ADVANCES IN CONVENTIONAL MANUFACTURING PRACTICES: IMPROVEMENT OF COMPOUND SLIDE TAPER TURNING METHOD.

R.L. Chary Nachinolkar

Department of Mechanical Engineering

Government Polytechnic Panaji Goa (India)

ABSTRACT

Of the many methods used for taper turning, the simplest one is using the compound slide. It has its own limitations. One limitation is the value of angle we set the tool at. On the cylindrical side of the compound rest, we have markings for noting the angle value, after swivelling the compound rest. These graduations are spaced at angle of 1 degree, which is low resolution value. This is the disadvantage of compound slide method as today's six sigma and total quality management policies demand extremely high accuracies in production methods and machines. Then, the only way left is to jobs by trial and error method or use high end CNC machines with high investment.

In the present investigation, a mechanical system is developed to get accurate angle value in compound slide method. It is a small attachment using mechanical gears with required ratio to give least count of 1 second and fraction thereof,which in manufacturing terms is a very high resolution value for precision works. It is simple to use, without any calculations involved, giving direct readings of angle values with no additional accessories requirement and is cost effective.

Keywords: 1 Second Taper Turning, Modified Compound-Slide, Accuracy

I. INTRODUCTION

The engine lathe called as mother of all machines, is a versatile machine with about 10 different machining operations possible to be carried out effortlessly [1]. No wonder that it has evolved with leaps and bounds and today we have sophisticated CNC turning centres with very high precision and accuracy possible in turning. But looking back at the lathe machine itself, there are millions of them existing worldwide and there is still some scope left to its improvement as it still serves as one of the most economical equipment in any machine shop.

One of the operations carried out on a lathe, is 'taper turning' and there are multiple methods of doing it. There are problems associated with taper turning even in CNCturning machines, as highlighted in the study conducted by K.Ravi Kumar and D. R. Jana [2].

In this paper, the author has highlighted the advantages and disadvantages of the various methods and found out that none of them are easy and free of time consuming calculations and tedious set-up. The paper also brings out a solution to get rid of complex calculations to set an angle desired with very fine values like 0.5 second. The method presented here is patented and will prove beneficial to millions of users the World over. Lathe manufacturers and turners using conventional turning machines will appreciate the ease once it is incorporated in any turning lathe. This is done without going for retrofitting or adding electronic controllers as specified in [3], which makes it economical to add this simple attachment for increasing taper turning resolution.

II. TAPER TURNING CONVENTIONAL METHODS

2.1.Form tool method

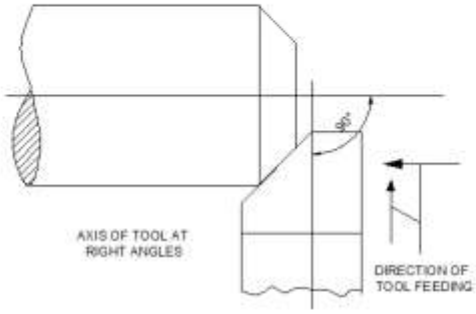

Figure 1: Form tool method

The tool is ground and shaped at a particular value which is needed in taper turning. Refer Fig. 1. This method is used in mass production for producing a small length of taper where accuracy is not a criterion. The form tool should be set at right angle to the axis of the work. The carriage should be locked while taper turning by this method. Advantage is that once the tool is made with cutting edge at particular angle, as long as tool is aligned perpendicular to the axis of the lathe, one can easily turn the jobs at required angle. Disadvantage is that there is only one angle value possible for the tool to be ground at a time.

2.2.Compound Slide Method

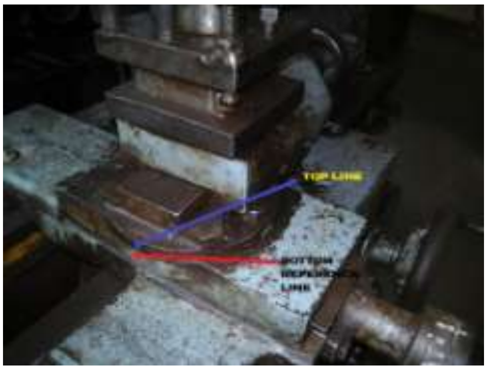

Figure 2: Compound Slide with swivel base

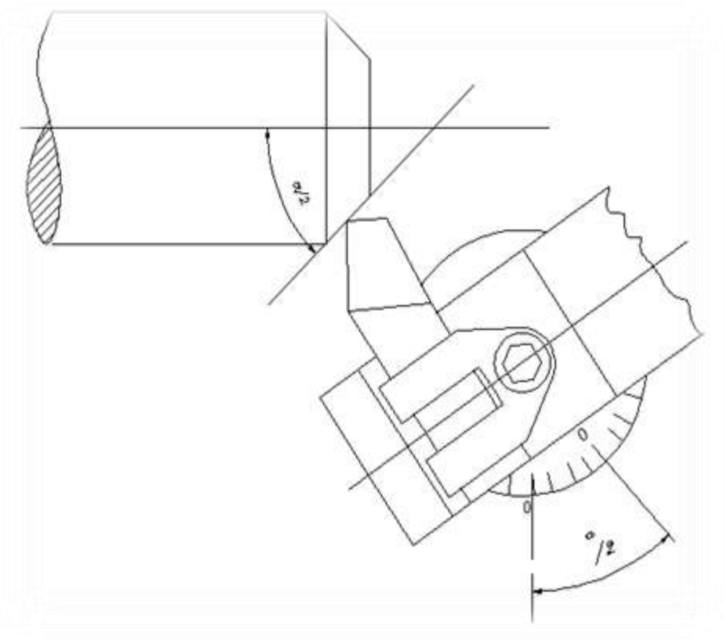

Figure 3: Schematic of Compound Slide Method

Refer Fig. 2 and Fig. 3. In this method, the top slide of the compound rest is swivelled to half the included angle of taper, and the taper is turned. It is this method, in which we are refining the angle setting and measuring process.

The amount of taper for setting the angle is found by the formula as given in (1)

$$\tan\frac{\alpha}{2} = \frac{(D-d)}{2*l} \quad \ldots (1)$$

where: D-big dia.

d-small dia.

l-length of taper

$\frac{\alpha}{2}$- half included angle in degree.

Nowadays, taper angles and cone angles can be easily computed by online computation facilities such as [4].

ADVANTAGES:

- Both internal and external taper can be produced.
- Steep taper can be produced
- Easy setting of the compound slide

DISADVANTAGES:

- Only hand feed can be given
- Threads op taper portion cannot be produced
- Taper length is limited to the movement of the top slide

2.3.Tailstock Offset Method

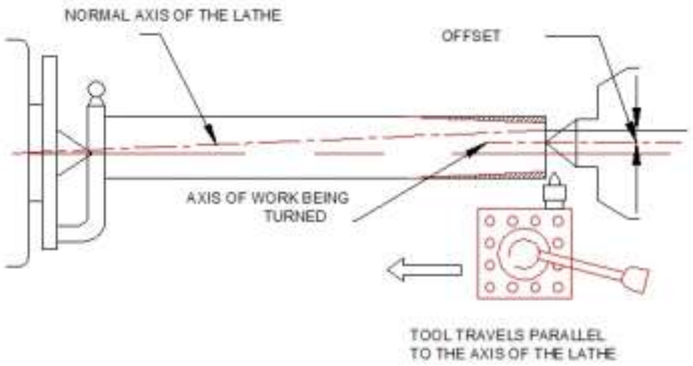

Figure 4: Taper turning by offset method

In this method the job is held at an angle and the tool moves parallel to the axis. The body of the tailstock is shifted on its base to an amount corresponding to the angle of taper. This method is best described in [5]. The taper can be turned between centres only and this method is not suitable for producing steep tapers. Refer Fig. 4.

The amount of offset is found by the formula given in (2):

$$\text{Offset} = \frac{(D-d)\times L}{2\times l} \qquad \dots (2)$$

where, D = big dia. of taper

d = small dia. of the taper

l = taper length

L= total length of job

ADVANTAGES

- Power feed can be given
- Good surface finish can be obtained
- Maximum length of the taper can be produced
- External threads on taper portion can be produced
- Duplicate tapers can be produced

DISADVANTAGES

- Only external taper can be turned
- Accurate setting of the offset is difficult
- Taper turning is possible when work is held between centres only
- Damages to the centre drilled holes of the work
- The alignment of the lathe centres will be disturbed
- Steep tapers cannot be turned

2.4.Taper turning by attachment

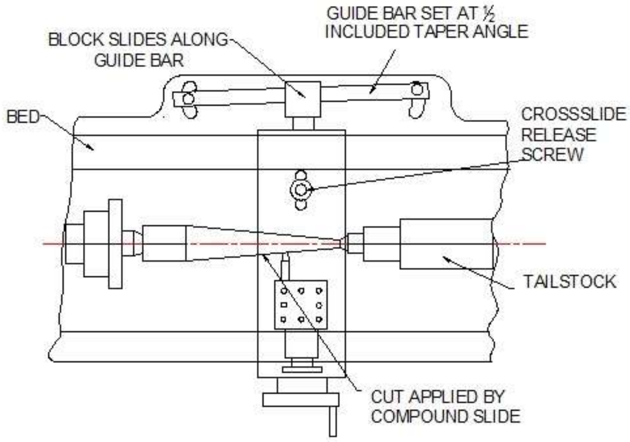

Figure 5: Attachment for taper turning

This attachment is provided on a few modern lathes. Here the job is held parallel to the axis and the tool moves at an angle. The movement of the tool is guided by the attachment. Way back in 1915, [6] a patent is granted for a turret lathe taper turning mechanism similar to the one shown in Fig. 5 above.

ADVANTAGES:

- Both external and internal tapers can be produced
- Threads on both external and internal taper portions can be cut.
- Power feed can be given
- Lengthy taper can be produced
- Good surface finish is obtained
- The alignment of the lathe centres is not disturbed.
- It is most suitable for producing duplicate tapers because change in length of the job does not affect the taper
- The job can be held either in the chuck or between centres

DISADVANTAGE

- Only limited taper angles can be turned.

III. NEW METHOD OF TAPER TURNING DEVELOPED BY AUTHOR

3.1.Construction

This mechanism is an attachment to the assembly of tool post consisting of cross-slide and compound rest with screw and hand wheels for tool traversal. Consider the layout of an existing carriage. Refer Fig. 6. There is a tool, tool post, cross slide, swivel base, top slide and a lock nut.Fig. 7 gives the list of different part involved. The new mechanism is drawn in red, shows the set of gears to be used, consisting of worm and worm wheel or a spur and a pinion, further engaged with the main angle indicator (MAI), which is a dial (15). This MAI indicates values of angle turned through in multiples of degree, minutes and seconds, similar to a clock or a watch that is commonly used. We can calibrate the dial to have 0.5 second reading and thus there will be 120 divisions for a minute or in other words, we have 2 X 60X60 = 7200 divisions of a degree possible.

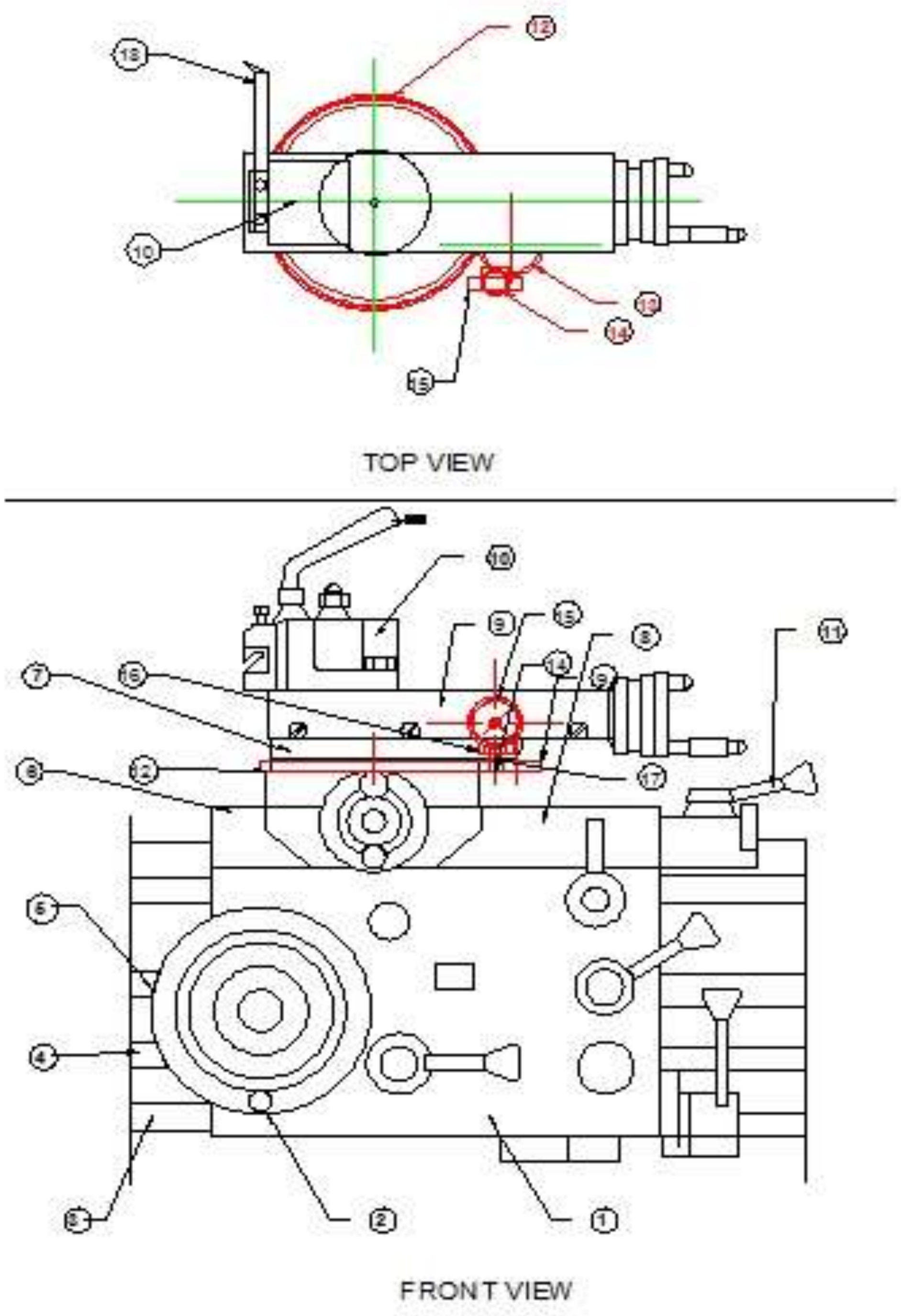

Figure 6: The Carriage and its various parts with modified compound slide

PART NO	DESCRIPTION
1	APRON
2	HAND WHEEL FOR CARRIAGE TRAVEL
3	CONTROL SHAFT
4	FEED SHAFT
5	LEAD SCREW
6	SADDLE
7	SWIVEL BASE
8	CROSS SLIDE
9	TOP SLIDE
10	TOOL POST
11	CARRIAGE LOCKING SCREW
12	ANNULAR SPUR GEAR (GEAR C)
13	IDLER GEAR (GEAR B)
14	PINION (GEAR A)
15	MAIN ANGLE INDICATOR (MAI)
16	SLIDE
17	COUPLER
18	TOOL

Figure 7: Part list of the carriage with modified compound slide attachment

Figure8: The main angle indicator (MAI)

The MAI instrument has three hands each one for degree, minute and second indication. It is easy to count the degrees, minutes and seconds by keeping a watch of the number of divisions, the respective hand crosses.

3.2.Advantages and limitation of the new method of taper turning

- The method gives high resolution of up to 0.5 second angular reading as an application of the main angle measuring instrument developed.
- It allows quick setting of taper
- No calculations using calculators involved which simplifies the procedure of taper turning
- The gears to be used can be either worm and worm wheel or a set of spur and pinion. Further amplification is within the instrument called MAI or Main Angle Indicator.
- The error in similar electronic devices is ± 5 second of angular readings, which can be brought down to about 2 second in the device of present invention through precise machining of all gears involved.

IV. CONCLUSION

Angle measurement methods have always been neglected and sidelinedin conventional engineering and manufacturing. This technical paper puts forth use of mechanical gears without electronics and electrical technology discussed herein, for setting any desired angle of tool for taper turning and machining with ease. This is only one of the many applications of the method of measuring angle developed by the author.

The author looks forward for partnership with precision gear manufacturers, lathe manufacturers and users of turning machinery for implementation of the newly developed patent pending technology.

V. ACKNOWLEDGEMENTS

The author wishes to thank the Principal Mr. L.R. Fernandesand Workshop Superintendent Mr. J. M. R. Noronha, of Government Polytechnic Panaji for allowing the photography of workshop machinery for the purpose of study of this project.

REFERENCES

[1] http://en.wikipedia.org/wiki/Lathe

[2] K. Ravikumar and D. R. Jana, "An Experimental Study of Wrong Positioning of Cutting Tool on Taper Turning Operation," *Journal of Emerging Trends in Engineering and Applied Sciences, Scholarlink Research Institute Journals,1(1);* pp. 24-29, 2010

[3] P.N.Parmar, V.R.Gondalia and N.C. Mehta, "Review on Advance Automation of Conventional Lathe Machine," *IJEDR | Volume 2, Issue 2*, pp. 2451-2455

[4] http://www.magafor.com/841/uk.htm

[5] J. Anderson and E.E.Tatro, *Shop Theory*(Tata McGraw Hill, 6th Edition, 42nd reprint, New Delhi, 2008)

[6] M.Harrison, Taper turning attachments for turret –lathes, *Patent no. US1187457A, June 1915*