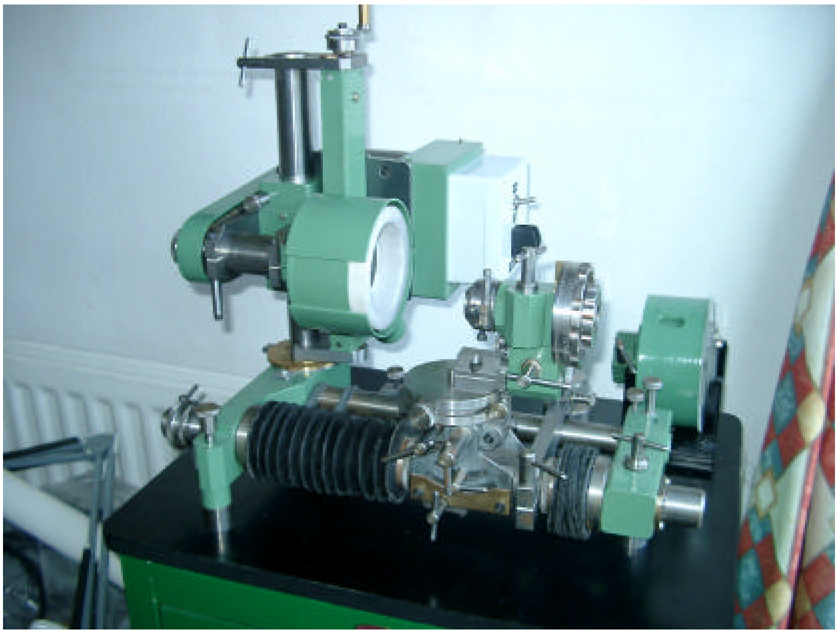
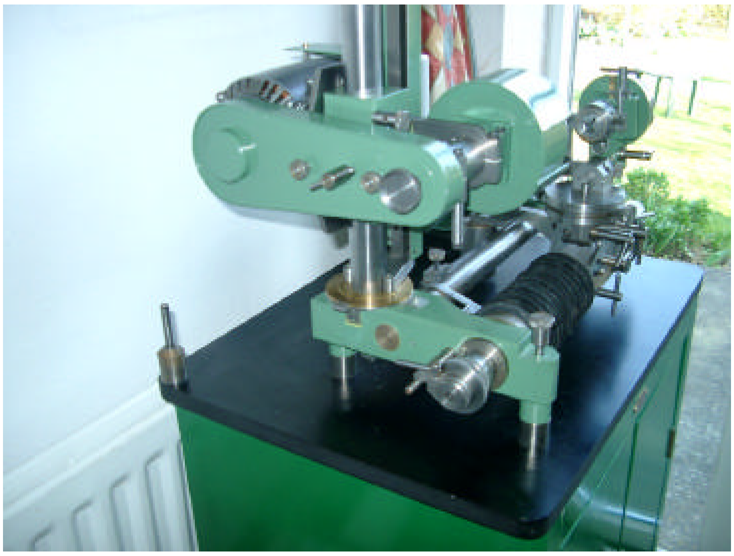
The Bonelle Tool and Cutter Grinder



The grinder was constructed about 1987 and exhibited at the 89th Model Engineering exhibition where it was awarded a bronze medal (see ME Vol164 No 3868 page 273). Subsequently it gained the Tee Publishing Cup at the 1992 Midlands Model Engineering Exhibition.



Requests for drawings were received as a result but none were available in a suitable form at the time. Circumstances arose that enabled a set to be produced which are available in a separate document (Bonelle TCG drawings). These have been published on the web and a number of grinders built. The present document contains photographs and explanatory notes on construction and use.

J B D Willis
July 2004

The Bonelle Tool and Cutter Grinder

A view with the wheelhead inverted

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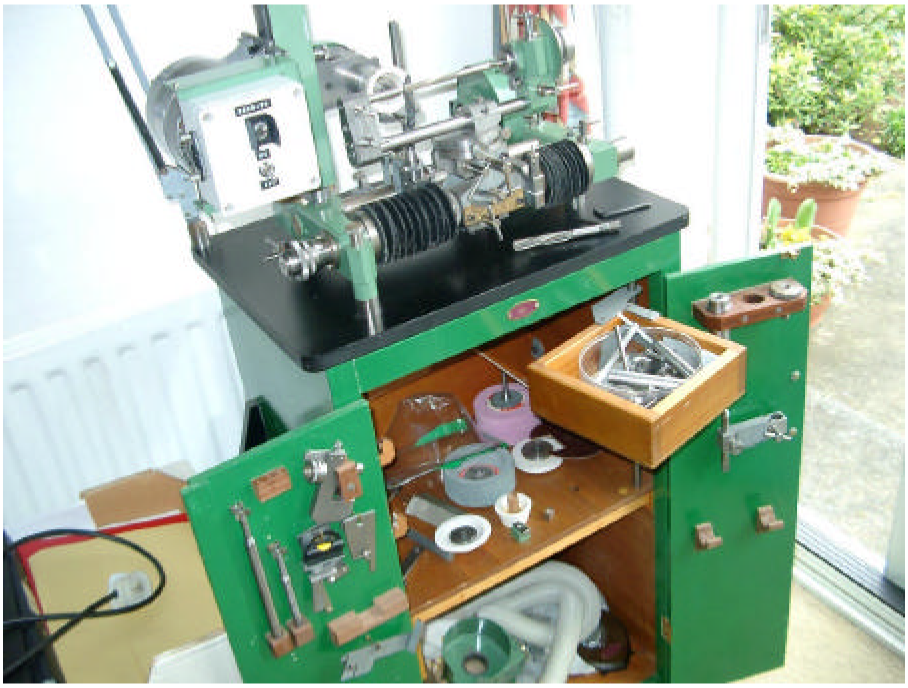
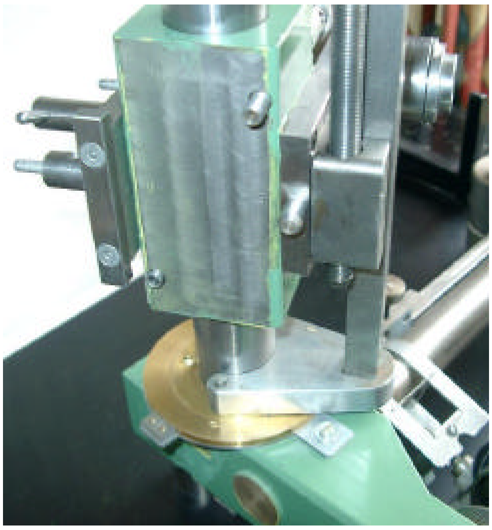
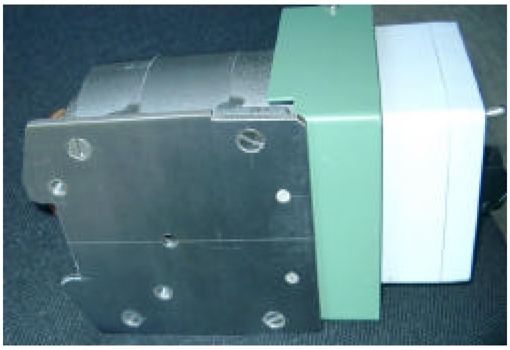
The prototype grinder stands on its own cabinet that contains various accessories.



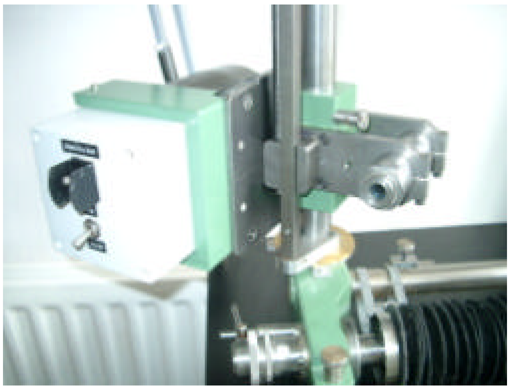
Illustrations of Wheelhead

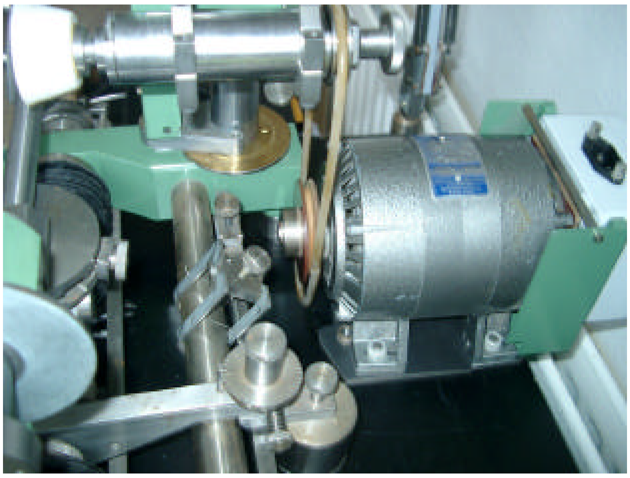
The picture shows the wheelhead with the motor assembly removed to show the arm extension on the left hand side into which the motor plate registers. The peg on the end of the arm on the right hand side also aligns the plate to allow the two bolts to engage easily and the weight of the unit to be supported with one hand.





This view of the inverted wheelhead shows the knurled headed bolts that hold the motor plate, Tommy bar holes are provided below the knurls.





The self-contained motor unit with its controls enables it to be used separately for other purposes.
Here it is being used to drive the spindle with the wheelhead inverted. (In this position the motor does not restrict the movement of the work across the grinding wheel.)

Constructional Notes

The Grinder was made using: -

- Myford ML7R lathe
- Centec 2a universal milling machine
- Warco band saw

Although it may be possible to use a vertical slide on the lathe and dispense with the milling machine the convenience of a vertical milling machine cannot be overemphasised.

Major components are fabricated from continuously cast iron bar which is exceptionally easy to machine. Unlike castings it is uniform and free from hard spots. It also has an ‘accurate’ cross section with the faces at right angles to each other. Only minimal cleaning up is required (a light skim with a milling cutter or filing-- the surface hardness is negligible)

The bar is cut to form a blank and all the holes machined before the piece is cut to shape using the band saw and miller. Blanks can easily be clamped down and the holes made in one face then re-clamped to bore the other. This means that the holes have accurately perpendicular axes. For the more critical cases the squareness of the blank should be checked as a matter of prudence.

When boring the holes where avoidance of taper is important (e.g. to mate with the front bar) it is preferable to use a boring bar rather than a tool mounted on the lathe top slide.

To ensure that the central hole of the rotating base is concentric the final machining was done between centres on a mandrel. The top face was also machined similarly.

A number of accessories were made as necessary as follows: -

- A ‘heavy duty’ parting tool to deal with the 3” dia components
- A combined engraving and slotting device having a turret type stop to engrave lines of different length
- A register for the bull wheel to lock the lathe spindle
- A file guide to easily generate squares flats and hexagons
- A boring head and bar combination tool
- A knurling tool
- A jig to position the stamp used for numbering components

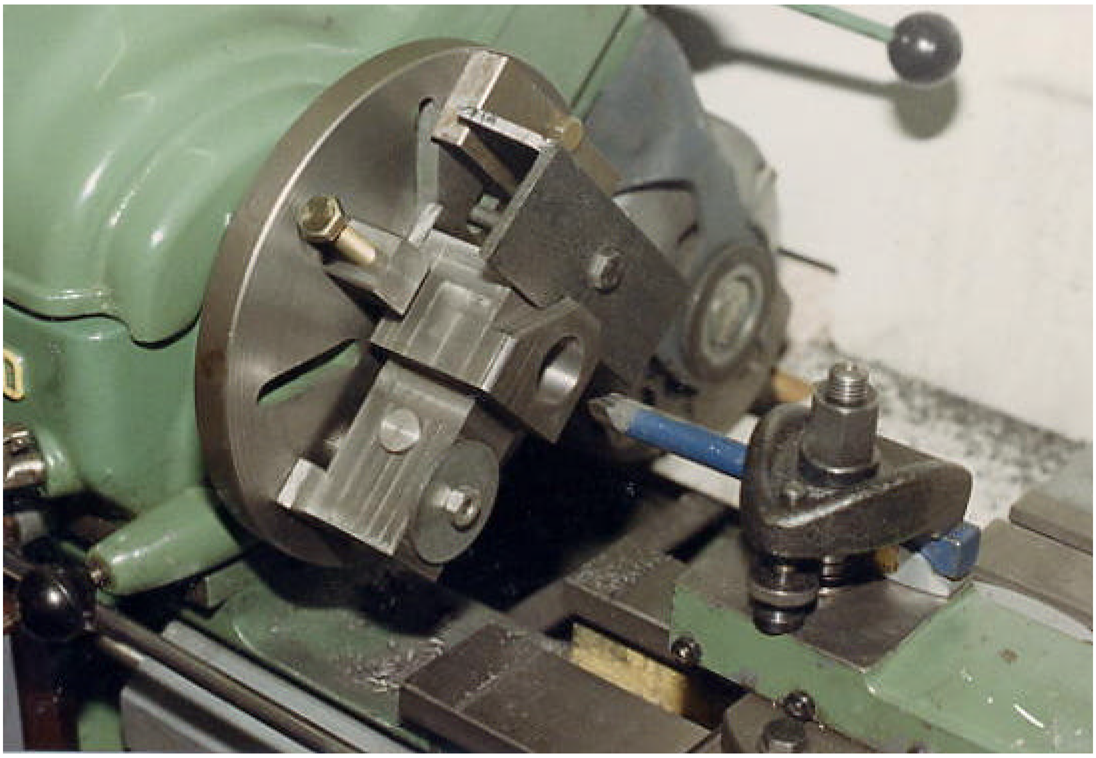
 

Boring Notes

The top pictures show the sequence in boring the bed bars. Note how easy it is to set up the work and how the holes will match in each component when they are separated. Functionally the distance between holes does not need to be especially accurate, however since this is produced by moving the cross slide it can be made within a ‘thou’. Since the work is moved past the cutter there will be no taper in the holes.

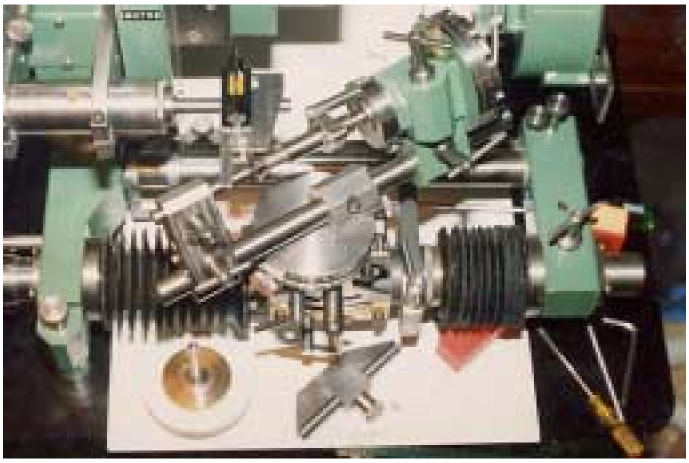
The left lower illustration shows a similar operation in making the toolholder.

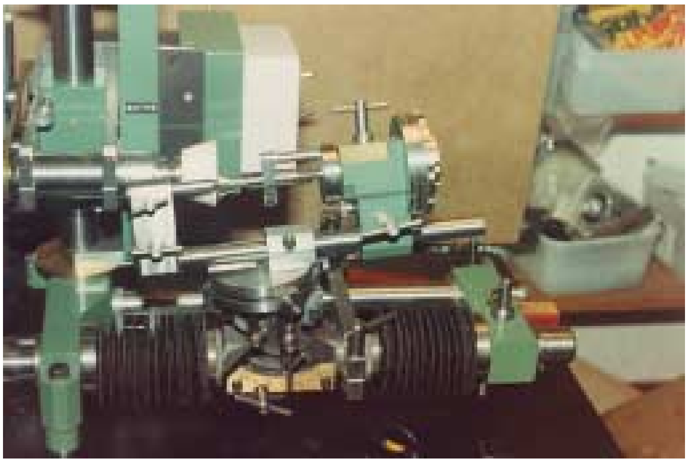
The right lower picture shows the boring head which was made by adapting the lathe catch plate. It enables accurate boring as a movement at the head results in the cutting tool being moved a much smaller amount (ratio of boring bar length to distance of cutter from the tailstock end). The centres must be maintained free from play.
A length of the material for the bars was used as a gauge in sizing the bores. One end was accurately turned to give a gauge of diameter .002” less than the final size and the parts bored to this. The head was readjusted appropriately and a final cut made. It is advisable to not to attempt tiny cuts where rubbing rather than cutting results. Refinements might involve honeing after boring.



This illustrates my first effort that was a disaster. Firstly I had transformed the blank into finished shape and then attempted to bore the holes by the method shown. It is difficult to place the holes the correct distance apart and to guarantee that the axes are truly parallel. If the lathe is not in good shape then the bore may be tapered.
Using a boring bar, with the work on the cross slide, it easy to make sure that these possible errors are eliminated. See the alternative illustration.
I was almost relieved to find out that I had cut the shape the wrong hand and even if I could have bored it correctly it would still have had to be scrapped!

Abridged sequence for sharpening a Dovetail Cutter



- The grinder is levelled (it should be kept so installed)
- A Moore & Wright blade is used as a gauge to adjust axis between centres to 45 deg
- The cutter is supported between centres and coupled to the toolholder via a flexible strip.
- Using an extended ‘arbor’ (the same diameter as the centre) the wheelhead is adjusted by means of a level so that spindle is the same height as the centres
- A simple gauge, having a lip below the lower face equal to the ‘arbor’ radius, is used to set the tooth position. Lock toolholder and set index ring to zero with register pin engaged.
- The wheelhead is then raised the appropriate amount to grind the required clearance angle. The first tooth is then sharpened.
- The toolholder is then unlocked and rotated to the next position to sharpen another tooth

Notes on Sharpening a Reamer

This is one of the most critical operations that the grinder may be called upon to achieve and it is principally on the considerations involved that the Bonelle is based. The tool is mounted on the bar bed and the workhead 'inverted' to use a cup wheel. See fig 1

Basic Requirements

1. The rear shear must be parallel to and lie in the same (horizontal) plane as the front bar. Designated the reference plane.
2. The wheel spindle must be parallel with the reference plane.
3. The reamer must be parallel with the front bar and in the same plane.
4. Initially the tooth rest tip and the centre line of the reamer must be set in a (horizontal) plane parallel to the reference plane. It must then be lowered orthogonally (vertically) by an amount that will give the correct clearance on the tool.

Setting up the bar bed

Setting up is facilitated by using a spirit level and it is assumed that the grinder base is set level.

Because the reamer height above the front bar varies with the distance from the wheel it must be positioned touching the wheel with an interposed piece of paper. The rocking arm should thereafter remain **permanently** locked to the workhead. The arm should then be adjusted so that the tool just clears the wheel

The normal state of the grinder is such that the bar bed is accurately parallel with the front bar when the settings of the tilting bracket and rotating base are at zero. However for the present purpose this must be verified by applying a dial indicator (DTI) both horizontally and vertically and the bar traversed to check that the run out is as closely to zero as practicable. (figs 2& 3)

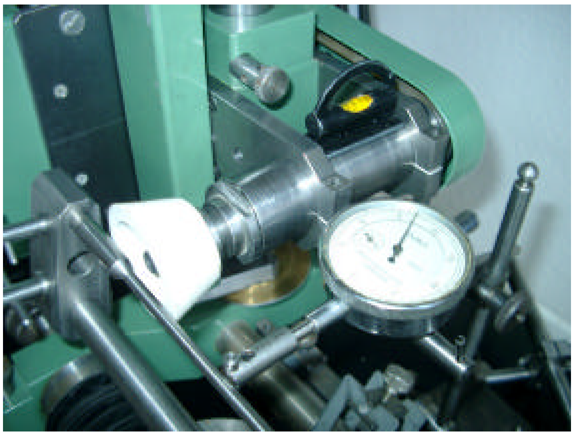
The bar should be horizontal to an accuracy of + and – 0.001" over a traverse distance roughly equal to the length being ground. (With the base set level checking the bed with a level may be a sufficiently good alternative)

The permissible run out with the DTI horizontal is much more critical as variations will result in grinding the reamer 'taper'. However the bed itself need only have a nominal adjustment to the same accuracy as in the vertical plane. This is because the critical accuracy need only apply to the tool being ground that is held between centres. To check a test piece should be prepared and substituted for the reamer. (fig 3)
The adjustment in the horizontal plane is made by altering the inclination of the rear shear. (The arrangement is equivalent to a 'sine bar'). One turn of an adjusting wheel results in roughly imparting an inclination of the tool of 1in 300

Setting up the Tooth Rest

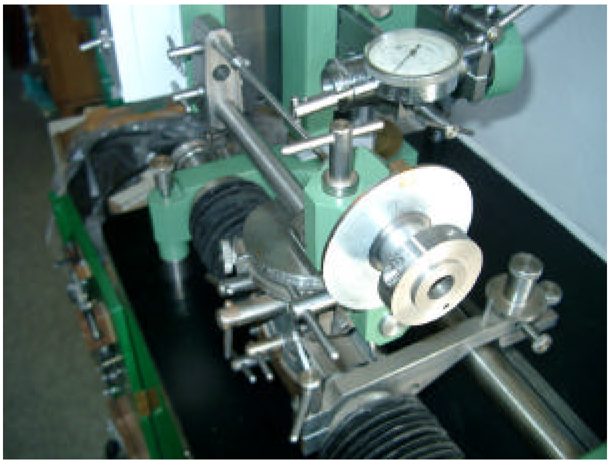
The test piece is fitted with a setting fixture (fig 4) that has a surface in line with its centre line. This surface rests on the end of the tooth rest which is then adjusted to bring the surface horizontal. The rest is then lowered, using the column adjustment, by an amount to give the required clearance to the cutting edge of the reamer.

Notes on Sharpening a Reamer

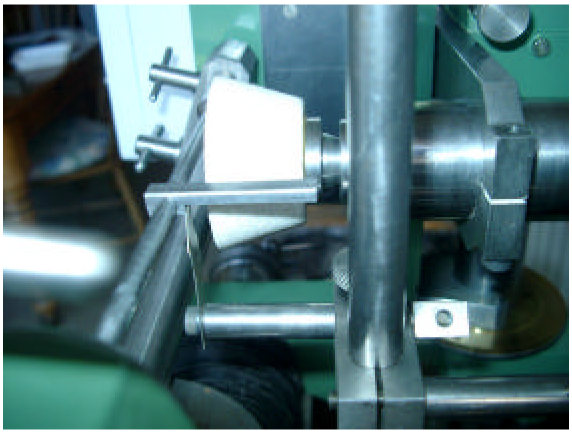


1.Checking Spindle

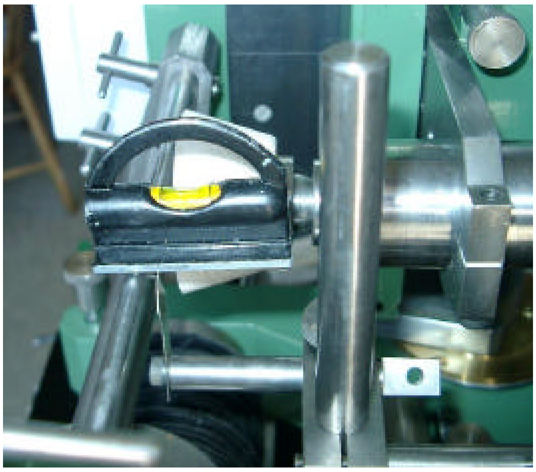
2.Checking Bar Bed



3.Adjusting Rear Shear



4.Setting Tooth Rest height



The tooth rest column is adjustable vertically by means of a graduated thimble at its base. The column can be moved along the base without disturbing this adjustment

The bellows do not restrict traversing the workhead and permit lubrication to give the sensitive movement desirable.

The test piece and tooth rest setting fixture are very simple accessories to set up this operation.

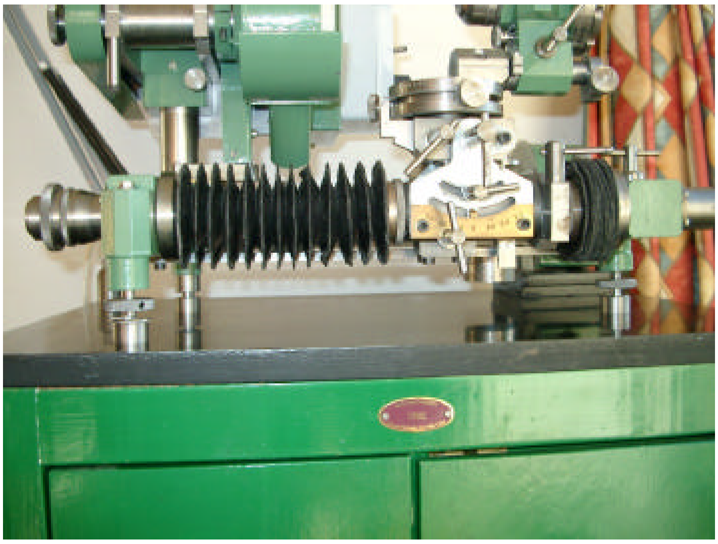
5. View showing use of level

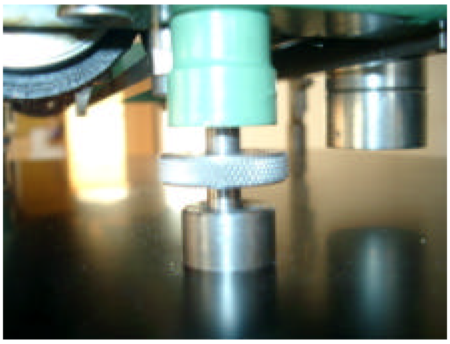
Notes on Sharpening a Reamer

Levelling screws

The general convenience afforded by using a level to obtain a common datum position for work and tooth rest was realized shortly after the grinder was constructed. The levelling of the grinder itself was by means of shims but since moving to a different position relevelling became necessary.

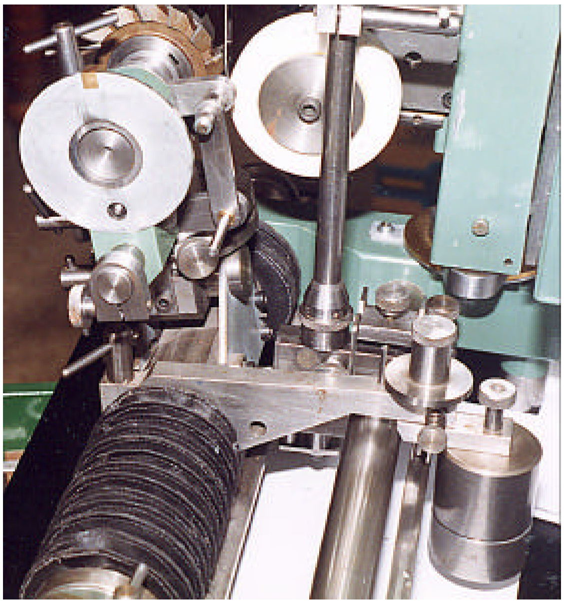
Levelling screws have been added to the feet of the grinder as shown below and as sketched in drawing Z2

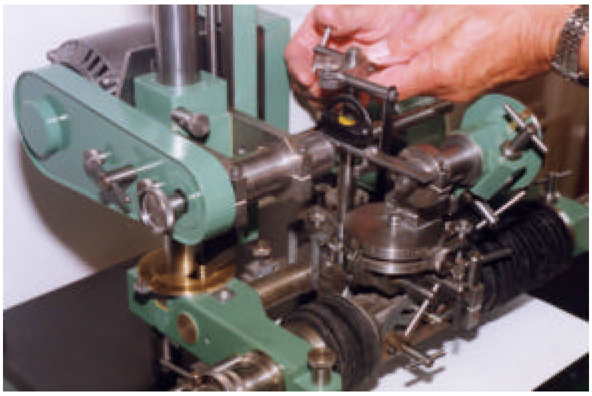


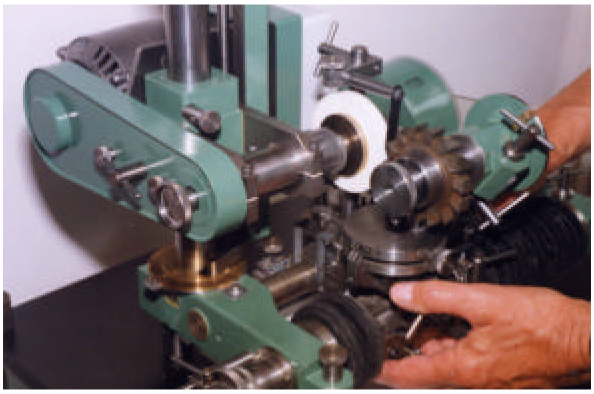


A simpler expedient might be to use studding to provide support with the adjustment made by turning the nuts holding the unit..

Notes on Using the Tooth Rest







As an example the sharpening of a milling cutter is shown

The tooth rest is carried on a pillar which is capable of vertical adjustment by means of a graduated thimble at its base. The thimble can be used to displace the rest after an initial setting with the wheel centre, tooth edge, and cutter centre all in line. This displacement will then determine the clearance angle being ground on the cutter. By using simple accessories and spirit level the rest can be accurately set in the initial position.

The stop on the front bar facilitates sharpening successive teeth identically.