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LAYOUT AND DESIGN OF SPECIAL PURPOSE MACHINE FOR FLAT WORKPIECE SLITTING

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ABSTRACT: *To increase the productivity and to overcome shortage of skill labor, most of the manufacturing industries are going for automation. The objective of this project is to reduce the cycle time by replacing manual cutting by special purpose machine (SPM) for slitting operation. The concept is that the component having different size and thickness are having complexity on it after casting process we cut those flat surfaces by using slitting machine. The cutting operation performed by workers manually earlier but due to large number of quantity it takes so much of time. This paper gives the overview of layout & design of special purpose machine*

Key Words: **SPM, Slitting, Conventional tool, Layout, Clamping, Design**

INTRODUCTION

The Over the past century, manufacturing has made significant impact progress. New machine tools, high performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. Special purpose machine is part of multi-tasking machine. This is new approach to increase the productivity of industry and manpower. If we compare between ordinary machine and special purpose machine in terms of time, costs, number of steps involved, etc. The multi-tasking machine is preferred choice. Technology of SPM is decided upon the principles of cost reduction, increased productivity and optimized safety, better safety etc., which posses with high initial capital; more maintenance cost etc., special purpose machine is part of multi-tasking machine. This is new approach to improve the productivity of organization. If we compare between ordinary machine and special purpose machine in terms of time, costs, number of steps involved, etc. The multi-tasking machine is first choice. SPM is higher degree mechanism in which human involvement is replaced by mechanical, electrical, fluid power technologies capable of doing physical.

METHODOLOGY:-

1. Define the Problem

2. Do Background Research

3. Specify Requirements

4. Brainstorm Solutions

5. Choose the Best Solution

MACHINE LAYOUT

1. **MACHINE BED:-**

Machine Bed acts as housing for every element of machine. It absorbs the vibrations and shocks produced during the machining process. It should be rigid enough to handle. The bed is a strong base that connects to the headstock and permits the tailstock and carriage to be moved parallel to the spindle axis. This is smoothen by hardened and ground bed ways which restrain the carriage and tailstock in a set track.

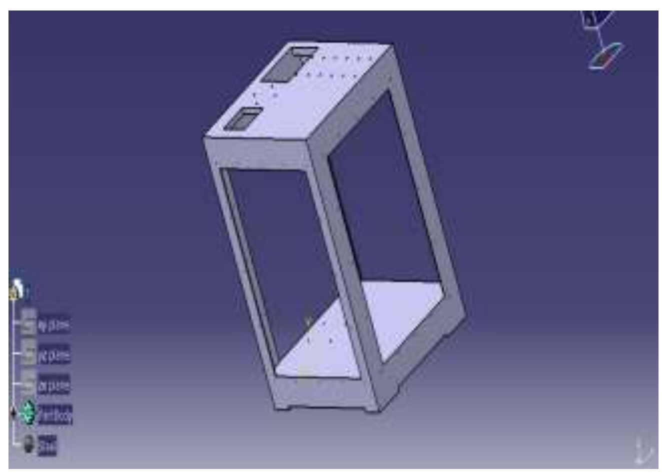

Fig.2: Machine Bed

2. CUTTER AND POWER TRANSMISSION SYSTEM

The power is transmitted from motor to the spindle assembly through the transmitters. It is an mutually joined linked system of shafts, gears and other electrical parts that form a bridge to transfer power and energy.. The oldest type of the transmission system is the manual transmission which has undergone several changes and alterations to form the present day transmission system of automated nature.

There are different types of transmission systems:

- Manually operated
- Semi-automatic
- Fully -automatic
- Continuously variable

We are here selecting here simple power transmission system that contains only Belt motor arrangement. It contains following parts

- Rotary Shaft
- Belts
- Motor
- Bearing

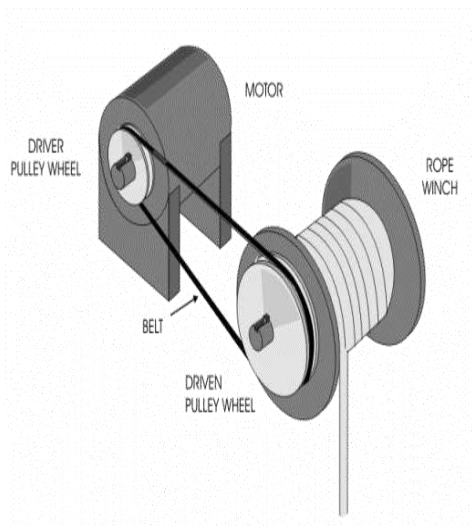

Fig.3: Power Transmission System

3. WORKPIECE P LACEMENT & CLAMPING ARRANGEMENT

Most fixtures have solid elements, attached to the floor or to the body of the machine and considered immovable relative to the motion of the machining bit, and one or more movable components known as clamps. These clamps allow work pieces to be easily hold in the machine or removed, and yet stay safe during operation. Many are also adjustable, permitting for work pieces of different sizes to be used for different operations. Fixtures must be designed such that the pressure or motion of the machining operation is directed primarily against the solid component of the fixture. This reduces the likelihood that the fixture will fail, interrupting the operation and potentially causing damage to infrastructure, components, or operators.

Fixtures may also be produced for very general or simple uses. These multi-use fixtures tend to be very simple themselves, often relying on the precision and obsolete of the operator, as well as surfaces and components already present in the workshop, to provide the same advantages of a specially-designed fixture. Examples include adjustable clamps, workshop vises, ,and improvised devices such as weights and furniture.

Each component of a fixture is designed for one of two purposes: location or support.

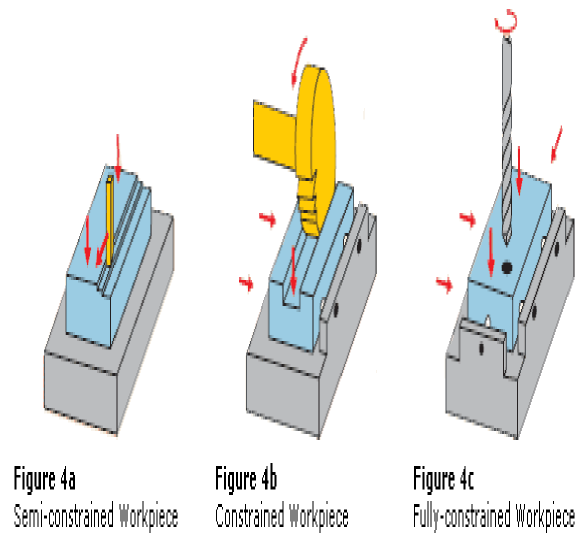

Fig.4: Work piece Placement

4. WASTE REMOVAL

The manufacturing region of the product life cycle starts when raw material enters the manufacturing system to be converted to a product. Loss of virgin material during production has a significant environmental impact in terms of

- The quantity of material lost,
- The associated economic price, and
- The environmental risk associated with the lost material.

It is important to point out at here that most forms of wastes are not easy to control. The chips generated in machining contain one such stream of material. Material losses during production processes occur due to chip formation. Since chip formation is an innate characteristic of machining processes, the production of chips is inevitable.

However the physical form of the material waste stream can be controlled.

Handling and disposal of the chips is dependent on their size, shape and texture. Chip shape influences the amount of cutting fluid carried away. It is more efficientlly viable to restore large amount of chips rather than small volumes. Another constraint in restoring is the decay of the stream due to the presence of dissimilar materials. Continuous chips are formed while cutting ductile metals such as steels, copper, iron, and aluminum. Shearing is the main phenomenon included in continuous chip formation. Chip formation takes place in the zone started from the cutting edge to the junction of the work and tool faces. This is called the primary deformation zone.

In case of brittle materials the displacement occurs in the primary deformation zone. This is due to huge strain in the workpiece. irregular chips thus formed are called discontinuous chips.

Fig. 5: Waste Removal

5. RAIL SYSTEM/ FEEDING ARRANGEMENT

Cross rail:

The cross rail is installed on the front of the machine body and can be moved up and down.. Sliding along the cross rail is a saddle which carries the work table.

Cross ways:

It contains horizontal table sideways which allow the functioning of table. It is attach with some cross movement mechanism.

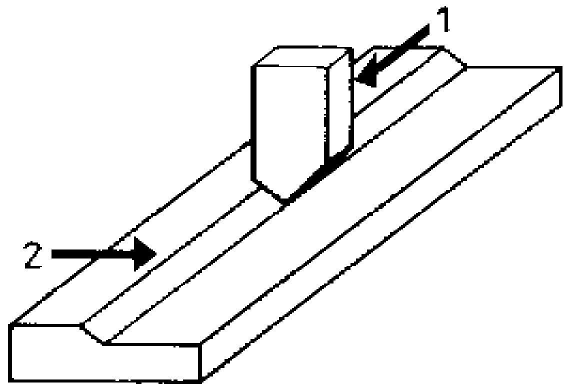

Fig. 6: Feeding Arrangement

DESIGN OF COMPONENTS:-

Size of cutter:

The outside diameter of the cutter D depends upon the arbor diameter, d, and thickness of the cutter ring, t, and the height of the cutting tooth, h, or the depth of the flute.

It is given as:

$D = d + 2t + 2h$

Generally the cutter diameter, D, is taken about 2.5 to 3 times the arbor diameter.

The face width of the cutter should be adequate so as to give sufficient support to the cutting edges.

Cutter hub diameter = d + 2 × thickness of body. = (1.5 to 2.5) × d

Diameter of plain milling cutters and the depth of cut are also interred related as follows:

D= 60 to 90 mm for depth of cut up to 5 mm

= 90 to 110 mm for depth of cut up to 8 mm

= 110 to 150 mm for depth of cut up to12

As size of the work piece is uneven and depth of cut is supposed to be maximum so we chose carbide cutter - 150 mm.

Number of teeth depends upon size of work piece. (Coarser, finer)

Selection of pulley diameters (d and D):

For power given select small pulley diameter (d) from V-Belt .then using the speed ratio, calculate the larger pulley diameter (D).

Speed ratio=D/d = N_1/N_2

As we required to keep same speed as motor we are taking speed ratio as 1 Larger pulley diameter, D = Speed ratio x d

Diameter of both the pulleys is 80mm

Approach Length of Cutter:-

AP = √ (d (D-d))

d =Depth of cut = 12mm

D = Diameter of cutter = 150 mm

AP =√ (12(150-12))

AP = 41mm

Slitting Time = (L+A)/f

f = feed rate =0.1 mm/sec

= (20+41)/0.1

= 610 sec

MRR = w*d*f

W =width of cut =5 mm

d =depth of cut = 12 mm

Feed rate = 0.1mm/sec

MRR = 5*12*0.1

MRR = 6 mm^3/sec

Force required cutting work piece (F):-

F = τ * (Shearing Area)

τ = Shear strength in Mpa =70 Mpa

Shearing Area = (40/120)

F =233.333N

Torque Required (T):-

T = (F * r)

r = radius of cutter =75mm

T =233.33*0.75

T =175 Nm

Power Required (P) in hp

P = ((2πNT)/60)

N =RPM of Cutter =720 RPM

P =1.3194 KW

P =1.5 HP

Hence 1.5 hp motor is selected

Selection of Belt:-

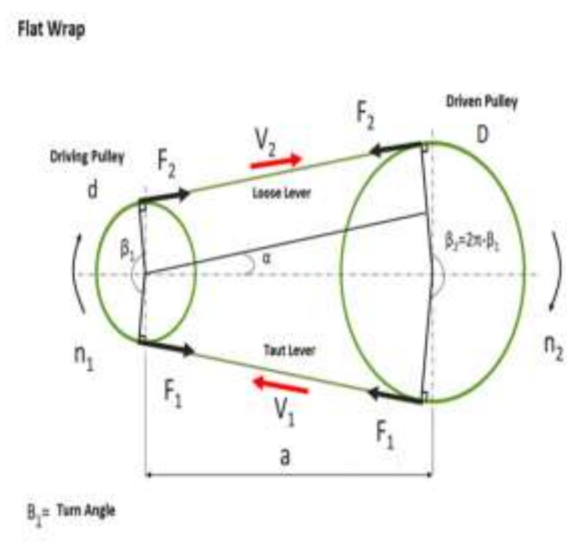

Fig.7. Belt design

$$Length = 2C + \frac{\pi(D_1 + D_2)}{2} + \frac{(D_1 - D_2)^2}{4C}$$

C =Center distance of pulley =475 mm

D_1 = Dia of Pulley at motor = 31 mm

D_2 =Dia of Pulley at Shaft/ Arbor = 62 mm

Length = 1097 mm

Angle of contact (α) =((180- 2β)(π/180))^c

Sinβ = (D_1/2C)

β =1.87º

α =3.0731^C

Belt Velocity (V)

V = (πD_1N)/60

V =2.36 m/sec

Tension in Belt (P_1, P_2)

P_1 =Tension on tight side

P_2 =Tension on Slack side

Coefficient of friction (μ) = 0.3 for leather

$P_1/P_2 = e^{\mu\beta}$

P_1 =2.5118P_2

Power Transmitted = (P1 – P2)*V

P= 1.3194Kw

P_1=927.4 N

P_2 =368.29 N

Stress developed in Leather Belt (σ)

σ_u = Ultimate tensile stress of leather =37.4733 Mpa

σ = P_1/ (b*t)

b= breadth of belt =13mm

t = thickness of belt =8.5mm

σ =8.39 Mpa

Hence stress generated is less than ultimate strength

Hence safe design

Forces on Bearings (B_1, B2):-

Resoving forces in verticle direction

$B_1 + B_2$ +234 – 1295 =0

$B_1 + B_2$ =1061

Taking Moment about bearing 2

1295*126 – B_1*55 + 234*162 =0

B_1 = 3655.9636 N

B_1 =3.65 KN

B_2 =-2.59 KN

Diameter of Shaft (D_s):-

Yield strength of EN24 =680Mpa

Factor of Safety =3

D_s = 25 mm

M =91947 Nmm

$$\sigma = \frac{32 * M}{\pi d3}$$

σ_{actual} = ((91947*32)/(π*25^3)

σ_{actual} =59.94 Mpa

σ_{design}=680/3

σ_{design}= 226.3 Mpa

σ_{actual} less than σ_{design}

Hence it is safe design.

CONCLUSION

The design of SPM is will be very useful for small scale industry. There are machine based on cutting flat surfaces but it has demerits like large in size, costly, need skilled labors to operate. But we have our machine which will overcome this demerit by compact size, less cost no need for skilled people. The main aim of this machine is to reduce timing for manual cutting and reduce the efforts. This aim can be achieved by our machine

Discussion

Once you connect motor to power and power switched on. The motor starts running. Through the belt the power is transmitted to the shaft. The shaft is connected to cutter. The cutter will start rotating. Now with use of clamping system you can clamp the work piece to the rail system.

After clamping work piece you can feed work piece to the cutter. The extra material will get cut and removed through tray runner

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