Design and Fabrication Of Automatic Operated Dressing Device

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ABSTRACT

Abstract - *This project aimed at designing and fabrication of pneumatically operated small scale dressing device to carry out dressing operations on resin-bond diamond grinding wheel with an abrasive diamond dressing stick. The primary objective of this project was to determine optimum Dressing parameters leading to minimum surface roughness. Modification in a manual dresser for automatic use of CNC machine being the main aim of this project work. This pneumatically operated dressing device consists of two sections, one section is automatic dressing stick feeding mechanism and the second section is conversion of linear reciprocating motion of pneumatic cylinder into rotary motion to transmit power both sections lie on same shaft.. The first section consists of chain and sprocket mechanism as a conveyor for a stack of dressing stick and the second section is pawl and ratchet mechanism to prevent the rotation of the conveyor in anti-clockwise direction. The dressing stick slides in one direction by connecting pneumatic cylinder with pawl bearing housing, which transmit power to chain and sprocket mechanism to carry sticks one by one towards the wheel. The dressing stick is fed automatically by a linear reciprocating motion of a double acting pneumatic cylinder and flow control valve. This results in better surface finish in glass used as a workpiece.*

Keywords: *Dressing device, dressing stick, resin-bond diamond grinding wheel, pneumatically operated, surface finish, etc.*

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1. INTRODUCTION

Grinding is a process of removing material by the abrasive action of a revolving wheel on the surface of work piece. During the process, the material is removed in the form of small chips. Grinding wheel consist of sharp crystals which are called as ‘abrasive’, held together with bonding material or bond. The grinding wheel may be a single piece or composed of several segments of abrasive blocks joined together. The grinding process can be distinguished into three phases, including rubbing, plowing and cutting. After continuous usage of grinding wheel, the cutting points of abrasive grains become dull. They lost their cutting ability, sharpness and are severely worn out. Hence, the wheel becomes smooth and provides a sort of rubbing action only, instead of cutting the work material. This phenomenon, which makes the wheel ineffective for cutting is known as ‘glazing’ and ‘leading’ of the wheel. Therefore, Dressing operation is performed on a grinding wheel.

Dressing is the process of conditioning the grinding wheel surface in order to reshape the wheel when it has lost its original shape through wear. This will generate a satisfactory grinding wheel topography, which has significant impact on the grinding force, energy, temperatures, wheel wear and surface finish. Dressing parameters include dressing lead, dressing depth, dresser tip radius, dressing angle, and number of passes, etc. Out of which dressing lead and dressing depth are most important. Dressing process decreases wheel life, dressing, actually improves the surface of the wheel during grinding and prolongs the whole life. Dressing reduces grinding forces between the wheel and the tool and as a result also reduces cycle times. In turn, tool production is improved, and the flow on effect is an increase in profits.

1.1 BACKGROUND

In grinding process down time during production is reduced by automating the stick dressing process, allowing unmanned production runs as wheel condition is maintained during the batch. Operator safety is also increased as manual interaction is eliminated. Regular stick dressing of grinding wheels reduces tool burn and material damage, as well as ensuring open cutting wheels that reduce grinding forces and minimize the spindle load. The noticeable results are a reduction in cycle times gained from improved feed rates and a significant increase in the life expectancy of your wheels. It ensures flexibility and user-friendliness, fully supports the stick in dressing process and use with the least amount of material removal rate.

2. PROBLEM STATEMEN

In conventional grinding machine, the manual dresser is used to dress the grinding wheel and set the alignment of dresser with a grinding wheel. Moreover the dressing stick is fed manually after continuous usage of grinding wheel. Due to the above reason, the entire process needs inspection and labor cost for dressing operation in high production volume. In this automatic operated dressing device, the dressing stick is fed automatically during the return stroke of dressing operation.

2.1 LITERATURE STUDY AND WORK

Different methods and experiments are performed to calculate grinding forces exerted by grinding wheel which is fully dependant on dressing feed and depth.

d (μm)	F (mm/min)	Measured		
		Fn	Ft	Ra
10	250	3.50	2.74	0.94
10	350	2.51	1.97	1.92
30	250	1.86	1.59	1.27
40	150	2.50	2.34	0.80
50	50	3.33	3.12	0.38

Table-1: Variation of grinding forces with different Dressing depth (μm) and lead(mm/min)

The various grinding experiments are performed to compare the forces and wear during dressing with stick and truing wheel.

Dressing technique	Truing wheel (at 2000rev/min)	Machine held Dressing stick
Initial wheel wear (in.× 10^{-4})	2.5	2.2
Initial force peak on wheel (N)	19.5	10
Dressing force (N)	8.5	5

3. PROPOSED MECHANISM

The new pneumatically operated dressing device for resin-bond diamond wheel is designed according to customer requirement and after studying different dressing methods. This device is automated on CNC machine by controlling flow of air in pneumatic cylinder by a flow control valve.

3.1 DESCRIPTION OF MACHINE

The Pneumatically operated Dressing device is developed using various components. The components are pneumatic cylinder, chain and sprocket drive, flow control valve, pawl and ratchet mechanism and mounting table. The sprocket and ratchet are located on the same shaft to transmit linear motion to each dressing stick. The pawl pin is bolted on disc and restrict the anticlockwise rotation of the sprocket by locking on ratchet teeth. The piston rod of pneumatic cylinder is bolted on a disc which is mounted on the same shaft by bearing. It is a low-cost dressing device also ensured minimum disruption to the grinding operation, higher level of safety and provide a constant infeed and force. Furthermore, manual application of a dressing stick would result in a poor wheel profile. Therefore, a new dressing device was developed.

3.2 WORKING PRINCIPLE

The basic principle of the new dressing device is that it holds a dressing stick securely when the rotating grinding wheel is moved across the dressing stick. As the required pressure is supplied to the pneumatic cylinder, it actuates and linear motion of the piston rod is converted into rotary motion of the disc. The disc rotates at a few degrees of angle with pawl pin which is locked on ratchet teeth. The ratchet tends to rotate sprocket at same speed and chain-sprocket drive is used as a conveyor for a stack of dressing stick. When cylinder retract, the pawl pin with disc slipped on the ratchet teeth and did not allow the sprocket to rotate anticlockwise.

4 DESIGN PROCEDURE

4.1 MATERIAL SELECTION: To prepare any machine part, the type of material should be properly Selected considering design and safety. The machine is basically made up of 304 Stainless Steel.
The reasons for the selection are:

1. Stainless steel **304** is the most versatile and the most widely used of all stainless steels.
2. Its chemical composition, mechanical properties, weldability and corrosion/oxidation resistance provide the best all-round performance stainless steel at relatively low cost.
3. It also has excellent low temperature properties and responds well to hardening by cold working.
4. It contains 17.5–20% chromium, 8–11% nickel, and less than 0.08% carbon, 2% manganese, 1% silicon, 0.045% phosphorus, and 0.03% sulphur.

Given terms used:

Available glass grinding wheel:
Required Feed-rate: 30mm/min
Depth of cut: 10µm
Dressing stick material and dimension:

1) The normal grinding force exerted by grinding wheel (Fn): 5 N
2) Velocity of stick is equal to dressing feed, therefore V is 0.0005 m/s
3) Power required for Dressing:
   $P = Fn \times V$
   $= 0.0025$ W

4.2 Calculation for selection of Chain and Sprocket drive.

By considering the required space of the device on which sprocket and chain are mounted, the maximum pitch circle diameter (D) is to be 60-65mm.
The minimum number of teeth on driving sprocket should be greater than 17 for durability and noise consideration. Therefore, considering the standard number of teeth (z) = 18 or 20

- <u>For 60mm PCD</u>
  - If z = 18
    Pitch = D (sin (180/z)

P = 10.41 mm

- If z = 20
  P = 9.38 mm

According to design data, for P = 9.525 mm chain number is 06B and Simplex sprocket 3/8" 20 teeth hub type.

4.3 Calculation for speeds of driving sprocket and Disc:

- Speed of driving or driven sprockets-
  $N = (v (60 (10^3) /z (p$
  $= 0.165$ RPM

The sprocket and disc are rotating on two different shafts and disc rotates the sprocket with the help of pawl ratchet mechanism. To select the diameter of disc following factors are considered:

1. The diameter of the disc should be greater than ratchet.
2. The disc should accommodate pawl pin and piston rod also bolted on it.

The standard diameter of sprocket is approximately 60mm. Therefore, diameter of disc (d_1) = 100mm

- Speed of Disc by reduction ratio:
  $60 (0.165 = n_1 (100$
  $n_1 = 0.099$ RPM

4.4 Selection of Pneumatic cylinder:

- The load factor for horizontal movement of the load = 0.3
- Operating pressure = 85% of the source air pressure.
  = 85% by 0.65
  = 0.56 mpa
- Taking the bore of the cylinder tube from the air cylinder selection graph:

Considering the maximum operating pressure = 0.7maps and maximum required cylinder force = 10N
Bore diameter = 10 mm
So, selecting 'AIR CYLINDER CJ2D10-50Z'.

5 Designed Pneumatic operated Dressing device in CAD:

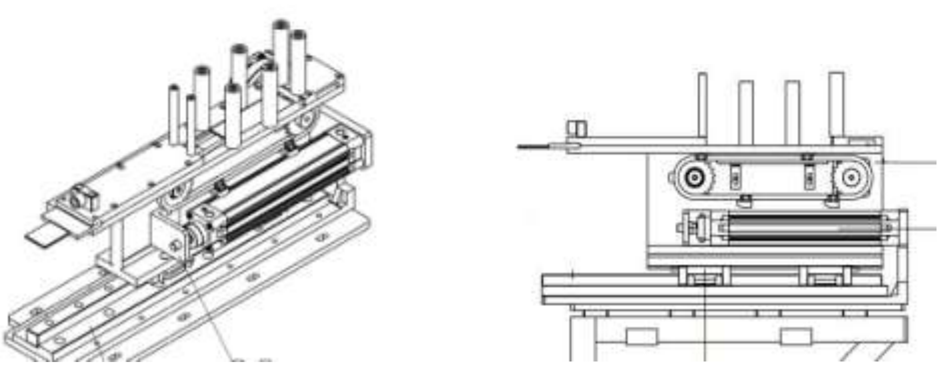

Fig 1. Assembly of dressing device

5. CONCLUSION

By using the simple device to dress the resin-bond diamond wheel, better surface finish was achieved compared to that when the conventional manual dressing method was used. Stick dressing is the least expensive and also used for additional or interim cleaning and opening up of diamond wheels. The dressing sticks are fed by chain and sprocket drive as a conveyor and power is transmitted by pneumatic cylinder. The device is used on CNC machine to dress the glass grinding wheel. Therefore, it must be compact in design, ensured minimum disruption to the grinding operation and a higher level of safety.

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