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Design and Fabrication of Dual Ram Shaper Machine

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Abstract - *Our project deals with the fabrication of a time reduction unit in a shaping machine using pneumatic mechanisms. A shaping machine or simply shaper is used to machine a single job by using a single point cutting tool and hence it cannot be used for high production rates. This project intends to use shaper for high production as well. A small skeleton structure has been thus devised to demonstrate the machining time reduction in shaping machines. The shaping machine has an idle stroke during its return motion. This project is uses the idle stroke as cutting stroke and hence increase the production rate. This can be achieved by an addition of clapper box with a tool such that the arrangement on tool holder has one tool clamped on the clapper box individually. This stroke would be a rough cutting stroke for the job, compared to the forward stroke. The pneumatic source of power with control accessories is used to drive the ram or the cylinder piston to obtain the forward and return strokes. By this arrangement the machining time of a work piece is reduced by half the time when compared with the conventional machines.*

Key Words: **Shaper**, **Ram**, **Dual Ram**, **Pneumatics**, **Manufacturing.**

1. INTRODUCTION

A mechanism is a simplified model, usually in the form of a line diagram, which is used to reproduce the motion occurring in a machine. The purpose of this reproduction is to enable the nature of the machine. The purpose of this reproduction is to enable the nature of the motion to be investigated without the encumbrance of the various solid bodies which form the machine elements the various parts of the mechanism are called links or elements. Where two links are in contact and a relative motion is possible, then they are known as a pair. An arbitrary set of a links which form a closed chain that is capable of relative motion, and that can be made into a rigid structure by the addition of a single link, is known as a kinematics chain. To form a mechanism from a kinematics chain one of the links must be fixed. However as any of the links can be fixed, it follows that there are as many mechanism as there are links in the chain. The technique obtaining different mechanism by fixing the various links in turn is known as inversion.

2. LITERATURE REVIEW

But looking at its recent history, the integration of digital controls technology and computers into machine tools have hit the industry in three waves of technology shocks. Most companies underestimated the impact of this new technology. This article gives an overview of the history of the machine tool industry since numerical controls were invented and introduced and analyzes the disruptive character of this new technology on the market.

Table -1: Literature Review

S.no	Author	Publisher	Points taken
1	Heinrich Arnold	innovation in the machine tool industry	The study of connection between technological change, industry structure, and competitive environment.
2	Dr.Toshimichi Moriwaki	Recent trends in the machine tool technologies	Combined multifunctional machine tools, ultra precision machine tools and advanced and intelligent control technologies.
3	Frankfurt-am Main	Dortmund and Chemnitz report	Store for machine tool manufacturers and users.

3. DESIGNING AND MODELLING

The 2D and 3D design of the machine

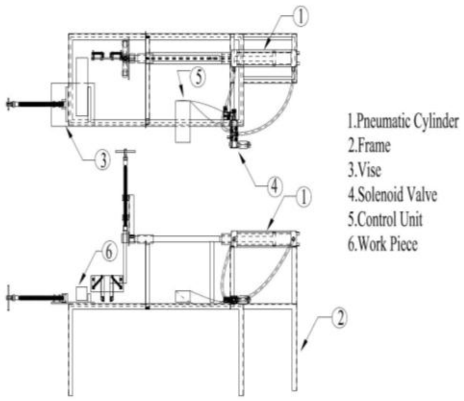

Fig -1: Components

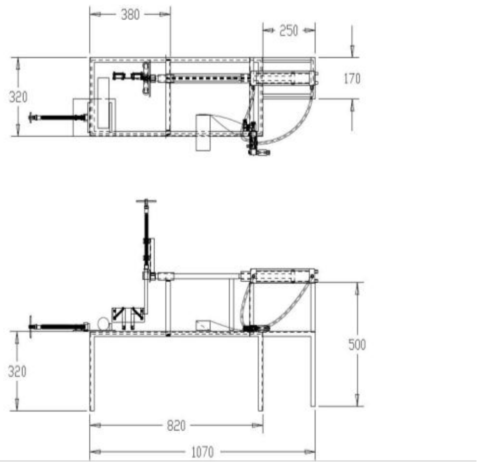

Fig -2: Dimensions

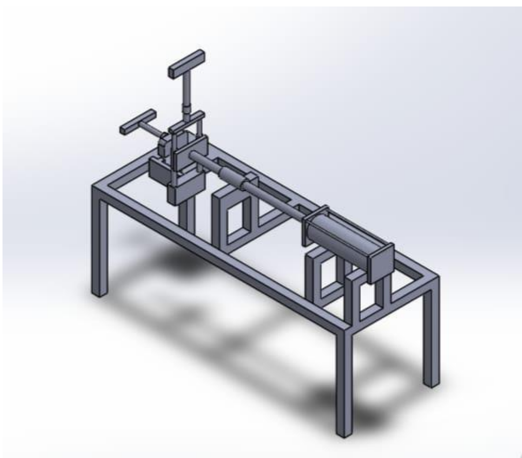

Fig -3: 3D Drawing

4. WORKING PRINCIPLE

The compressed air from the compressor reaches the solenoid valve. The solenoid valve changes the direction of flow according to the signals from the timing device. The compressed air pass through the solenoid valve and it is admitted into the front end of the cylinder block. The air pushes the piston for the cutting stroke. At the end of the cutting stroke air from the solenoid valve reaches the rear end of the cylinder block. The pressure remains the same but the area is less due to the presence of piston rod. This exerts greater pressure on the piston, pushing it at a faster rate thus enabling faster return stroke. The screw attached is fixed to the clapper box frame gives constant loads which lower the sapper to enable continuous cutting of the work. The stroke length of the piston can be changed by making suitable adjustment in the timer.

COMPONENTS REQUIRED

S.no	Name of the parts	Quantity
1	Solenoid valve	1
2	Flow control valve	1
3	Electronic control unit	1
4	Pneumatic Cylinder	1
5	Flexible hoses	Required Qty
6	Clapper box and dead weight arrangement	1
7	Air compressor	1
8	Mild steel	Required Qty

4.1. Mild steel Composition

Mild steel contains –C45

Carbon 0.35 to 0.45 % (maximum 0.5% is allowable)

Manganese 0.60 to 0.90 %

Silicon maximum 0.40%

Sulfur maximum 0.04%

Phosphorous maximum 0.04%

Mildest grade of carbon steel or mild steel contains a very low amount of carbon - 0.05 to 0.26%

Tensile strength – 63-71 kgf/mm2

Yield stress -36 kgf/mm2

Izod impact valve min -4.1 kgf m

Brinell hardness (HB) – 229

5. CALCULATIONS

5.1. DESIGN OF CYLINDERS:

Double Acting Pneumatic cylinders are of same design and selected from the product catalogue **(Janatics pneumatic products).** According to the applications the forward and return stroke of the piston has to be controlled with some time interval so double acting cylinders are preferred. This time interval cannot be achieved by single acting cylinders.

Force Calculation:-

Force to be exerted is 40N

Force = pressure×area

Pressure in the cylinder= 0.4×10^5 N/m^2

Area of the piston, $(\pi d^2)/4$= Force/pressure

= 40/ 40000

= 0.001m^2

Bore diameter = 0.0356m = 35.6 mm

From **Janatics pneumatic products** catalogue we have selected 40mm bore diameter cylinder

For forward stroke:

For 40mm bore diameter

Corresponding rod diameter = 16mm

Area of the piston = $(\pi d^2)/4 = (\pi \times 40^2)/4 = 1256.8$mm^2

Force (modified) to be exerted = pressure ×area
= $0.4 \times 10^5 \times 1256.8$ = 50N

For return stroke:

On the return stroke, when the pressure is applied to the reverse direction, the force on the piston due to the pressure is = P ×(A-a)

Where, P = Pressure in the cylinder (N/m^2)

A = Area of the piston (m^2)

a = Cross sectional area of the piston rod (m^2)

Therefore

Area of the piston (A-a)= $\{(\pi\times d^2)/4\}-\{(\pi\times d_1^2)/4\}$

= $\{(\pi\times 40^2)/4\}-\{\pi (\times 16^2)/4\}$

= 1256.6-201
= 1055mm^2

Force to be converted

On the reverse direction = pressure×area

= $0.4\times 10^5\times 1055$
= 42.2 N

For working pressure of 0.4×10^5 N/m^2

Extending force = **50.3 N,**

Retracting force = **42.2 N**

5.2. Design of cylinder thickness:

Material used = Cast iron

Assuming internal diameter of the cylinder = 40mm

Ultimate tensile stress = 250N/mm^2=2500gf/mm^2

Working Stress =Ult. Tensile stress/factor of safety

Assuming factor o fsafety = 4

Working stress(f_t) = 2500/4 = 625Kgf/cm^2

According to'LAMES EQUATION'

Minimum thickness of cylinder(t) = $ri\{\sqrt{(f_t+p)/(f_t-p)}-1\}$

Where,

ri= inner radius of cylinder in cm.

f_t = Working stress(Kgf/cm^2)

p = Working pressure in Kgf/cm^2

∴Substituting values we get,

$T = 2.0\{\sqrt{(625+6)/(625-6)}-1\}$

t = 0.019cm = 0.19mm

We assume thickness of cylinder = 2.5mm

Inner diameter of barrel = 40mm

Outer diameter of barrel = 40+2t

=40+ (2x2.5) = 45mm

5.3. Design of Piston rod:

Load due to air Pressure.

Diameter of the Piston (d) = 40 mm

Pressure acting (p) = 6 kgf/cm^2

Material used for rod = C 45

Yield stress (σ_y) =36 kgf/mm^2

Assuming factor of safety =2

Force acting on the rod (P) = Pressure x Area

$= p \times (\Pi d^2 / 4)$

$= 6 \times \{(\Pi \times 4^2) / 4\}$

P =73.36 Kgf

Design Stress (σ_y) = σy / F0S

$= 36 / 2 = 18$ Kgf/mm^2

$\sigma_y = P / (\Pi d^2 / 4)$

$\therefore d = \sqrt{} 4 p / \Pi [\sigma_y]$

$= \sqrt{} 4 \times 75.36 / \{\Pi \times 18\} = \sqrt{} 5.33$

= 2.3 mm

∴ Min dia of rod req for the load= 2.3 mm

We assume diameter of the rod = 15 mm

5.4. Length of piston rod:

Approach stroke = 160 mm

Length of threads = 2 x 20 = 40mm

Extra length due to front cover = 12 mm

Extra length of accommodate head = 20 mm

Total length of the piston rod = 160 + 40 + 12 + 20

= 232 mm

By standardizing, length of the piston rod= 230 mm

Material removal rate in conventional shaper machine

Work piece material - Mild steel

Initial weight of work piece - 0.401kg

Final weight of work piece - 0.391kg

Machining time - 20.5min

Density of work piece - 7.85*10^$^{-6}$kg/mm^3

Material removal rate= (0.401-0.391)/20.5*7.85*10^$^{-6}$

=62.14mm^3/min

Material removal rate in pneumatic shaper machine

Work piece material - Mild steel

Initial weight - 0.401kg

Final weight of work piece - 0.391kg

Machining time - 16.5min

Density of work piece - 7.85*10^$^{-6}$kg/mm^3

Material removal rate=(0.401-0.391)/16.5*7.85*10^-6

=77.21mm^3/min

6. ADVANTAGES

- Machining Time Reduced.
- Quick response is achieved.
- Simple in construction.
- Easy to maintain and repair.
- Cost of the unit is less when compared to other Machines.
- Comparatively the operation cost is less.

CONCLUSION

This machine consumes less time and can produce finished product in half the time taken by conventional shaper machine. This machine can only used for operating the work piece with less thickness, if high thickness material is used it will end up with improper finish and the tool may also get damaged. In future, few upgrades can be made for machining high thickness materials in this machine.

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