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DESIGN AND FABRICATION OF GEAR DEBURRING MACHINE

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Abstract - *Gears are the machine element that transmits the rotary motion and power by successive engagements of teeth on their periphery. The Gears have been used for more than 3000 years and they play a vital role in running small and big types of machinery. Although for smooth functioning, Gears should be well manufactured which include their smooth finish and long life running. The gears are manufactured by various processes and each process requires precision and accuracy as an integral part. After welding (or cutting) or manufacturing of gears, the left-over part is known as a burr. It is the unwanted part (or byproduct) that is to be removed. But the Burr is also great for protecting the weld while it cools. After Burr did its job it should be removed. There are several ways to remove off the burr, but the common method past many years was with the chipping hammer. But using a chipping hammer which is pencil like structure, it could damage the surface by leaving some marks. The use of a chipping hammer is good when it will be used with a wire brush and they are gently good. Hence, there is a need for a special purpose machine to remove it, for the smooth functioning of the component.*

***Key Words*: Deburring machine, Burr, Gears, Motor, Gearbox, etc.**

1. INTRODUCTION

Before studying the design & fabrication of gear deburring machines. Firstly, we should understand why Burr is removed after welding (or cutting) or manufacturing of Gears? What will happen if we didn't deburr the gear properly? How it is important to remove the unwanted part i.e. Burr after welding (or cutting) or manufacturing. As we know that burr is the byproduct which should be removed. Before all this we have to understand what actually burr is. And what will be the results of Deburring Machine.

1.1 Burr:

- These are the uncut / unwanted material which will remain on the workpiece after being welded or manufactured.
- A burr is a material which accumulates on the surface of workpiece during the manufacturing or welding (or cutting).
- It is the material (tiny or big) depends on types of welding (or cutting) or manufacturing process which remains on the job and which creates the problems in many situations for example, Accuracy, Precision of jobs, Measurement of jobs, Functionality of jobs, Life of the component, etc.

1.2 Why we need to remove burr?

There are many reasons to remove Burr which are as follows:

- If the burrs are not removed, the size of the part cannot be measured accurately. Therefore, it is imperative to remove the burrs before the measurements are taken.
- After welding or cutting, the Burr doesn't help to protect the metals. And hence, Burr is a waste material.
- It should be removed to get the ability to inspect the quality of weld area.
- Workpiece appearance should be aesthetics or ergonomically for that we have to remove burr.
- Clean and clear surface for coating such as paint or oil.

1.3 Main Functions of Weld Burr:

- It protects the high-temperature metal from atmospheric contaminants which may weaken the weld joint or weld area.
- It can also be globules of the molten metal that is expelled from the joint after the welding and then it may re-solidify on the metal surface.
- It protects the weld from oxidation and slows down the rate at which the welding cools down.
- Burrs are also used as it helps to prevent the brittleness of the metal.

2. PROBLEM STATEMENT

- Many welding (or cutting) and machining operations are there, which produce the unwanted material known as a burr. And also, it produces the sharp edges on the different components. This unwanted byproduct or sharp edges produce problems for the accuracy and precision of components such as gears.
- The burr can loosen from the gear either during assembly or later when the gear is in operation & damages the components and it leads to part failure.
- It's difficult to weld any circular shape objects and after welding to deburr the unwanted material again becomes a tedious task so using these machines, we can easily deburr any circular shape objects.

3. OBJECTIVES

- If we deburr any shape (especially circular), then it will increase the efficiency.
- It will increase production.
- Any unskilled operator can also operate the machine.
- There will be less rework or rejection of the components.
- Sharp edges may harm the operator (human hand) and this can be reduced by removing the burr after welding or cutting process.
- The components are measured accurately.
- It will be easy functioning so there will be fewer worker requirements. Accuracy and precision will be high.
- It will decrease the cycle time. i.e. Less time will be consumed.
- Many Industries can use this machine for their advancement.
- This machine is also used for improvement.

4. PURPOSE

In a mechanical power transmission system, the gearing is one of the most critical components. When the gear teeth mate, the transfer of power takes place. At the point of contact the tooth flankes of gears are submitted to high pressure and due to repeated stress on the gear the tooth damage takes place. It is one of the major causes of gear failure. It is because of poor finishing and improper deburring. Gear plays a vital role in many industries. And for the long life of the machine and for the smooth functioning, the gears must be deburred properly. Though we have many ways to deburr like earlier days, the gears were deburred using chipping hammer. And filing or many ways. But if we use these tools, they may cause damage on the weld area and hence there is a need of automatic deburring machine. These automatic deburring machine can be user friendly and less time-consuming also.

5. METHODOLOGY

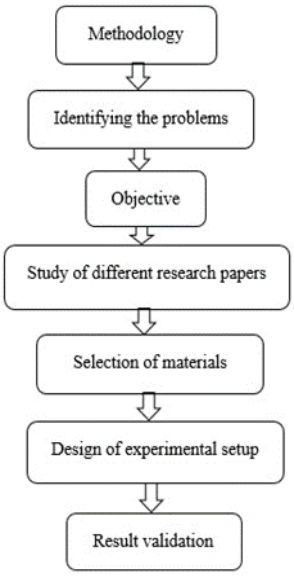

Fig -1: Flow-Chart of Methodology

6. MATERIAL SELECTION

The main objective in the fabrication of the machine is the proper selection of material for the different parts or different components of the machine. The main role of a design engineer is that he must be familiar with the effect which is caused during the manufacturing process and heat treatment process on the properties of the material. Below is the list of materials for engineering purpose which depends upon the following factor:

- The availabilities of the materials.
- For the working condition of the material.
- The cost of the materials.
- The physical and chemical properties of the material.
- And the mechanical properties of the material.

The different properties which are as follows:

A. Strength	B. Elasticity
C. Stress	D. Plasticity
E. Stress	F. Ductility
G. Brittleness	H. Malleability
I. Toughness	J. Resilience

7. CALCULATION

7.1 Motor

Use of motor is to provide motion for the Turn- Table. There is a need of high torque during heavy weight of gears, we select the DC motor. And also, it reduces the problem of spark generation as compared to the AC motor.

Total mass including setup = 15Kg
= 15 x 9.81
= 147.15 N
Normal Force acting (P_1) = m x g x cos(Θ)
= 15 x 9.81 x cos (35)
= 120.5382 N
Frictional Force (P_2) = μ x P_1
= 0.2 x 120.5382
= 24.1076 N
Opposing force (P_o) = m x g x sin(Θ)
= 15 x 9.81 x sin (35)
= 84.4017 N
Torque required = (P_2 + P_o) x R
= (24.1076 + 84.4017) x 0.18
R – Radius = 0.18 m
= 19.5316 Nm

7.2 Shaft

Power of motor = 120 Watt

Power transmitted by shaft (P) = $\frac{2\pi NT}{60}$

Where, T - Torque transmitted
N - Rpm of motor = 30 rpm

$$120 = \frac{2 \times 3.14 \times 30 \times T}{60}$$

T = 38.1971 Nm

Torque transmitted (T) = Force x radius
F = 212.2061 N

Torque transmitted by Shaft (T) = $\frac{\pi}{16}$ x ζ x D^3

$$38.1971 = \frac{3.14 \times 70 \times D^3}{16}$$

... ζ = 70 N/mm²

$38.1971 \times 10^3 \times 16 = 3.14 \times 70 \times D^3$
$D^3 = 2780.4986$
D = 14.0617 mm
Taking Factor of safety = 1.6
D = 22.50 mm
We select diameter of Shaft = 25 mm, for safety factor.

7.3 Calculation for Sprocket

We know,
No. of teeth of Gear G = 18
No. of teeth of Sprocket S = 18
Ratio = 1:1
Torque on sprocket = 1 x T
= 38.1971 Nm
Diameter of sprocket (D)
Periphery = π x D
18 x 6.25 = π x D
D = 35.8098 mm

7.4 Power Source

Here we used 1 x 12 V supply required current to drive high torque motor and related accessories specification.
Cycle use: - 14.4 V – 15 V
Standby use: - 13.5 V – 13.8 V
Watt = V x I
=120 W

7.5 Bearing calculation

For calculation of bearing, we have selected the radial load of transportation along the self-weight of the plate including friction as 10Kg load during 90% & 15Kg load during remaining percentage. i.e. 10%. We have taken the speed of the shaft at maximum 30 rpm. And we have to find the value of dynamic load rating for 5000hrs of operation with not more than remaining percentage of failure.
M_1 = 10 Kg
M_2 = 15 Kg
N = 30 rpm
The number of revolutions during 90% of time,
$R_1 = 0.9 \times M_2 \times 60 \times 5000$
$= 0.9 \times 15 \times 60 \times 5000$
$= 4.05 \times 10^6$
$R_2 = 0.1 \times M_1 \times 60 \times 5000$
$= 0.1 \times 10 \times 60 \times 5000$
$= 0.3 \times 10^6$

Basic dynamic load rating (C) = $\frac{(L_1W_1^3 + L_2W_2^3)^3}{10^6}$
C = 5.0625 X 10^{15}

7.6 Selection of Bolt

Bolt should be fastened tightly and also it will take due to rotation. Therefore, stress for C 25 steel F = 420 Kg/cm² (41.885 N/mm²). Standard nominal diameter of bolt is 8 mm. From table in design book, diameter corresponding to M8 bolt is 8.160 mm.
Let us check the strength: -
F = 30 kg
= 294.3 N
≈ 300 N which is the value of force applied by human hand.

P = $\frac{\pi}{4}$ x d_c^2 x F

$$F = \frac{4 \times 300}{3.14 \times 8.16 \times 8.16}$$

F = 5.736 N/mm²
The calculated F is less as compare to the maximum F; hence our design is safe.

8. EXPERIMENTAL SETUP

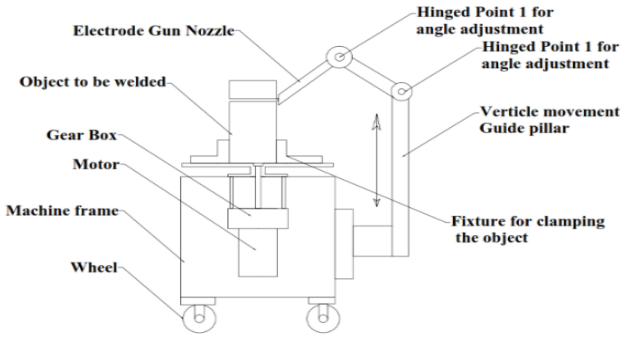

Fig -2: Theoretical Experimental Setup

The above diagram shows the complete experimental setup of our proposed system. The job which is to be welded is placed on the indexer table and considering the welding or cutting process and electrode size, the speed regulator is adjusted to give desired table speed. The table carries indexer buttons as per the number of welds and position of the same. The table is indexed to the first stop position. Now inching switch is operated simultaneously as the welding or cutting process is started, the job rotates as welding or cutting operation is done, after the second indexer button comes in front of the proximity switch it stops the welding or cutting process, and the table movement. Inching switch is operated which starts the next position welding or cutting and the process is repeated till the last stop i.e., the first stop comes in front of the proximity switch. The job welded is unloaded and a new workpiece is loaded for the next operation. Thus, this operation is user-friendly and can be operated by any unskilled operator.

9. 3D DESIGN MODEL

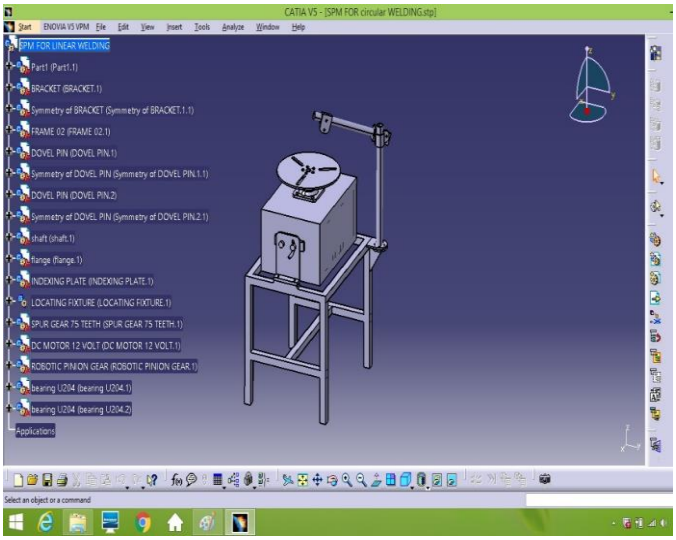

Fig -3: Gear Deburring Machine

10. FACILITIES AVAILABLE

Our Facilities Includes:

- Well-equipped service labs
- Warehouses for Ex-stock deliveries
- Training school for operational, maintenance & troubleshooting trainings
- Workshop for maintenance of machinery
- Live demonstration of cutting and Welding or cutting machines.

Manufacturing resources available:

- Gas cutting set.
- Grinding machine
- Turning machine
- Drilling machine
- Spray painting.
- Packing accessories.

11. EXPECTED OUTCOME

- **Advantage:**
  - Decreased the cycle Time.
  - Increase the efficiency.
  - Less worker requirement.
  - Less maintenance cost
  - Low cost system
  - Easy functioning

- **Application:**
  - Welding or cutting of circular components.
  - Welding or cutting of linear components.

Fig -4: Rotator of Welding

Fig -5: Circular plate with sheet metal cover

12. TESTING AND RESULTS

Testing are necessary to check performance of the machine. For that we take some observations by comparing Conventional method and Gear deburring machine. The points are listed below:

Conventional Method	Gear Deburring Machine
Tool used for slag / burr removal are frequently break and more wear of tool.	Tool doesn't break, less wear of tool compares to conventional method.

It removes more material from the workpiece/ weld joint therefore, it weakness the workpiece or the weld area.	It removes only Burr/slag therefore, it doesn't weaken the workpiece or weld joint.
It forms more marks or chatter on the surface Of workpiece, Hence poor surface finish.	It forms less marks or chatter on the surface of workpiece, Hence better surface then conventional method.
More time required for removing burr. i.e. more time consuming.	Less time required for deburring. i.e. less time consuming.
More chances of injury to worker.	Less chances of injury to worker, as it is automatic operating machine.
Process involves more fatigue to worker.	Process involves less fatigue to worker.
Machine used for removal of slag or burr have very complex configuration.	It is simple in construction.
Low initial cost.	Though initial investment is more, the machine can be used without stopping. Thus, making it more profitable.

13. CONCLUSION

Hence, we have successfully deburred the gear. We have considered all the design aspects and we have also considered the safety of the machine as well as the products. The design part is very economical and the mechanical parts that have been fabricated are extremely simple. It has an adjustable table speed of approximately 0 to 75 rpm. This machine includes an auto-stop feature that can be used to start and end the process operations at specific positions. It is an easy operation because the table automatically stops as per the indexer button position and to do the next operation press the inching switch. It is compact as the entire assembly can be filled below the table itself and the operations. It is low power consumption. A wire brush is used and it is very effective for intricate shape because in manually deburring compact metal parts is very difficult to deburr but using a wire brush, it goes to every nook's crannies of the part. Though it requires less space than it will be best suitable for small industries. Unskilled operate can also operate this machine and it provides more safety to humans as compared to chipping hammers. The main aim of our project to reduce the time for deburring. The conventional method is time-consuming and many laborers are also required. Trials were conducted. The force applied will be uniform as the machine is operated, thus it maintains the quality of products. Though the initial investment is more the machine can be used without stopping thus making it more profitable.

14. FUTURE SCOPE

In the future, we will be adding an automation part so that system will automatically come to know each and every point location of the gear which has been deburred. By using two arms it can be used for welding as well as the deburring process. Many Industries can use these automatic gear deburring machines for their improvement and advancement.

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