A PROJECT REPORT
ON

“SPHERICAL TURNING ATTACHMENT”

Submitted by

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In partial fulfillment for the award of the Degree
Of
BACHELOR OF ENGINEERING
IN
MECHANICAL ENGINEERING
UNDER THE GUIDANCE
Of
Prof. YUSUF KHAN

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UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2015-2016

ANJUMAN-I-ISLAM

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

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(Internal Examiner)	**(External Examiner)**
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Date: __________

Abstract

Spherical Turning Attachment: On lathe machine it is not possible to manufacture spherical objects but with the help of spherical turning attachment it can be easily manufacture. Earlier the spherical objects were made by various processes like annealing, wire drawing, cold forging, flashing, heat treatment, grinding, lapping etc. but this process were tedious, time consuming and comparatively cost of this process is high.

The movement of tool post on normal lathe machine is restricted in only two directions, by replacing the tool post with spherical turning attachment the rotating motion can be achieved of about 360^{o}. The machine named ball turner which is available in the market for manufacturing spherical objects cost very high.

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Nomenclature/Abbreviation

STA →Spherical Turning Attachment

A1→Appendix 1

M→Bending Moment In N-mm

Y→Centre Of Gravity In mm

$\Sigma_{b\rightarrow}$Bending Stress In N/mm^2

I→ Moment Of Inertia In mm^4

F→Force In N

L→Length Of Lever

Chapter 1

Introduction

1.1 Background

This project, “spherical turning attachment” is related with the production and manufacturing field. Production is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). It is the act of creating output, a good or service which has value and contributes to the utility of individuals. Manufacturing is the production of merchandise for use or sale using labour and machines, tools, chemical and biological processing, or formulation. The term may refer to a range of human activity, from handicraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods. Various manufacturing techniques of spherical object is present in the market some are tedious some are not affordable with the small scale industries. Spherical turning attachment is the best solution to create the spherical objects.

1.2 Motivation

Besides various manufacturing techniques available for making spherical objects none of them was cheap and easy. Requirement of skilled labour was also a major disadvantage. This was the main factor that led us to think the alternate method for producing sphere objects at an affordable price. By market survey we came to a conclusion that not only skilled labour was required but also a different type of process has to undergo by an object to complete it with a sphere. Also in many engineering colleges basic manufacturing operation has been taught to students, such as facing, turning, chamfering, etc. This above factor motivated us to think something different to tackle all this problem and spherical turning attachment is the best solution for all this.

1.3 Aim And Objective

In today’s modern world each and every human being required a comfortable & luxurious lifestyle. To overcome all those facilities every emerge wants to be as successor. Due to this competition in the world every mankind wants to wins the race and want to challenge all type of difficult situation. WHO said it could not be done? And what great victories has he to his credit which qualify him to judge others accurately?

Now, let me introduced you the objective behind our project we have deals with lathe machine in our 4 years Bachelor degree course. This machine is the heart of every Mechanical Engineer. We can perform several operation on this machine such as threading, turning,facing,drilling, grooving, chamfer, fillet etc. and so on. But when it comes to make spherical object, we have to send our job to another inventory. For to give a simple spherical shape we required to bear lots of human hard work during handling the job and transportation cost. During transportation some of the job even gets destroyed also. Our main objective is overcome all those problem which give lots of advantage to our production industry. We have seen the tool post which is mounted on the lathe bed. We have replaced that tool post by our attachment. By this we can perform spherical turning on our lathe machine. Our objective is to reduce the stress and cost of the production industry so that it gives benefits to our nation. This attachment is cheap (no bushings or bearings), so even small scale industry can afford its. Production industry invest $600 for a tool that would be used only occasionally. So, we have designed a quick (simple setups), cheap and easy to make radius turning.It took less than one day to make and works beautifully for 25mm to 80mm ball. We can scale up if we need larger diameter.Since producing the drawing took as long as actually building the tool. Our main aim is make an attachment which can be easily operated by less skills worker.

1.4 Problem Definition

In lathe machine we can do several operations such as threading, grooving, turning, boring etc, and so on. But the difficult part comes when there is a need to give a spherical shape. The major problem is to give spherical shape i.e. (concave or convex).To give spherical shape we have to send the job to another inventory and their also the problem doesn’t end. To give spherical shape the machine which is used is “BALL TURNER”. Its cost is around 30,000-40,000 INR. For this part, it is time consuming, handling cost increases with increase in labor cost, because we have to assign one worker only to give spherical shape. Sometimes, carrying the job to another inventory it gets damage so the handling cost increases.

We came across such several problem to give a simple spherical shape in market there is no other option to reduce cost and time if customer requirement is to give spherical shape to an object for single job, we cannot afford to send that single job to another inventory because it is expensive as well as time consuming. On lathe machine it is not possible to manufacture spherical objects but with the help of spherical turning attachment it can be easily manufacture. Earlier the spherical objects were made by various process like annealing, wire drawing, cold forging, flashing, heat treatment, grinding, lapping etc. but this process were tedious, time consuming and comparatively cost of this process is high.

1.5 Scope

Spherical objects can be easily made with this attachment also semi skilled worker can be able to operate. Cylindrical shape objects can manufacture easily. Can be implemented in engineering institutes for educational purposes.

Chapter 2

Review Of Literature

- SteveBedair's design made the first design of spherical turning attachment.It uses a TNMG insert which is necessarily angled downward 5 degrees. This design has a large bearing surface for the rotor plus minimal extension of the cutter from its holder to minimize the chance of chatter.
- Elements of spherical turning by Edgar T. Westbury
- Black book of the past few years projectes related to this topic (2007-2008)
- Various books on manufacturing available in library.
- A literature review on machining of different materials on lathe by Er.manpreetsingh, Er.Sanjeevverma,Dr. sanjivekumarjainM.Tech.student ,Punjab, Technical university, india.Asstt.prof., PCET,Lalru,India.prof. &Head of Department, Ambala college of Engg., Devsthali, India.
- This paper discusses literature review of different materials on lathe. Today lathe manufactured products has major contribution in industries. They are main platform in the contribution of good quality products in industries

Chapter 3

Theory Of Spherical Turning Attachment

3.1 STA Using Worm And Worm Wheel

Whether the device employed for producing spherical contours is simple or elaborate, the very first principle to be observed in its operation is the location of the centre around which the generating tool is rotated, by means of a hand lever or other means. If carried to the extent indicated, the error is readily visible to the eye, but for work in which high spherical precision is necessary, even the smallest discrepancy may spoil the finished results. For this reason, some positive means of locating the pivot centre on the cross-slide or bed of the lathe is an advantage and in some cases may be absolutely essential.

In general work, some method of radial adjustment for the tool point, to deal with varying sizes of work, is equally important; it is also an advantage to provide the smoothest possible feed movement of the rotating tool fixture. But it may be mentioned that in commercial production, spherical curves of fixed dimensions, over a limited angle of arc, are accurately produced by methods and appliances which do not provide either of these facilities. Components such as ball-and socket joints for motor car steering and suspension systems, in which smooth articulation is absolutely necessary are often finished to close limits of precision by means of a hollow grinding wheel, running at high speed on an axis at 45 deg. to that of the work. The spherical arc generated in this way is usually limited to about 90 deg., which is sufficient for the particular purpose, provided that the rest of the surface is undercut or relieved, as indicated in the example of work dealt with. In order to maintain the uniformity of the spherical diameter despite the inevitable wear of the grinding wheel, it is dressed, when necessary, on the front flat face only. The same generating principle could be applied to the use of a cutting tool such as a hollow milling cutter. Increasing the angle of the tool axis in relation to the work would enable the spherical arc to be extended within certain limits, but it would always leave either a cone or a flat on the front end of the work. It is just as important, however, to observe the first principle, in locating the axis of the grinding or cutting tool so that it exactly intersects that of the work.

Another one is designed to be mounted either on the bed or cross-slide of the lathe by means of two bolts, and it incorporates a geared rotary movement, in conjunction with a radial tool slide. As an example of machine tool component design, it deserves commendation, and the mechanical details are well made and fitted. The worm gear provides an adequate turntable for the radial slide, with a broad under-surface to form a thrust bearing, with adjustment for end play from below, in the recessed bolster plate. A removable gauge pin, cut away to the centre to facilitate radial measurement, is fitted to the centre of the worm wheel. The radial sliding member is fitted with a gib for adjustment, and is moved by a feed screw with a balanced handle, hating an indexed sleeve, though the markings on it are not visible in the photograph. A lantern type of tool post, with rocker adjustment for the tool height, is anchored in a T-slot which enables the latitude of radial movement to be extended. Smooth and steady motion of the rotary traverse is facilitated by the worm gearing, and the worm shaft is fitted with a flexible drive, so that it can be operated from any convenient position, or even coupled to a self-acting drive if required, The utility of this appliance, however, is restricted in certain respects, wherein its refinements may, In fact, constitute a handicap rather than a practical advantage. In the first place, the vertical height of the bolster, worm gear, and radial slide impose a limit on the size of the work which can be machined on a lathe of small centre height when using the appliance. Though it is likely that most of the spherical turning required will be on parts of small diameter, there are occasions when large work may be encountered, calling for the maximum possible clear swing. The space occuplied by the worm gearing, etc., can then ill be spared, and the appliance is at a disadvantage, compared with one having a direct lever feed. Most spherical turning operations, other than those which are limited to a relatively small arc, involve the need for rotating the tool as far as possible to the left, to carry the curve right down to the neck or stem. When the work is held in a normal chuck, or between centres, the radial slide and its handle may not be capable of swinging far enough rounds without fouling the chuck or other revolving parts. It is possible to make the handle removable, which helps to some extent, but I have often found that this does not give sufficient clearance. The only thing to be done then is to slew the tool round to the left in the tool post, but though this enables the arc of surface to be increased, it reduces the advantages of fitting a slide which gives direct radial tool adjustment. It will be clear that the movement of the tool slide is no longer truly proportional to the radial adjustment at the actual tool point. As I have often had to carry out spherical turning, in the course of solving those awkward little machining problems which are passed on to me from time to time, I have devoted a good deal of time to the design of appliances which give maximum facility without serious limitations for work of this nature.

A spherical turning appliance with oblique worm shaft.

The base of the appliance is a rectangular piece of 1/4 in. steel plate, scraped flat and true on both sides. For mounting it on the cross-slide of the lathe, two recessed socket head screws are provided, which engage with 1/4 in. B.S.F. tapped holes in a strip suitably shaped to fit the T-slots of the cross-slide. This method, incidentally, can be recommended for securing all sorts of attachments to Tslotted cross or vertical-slides. It facilitates quick setting-up and removal, avoids the need for loose clamps and bolts, or projections which may get in the way of operations. Moreover, they reduce the risk of overstraining the T-slots, by providing increased bearing surface over their full length. The strips can easily be made from mild steel bar by milling or shaping; they should slide easily in the T-slots, with clearance on the top surface, so that they lie below the slide level.

A hole is drilled and tapped 3/8 in. X 26 t.p.i. in the centre of the baseplate, which is recessed on the underside so that a thin locknut can be fitted to secure the pivot bush when it is screwed in to eliminate end play of the rotating parts. As in the appliance, worm gearing is used for the rotating movement, but instead of using a proper worm wheel, it makes use of a spur gear with straight axial-cut teeth. The reason for this is to allow the wormshaft to b e inclined upwards at a sufficiently steep angle to give ample clearance for the operating handle, over the crossslide. Whether this shaft is located parallel to the lathe axis, or at any other convenient angle, it allows the gearing to be operated with the minimum interference from other slide movements A hole is drilled and tapped 3/8 in. X 26 t.p.i. in the centre of the baseplate, which is recessed on the underside so that a thin locknut can be fitted to secure the pivot bush when it is screwed in to eliminate end play of the rotating parts. As in the appliance worm gearing is used for the rotating movement, but instead of using a proper worm wheel, it makes use of a spur gear with straight axial-cut teeth. The reason for this is to allow the worm shaft to b e inclined upwards at a sufficiently steep angle to give ample clearance for the operating handle, over the cross slide. Whether this shaft is located parallel to the lathe axis, or at any other convenient angle, it The gear wheel actually used for the original appliance was one which happened to be available, in the traditional model engineers' " treasure chest " (some unkind people refer to it as the " jackdaw's nest "). But in order to cater for those who may not be able to obtain a gear wheel of the same size and pitch, the drawing has been modified to show one which may more readily be available. Change wheels of 20 d.p., and with varying numbers of teeth, are used on several popular lathes, and are obtainable as spares from makers or dealers. The 50-tooth wheel shown is a convenient size, but the exact gear ratio is not important. Both sides of the wheel should be flat and parallel on their essential bearing surfaces; recesses, if they already exist in one or both sides, are permissible, and the teeth on the lower side should be relieved.

3.2 Traditional Methods

Method 1 :

Heading:

In the first step, heading machines cut wire into short lengths and form it into spherical shapes between dies.

Deflashing:

The flash line, a ridge left by the forming dies, is removed as balls roll between heavy, cast iron plates.

Soft Grinding:

Similar to deflashing, except that a grinding stone is used to improve precision.

Heat-treating:

Carbon steel balls are next carburized and hardened. Heat treatment imparts the desired hardness and case depth.

Descaling:

This step removes the residues and by-products from the heat-treating process.

Hard Grinding:

Slow, meticulous grinding assures proper sizing and sphericity, with tolerances as close as ±.0001".

Lapping:

Several proprietary lapping processes can bring balls to the requirements of ISO 3290 Grade 10 - 48.

Finishing:

Proprietary chemical and mechanical processes give the balls their final micro-smoothed finish, for increased wear resistance and product longevity.

Inspection:

All products pass through at least two 100% inspection stages, using proprietary, automated inspection processes.

Method 2 :

Annealing:

Steel is heat treated at a high temperature and control cooled to primarily soften metal and to simultaneously provide change in microstructure to improve machinability and facilitation in cold working.

Wire Drawing:

The wire rod is drawn to the required size, in closer tolerances so that it can be used in cold forging.

Cold Forging:

Calculated length of wire is sheared and cold forged in a close die to give it the spherical shape.

Flashing:

The second production step is the rolling between plates with concentric grooves in order to eliminate the heading witness marks and to increase the precision of the ball. In this operation, the spheres are ground between two concentric pressure plates to correct the spherical shape and remove the seam formed in the cold forging.

Heat Treatment:

The balls are heat treated, i.e. hardened and tempered to attain the desired level of hardness and microstructure. The heat treatment, when necessary, gives the maximum possible hardness and the desired microstructure to the ball and therefore the best obtainable technical features in compliance with materials used.

Grinding:

Here the hardened balls are ground to improve surface finish and geometrical parameters. Several careful grinding processes with ceramic wheels lead to a higher size precision preparing the balls for the next final lapping operation.

Lapping:

The final lapping operation gives the ball a perfect bright, compact surface, without any defect, with a very low surface roughness, very low deviations from spherical form, very low roughness values, very low waviness values and total lack of surface defects assured by optical control machines. These four basic parameters guarantee final customer an extremely qualified product for its relevant use.

Inspection:

To ensure the highest quality, each and every parameter of the balls is thoroughly inspected before packing and dispatch. All precision, hardness, material features, etc. are tested at every stage of the production and again before shipping, at the end of the manufacturing process, in order to assure and guarantee the quality.

3.3 Materials For Cutting Tools

1. Carbon Steels

Carbon steels have been used since the 1880s for cutting tools. However carbon steels start to soften at a temperature of about 180oC. This limitation means that such tools are rarely used for metal cutting operations. Plain carbon steel tools, containing about 0.9% carbon and about 1% manganese, hardened to about 62 Rc, are widely used for woodworking and they can be used in a router to machine aluminium sheet up to about 3mm thick.

2. High Speed Steel (HSS)

HSS tools are so named because they were developed to cut at higher speeds. Developed around 1900 HSS are the most highly alloyed tool steels. The tungsten (T series) were developed first and typically contain 12 18% tungsten, plus about 4% chromium and 1 5% vanadium. Most grades contain about 0.5% molybdenum and most grades contain 4 12% cobalt. It was soon discovered that molybdenum (smaller proportions)could be substituted for most of the tungsten resulting in a more economical formulation which had better abrasion resistance than the T series and undergoes less distortion during heat treatment. Consequently about 95% of all HSS tools are made from M series grades. These contain 5 10% molybdenum, 1.5 10% tungsten, 1 4% vanadium, 4% Chromium and many grades contain 5 10% cobalt. HSS tools are tough and suitable for interrupted cutting and are used to manufacture tools of comple shape such as drills, reamers, taps, dies and gear cutters. Tools may also be coated to improve wear resistance. HSS accounts for the largest tonnage of tool materials currently used. Typical cutting speeds: 10 60m/min.

3. Cast Cobalt Alloys

Introduced in early 1900s these alloys have compositions of about 40 55%cobalt, 30%chromium and 10 20%tungsten and are not heat treatable. Maximum hardness values of 55 64Rc. They have good wear resistance but are not as tough as HSS but can be used atsomewhat higher speeds than HSS. Now only in limited use.

4. Carbides

Also known as cemented carbides or sintered carbides were introduced in the 1930s and havehigh hardness over a wide range of temperatures, high thermal conductivity, high Young'smodulus making them effective tool and die materials for a range of applications.The two groups used for machining are tungsten carbide and titanium carbide, both types maybe coated or uncoated.Tungsten carbide particles (1 to 5 microm)are are bonded together in a cobalt matrix usingpowder metallurgy. The powder is pressed and sintered to the required insert shape. Titaniumand niobium carbides may also be included to impart special properties.A wide range of grades are available for different applications.Sintered carbide tips are the dominant type of material used in metal cutting.The proportion of cobalt (the usual matrix material) present has a significant effect on theproperties of carbide tools. 3 6%matrix of cobalt gives greater hardness while 6 15%matrixof cobalt gives a greater toughness while decreasing the hardness, wear resistance andstrength. Tungsten carbide tools are commonly used for machining steels, cast irons andabrasive nonferrousmaterials.Titanium carbide has a higher wear resistance than tungsten but is not as tough. With a nickelmolybdenumalloy as the matrix, TiC is suitable for machining at higher speeds than thosewhich can be used for tungsten carbide. Typical cutting speeds are: 30 150m/min or 100 250when coated.

5. Coatings

Coatings are frequently applied to carbide tool tips to improve tool life or to enable highercutting speeds. Coated tips typically have lives 10 times greater than uncoated tips. Commoncoating materials include titanium nitride, titanium carbide and aluminium oxide, usually 215micromthick. Often several different layers may be applied, one on top of another, dependingupon the intended application of the tip. The techniques used for applying coatings includechemical vapour deposition (CVD) plasma assisted CVD and physical vapour deposition (PVD).Diamond coatings are also in use and being further developed.

6. Cermets

Developed in the 1960s, these typically contain 70% aluminium oxide and 30% titaniumcarbide.Some formulation contain molybdenum carbide, niobium carbide and tantalum carbide.Their performance is between those of carbides and ceramics and coatings seem to offer few benefits. Typical cutting speeds: 150 350m/min.

7. Ceramics Alumina

Introduced in the early 1950s, two classes are used for cutting tools: fine grained high purity aluminium oxide (Al_2O_3) and silicon nitride (Si_3N_4) are pressed into insert tip shapes and sintered at high temperatures. Additions of titanium carbide and zirconium oxide (ZrO2) may be made to improve properties. But while ZrO2 improves the fracture toughness, it reduces the hardness and thermal conductivity. Silicon carbide (SiC) whiskers may be added to give better toughness and improved thermal shock resistance. The tips have high abrasion resistance and hot hardness and their superior chemical stability compared to HSS and carbides means they are less likely to adhere to the metals during cutting consequently have a lower tendency to form a built up edge. Their main weakness is low toughness and negative rake angles are often used to avoid chipping due to their low tensile strengths. Stiff machine tools and work set ups should be used when machining with ceramic tips as otherwise vibration is likely to lead to premature failure of the tip. Typical cutting speeds:150 650m/min.Silicon NitrideIn the 1970s a tool material based on silicon nitride was developed, these may also contain aluminium oxide, yttrium oxide and titanium carbide. SiN has an affinity for iron and is not suitable for machining steels. A specific type is 'Sialon', containing the elements: silicon,aluminium, oxygen and nitrogen. This has higher thermal shock resistance than silicon nitrideand is recommended for machining cast irons and nickel based supe ralloys at intermediate cutting speeds.

8. Cubic Boron Nitride (cBN)

Introduced in the early 1960s, this is the second hardest material available after diamond. cBN tools may be used either in the form of small solid tips or or as a 0.5 to 1 mm thick layer of of boron nitride sintered onto a carbide substrate under pressure. In the latter casethe carbide provides shock resistance and the cBN layer provides very high wear resistanceand cutting edge strength. Cubic boron nitride is the standard choice for machining alloy andtool steels with a hardness of 50 Rc or higher. Typical cutting speeds: 30 310 m/min.

9.Diamond

The hardest known substance is diamond. Although single crystal diamond has been used as atool, they are brittle and need to be mounted at the correct crystal orientation to obtain optimaltool life. Single crystal diamond tools have been mainly replaced by polycrystalline diamond(PCD). This consists of very small synthetic crystals fused by a high temperature high pressureto a thickness of between 0.5 and 1mm and bonded to a carbide substrate. The resultis similar to cBN tools. The random orientation of the diamond crystals prevents the propagation cracks, improving toughness. Because of its reactivity, PCD is not suitable for machining plain carbon steels or nickel, titanium and cobalt based alloys.PCD is most suited to light uninterrupted finishing cuts at almost any speed and is mainly used for very high speed machining of aluminum silicon alloys, composites and other non metallic materials. Typical cutting speeds: 200 2000m/min.

10.Other Materials

To improve the toughness of tools, developments are being carried out with whisker

Reinforcement, such as silicon nitride reinforced with silicon carbide whiskers.

Chapter 4

Design,Working,Manufacturing And Cost Of STA

4.1 Design Procedure

Step 1:

Selection of Material:

Mild Steel (C35)

Table 4.1 Selection Of Material

Element name	Designation	Tensile strength(N/mm^2)	Yield stress(N/mm^2)	hardness
lever	C35	520-620	310	187
base plate	C35	520-620	310	187
Circular plate	C35	520-620	310	187
Tool	carbide	280		>300

.......From (psg 1.9)

Tensile stress=σ_t

=Yield strength/factor of safety

=310/2

=155 N/mm^2

Factor of safety=2

Bending stress=σ_b=155 N/mm^2

Shear stress=(Yield strength/factor of safety)/2

=(310/2)/2

=77.5 N/mm^2

Crushing stress=(Yield strength/factor of safety)×2

=(310/2) ×2

=310 N/mm^2

Step 2: Design Of Lever:

Design of lever:

(M×y)=(σ_b×I)

Where;

M=bending moment in N-mm

y= centre of gravity in mm

$\sigma_{b=}$ bending stress in N/mm^2

I= moment ofinertia in mm^4

M=Force × length of lever

M =F×L

Where ;

F= Force in N

L=length of lever

$I=(\pi/64)\times d^4$

$Y=d/2$

By using material c35 the bending stress....

$\sigma_b=155\ N/mm^2$

hence, $(M\times Y)=(\ \sigma_b\times I)$

$(\ (150\times 140)\times(d/2))=((155)\times(\pi/64\times d^4))$

$d=10.93mm=11mm$

Step 3:Design Of Base Plate:

A)Design Of Bolt:

Crushing stress= σ_c=Force/area

Crushing stress= $\sigma_c = ((24.347)/((\pi/4)\ \times d_C^2)$

Where;

Crushing stress=$\sigma_c=310\ N/mm^2$

Force acting on bolt=24.347 N

Crushing stress=σ_c=Force/area

$310=((24.347)/((\pi/4)\ \times d_C^2)$

$d_c=8.78mm$

$d_{0=}d_c/0.84=9.84=$ 10mm

d_0=10mm

B)Base Plate Fails In Crushing:

σ_c=Force/Area

Crushing stress=σ_c=310 N/mm^2

Force=38.955N

Area=A=$\pi\times D_{1i}$

σ_c=Force/Area

310=((38.9550/($\pi\times D_{2i}$))

D_{2i}=40mm

C) Base Plate Fails In Shear:

Shear stress=Force/Area

Where;

Shear stress=77.5 N/mm^2

Force acting on base plate=90.043 N

Area=(π/4)×((D_{2i})^2-(D_{1i})^2)

Shear stress=Force/Area

77.5=90.043/(π/4)×((40)^2-(D_{1i})^2)

D_{1i}=11mm

Step 4:Design Of Circular Plate:

a) Circular plate fails in crushing:

i)Crushing stress=σ_c=Force/Area

Crushing stress=σ_c=310 N/mm^2

Force acting on inner circular part=58.433 N

Area=πD_{3i}

Crushing stress=σ_c=Force/Area

$$310=(58.433)/(\pi D_{3i})$$

$$D_{3i}=59.45mm=60mm$$

ii)Outer part of circular plate is fails in crushing:

Crushing stress=σ_c=Force/Area

Crushing stress=σ_c=310 N/mm^2

Force acting on Outer circular part=73.042 N

Area=$\pi \times D_{4i}$

Crushing stress=σ_c=Force/Area

$$310=(73.042)/(\pi \times D_{4i})$$

$$D_{4i}=74.5mm=75mm$$

b)Circular plate fails in Shear:

Shear stress=Force/Area

Where;

Shear stress=77.5 N/mm^2

Force acting on base plate=90.043 N

Area=$(\pi/4)\times((D_{2i})^2-(D_{1i})^2)$

Shear stress=Force/Area

$77.5=90.043/(\pi/4)\times((40)^2-(D_{1i})^2)$

D_{1i}=11mm

4.2 Working

The working of spherical turning attachment is quite simple. We can obtain different shapes such as spherical, elliptical with the help of the axis of the job which will be held in the chuck, through the axis of the tool point and the axis of the circular plate. When both the axis is in line, then we lock both the sliding. Now, the complete work will depend upon the attachment. When the job is rotating in a chuck with the help of motor. Generally in lathe machine the depth of cut is given by tool which is held above the circular plate & the turning operation is done by rotating the lever which is mounted on the circular plate. In other words, we have to match the axis as per our requirement. For to get elliptical shape we have to give some offset to axis. The offset can be given as per requirement. The most important thing while working on this attachment is that we have to groove the amount of length as equal to the diameter needed, so that the circular plate rotate fully. To get shape of hemisphere we have to rotate upto 90^0an to get the whole sphere we have to rotate till the angle reaches to 180^0. We can obtain the range of diameter between 25mm to 80mm. This can be achieved by sliding the tool holder in the slot of the circular plate. To get the diameter more than the range, we can design another tool holder as per requirement of the industry. The is fixed by tightening the ln key which is present on the circumference of the circular plate. It is easy to obtain a convex surface also with this attachment. In this case the axis of the tool point tip will be behind the axis of the circular plate. So that when we move the lever it will cut in the convex manner or in a convex shape with the tool point. On the job which will be held in the chuck. But the axis of the job must be in line with the axis of the tool point so that we can get a proper convex shape as a mirror image. And the remaining working procedure is same of the attachment.

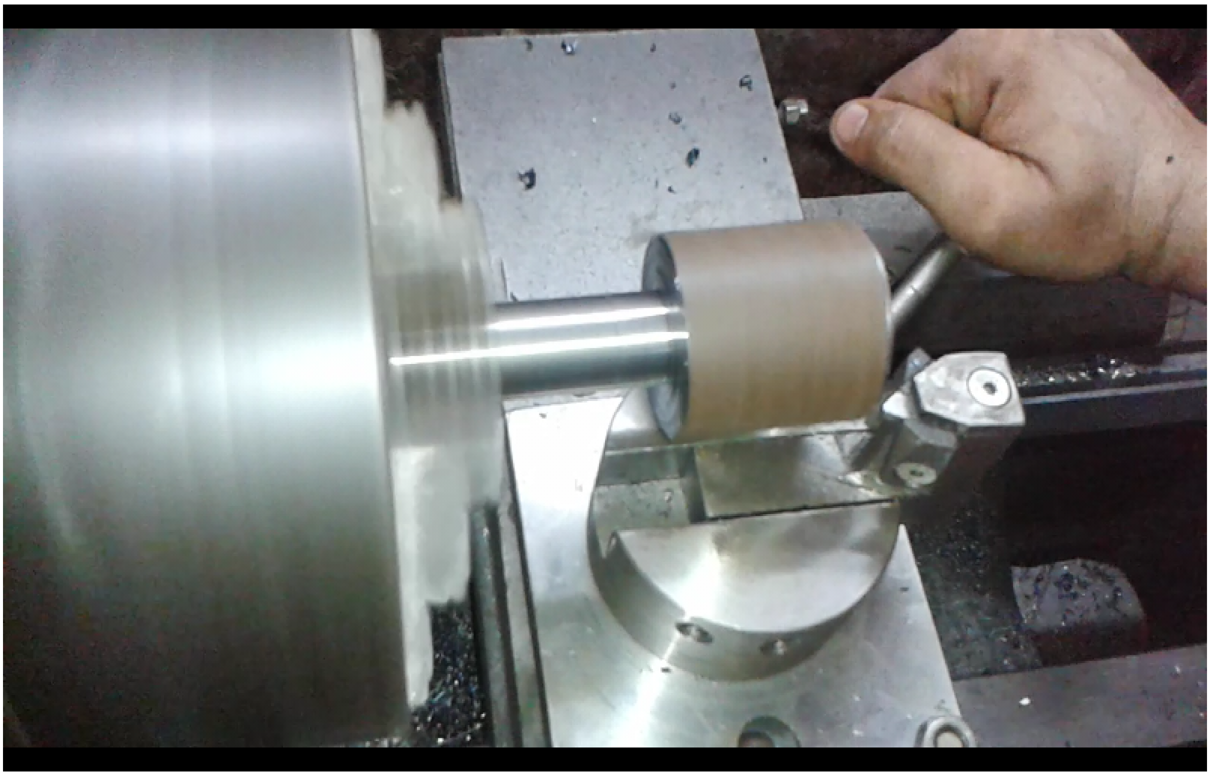

Fig. 4.2.1 Job At The Start Of Machining

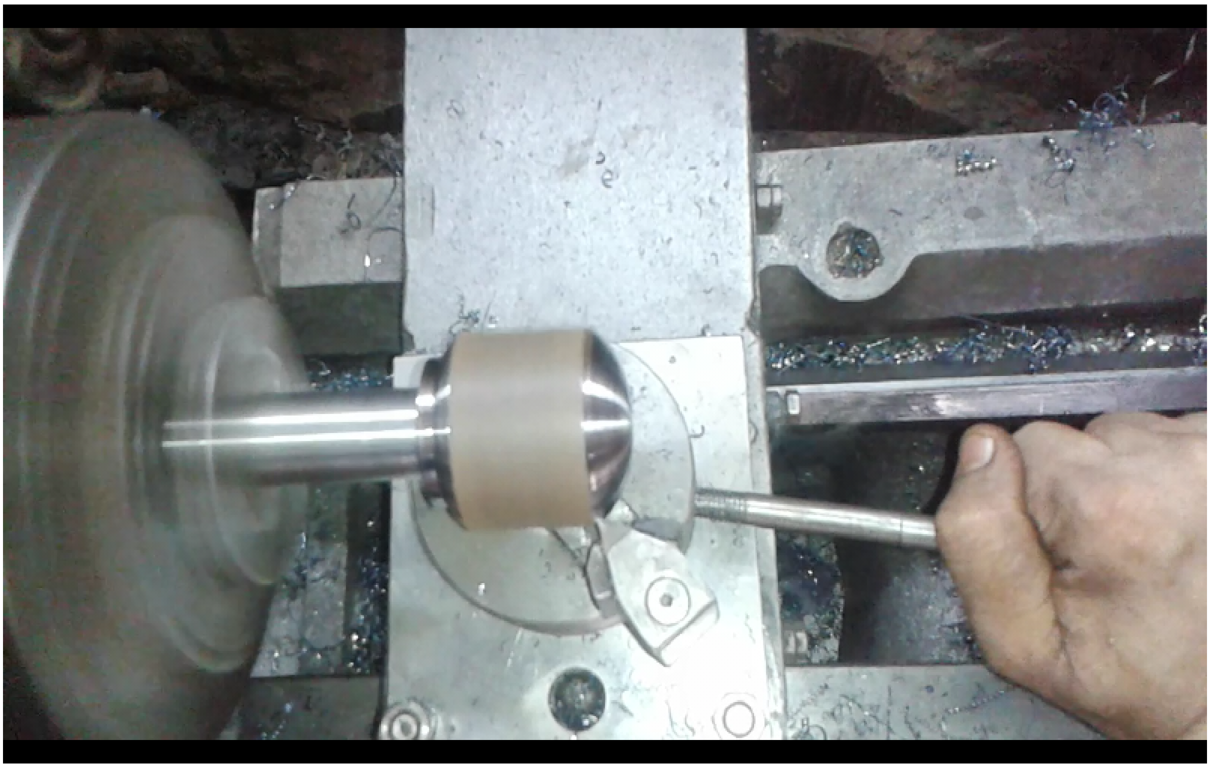

Fig. 4.2.2 Job During Machining

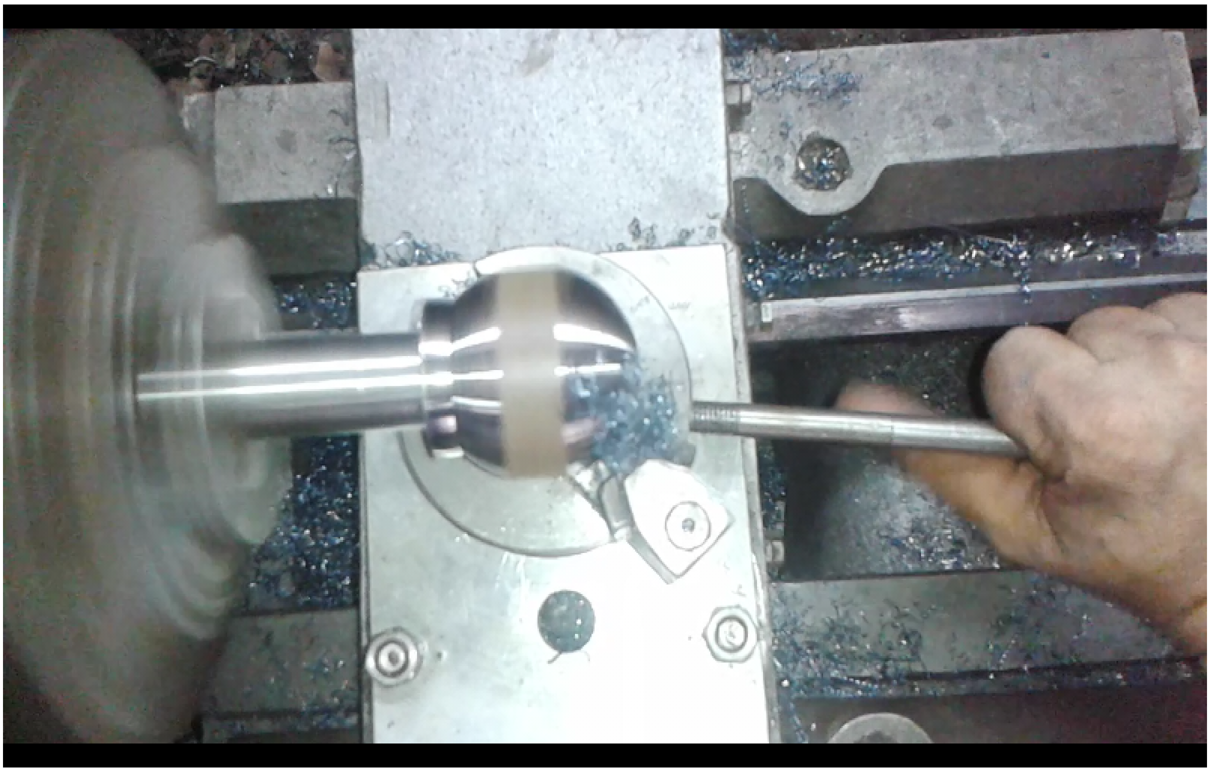

Fig. 4.2.3 Job During Machining

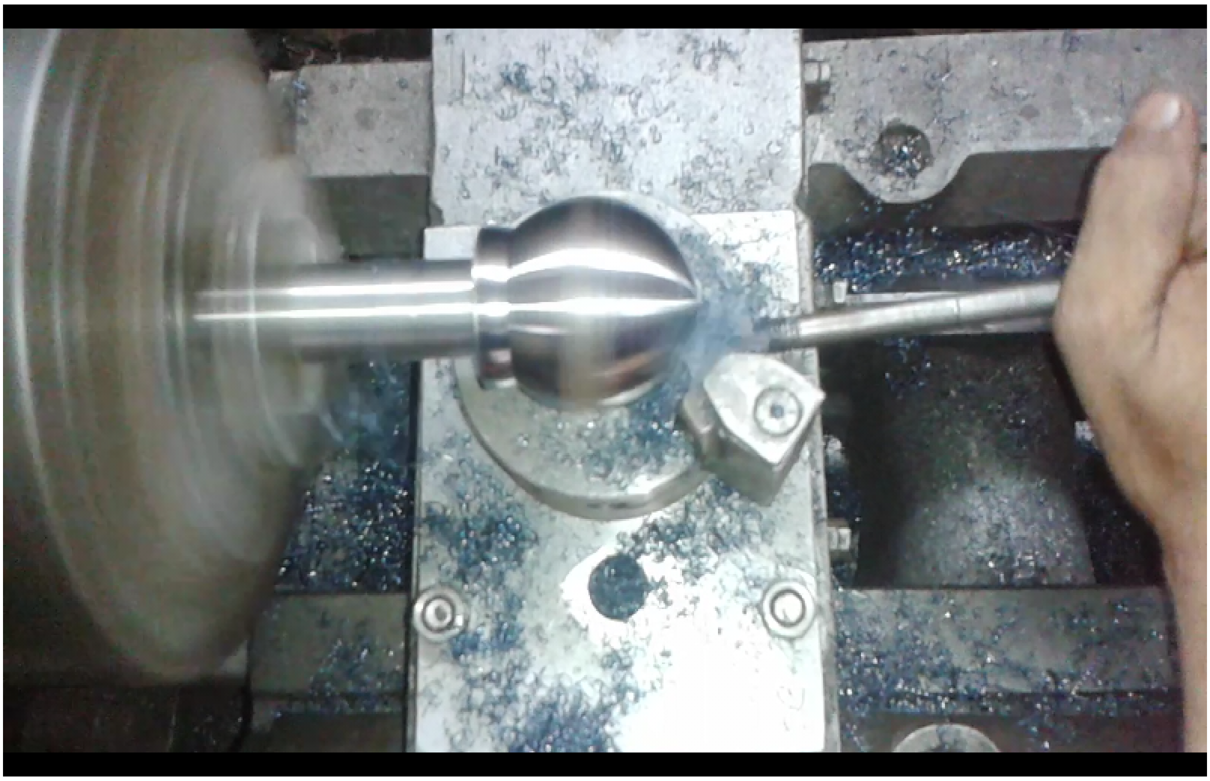

Fig. 4.2.4 Job At The End Of Machining

4.3 Manufacturing

4.3.1 Base Plate

Fig.4.3.1 Base Plate

Specifications:

Height of the base plate=148mm

Width of the base plate=115mm

Thickness of the base plate=19mm

Diameter of bolt=10mm

Inner diameter of base plate=11mm

Outer diameter of base plate=40mm

4.3.2 Circular Plate

Fig.4.3.2 Circular Plate

Specifications:

Inner diameter of base plate=60mm

Outer diameter of base plate=75mm

4.3.3 Lever

Fig.4.3.3 Lever

Specifications:

Length of the lever =140mm

Diameter of the lever=11mm

4.3.4 Tool post

Fig.4.3.4 Toolpost

Specifications:

Height of the tool post=55mm

Length of the tool post=72mm

Width of the tool post=20mm

4.4 Cost

Cost Estimation

Table 4.4 Cost Of Element

Element Name	Material Cost	Machining Cost	Labour Cost
Lever	200	50	150
Base Plate	5oo	150	180
Circular Plate	400	120	175
Tool Post	200	50	150
Tool	150	30	130
Spindle And Nut	200	150	50
Total	1650	550	835

Total Material Cost=1650 Rs.

Total Machining Cost=550 Rs.

Total Labour Cost=835 Rs.

Total Cost Of Project=3035 Rs.

Chapter 5

Results And Discussion

- Spherical object is successfully made from this attachment.
- Good surface finish is achieved.
- By Aesthetics point of view the attachment looks excellent.
- By adjusting the tool from tool holder a different range of diameter is achieved.
- 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 spherical turning attachment on the lathe machine is easy.
- Different size of sphere has been manufactured from this attachment.

Chapter 6

Conclusion

- Cylindrical shape objects can manufacture easily.
- Concave and convex type design can be given to the component.
- Can be implemented on every lathe machine in college at cheap cost.
- A complete analysis of total force acting on tool as well as work piece can be done.
- The attachment which is available in the market is costlier than our attachment.
- Accuracy is equal to 0.4 which is enough to have finished surface.
- It can obtain diameter range 25mm to 80mm.

Appendix 1

Final View Of Spherical Turning Attachment

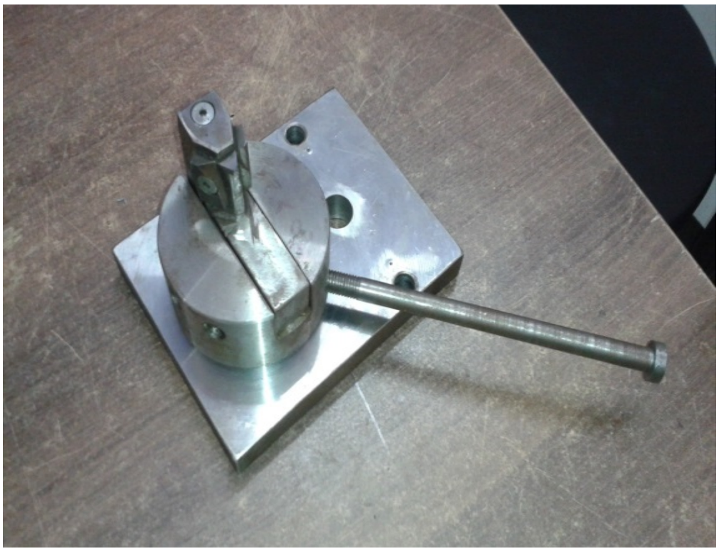

Fig.1 Actual Image Of STA

Jobs Made By STA

Fig.2 Jobs Made By STA

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ACKNOWLEDGEMENT

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound grtitude to our guide **Prof.Yusuf Khan** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

We would also like to give our sincere thnaks to **Prof.**Ansari Zakir, Head Of Department, Prof.Yusuf Khan, Project Co-Guide and Prof.Shaikh Rizwan, Project co-ordinator from Department of Mechanical Engineering, Kalsekar Technical Campus, New Panvel, for their guidance, encouragement and support during a project.

I am thnakful to Dr.Abdul Razzak , Kalsekar Technical Campus New Panvel, for providing an outstanding academic environment, also for providing the adequate facilities.

Last but not the least I would also like to thnaks all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable guidance with their interest and valuable suggestions brightened us.

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