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Design and Fabrication of Gear Cutting Attachment for Lathe

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ABSTRACT

The gear cutting machine lathe attachment is attachable to an existing gear cutting machine so as to eliminate the need for an operator owning both a gear cutting machine and a lathe. It is designed to be mounted to the side of the gear cutting machine and to be used without disturbing a setup in the associated vise. The attachment is also designed to be mounted to the front of a gear cutting machine and allows the programming of the very point of single point tool contact so as to follow whatever contour or steps are desired. This type of cutting is not possible on a lathe with guaranteed accuracy, while on a gear cutting machine it is quite feasible. Mechanical engineering without production and manufacturing is meaningless and inseparable. Production and manufacturing process deals with conversion of raw materials inputs to finished products as per required dimensions, specifications and efficiently using recent technology. The work is on design and fabrication of gear cutting attachment which is used to cut gear or splines over the cylindrical job. The main aim is to prove lathe is a versatile machine

Key Words: *Design*, *Fabrication*, Gear Cutting, Lathe Attachment.

1. INTRODUCTION

In recent years, new fabrication techniques have been developed to satisfy the technological demands. Moreover, emphasis is stressed on attachments. Attachments are used in various fields and machines depending upon the needs to be fulfilled and mode of operation. An attachment eliminates the purchasing of a new unit which serves the same purpose. For example, a lathe occupies a place opposite to that of a gear cutting machine, the ten machines mainly used to produce cylindrical and plain surfaces respectively. By implementing an attachment to a unit, the capacity of the unit can be increased which is very economical. Each general purpose conventional machine tool is designed and used for a set of specific machining work on jobs of limited range of shape and size[2]. But often some unusual work also need to be done in a specific machine tools, e.g. milling in a lathe, tapping in a drilling machine, gear teeth cutting in shaping machine and so on. Under such conditions, some special devices or systems are additionally used being mounted in the ordinary machine tools. Such additional special devices, which augment the processing capability of any ordinary machine tool, are known as Attachments, Unlike accessories, Attachments are not that inevitable and procured separately as and when required and obviously on extra payment. Taper cylindrical surface, which is a very common feature of several engineering components, is generally produced in lathes in a number of methods, depending upon length and angle of the tapered position of the job, such as offsetting tailstock, swiveling the compound slide using form tool and combined feed motions[1]. But jobs with wide ranges of length and angle of taper, are easily machined by using a simple attachment, called taper turning attachment schematically shows a taper turning attachment where the cross slide is delinked from the saddle and is moved crosswise by the guide block which moves along the guide bar preset at the desired taper angle. Thus, the cutting tool, which is fitted on the cross slide through the tool post and the compound slide, also moves along with the guide black in the same direction resulting the desired taper turning. Gear cutting is the process of machining flat, curved, or irregular surfaces by feeding the work piece against a rotating cutter containing a number of cutting edges. The gear cutting machine consists basically of a motor driven spindle, which mounts and revolves the gear cutting cutter, and a reciprocating adjustable worktable, which mounts and feeds the work piece.Gear cutting machines are basically classified as vertical or horizontal. These machines are also classified as knee-type, ram-type, manufacturing or bed type, and planer-type. Most gear cutting machines have self-contained electric drive motors, coolant systems, variable spindle speeds, and power-operated table feeds[5]. The basic difference between a universal horizontal gear cutting machine and a plain horizontal gear cutting machine is the addition of table swivel housing between the table and the saddle of the universal machine. This permits the table to swing up to 45° in either direction for angular and helical gear cutting operations[6]. The universal machine can be fitted with various attachments such as the indexing fixture, rotary table, slotting and rack cutting attachments, and various special fixtures

II. DESIGN CALCULATIONS

To cut 31 number of teeths in the gear blank having module of 2 mm.

No. of teeths = Z= 31

Module = m= 2 mm

1. Dia of the gear blank, D

   D = m[Z+2]

   = 2 [31 +2]

   = 66 mm

2. Circular pitch , P

   P = π m

   = 2 x 3.14

   = 6.284 mm

3. Pitch circle dia, Pcd

   Pcd = mZ

   = 2 x 31

   = 62 mm

4. Addendum, h_a

   h_a=m

   = 2 mm

5. Dedendum, h_f

   h_f = 1.25 m

   = 1.25 x 2

   = 2.5 mm

6. Tooth depth, h

   h =h_a+h_f

   = 2 + 2.5

   = 4.5 mm

7. Cutting speed, V

V = π d N / 1000

= π x 66 x 200/1000

= 41.46 m/min

8. Blank Thickness, b

b=10m

=10 x 2

=20mm

9. The thickness of a rectangular plate subjected to uniform load.

According to Grashoff& Batch (referred from design data hand book K Mahadevan and K Balaveera Reddy)

$$t = abc_3\left[\frac{P}{f\left(a^2+b^2\right)}\right]^{1/2}$$

a= length of the plate

b= breadth of the plate

C_3= constant for bending / tension load

P = pressure

f = allowable stress value MPa

Material used: M.S

Allowable stress: 250 MPa

For bending load, f =0.65(allowable stress)

=0.65 x 250

= 162.5 MPa

C_3= 0.49 from data hand book for bending

Weight of the motor: 4kg=40 N

Substituting the values in the above formula we get

$$t = 155\times 95\times .49\left[\frac{40}{162.5(155^2+95^2)}\right]^{1/2}$$

t = 19 mm

III. FABRICATION

3.1 Gear Cutting Using Indexing Plate Method:

Construction and Working:

Here the tool post is removed and the base plate is mounted on the slot of the tool post. Sliding plate is made to slide over the base plate with the slot.

Figure 1: Mounting Position of The Attachment

Slidingplate consist of bush in which the shaft is made to rotate for indexing .The work piece is hold rigidly at one end of the shaft and indexing crank at the other end. The indexing plate is attached to the bush with help of the screw.In this work the end milling cutter is fixed between lathe chuck and tail stock .The job is fixed over the compound slide (shaft) by gear cutting attachment. This fixture has shaft with indexing plate at one end with the help of the bush, here job or work piece hold rigidly in shaft at the other end itself .So feed is given by cross slide movement of the lathe and depth of cut is given by the movement of the sliding plate.When the cutter is rotated at required RPM (say 280RPM) and work piece is brought near the cutter. Depending upon the required number of teeth gear cutting operation is carried out by turning the indexing crank over the indexing plate. The index plate has 27, 31, 41 and 47 number of holes.

3.2 Gear Cutting Using Ratchet and Pawl Mechanism for Indexing:

Construction and Working:

The sliding bed is rotated with the help of a screw rod. In that sliding bed the vice is fixed. The vice is used to hold the work piece. The gear cutting cutter is fixed to the lathe drill chuck. The exciting tool post is replaced so that to fix the attachment here by suitable arrangement. By changing the gear cutting cutter, the required shape is obtained in the work piece.

Holding Workpieces in the Vise

As previously mentioned, five types of vises are manufactured in various sizes for holding gear cutting machine workplaces. These vises have locating keys or tongues on the underside of their bases so they may be located correctly in relation to the T-slots on the gear cutting machine table. The plain vise similar to the machine table vise is fastened to the gear cutting machine table. Alignment with the gear cutting machine table is provided by two slots at right angles to each other on the underside of the vise.These slots are fitted with removable keys that align the vise with the table T-slots either parallel to the machine arbor or perpendicular to the arbor .The swivel vise can be rotated and contains a scale graduated in degrees at its base which is fastened to the gear cutting machine table and located by means of keys placed in the T-slots. By loosening the bolts which clamp the vise to its graduated base, the vise may be moved to hold the work piece at any angle in a horizontal plane. To set a swivel vise accurately with the machine spindle, a test indicator should be clamped to the machine arbor and a check made to determine the setting by moving either the transverse or the longitudinal feeds, depending upon the position of the vise jaws. Any deviation as shown by the test indicator should be corrected by swiveling the vise on its base. The universal vise is used for work involving compound angles, either horizontally or vertically. The base of the vise contains a scale graduated in degrees and can rotate 360° in the horizontal plane and 90° in the vertical plane. Due to the flexibility of this vise, it is not adaptable for heavy gear cutting.

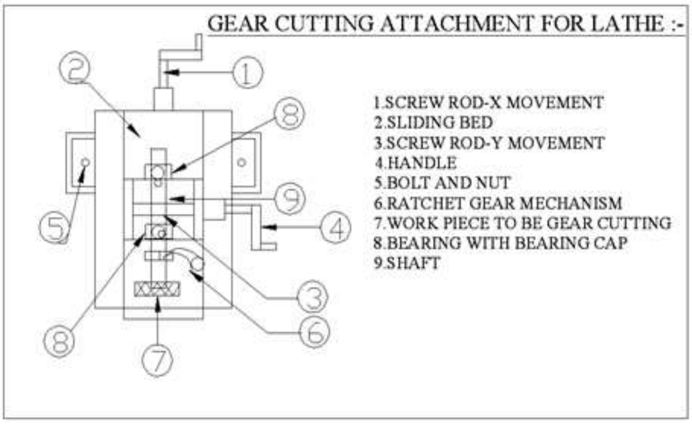

Figure 2: Gear Cutting Using Ratchet and Pawl type indexing Method

IV. COST AND ESTIMATION

Table1 Cost Analysis for Gear Cutting Attachment With Indexing Plate

COMPONENTS	AMOUNT (INR)
Base Plate	500/-
Sliding Plate	100/-
Shaft	500/-
Bush	100/-
List of equipment's required	2500/-
Labour cost	3000/-
Raw Material	1500/-
Indexing Plate and Crank	3000/-
Nut, Bolt and Work piece	500/-
Miscellaneous Costs	3500/-
Total Cost	15,200/-

Table.2 Cost Analysis for Gear Cutting Attachment With Ratchet and Pawl Mechanism as Indexing Method

COMPONENTS	AMOUNT (INR)
Base Plate	700/-
Sliding Plate	300/-
Shaft	300/-
Bush	200/-
List of equipment's required (Lathe, Drilling, Boring machine, Bench Vice, Arc Welding etc.)	2000/-
Labour cost	2500/-
Raw Material (Tool, Tool holder, Lead Screw etc.)	2000/-
Ratchet Wheel And Bearing	1000/-
Nut, Bolt and Work piece	500/-
Miscellaneous Costs	2500/-
Total Cost	12,000/-

V. RESULTS AND DISCUSSIONS

- Gears are successfully made from this attachment.
- Good surface finish is achieved.
- By Aesthetics point of view the attachment looks excellent.
- No skilled labour on the part of operator is required to operate the machine.
- The construction of lever is such that the operator does not have to apply much force.
- The attachment does not vibrate due to machine vibrations good clamping arrangement has been made.
- The attachment is not that much heavy it can be easily transfer from one place to another.
- Mounting the gear cutting attachment on the lathe machine is easy.
- Different size of gear can been manufactured from this attachment.

5.1 Advantages

1. The unit is compact in size.
2. Less maintenance is essential.

3. The unit gives long life with proper alignment of gears.
4. Jobs can be easily handled in this unit.
5. Fixing of the attachment is easy.
6. This attachment is economical.

5.2 Limitations

1. Adjustment of cutting speed is a problem.
2. Accuracy is low as compared to conventional milling machine.
3. Since indexing head is not used number of teeth's which can be manufactured is limited (in the case of ratchet mechanism).
4. Providing accurate depth of cut is difficult (in the case of indexing mechanism).

5.3 Applications

1. Desired gear cutting can be easily turned.

VI. CONCLUSIONS

Milling operation is a special machining process which is very expensive. A simple attachment to an ordinary lathe serves extra purpose of milling in a very economical manner. This project can be implemented in industries where milling is necessary. This lathe eliminates the requirement of possessing a milling machine which is costlier than the lathe machine. The gears can be easy produced on the gear blank with the acceptable level of accuracy. Also the indexing method adopted is very simple wherein only one hole has to be moved per teeth. Our attachment also provides the operator the freedom of rotating the workpiece in both the directions i.e. clockwise and counter-clockwise direction which is not possible in conventional milling machine. This is helpful when the operator forgets to bring back the workpiece to the initial position before indexing has been done. Hence we can conclude that the gears can be easily produced in lathe machine with the use of an attachment.

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