DESIGN AND DEVELOPMENT OF A MULTIPURPOSE COMBINED BUFFING MACHINE

SARAVANAKUMAR M[1], NAGARAJ A[2]

[1,2] Lecturer, Department of Mechanical Engineering, PSG Polytechnic College, TamilNadu, India

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Abstract - *This project focuses on the design and fabrication of a combined buffing machine that enhances multipurpose applications while improving production rates with high dimensional accuracy. Buffing, a metal polishing process, smoothens surfaces by rubbing with polishing particles on a rotating disk. Traditional manual buffing methods often result in inaccuracies, affecting surface finish and productivity. The proposed machine integrates linear and radial buffing techniques using a single motor, ensuring precise polishing with increased efficiency. A 0.25 HP, 1440 rpm AC motor rotates the workpiece, while a 90-watt, 60 rpm DC gear motor controls the buffing actuator. The machine frame, made of mild steel for durability, is supported by deep groove ball bearings for improved load handling and longevity. Gears facilitate the transmission of rotary motion and power. By automating buffing movements, this system eliminates small dimensional errors, enhances surface finish, and significantly reduces processing time. Its cost-effectiveness and efficiency make it a valuable innovation for industrial applications, benefiting both production and environmental sustainability.*

Key Words: Buffing Machine, Dimensional Accuracy, Productivity, Errors, Sustainability

1. INTRODUCTION

Nowadays, it is essential to continuously increase the production rate to achieve higher output with minimal human intervention. To meet these demands, there is a need to develop innovative machinery that enhances efficiency. The buffing operation, primarily performed on the face of components, is similar to polishing and is aimed at improving surface finish. Currently, buffing is done by mounting a fine polishing disk on the spindle of a bench grinder and feeding this rotating disk against the job surface. Buffing is the process of creating a smooth and shiny surface by rubbing it or using chemical action, resulting in a significant specular reflection. Metal polishing is a multi-stage process. The first stage begins with rough polishing, where material removal occurs, using progressively finer buffing wheels until the desired finish is achieved.

The second stage, fine polishing, involves minimal or negligible material removal and is mainly used to eliminate scratches from the specimen's surface. Finally, etching is performed to reveal the microstructural features of the polished specimen through selective chemical attack. A common misconception is that a buffed surface always has a mirror-bright finish; however, most mirror-bright finishes are actually the result of a combination of polishing and buffing. Polishing serves multiple purposes, such as enhancing an item's appearance, preventing contamination, removing oxidation, creating a reflective surface, and preventing corrosion. In metallography and metallurgy, polishing is used to achieve a flat, defect-free surface for examining a metal's microstructure under a microscope. Silicon-based polishing pads or diamond solutions are often used in the process. Polishing stainless steel can also enhance its sanitary properties. In a buffing machine, the buffing wheel spins at high speed in a plane perpendicular to the surface being machined, ensuring surface flatness and maintaining the parallelism of opposite surfaces. The depth of cut is controlled by the sliding motion of the table on which the buffing motor is mounted. This sliding mechanism ensures that the entire surface is evenly machined.

1.1 Problem Definition

- In most industries, the buffing process is performed manually by hand, which affects the accuracy of the workpiece's finish and dimensions. Manually buffed workpieces are more likely to be rejected or require rework, leading to increased production time.
- Some industries face challenges in buffing both radial and linear components with the same level of accuracy in a short time. To achieve high precision for both types of components, they often purchase two separate machines for each operation. This requires additional space and operators, ultimately increasing the company's costs.

1.2 Objective

- To buff the components with high accuracy.
- To reduce the rejection and rework of workpiece.
- To increase the production time.
- To implement combined form technique to increase production rate.
- To reduce the cost of the company.
- To be applicable in buffing different workpieces.

2. COMPONENTS AND ITS DESCRIPTION

2.1 BUFFING WHEEL

Polishing wheels come in a wide variety of types to fulfil a wide range of needs. The most common materials used for polishing wheels are wood, leather, canvas, cotton cloth, plastic, felt, paper, sheepskin, impregnated rubber, canvas composition, and wool leather and canvas are the most common. Hard roughing wheels can be made by cementing together strawboard paper disks. Softer paper wheels are made from felt paper.

Fig -1: Buffing Wheel

2.2 BUFFING MOTOR

The polishing machine is used to polish soft metals such as copper and brass, as well as plastics like Perspex. The two wheels spin at high speed, and when the material is carefully pressed against them while moving back and forth, it achieves a polished finish. Before polishing, the material must be filed to remove scratches, followed by the use of wet and dry sandpaper or emery cloth to further smooth the surface.

Fig -2: Buffing Motor

2.3 ELECTRIC MOTOR

An electric motor is an electro-mechanical device that converts electrical energy into mechanical energy. In other words, a motor is a device that generates rotational force. The working principle of an electric motor is based on the interaction between magnetic and electric fields. Electric motors are primarily classified into two types: AC motors and DC motors. AC motors operate using alternating current, while DC motors operate using direct current.

2.3.1 AC MOTOR

An AC motor is an electric motor powered by alternating current (AC). It typically consists of two main components: an external stator with coils supplied with AC to generate a rotating magnetic field and an internal rotor attached to the output shaft, which produces a second rotating magnetic field. The rotor's magnetic field can be generated by permanent magnets, reluctance saliency, or DC/AC electrical windings. In this setup, the motor is mounted on the left side of the frame and is used to rotate the workpiece during the buffing operation.

Fig -3: AC Motor

2.3.2 DC GEAR MOTOR

These simple motors have excellent characteristics that make them suitable for a wide range of applications. They generally operate at low speeds but are capable of extremely high torque. Worm drives inherently provide a braking feature due to their design. Additionally, they offer right-angle or left-angle gearboxes, making them practical for mounting in tight spaces. The only significant drawback of worm gear drives is their low efficiency. Even the best worm gear drives have an efficiency of only 60–80%.

Fig -4: DC Gear Motor

2.4 SPUR GEAR

Spur gears, or straight-cut gears, are the simplest type of gear, consisting of a cylinder or disk with radially projecting teeth. They mesh properly only on parallel shafts and generate no axial thrust. While efficient at moderate speeds, they become noisy at high speeds. Spur gears are classified as external or internal. External gears have teeth on the outer surface and can mesh with either external or internal gears, rotating in opposite directions when paired. Internal gears have teeth on the inner surface and only mesh with external gears, rotating in the same direction. Internal gear assemblies are more compact due to closer shaft positioning.

Fig -5: Spur Gear

2.5 BEVEL GEAR

A bevel gear is a type of gear typically mounted on shafts that are 90 degrees apart. These gears are used to change the drive direction of a gear system by 90 degrees. The tooth-bearing surfaces of bevel gears are conically shaped, and their axes intersect. In straight bevel gears, the pitch surface is conical, and the teeth are straight and tapered toward the apex.

Fig -6: Bevel Gear

2.6 LEAD SCREW

A lead screw, also known as a power screw or translation screw, is a mechanical component used to convert rotational motion into linear motion. Due to the large sliding contact area between the male and female threads, lead screws experience higher frictional energy losses compared to other linkages. They are typically not used for high-power transmission but are more suitable for intermittent use in low-power actuator and positioner mechanisms. Common applications include linear actuators, machine slides, vices, presses, and jacks.

Fig -7: Lead Screw

2.7 PULLEY

A pulley is a small fixed wheel, sometimes mounted in a block, with a grooved rim that allows a rope or chain to run through it. It is used to raise a weight by pulling on the opposite end of the rope. A single fixed pulley changes the direction of effort but provides no mechanical advantage. A combination of multiple pulleys is used to increase mechanical advantage. Pulleys can also be used to transmit power when turned by a belt, rope, or chain.

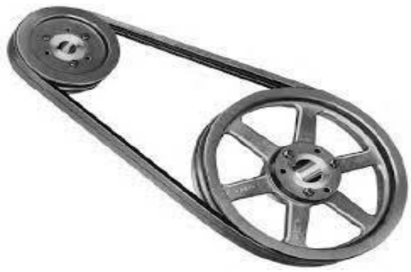

Fig -8: Pulley

2.8 BEARING

A bearing is a machine element that restricts relative motion to a specific direction while reducing friction between moving parts. Its design may allow free linear movement of a component, free rotation around a fixed axis, or controlled motion by managing the normal force vectors acting on the moving parts. Bearings are broadly classified based on their operation, the type of motion they permit, or the direction of the loads they support.

Fig -9: Bearing

3. SPECIFICATIONS OF COMPONENT

Table -1: Components Specification

AC MOTOR	Voltage	220V, Single Phase
	Current	2.5 A
	Power	0.25 HP
	Speed	1440 Rpm
DC Gear Motor	Input Power	12 V
	Watts	90 W
	Speed	60 Rpm
Buffing Actuating Motor	Voltage	220V, Single Phase
	Watts	120W
	Power	0.5 HP
	Speed	3000 Rpm
Lead Screw	Diameter	30 mm
	Pitch	5 mm
Lead Screw and Nut Mechanism	Guide Shaft Diameter	15 mm
	Guide Bush Diameter	25 mm
Frame Metal	Type of Metal	L angle
	Material	Mild Steel
	Length	1 inch
	Breadth	1 inch
	Thickness	3 mm
Bevel Gear Setup	Bevel gear ratio	1:2
	Lead screw Diameter	16 mm
	Pitch	1 mm
Belt and Pulley Drive	Belt Tension ratio	1:9 (inches)
	Pulley material	Cast Iron
	Shaft Diameter	15 mm
	Shaft Material	Mild Steel
Bearing	Bearing No.	6202
	Type of Bearing	Deep Groove ball Bearing
	Outside Diameter	30 mm
	Inside Diameter	15 mm

4. DESIGN OF THE BUFFING MACHINE

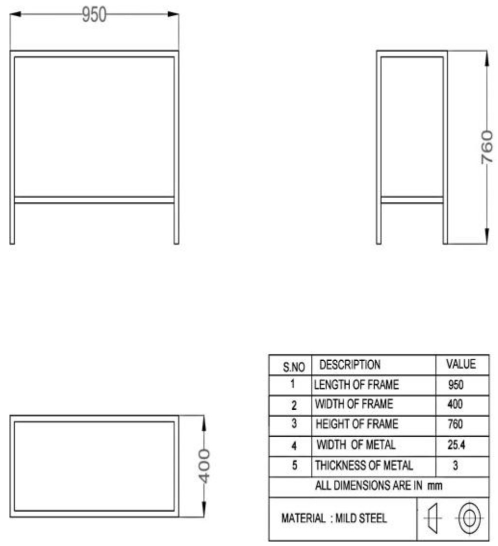

Fig -10: Frame

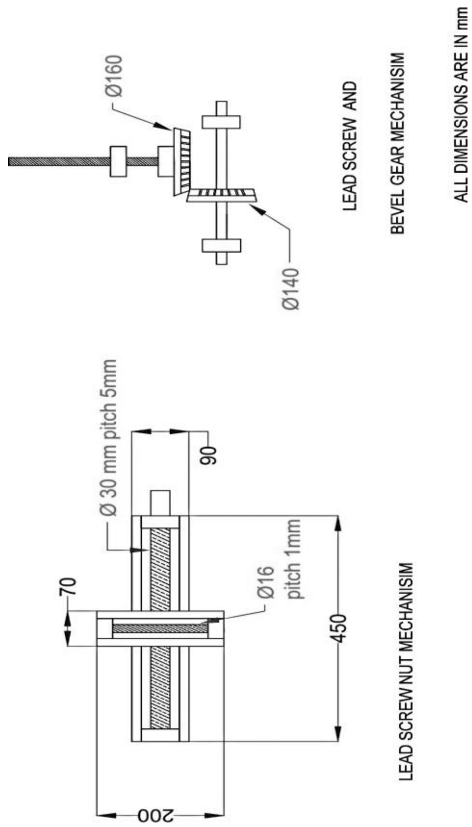

Fig -11: Design of Mechanism

5. DESIGN CALCULATIONS

5.1 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*Π*N) / 60
= (2*π*60) / 60
ω = 6.28 Rad/s
T = P / ω= 90 / 6.28 = 14.32 Nm

5.2 TORQUE PRODUCED BY BUFFING ACTUATING MOTOR

Given:
Power, P = 0.5HP Speed, N = 3000 rpm
FORMULA TO FIND TORQUE,
T = Power (P) / Angular Velocity (ω)
FORMULA TO FIND ANGULAR VELOCITY,
ω = (2*Π*N) / 60
= (2*π*3000) / 60
ω = 314.16 Rad/s
T = P / ω= 372.85 / 314.16 = 1.18 Nm

5.3 TORQUE PRODUCED BY AC MOTOR

Given:
Power, P = 0.25HP Speed, N = 1440rpm
FORMULA TO FIND TORQUE,
T = Power (P) / Angular Velocity (ω)
FORMULA TO FIND ANGULAR VELOCITY,
ω = (2*Π*N) / 60
= (2*π*1440) / 60
ω = 150.8 Rad/s
T = P / ω= 186.42 / 150.8= 1.24 Nm

5.4 SPEED OF LEAD SCREW

Given:
Speed of motor=60 rpm
No. of teeth on gear 1 = 72
No. of teeth on gear 2 = 8
Gear Ratio=1:9
Speed of Lead Screw= Gear ratio * Speed of motor
= (1/9) * 60
= 6.6 = 7 Rpm

6. TESTING OF THE BUFFING MACHINE

Testing is way to find errors and problems of the completed project. Testing is carried out to improve the quality of a completed product or project. In our project, list of testing process is carried out after the completion of the project. They are,

- Testing of motors.
- Testing of linear actuation movement.
- Testing of rotary actuation movement.
- Testing of buffing process.

6.1 TESTING OF BUFFING PROCESS

Buffing process is a metal polishing process, which enhances look of the product and removes burs and irregularities. Buffing process is carried out by touching the buffing wheel against the workpiece surface. There are totally two different buffing process is carried out this project, they are

- Linear buffing process
- Radial buffing process

6.1.1 LINEAR BUFFING PROCESS

Linear buffing is a type of buffing process carried out in a linear direction, both forward and reverse. The linear actuation movement process has been explained earlier. During this movement, the workpiece undergoes buffing (i.e., polishing). In this linear buffing test, the effectiveness of buffing in a linear direction is evaluated. Once the workpiece is secured in the coupling, it begins to rotate. Simultaneously, the buffing actuating motor moves linearly. The required polishing depth is adjusted manually based on the desired surface finish. During this process, the buffing performance is carefully monitored.

6.1.2 RADIAL BUFFING PROCESS

The radial buffing process is a type of buffing used to correct runout in workpieces. Since runout occurs in a radial direction, this process is called radial buffing. Radial buffing is performed by keeping the buffing actuating motor in a fixed position while adjusting the depth for polishing. The workpiece rotates against the buffing wheel, allowing the buffing to take place. The rotation of the workpiece is driven by rotary actuation movement. This process is tested to evaluate the buffing effectiveness when the workpiece is rotated against the spinning buffing wheel.

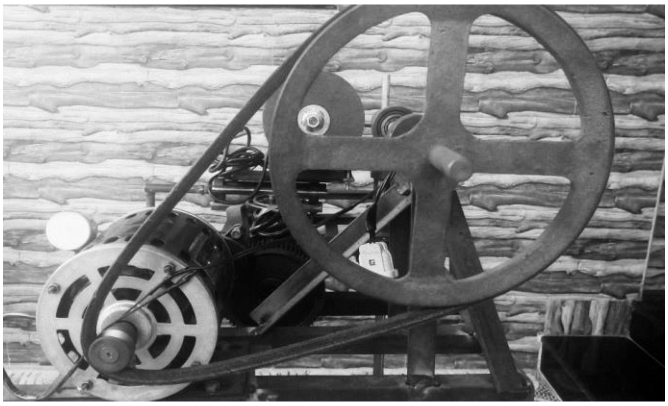

Fig -12: Buffing Machine

7. CONCLUSION

Workpieces often have surface inaccuracies and burrs. This project effectively reduces these imperfections using a buffing machine, resulting in a smooth and shiny surface. It also removes scratches from the specimen. After buffing, no further machining is required, and the component can be directly used in assembly. Additionally, this machine ensures parallelism between opposite faces, enhancing precision. Through this project, we achieve the desired surface finish and eliminate irregularities. Finally, we would like to express our gratitude to everyone involved in the development of this system, both directly and indirectly. We also extend our sincere thanks to the department for their invaluable support in bringing this project to completion. We hope that this project successfully fulfills its intended purpose, demonstrating the effectiveness of the process.

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