Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 5, No. 1, May : 2023

DESIGN AND FABRICATION OF COMBINED FORM OF BUFFING MACHINE FOR LINEAR AND RADIAL BUFFING

B. BALAMURALI Assistant Professor, Department of Mechanical Engineering, SNS College of Engineering, Coimbatore.
A. DEEPAK WILLIAM, R. KAMALAKKANNAN, G. MADHAVAN, M. THUSHAR
Final year B.E students, Department of Mechanical Engineering, SNS College of Engineering, Coimbatore.

Abstract
The goal of this project is to design and manufacture a combined buffing machine that reduces its multipurpose uses and speeds up production while maintaining high dimensions accuracy. One of the processes for polishing metal is buffing. One of the earliest processes for producing a smooth, shiny surface is polishing. The workpiece is rotated by a 0.25 HP, 1440 rpm AC motor, and the buffing actuating motor is propelled forward and backward by 90 watts, 60 RP DC gear motors. Mild steel is used in the fabrication of this project's frame because it is extremely strong and has high impact strength. The buffing process is typically done by hand using a manual method in most industries. This project completely eliminates small dimensional errors caused by buffing. It is very cost-effective and will benefit contemporary society and the environment.

Keywords: Buffing, Polishing, Work piece, DC gear, Mild steel

I. Introduction

In order to achieve higher production rates with little human input, it is now necessary to continuously increase production rate. To meet these needs, innovative machinery must be developed. Currently, a fine polishing disk is mounted on the bench grinder's spindle and rotated against the work surface to perform the buffing operation.

By rubbing or chemically reacting, buffing is the process of producing a surface that is both smooth and shiny while still reflecting strongly in the secular direction. Metal polishing is a multi-stage process. After a rough polishing in the first stage, buffing wheels are used in subsequent stages to achieve the desired finish.

Finally, etching is the process of selectively chemically attacking the surface to reveal micro-structural characteristics of the polished specimen. Contrary to popular belief, most mirror bright finishes are actually buffed, despite the common misconception that they do.

Polishing is frequently used to improve an item's appearance, stop instrument contamination, get rid of oxidation, make a reflective surface, or stop corrosion. The polishing process can be carried out using diamond solution or silicon-based pads. The sanitary advantages of stainless steel can be increased by polishing it.

The table's sliding motion, where the buffing motor is mounted, determines the depth of cut. When the table slide is offered, make sure the entire surface is machined.

II. Literature Review

1. "Surface Finishing by Abrasive Buffing and Polishing" (2011) by Loan D. Marinescu, et.al., This comprehensive review paper provides an overview of abrasive buffing and polishing, including the mechanisms of material removal, the different types of abrasive particles and their properties, and the various techniques and equipment used for surface finishing.
2. "A Construction of Polishing Machine Cooperating with Robot" (2014) by Doc. Ing. Vladimir Andric, Csc et.al., The paper likely describes the design and implementation of a polishing machine that is capable of cooperating with a robot. This type of automation can increase efficiency and precision in the polishing process by utilizing the strengths of both machines and humans. However, without access to the full paper, it's difficult to provide more detailed information.

3. "Experimental Study of Surface Roughness in Buffing Machine Using Multi-Objective Optimization" (2015) by P. N. Rao, R. Kumar And K. R. Raju et.al., This paper presents an experimental study of the surface roughness in buffing machines using multi-objective optimization techniques. The authors used a genetic algorithm to optimize the process parameters and concluded that the rotational speed of the buffing wheel and the feed rate of the workpiece are the most significant factors affecting the surface roughness.
4. "Design and Fabrication of Bar Polishing Machine" (2016) by Shrikant Bharamu Pawar & Swapnil Kumar Koli. et.al., This journal explains that the polishing is one of the oldest processing methods used to generate smooth and shiny surface. This smoothness is obtained by rubbing the surface with the polishing particles with a rotating disk. Polishing particles removes small elements of the surface and make them smooth. In a bar polishing machine polishing wheel spins at high speed in a plane perpendicular to the surface to be machined. The depth of cut is governed by the sliding motion of cutter carrier.
5. "Optimization of The Buffing Process for Surface Roughness Using Response Surface Methodology" (2016) by R. Kumar, M. Rahman and M. A. Maleque, et.al., This paper presents an optimization study of the buffing process using response surface methodology. The authors investigate the effect of process parameters such as cutting speed, feed rate, and depth of cut on surface roughness and conclude that cutting speed has the most significant effect.
6. "Investigation of Surface Roughness in The Buffing Process Using Response Surface Methodology" (2016) by R. Kumar, M. Rahman, and M. A. Maleque et.al., This paper presents an experimental study of the buffing process and the effects of various process parameters on the surface roughness of the finished product. The authors used response surface methodology (RSM) to optimize the process parameters and obtain a desirable surface finish.
7. "Fabrication of Wet Grinding Machine and Measure the Metal Removal Rate Using Different Grades Emery Paper" (2016) by Bhaskar Chandra Kandpal; Rajesh Kumar Verma; Dalip Malhotra; Ashish Kumar; Anuj Kumar; Mallika Taneja, et.al., The fabrication of a wet grinding machine capable of removing metal from various materials using different grades of emery paper is presented in this paper. The machine is designed to operate with a constant flow of water, which helps to reduce heat generated during the grinding process and also flushes away the debris. The machine was fabricated using locally sourced materials, and the performance was evaluated using different grades of emery paper.
8. "Design Data Book" (2016) by PSG College of Technology, Coimbatore. It is a comprehensive reference guide for engineers and designers, providing technical data, specifications, and practical information on a wide range of topics related to mechanical engineering, including materials, fasteners, gears, bearings, and more. The book is organized into chapters that cover specific topics, with each chapter including tables, graphs, equations, and other relevant information. The book also includes a glossary of terms and a list of industry standards and codes. The PSG Design Data Book is an essential resource for anyone involved in mechanical engineering design and analysis.
9. "Design and Development of an Automated Buffing Machine for Aluminum Alloy Wheels" (2017) by A. S. Sankar and S. S. Kumar et.al., This paper presents the design and development of an automated buffing machine for aluminum alloy wheels. The authors used CAD software to design the machine and developed a control system using programmable logic controllers (PLCs) to automate the buffing process.
10. "Development of A Robotic Buffing Machine for Complex-Shaped Parts" (2018) by K. H. Koo, J. H. Kim and J. H. Kim, et.al., This paper presents the development of a robotic buffing machine for complex-shaped parts, such as turbine blades and impellers. The authors used a six-axis industrial robot and developed a control algorithm to optimize the buffing process.
11. "The effects of polishing parameters on surface roughness and glossiness of polyurethane clearcoat" (2018) by K. Kim, et.al., This paper investigates the effects of polishing parameters, such

as rotational speed, polishing time, and tool pressure, on the surface roughness and glossiness of polyurethane clearcoat, using different polishing techniques and abrasive materials.
12. "Improving Surface Quality of Polypropylene Composites Using Magnetic Abrasive Finishing" (2019) by P. G. Kale and R. P. Deshmukh, et.al., This paper investigates the use of magnetic abrasive finishing (MAF) for improving the surface quality of polypropylene composites. The authors conducted experiments to study the effect of process parameters such as magnetic field strength and abrasive concentration on surface roughness and material removal rate.
13. "Modeling and Simulation of a Robotic Buffing Process for Aircraft Engine Components" (2019) by J. Wang; G. Chen And Y. LI et.al., This paper describes a robotic buffing process for aircraft engine components and the development of a simulation model to optimize the process parameters. The authors used finite element analysis (FEA) to simulate the deformation of the workpiece during the buffing process and developed a control algorithm to improve the surface quality of the finished product.
14. "Investigating the effects of polishing time and abrasive size on surface roughness and glossiness of stainless steel" (2019) by P. Arulraj, et.al., This study examines the effects of polishing time and abrasive size on the surface roughness and glossiness of stainless steel, using different polishing techniques and abrasive materials.
15. "Experimental Study on the Characteristics of Surface Roughness and Glossiness in High-Speed Polishing with Soft Abrasive Tools" (2020) by Yuki Ueda, et.al., This paper investigates the effects of polishing parameters, such as tool pressure, rotational speed, and abrasive size, on surface roughness and glossiness in high-speed polishing with soft abrasive tools.
16. "Vibration-assisted polishing of metals and alloys: A review" (2021) by A. Kumar, et.al., This review paper discusses the benefits and limitations of vibration-assisted polishing for metals and alloys, including the mechanisms of material removal, the effects of process parameters, and the potential applications of this technique.

III. Problem Definition

In the majority of industries, hand-held manual buffing is used to complete the process. Manually buffed workpieces will typically be rejected and reworked as a result of this impact on the accurate finish and dimensions. The production time will be impacted as a result.
Some industries struggle with quickly and accurately buffing radial and linear components. They would purchase two machines and use them for two different operations in order to achieve excellent accuracy for both components. There will need to be two distinct areas and operators for these two machines. As a result, the company's cost will rise.

IV. Objectives

- To precisely buff the components.
- To lessen workpiece rejection and rework.
- To lengthen the production process.
- To speed up production, use the combined form technique.
- To lower the business's cost.
- To be used when buffing various workpieces.

V. Components

5.1 Buffing Wheel

To meet a wide range of needs, polishing wheels are available in many different types. Wood, leather, canvas, and cotton cloth are the most popular materials for polishing wheels. The most popular materials are wool leather and canvas, felt, paper, sheepskin, impregnated rubber, and plastic. Strawboard paper disks can be glued together to create hard roughing wheels. Felt paper is used to create paper wheels that are softer.

5.2 Buffing Motor

Soft metals like copper and brass as well as plastic like Perspex are polished using the polishing machine. High speeds are produced by the two wheels. The material will be polished if it is carefully pressed up against the wheels and moved backwards and forwards. Scratches must be removed by filing the material, and the surfaces must then be further smoothed with wet and dry paper or emery cloth.

5.3 Electric Motor

The electro-mechanical device known as an electric motor transforms electrical energy into mechanical energy. In other words, the motor refers to the objects that generate rotational force. The interaction of the magnetic and electric fields is primarily responsible for the electric motor's operating principle. There are primarily two types of electric motors. The AC motor and the DC motor are them. The DC motor receives direct current, whereas the AC motor accepts alternating current.

5.4 AC Motor

An electric motor powered by alternating current (AC) is referred to as an AC motor. An inside rotor attached to the output shaft creates a second rotating magnetic field, and an outside stator with coils supplied with alternating current make up the typical two components of an AC motor. This motor is assembled in left side of the frame, which is used to run the workpiece during the buffing operation.

5.5 DC Gear Motor

These straightforward motors are suitable for a variety of applications due to their excellent qualities. Although they typically have low speed, they have very high torque. By their very nature, worm drives provide a brake feature. For practical mounting in small spaces, they provide a right- or even left-angled gearbox. Even the best worm gear drives only have efficiencies between 60 and 80%, which is the only real drawback of these.

5.6 Gear

A rotating machine part with cut teeth, or, in the case of a cogwheel, one that meshes with another toothed part to transmit torque, is known as the gear. A power source's speed, torque, and direction can all be altered by gears. Through their gear ratio, gears almost always change torque, giving them a mechanical advantage and making them appear to be simple machines. With the rotational speeds and torques of the two gears varying in proportion to their diameters, a mechanical advantage is produced when two wheels mesh if one gear is larger than the other.

5.7 Spur Gear

Spur gear, sometimes referred to as straight-cut gear, is the most fundamental type of gear. They consist of a disc or cylindrical structure with radiating teeth. These gears only correctly mesh together when mounted on parallel shafts. There is no axial thrust caused by the tooth loads. Spur gears can be divided into two basic categories: internal and external. External gears are ones from which the cylinder's teeth have been removed. Internal gears are ones whose internal cylinders have had teeth taken out of them. A gear can communicate with another gear either internally or externally. Two external gears rotate in opposition to one another when they mesh. Only an internal gear and an external gear can mesh, and both gears rotate simultaneously. Internal gear assemblies are smaller than external gear assembly due to the shafts' close positioning.

5.8 Bevel Gear

A gear called a bevel gear is typically mounted on 90-degree-diameter shafts. A gear system's drive direction can be adjusted by 90 degrees using these kinds of gears. The tooth bearing faces in the Bevel Gears are conically shaped and the axes of the two bevel gears intersect each other. For Straight Bevel Gear, the pitch surface of this type of Bevel Gear is conical and their teeth are straight and tapered towards the apex.

5.9 Lead Screw

A machine's linkage is a screw that converts turning motion into linear motion. This screw is also referred to as power screw or translation screw. Screw threads experience greater frictional energy losses than other linkages due to the large area of sliding contact between their male and female

members. They are typically used intermittently in low power actuator and positioner mechanisms rather than to carry high power. Linear actuators, machine slides, vice, press, and jacks are typical applications.
A rope or chain is inserted into the grooved rim of a small fixed wheel that occasionally rotates in blocks in order to raise the weight that is attached to one end by pulling on the opposite end. It alters the effort's course but doesn't offer a mechanical benefit. a set of these wheels combined. increased the mechanical advantage was used.

5.10 Pulley

A rope or chain is inserted into the grooved rim of a small fixed wheel that occasionally rotates in blocks in order to raise the weight that is attached to one end by pulling on the opposite end. It alters the effort's course but doesn't offer a mechanical benefit. a set of these wheels combined. increased the mechanical advantage was used. a wheel that transmits power by rotating or being rotated by an electric belt, rope, chain, etc.

5.11 Bearing

A bearing is a machine component that lessens friction between moving parts and restricts relative movement to the desired motion. The bearing's design may, for instance, allow for the moving part to rotate freely around a fixed axis or move linearly, or it may prevent motion by regulating the normal force vectors that are applied to moving parts.

VI. Specifications

6.1 AC Motor

VOLTAGE	220V, 1 PHASE
CURRENT	2.5 Amps
POWER	0.25 HP
SPEED	1440 rpm

Table 1: AC Motor

6.2 DC Gear Motor

INPUT POWER	12V
WATTS	90W
SPEED	60 rpm

Table 2: DC Gear Motor

6.3 Buffing Actuating Motor

VOLTAGE	220V, 1 PHASE
WATTS	120W
POWER	0.5 HP
SPEED	3000 rpm

Table 3: Buffing Actuating Motor

6.4 Lead Screw

DIAMETER	30mm
PITCH	5mm

Table 4: Lead Screw

6.5 Leadscrew and Nut Mechanism

GUIDE SHAFT DIAMETER	15mm
GUIDE BUSH DIAMETER	25mm

Table 5: Leadscrew and Nut Mechanism

6.6 Frame Metal

TYPE OF METAL	L ANGLE
MATERIAL	MILD STEEL

LENGTH	1 inch
BREADTH	1 inch
THICKNESS	3mm

Table 6: Frame Metal

6.7 Bevel Gear Setup

BEVEL GEAR RATIO	1:2(SIZE)
LEADSCREW DIAMETER	16mm
PITCH	1mm

Table 7: Bevel Gear Setup

6.8 Belt and Pulley Drive

BELT TENSION RATIO	1:9(inch)
PULLEY MATERIAL	CAST IRON
SHAFT DIAMETER	15mm
SHAFT MATERIAL	MILD STEEL

Table 8: Belt and Pulley Drive

6.9 Bearing

BEARING NO	6202
TYPE OF BEARING	DEEP GROOVE BALL BEARING
OUTSIDE DIAMETER	30mm
INSIDE DIAMETER	15mm

Table 9: Bearing

VII. Methodology

Methodology refers to the systematic approach or method used to achieve the desired finish on a workpiece. This involves a set of principles, rules, procedures, or techniques that are used to guide the buffing process. The methodology in buffing includes steps such as preparing the workpiece by cleaning it, selecting an appropriate buffing wheel, choosing the right buffing compound, and applying the buffing compound to the wheel. The buffing process itself involves holding the workpiece securely against the rotating buffing wheel and moving the wheel across the surface of the workpiece to remove any imperfections, scratches or blemishes.

The methodology of the buffing process typically involves the following steps:

- Preparation.
- Selection of buffing wheel.
- Application of buffing compound.
- Buffing.
- Finishing.
- Inspection.
- Clean-up.

VIII. Process Parameters of Buffing Operation

Process parameter refers to a specific variable or factor that can have an impact on the outcome of a process. In manufacturing, process parameters are the key variables that must be controlled to ensure consistency, quality, and efficiency in the production process. The selection and control of appropriate process parameters are essential to ensure that a process meets the desired quality and efficiency standards. Process parameters are often monitored and adjusted during the production process to ensure that they remain within acceptable limits and to optimize the process.

The process parameters of buffing process may include the following:

- Material.
- Buffing wheel.

- Buffing compound.
- Pressure.
- Speed.
- Time.
- Temperature.

IX. Design of Combined Form of Buffing Machine for Linear and Radial Buffing

The foundation of the machinery that aids in putting the components together to create the finished product is the frame. Because of their unique needs, every piece of machinery will have a frame that they have developed and constructed. So, using a cutting, welding, and grinding technique, we developed and made our own frame. Our frame was made of mild steel, which we had produced. This has an L-shaped form and is 3 mm thick and 1 inch broad on both sides.

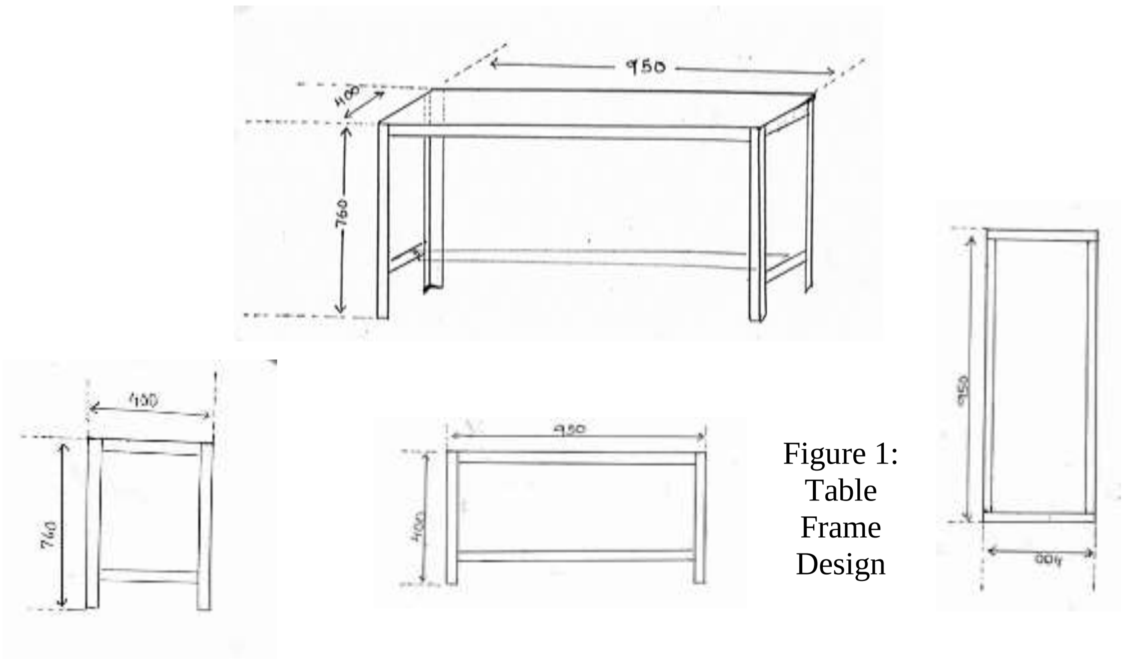

Figure 1: Table Frame Design

X. Design Calculation

Torque produced by dc gear motor

Given:

Power, P = 90 watts; Speed, N = 60 rpm

Formula to find torque,

T = Power(P)/Angular Velocity(ω)

Formula to find angular velocity,

ω = (2*11*N)/60 = (2*x*60)/60

ω = 6.28 Rad/s

T = P/ω = 90/6.28

T = 14.32 Nm

Torque produced by buffing actuating motor

Given:

Power, P = 0.5 HP

Since, 1 HP = 745.7 W

Therefore, 0.5 HP = 745.7/2

=372 85 W

Speed, N = 3000 rpm

Formula to find torque,

T = Power(P)/ Angular Velocity (ω)

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 5, No. 1, May : 2023
Formula to find angular velocity,
$\omega = (2°11°N)/60 = (2*\pi*3000)/60$
$\omega = 314.16$ Rad's
$T = P/\omega = 372.85/314.16$
$T = 1.18$ Nm
Torque produced by ac motor
Given:
Power, P = 0.25 HP
Since, 1 HP = 745.7 W
Therefore, 0.25 HP = 745.7/4
= 186.42 W
Speed, N = 1440 rpm.
Formula to find torque,
T = Power(P)/ Angular Velocity (ω)
Formula to find angular velocity,
$\omega = (2*\pi*N)/60 = (2*\pi*1440)/60$
$\omega = 150.8$ Rad/s
$T = P/\omega = 186.42/150.8$
$T = 1.24$ Nm
Speed of lead screw
Given
Speed of motor = 60 rpm
Speed of leadscrew = X
No. Of teeth on gear 1 = 72
No. Of teeth on gear 2 = 8
Gear ratio= 1:9
Speed of motor, x = gear ratio * speed of motor = (1/9)*60 = 6.6 (approximately 7 rpm)
Therefore, speed of the leadscrew is 7 rpm.

XI. Mechanisms Used

11.1 Lead Screw and Bevel Gear Mechanism

A lead screw and bevel gear mechanism is a type of power transmission system used to convert rotary motion into linear motion. The lead screw is a threaded rod that translates rotational motion into linear motion, while the bevel gear is a type of gear that transmits power between two intersecting shafts at a right angle.
In this mechanism, the lead screw is driven by a motor, which rotates the screw and causes it to move linearly. The bevel gear is mounted on the end of the lead screw and meshes with another bevel gear that is fixed to a shaft. As the lead screw moves linearly, it rotates the bevel gear, which in turn rotates the fixed bevel gear and the shaft it is mounted on. This mechanism is commonly used in machines that require precise linear movement, such as CNC machines and 3D printers.

11.2 Lead Screw and Nut Mechanism

A lead screw nut mechanism is a type of linear motion system that uses a lead screw and a nut to convert rotary motion into linear motion. The lead screw is a threaded rod that is driven by a motor, causing it to rotate. The nut, which is usually made of a self-lubricating material such as bronze or plastic, engages with the threads of the lead screw and moves along its length as the screw rotates.
The lead screw nut mechanism is used in a wide variety of applications, including CNC machines, 3D printers, and other automated machinery that require precise linear motion. One of the advantages of this mechanism is that it can be designed to have very low backlash, meaning that there is minimal play or slop between the nut and the lead screw. This results in highly accurate and repeatable linear motion, making it ideal for applications where precision is critical.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 5, No. 1, May : 2023

XII. Design and Calculation of Mechanisms Used

12.1 Lead Screw and Bevel Gear Mechanism

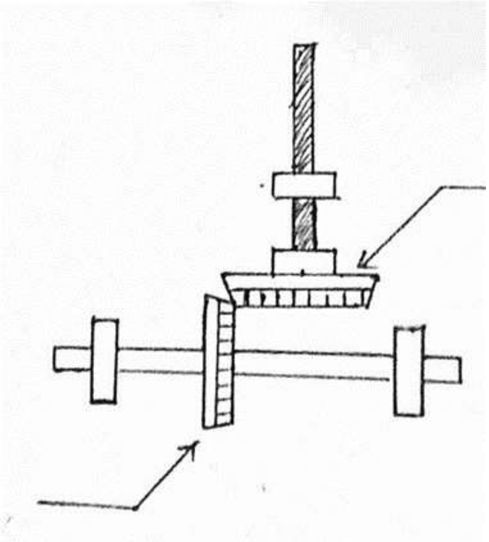

Figure 2: Lead Screw and Bevel Gear Mechanism

12.2 Design Calculation of Lead Screw and Bevel Gear Mechanism

To calculate the leadscrew and bevel gear mechanism, we need to know the desired travel distance, pitch of the leadscrew, number of teeth on the bevel gear, and the diameter of the leadscrew.

Given Parameters:

Desired travel distance: 200 mm

Leadscrew pitch: 5 mm

Number of teeth on the bevel gear: 20

Diameter of the leadscrew: 10 mm

First, we need to calculate the linear travel per revolution of the leadscrew using the following equation:

Linear travel per revolution (mm/rev) = Pitch of leadscrew (mm)

Linear travel per revolution = 5 mm/rev

Next, we need to calculate the gear ratio of the bevel gear mechanism, which is the ratio of the number of teeth on the bevel gear to the number of teeth on the pinion gear. Assuming that the pinion gear has 10 teeth, the gear ratio is:

Gear ratio = Number of teeth on the bevel gear / Number of teeth on the pinion gear

Gear ratio = 20 / 10 = 2

This means that for every 2 revolutions of the bevel gear, the leadscrew will make 1 complete revolution.

To calculate the number of revolutions of the leadscrew required to travel a distance of 200 mm, we can use the following equation:

Number of revolutions = Desired travel distance (mm) / Linear travel per revolution (mm/rev) / Gear ratio

Number of revolutions = 200 mm / (5 mm/rev) / 2 = 20 revolutions

Therefore, the leadscrew must make 20 revolutions to achieve the desired travel distance of 200 mm.

12.3 Lead Screw and Nut Mechanism

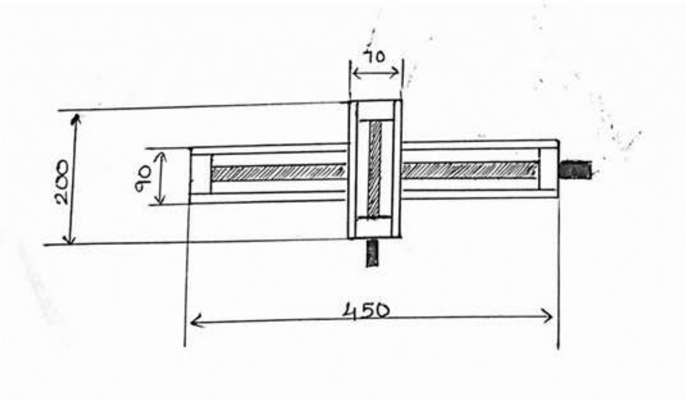

Figure 3: Lead Screw and Nut Mechanism

12.4 Design Calculation of Lead Screw and Nut Mechanism

To calculate the leadscrew and nut mechanism, we need to know the desired travel distance, pitch of the leadscrew, lead of the nut, and the diameter of the leadscrew.

Given parameters:

Desired travel distance: 100 mm

Leadscrew pitch: 5 mm

Lead of the nut: 10 mm

Diameter of the leadscrew: 12 mm

First, we need to calculate the linear travel per revolution of the leadscrew using the following equation:

Linear travel per revolution (mm/rev) = Pitch of leadscrew (mm)

Linear travel per revolution = 5 mm/rev

Next, we need to calculate the lead ratio, which is the ratio of the lead of the nut to the pitch of the leadscrew. The lead ratio determines the linear travel of the nut for each revolution of the leadscrew. The lead ratio is:

Lead ratio = Lead of the nut (mm) / Pitch of leadscrew (mm)

Lead ratio = 10 mm / 5 mm = 2

This means that for every 2 revolutions of the leadscrew, the nut will travel a distance equal to the lead of the nut.

To calculate the number of revolutions of the leadscrew required to travel a distance of 100 mm, we can use the following equation:

Number of revolutions = Desired travel distance (mm) / (Lead ratio x Pitch of leadscrew)

Number of revolutions = 100 mm / (2 x 5 mm) = 10 revolutions

Therefore, the leadscrew must make 10 revolutions to achieve the desired travel distance of 100 mm.

XIII. Testing and Calculation

13.1 Buffing of 20mm Steel Shaft

Desired surface finish: Ra 0.2 µm

Material removal rate: 0.02 mm/min

Steel shaft diameter: 20 mm

Starting condition: Ra 1.0 µm

Abrasive material: Diamond abrasive paste

Buffing wheel diameter: 150 mm

Calculation:

Calculate the depth of cut:

Based on the desired surface finish of Ra 0.2 µm and the starting condition of Ra 1.0 µm, the depth of cut required to achieve this finish is 0.8 µm.

Calculate the width of cut:
Assuming a contact area of 10% between the buffing wheel and the steel shaft, the width of cut is 3 mm.
Calculate the material removal rate:
Using the formula MRR = (feed rate x depth of cut x width of cut), we can calculate the material removal rate required to achieve the desired finish:
MRR = (0.1 m/min x 0.0008 mm x 3 mm)
MRR = 0.00024 mm^3/min
Determine the buffing time:
Assuming the total material to be removed is 100 µm (to account for any surface imperfections), the buffing time required to achieve this removal can be calculated as:
Buffing time = (total material to be removed / material removal rate)
Buffing time = (0.1 mm / 0.02 mm/min)
Buffing time = 5 min
Determine the required amount of diamond abrasive paste:
Assuming an average diamond grit size of 3 µm and a density of 3 g/cm^3 for the diamond abrasive paste, the required amount of paste can be calculated as:
Volume of paste = (material removal rate x buffing time) / (average grit size x density)
Volume of paste = (0.02 mm/min x 5 min) / (3 µm x 3 g/cm^3)
Volume of paste = 0.37 cm^3
Determine the required amount of buffing wheel material:
Assuming a density of 7.5 g/cm^3 for the buffing wheel material, the required amount of material can be calculated as:
Volume of buffing wheel material = (material removal rate x buffing time) / density
Volume of buffing wheel material = (0.02 mm/min x 5 min) / 7.5 g/cm^3
Volume of buffing wheel material = 0.007 cm^3
Based on the calculation provided above, the required buffing time to achieve a material removal rate of 0.02 mm/min and remove a total of 100 µm from a steel shaft of 20 mm diameter is 5 minutes. This calculation assumes that the material removal rate is constant throughout the buffing process and that the buffing wheel and abrasive material remain consistent in their performance. In practice, buffing times may vary depending on factors such as the condition of the buffing wheel and the skill of the operator.
During the buffing process, it is important to periodically measure the surface roughness of the steel shaft using a surface profilometer to ensure that the desired surface finish is being achieved. If the measured surface roughness is not within the desired range, the buffing time may need to be adjusted accordingly. Additionally, the buffing time may need to be extended if there are any initial surface imperfections that need to be removed before achieving the desired surface finish.

13.2 Buffing of 20mm Steel Dish

To calculate the buffing time for a 20mm steel dish, we need to know the desired surface finish and the material removal rate required. Let's assume the following:
Desired surface finish: Ra 0.4 µm
Material removal rate: 0.01 mm/min
To buff the steel dish to the desired surface finish, we will need to remove a certain amount of material from the surface. The amount of material to be removed can be calculated using the following equation:
Material removal (mm) = Desired surface finish (µm) / 1000
Material removal = 0.4 µm / 1000 = 0.0004 mm
Now, we can calculate the buffing time using the following equation:
Buffing time (min) = Material removal (mm) / Material removal rate (mm/min)
Buffing time = 0.0004 mm / 0.01 mm/min = 0.04 min or 2.4 seconds

Therefore, it will take approximately 2.4 seconds of buffing time to achieve the desired surface finish on the 20mm steel dish, assuming a constant material removal rate and consistent buffing wheel performance. However, as with any real-world process, the actual buffing time required may vary depending on a variety of factors such as the condition of the buffing wheel, the skill of the operator, and the initial condition of the steel dish.

XIV. Prototype

Figure 4: Combined form of Buffing Machine

XV. Conclusion

On the surface of the work piece, there are several errors. Therefore, we eliminated any errors from this job by employing a polishing machine. The surface is smooth and lustrous. Additionally, it smooths out surface nicks on the specimen. After utilizing the machine, no more machining is necessary, and the component may be utilized in assembly right away. This device can also parallelize two faces that are in opposition to one another. As a result, this project provides the necessary smooth surface finish and eliminates surface imperfections. Last but not least, we would like to express our gratitude to everyone who was directly or indirectly engaged in the construction of the system.

XVI. Future Scope

Instead of using gear motors and gear systems, we advise using stepper motors. Additionally, for greater performance, we advise using buffing actuation motors with a power rating higher than 1 horsepower. We also advise using various buffing wheels for better surface quality. Then, by adding a timing control mechanism and sensors, this project may be turned into a functional machine that operates semi-automatically.

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