the front and the rear of the carriage dovetail should be within 0.001 inch.

After the near-spindle side has been squared, the other side of the dovetail must be paralleled to it. The cross slide is then scraped to fit the carriage and the tapered gib must be refitted or a new gib installed.

On flat bed or ram-type machines the dovetail itself need not be squared with the spindle. If necessary, the carriage and cross slide bearing surfaces and dovetails may be scraped to re-establish good bearing and straightness, and a new taper gib installed, but the actual squaring of the cross slide with the spindle is usually best done by scraping the carriage where it heels against the bed on the side opposite the adjusting screws or gib.

When the out-of-square condition of a cross slide which produces a cone-shaped surface is the result of side wear of the spindle bearing, the spindle should be re-aligned with the bed. This is not frequently encountered. Procedure for its elimination will be outlined in question 6.

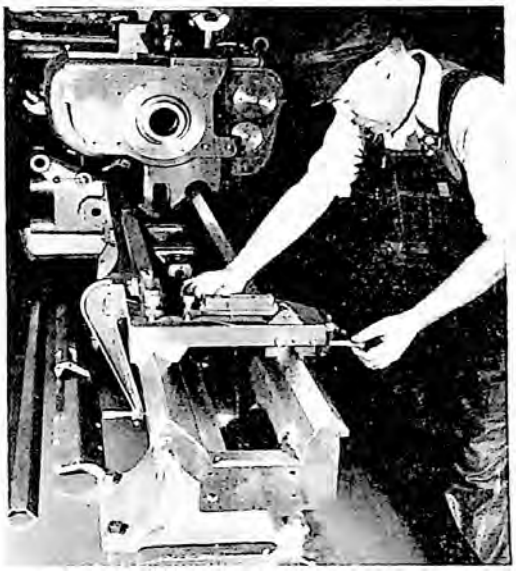

Fig. 3—Fixture Used for Aligning Turret Lathe Bed

5. Do Reamers and Counterbores Cut Properly? If reamers and counterbores cut oversize but straight, the tools are not held on the center-line of the spindle. In this case the turret hole or the shank of the tool should be repaired so that the reamer or counterbore is exactly on center.

If the reamers cut tapered holes, you have a definite indication that they are not held parallel with the spindle and that they enter the hole at an angle. The cause may be in the tool holder, the turret hole or turret face, a worn condition of the bed,

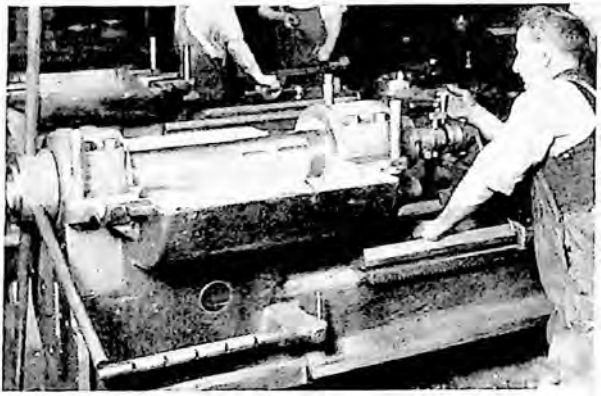

Fig. 4—Checking a Reconditioned Machine to Make Sure that Spindle Lies Parallel with Bed

or a worn spindle bearing. The trouble can usually be corrected, however, by repairing the tool holder or the turret hole or by providing sufficient float for the reamer.

The most practical method of repairing flanged type tool holders is to mount the holder on a straight arbor, tighten the tool-holding screws, place the arbor in the lathe and take a finishing cut on the back face of the tool holder. This will give a face on the back of the holder which is square with the tool hole, and drills and reamers will be parallel with the spindle provided the turret face itself is square with the spindle.

Another method sometimes used and recommended when the turret tool holes are in bad condition is to bore the holes oversize, install a bushing and rebore to standard size. Bushings can be purchased at the factory and the boring can be done on the turret lathe by using a boring bar in the chuck, as shown in Figure 5. The fixture used at the factory for refacing turrets is shown in Figure 6.

Shank-type tools that have become bent or worn can usually be readily repaired. On machines that have seen a great deal of use, however, the turret holes themselves are apt to be below center due to wear on the bed, wear on the turret saddle or slide, or wear on the turret and turret seat.

This condition can usually be improved by boring the turret holes oversize, installing bushings, which can be furnished from the factory for this purpose, and reboring to a standard size. This reboring operation is, of course, accomplished on the machine itself by using a boring bar in the chuck or in the collet. Before the reboring operation the lockbolt or indexing mechanism should be checked as outlined under question 1.

It should be noted, however, that while this reboring operation re-establishes alignment of the turret hole with the spindle at the point on the bed where the turret is rebored, it does not correct for the down-hill travel experienced on old machines and caused by uneven bed or spindle wear. (The method of correcting for uneven wear on the bed and re-alignment of the spindle will be discussed in question 6.) However, many machines are made to produce in a much more satisfactory manner by re-establishing the turret holes to center by reboring and bushing them.

6. Does the Machine Cut Taper With Tools Held in the Hexagon Turret? Elimination of the taper cutting of tools held in the hexagon turret is probably the most difficult job in the reconditioning of a turret lathe. The work involved requires skill and

experience. The reason for cutting taper, together with the plan for correcting the difficulty, should therefore be very carefully predetermined.

A machine should not be condemned of cutting taper, however, until it has been carefully leveled and a test boring-cut made with a cutter held in an unpiloted bar. All turret lathes (except under conditions discussed below) must be leveled to remove twist in the bed, if accurate work is to be produced. An unpiloted bar must be used because even a perfect machine will bore taper with a piloted boring bar if the bar is not straight or if it is held in an inaccurate tool holder.

If under these tests conditions a taper bore is produced, you have definitely established that the turret does not travel parallel with the axis of the spindle. On saddle or "A"-type machines, this condition is the result of wear on either the bed or the spindle bearings, or both. On ram-type machines the cause may be wear on the turret saddle, the turret slide, the spindle bearings, or all three.

With either type of machine the elimination of wear by re-establishing parallel bearing surfaces is a major operation, as will be seen below. It is therefore often practical on old machines to overcome the amount of this wear by deliberately putting a twist in the bed in such a direction as to compensate for all or part of the inaccuracy. Beyond this, it should be remembered that a change in cutter positon will often greatly reduce the amount of taper produced.

If the bed and spindle have worn sideways, changing the cutter from the horizontal to the vertical position will help. Changing the cutter from the vertical to the horizontal position will reduce the error of a turret that runs down hill as it approaches the spindle.

Neither change of cutter position nor the deliberate twisting of the bed will restore perfect operation of the machine, but such changes and adjustments often make it possible to continue an old machine in service without costly repairs. If your machine is so worn that required accuracies cannot be produced in this way, it is necessary to rescrape the bearing surfaces.

In order to show the magnitude of the problem of reconditioning these bearing surfaces, a brief outline of the recommended operations follows. This procedure is for saddle or "A" type machines with plain spindle bearings only.

1. Rescrape bed bearings.
   a. Remove cross slide and hex turret units and eliminate any twist in bed by supporting right hand

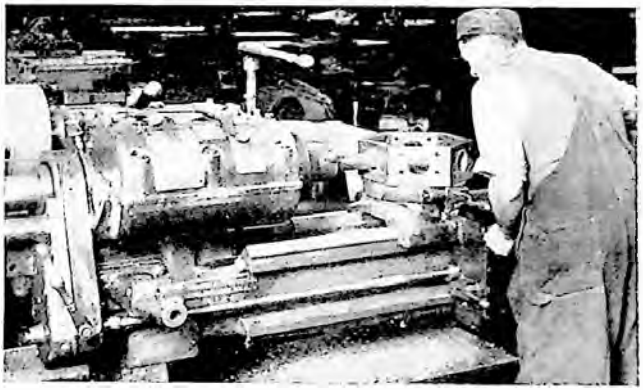

Fig. 5 — Reboring Turret Holes on Reconditioned Machine

end of bed as shown in Figure 7.

b. Scrape inside of front "V" to a straight edge, see Fig. 2.

c. Scrape outside of front "V" straight and parallel to inside of front "V", using straight edge and an adjustable level mounted longitudinally on a fixture similar to that shown in Fig. 3.

Fig. 6—Refacing Turret with Fixture Mounted in Spindle

d. Scrape rear "V" straight and parallel to front "V" using straight edge, level and indicator in an adjustable block, as in Fig. 3.

e. Scrape apron pad in front of bed straight and parallel to the front way.

2. Scrape the saddle bearing surfaces to the bed, using the bed as a surface plate.

3. Rescrape the spindle bearings.

a. Remove head cover and top caps from spindle bearings.

b. Check to determine the angle at which spindle lies in relation to the refitted bed bearing. Mount a plug in one turret hole and a simple fixture, such as illustrated in Fig. 4, in the spindle. Move turret close to spindle and take readings 180 deg. apart in the horizontal plane. Move the turret 12 in. back and compare similar readings. Repeat this procedure in the vertical plane.

c. Scrape the bearings, after carefully determining from the above check where the metal must be removed to bring the spindle parallel with the bed.

d. Continue the procedure until the micrometer readings compare within 0.001 in., and then scrape for good bearing surfaces.

e. Fit the top caps until the bearings are tight and good bearing surfaces are obtained.

4. Install the cross slide unit.

a. Place machine on its four legs and carefully level to remove twist.

b. Scrape the cross slide carriage to the bed.

c. Scrape the cross slide bearing so that cross slide travels at right angles to the spindle (See Ques. 4).

5. Bore turret holes oversize, install bushings, and rebore to a standard size using a boring bar in the spindle chuck. See Fig. 5.

6. Reface turret with a fixture mounted in the spindle. If your machine is a Warner & Swasey, you may borrow the fixture (Fig. 6) used at the factory.

On ram or flat bed machines where the turret is mounted on a slide in the saddle instead of directly on the bed, the procedure for reconditioning bearings is somewhat different and usually simpler. Ordinarily the bed bearings will not be worn enough to require rescraping, and the following procedure may be followed:

1. Level the machine.

2. Refit the turret slide to a good bearing in the saddle. Install and fit new gibs if necessary, and refit the top caps.

3. Rescrape the bottom of the saddle

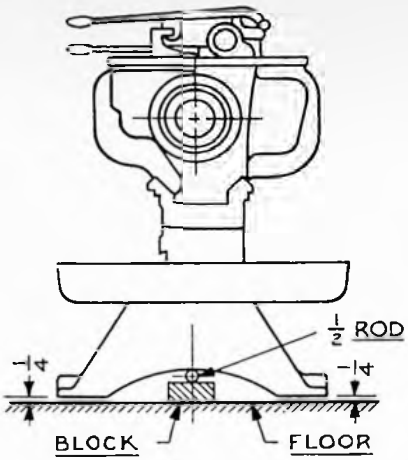

Fig. 7—Drawing Illustrating Manner of Supporting End of Bed to Eliminate Twist while Rescraping Bed Bearings

until the slide moves parallel with the bed, in both horizontal and vertical direction.

This may be checked by clamping an indicator to the slide and comparing the distance, from the slide to the bed when the slide overhangs the saddle by different amounts.

4. Re-align the spindle bearings and rebore and reface the hexagon turret, using the same procedure as outlined above for "A"-type machines.

Before attempting any reconditioning of bearing surfaces, on either type machine, it is advisable to first make all necessary repairs to the lockbolt mechanism (See Question 1). This will guard against changing the bearing surface in driving the old lockbolt sleeve out or in driving the new one in. It will also leave the reboring and refacing of the turret to be done only after all other repairs have been made.

So that its machines will give better service, The Warner & Swasey Company maintains the following:

1. A factory trained man in your locality available for advice and help on service problems.
2. Service parts books and folders to make ordering of repair parts easier.
3. A large Service Department in Cleveland to quickly interpret your orders.
4. 16,000 different kinds of repair parts in stock at all times, so that delivery is usually made from stock.
5. A complete factory rebuilding service for worn machinery. By a more complete process than is described in this article and by replacing all worn parts (usually this means at least 50% of them), the machine is brought back equal to new condition. Because of the quantities of machines rebuilt, the cost of this service is surprisingly low.

When ordering repair parts, you will get better service if you follow these simple instructions:

1. Use a Warner & Swasey repair parts circular furnished for your machine, and order by part number as well as name. (If this isn't possible, a rough sketch of the part should be made.)
2. Give the serial number of the machine. This usually consists of 5 or 6 numerals, and will be found stamped on the name plate. (If you cannot see it there, look on the end of the bed.)

This is a list of the models of Turret Lathes built during the last 25 years. You can see why it is necessary for us to know more than just that a repair part is needed for a Warner & Swasey Number 4.

RAM TYPE

No. 1
M-134
M-1270

No. 2 or 12"
M-50
M-70
M-71
M-1140
M-1330
M-1360

No. 3 or 14"
M-170
M-172
M-1200

No. 4
M-322
M-370
M-372
M-452
M-730
M-732
M-1100
M-1105
M-1110
M-1115
M-1320

No. 5
M-1120
M-1240

No. 6
M-80
M-82
M-90
M-340
M-342
M-382
M-432

SADDLE TYPE

1A
M-470

2A
M-492
M-510

3A
M-520
M-540
M-550
M-580
M-590

4A
M-580
M-590
M-1190
M-1310
M-1500
M-1550

5A
M-1150
M-1180