AUTOMATION OF LATHE USING PNEUMATIC ACTUATORS

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ABSTRACT

To make a brake component, it needs a Computerized Numerical Control, which is very costly compared to a conventional lathe. In the latter, it consumes time, money for unskilled labour, maintenance, etc...All kinds of vehicles are using brake components; we can’t achieve the target manually in lathe due to large need of components by traditional machining process. Instead, the target can be achieved within time by using this robotics and flexible tooling. Since it is totally automated, the workforce has been reduced with less numbers according to the machine operating requirements. The main job of the worker is to load the work piece at first, receiving the finished job. So total time taken is very less when compared to the previous kind of work done by the worker. By implementing this control and Automation, we can achieve Just in Time concept and also increases the productivity. This process reduces the problem of less availability of skilled labour. So we automated a lathe using pneumatics to produce it economically.

Key words: Computerized Numerical Control, Boring, Drilling, Pneumatics, Just In Time.

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1. INTRODUCTION

Since it is totally automated, the workforce has been reduced with less numbers according to the machine operating requirements. The main job of the worker is to load the work piece at first, receiving the finished job. So total time taken is very less when compared to the previous kind of work done by the worker. A bleed screw is a device used to create a temporary opening in an otherwise closed hydraulic system, which facilitates the removal of air or another substance from the system by way of pressure and density differences. Its applications are domestic heating radiators, hydraulic brakes, engine cooling system, etc.

In 1984, department of mechanical engineering IIT, New Delhi[1] has taken a research topic named as "machine tool failure data analysis for condition monitoring application " with the development of Modern manufacturing technology, flexible manufacturing system have
become key equipment in factory automation machine tool is heart of flexible manufacturing systems. Tighter hole tolerances have led to the development of finishing tools.

During the operation of this machine tool, different kinds of failures can are faced by the industry. A systematic study of such failures can help in identifying the condition monitoring needs the machine tools. Micro-machining requires a machine tool that has very high sensitivity and fine resolution in the feed axis. For many micro-drill applications, the ability to cut such a small hole is sufficient. However, as micro-drilling operations proliferate, there is increasing demand to hold these tiny holes to similar tolerances for size and surface finish as non-micro holes.

Machines must also have very precise spindles capable of high-speed rotation with low dynamic run out. It can be observed that the maximum failures took into place in headstock and carriage sub-system. These sub-system face failures face failures in component like gear, gearbox, bearings, spindle bearing, clutch and cross-jib. Here it could be observed that the bearing failures cause longer downtime.

Actually to do precision drilling, it requires a CNC which is costly to buy. So we have done a special purpose mini CNC for micro-drilling. For micro-drilling, diameter, tolerance, recessed top, threads, etc are its specifications. We can use it till medium sized components at very less cost of about 1 lakh. Thereby stimulated productivity at reasonable cost with limited skilled labor can be achieved. The three operations we used at first are: centre biting, 1st and final stage drilling for the last half. This machine is done in Infant Engineering Private limited. The automatic tool fitting and indexing is done through pneumatic solenoid valves. The electricity consumption is also minimized.

2. MODEL DETAIL

2.1. Methodology

![Methodology flow chart of operation](image)

First of all, controller system checks about home position and verifies the presence of job, if not alarm is notified. If everything is ok, machining is done.
2.2. Design

![Side View](image1)
![Front View](image2)
![Top View](image3)

**Figure 2.2** Total design of setup.

It mainly contains components like LM guide way, gripper, 6 double acting cylinders and electronic, pneumatic circuit. The LM guide way is to feed the tool to the gripper. The indexing mechanism contains six sets of tools: 3 for each type of operation. The gripper with specifications is shown in table 2.1.

Here the gripper stroke length, opening and closing width, operating pressure, temperature are shown in detail. The total lathe bed is about 120 cm. The double acting cylinder and gripper has bore size of 10 mm with stroke length of 4 mm.

**Table 2.1.** Shows the gripper specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening width</td>
<td>6</td>
</tr>
<tr>
<td>Closing width</td>
<td>10</td>
</tr>
<tr>
<td>Stroke</td>
<td>4</td>
</tr>
<tr>
<td>Port size</td>
<td>M3</td>
</tr>
<tr>
<td>Main body weight (kgf)</td>
<td>0.05</td>
</tr>
<tr>
<td>Max gripping length (mm)</td>
<td>30</td>
</tr>
<tr>
<td>Fluid</td>
<td>Air</td>
</tr>
<tr>
<td>Operating pressure (bar)</td>
<td>3–7</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>5–60</td>
</tr>
<tr>
<td>Optical performance (r.p.m)</td>
<td>160</td>
</tr>
<tr>
<td>Autoswitch for opening</td>
<td>W9H</td>
</tr>
<tr>
<td>Closing</td>
<td>W9/</td>
</tr>
</tbody>
</table>
The tube hose diameter with an overall view in pneumatic connections are shown in the figure 2.3.

2.3. Pneumatic circuit

![Pneumatic Circuit](image)

Figure 2.3 Pneumatic Circuit

3. DESIGN CALCULATION

3.1. Selection of Cylinder for up and down movement of the gripper

The Mass to Be Carried By the Cylinder = 20kg (10 kg * 2 -- To Be Considered On Factor of Safety)

Pressure Supplied to the System = 3 bar (2- 8 Bar- Can Be Controlled Using Flow Control by the Operator)

Pressure \( P = \frac{F}{A} \) (force / area) \( \text{-------- (1)} \)

\[
0.3N/ \text{mm}^2 = \frac{(20*9.81)}{\text{area}}
\]

Area = \( \frac{196.2}{0.3} = 654 \text{ mm}^2 \)

**Area, \( A = (\pi/4) * d^2 \) (for cylinder bore) = (3.14/ 4) * \( d^2 \) \( d^2 = 654/0.785 = 833.121 \text{ mm}^2 \)**

Diameter, \( d = 28.86 \text{ mm as found through eqs (1)} \)

where \( A \) denotes the area, \( d \) is the diameter of piston. Therefore We Consider A Cylinder of Dia 32mm (Standard size). Similarly for turret movement cylinder, it is calculated as 50 mm diameter.
3.2. Time calculations

\[ N = \frac{1000S}{3.14D} \]  

\[ S = 3.14 \times 3 \times 1500 / 1000 = 14.13 \text{m/min} \]

\[ T = \frac{L}{f} N = \frac{26}{(17 \times 1500)} = 109 \text{ min} = 6 \text{ sec/drink} \]

Here \( T \) denotes time taken for a drill, \( f \) is feed rate, \( s \) is the spindle speed, \( D \) is the depth of cut. Thus time taken for a drill takes 6 seconds which involve a complete single operation including retracting as given in eqs (2).

4. PROJECT FABRICATION

The fabrication of all pneumatic components is bought from Janatics, Coimbatore. Then a capstan lathe is realtered by doing modifications (i.e.) removing the handle and other sub-parts which hindering the motion. Instead they were connected through pneumatic circuits for activation. The 2 sliders, one for the gripper mechanism and other for the tool to and fro movement. Two individual sets of tool are fixed in a turret and process flow is hole punching, deepening of a hole, final accurate feed drilling.

The assembly of pneumatic cylinder fitting is tedious and also the gripper mechanism is fitted with ease. First while fitting, the holes doesn't match. With pre-adjustment and grinding, we inserted the fittings. The M-codes which we designed faulted earlier. But with redesigning and fitting, the problems in turret movement for precision drilling are rectified. The assembly of pneumatic cylinder for turret movement is shown in fig.4.1.

![Figure 4.1 Shows the assembly of pneumatic cylinder for turret movement.](image-url)
The full focus front view is shown in fig.4.2.

![Figure 4.2 Front view](image1)

The gripper is only specified for small jobs like bleed screw, nut, etc. The gripper mechanism is shown in fig.4.3.

![Figure 4.3 Gripper Mechanism](image2)
5. CONCLUSION
Thus by fabricating this machine, we can achieve flexibility and promotes skilled labour with cost effectiveness. The full time results are yet be tested. It should be analysed based on accuracy, tolerance, reliability, flexibility, effectiveness, etc. Based on results of this test machine, the company is planning to do about 4 machines of the same set to improve productivity and also to attain customer targets. This reduces the problem of less availability of skilled labor. It reduces current consumption and improves productivity by establishing Just in Time (JIT) concept.

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NOMENCLATURE
A : Bore area of cylinder
d : diameter of the cylinder
P : Pressure differential
N : Spindle speed
D : Depth of cut
f : feed rate
T : Effective time taken for a drill

REFERENCES