Design and Analysis of Screw Driver Slot Milling Machine (SPM)

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Abstract – This paper discusses design and analysis of "Screw Driver Slot Milling Machine". It is well known that the slots can be done by various machines like milling machine, slotting machine, shaper, planer, slotter, EDM and by using various attachment on lathe machine and drilling machine. Major disadvantage of these methods is, these processes can't be used for mass production due to more setting time of work-piece. Considering the limitations of current methods of slotting, in this research a SPM is designed. This SPM is continuous moving machine used for mass production with reduced production time and less fatigue to workers**.**

INTRODUCTION

A screw drive is a system used to turn a screw. At a minimum, it is a set of shaped cavities and protrusions on the screw head that allows torque to be applied to it. Usually, it also involves a mating tool, such as a screwdriver, that is used to turn it. The slot screw drive has a single slot in the fastener head and is driven by a "common blade" or flat-bladed screwdriver. Uniquely among common drives, it is straightforward to manufacture a slot head or drive by hand.

These slots can be produced by different methods viz. milling, slotting, shaper, planer, EDM, etc. and also on lathe machine and drilling machine by sing various attachments. Major disadvantage of these methods is, these processes can't be used for mass production due to more setting time of work-piece.Therefore, sophisticated machines and modern techniques have to be constantly developed and implemented for economical manufacturing of products.This machinecan produce slots with less time and less cost, also it reduces fatigue to worker.

2. LITERATURE REVIEW

[1] Keyurbhai K. Maniya-He has developed an automatic mechanism for conventional slotting machine. After loading the work-piece the worker have to only pre define the desired no of slot required on the work-piece

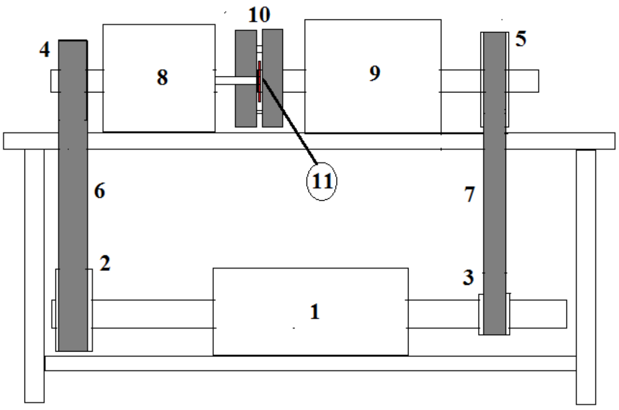
[2] Patel Kiran- He has developed Semiautomatic slotting machine which reduces the consumption of time required to perform slotting operations and also reducing fatigue on worker, therefore production rate will also get increase.

[3] Harvinder lal, Heera Lal, S. S. Sehgal- This paper provides a summary of the three types of manufacturing processes currently being used in the fabrication of micro channels. The three micromachining techniques compared in this research are wire-cut EDM, micro-slotting and micro milling.

[4] Mr.Malvaniya Jay -This paper aims to help the small scale production floors where a drilling machine exists and the scope of work extends to be done on a slotting machine also. Using this project slots can be cut on work pieces using a drilling machine. This project is an attempt to design and fabricate an attachment for drilling machine which would produce square and polygonal holes much easier than the currently available methods.

[5] P. Sivasankaran -The objective of this research is to design and develop an attachment to do slotting/ milling operation in lathe. The attachment designed and developed in this research will add the above two features in lathe, which will help small industries to avail the existence of lathe for such operations.

3. CONSTRUCTION AND WORKING



1. Pulley On Motor Shaft To Drive Cutter
2. Pulley On Motor Shaft To Drive Gear Box
3. Pulley On Cutter Shaft
4. Pulley On Gear Box Shaft
5. Belt To Drive Cutter From Motor
6. Belt To Drive Gear Box From Motor
7. Both Side Extended Shaft Motor
8. Cutter Holder
9. Gear Box
10. Job Holding Plates
11. Cutter
12. Fabricated Table

Above fig. shows that schematic diagram of machine.in this operation of machine we require rotary motion to cutter and job holding plate assembly. But cutter requires high speed for cutting and holding plates require low speed for ease of loading to the worker.Instead of sing two separate motors a single both ended shaft motor is used. Cutter requires diff. speed for diff. materials so step cone pulley and belt drive arrangement is provided to one end of motor.

Holding plates are require to move at speed 16rpm. But speed of motor is 1500 rpm. So it reduced by using chain drive and gear box. Worker only has to insert the screw in the v blocks. As holding plates rotates. They are pressed against each other due to pressure rollers from both sides. So it automatically lock the screw. Depth of slot can be controlled by adjustment screw in the v-block.This screws are fed against cutter for cutting a slot. After cutting a slot as the plates pass the pressure roller pressure on plates is released and screw falls down due to gravity.

4. DESIGN CALCULATIONS:-

1) For Plates- En19 Steel Din

Density 7800 Kg/m^3

2) For V Notch Plate- Dim. 250*30 mm

Volume = (Π/4)*0.25*0.25*0.03

V = 0.001473 m^3

Mass = Volume*Density

= 0.001473*7800

= 11.48 Kg

3) For V Block Plate- Dim. 250*15 Mm

Volume= (Π/4)*0.25*0.25*0.015

=7.3631*$10^{-4}$$m^3$

Mass = 5.7432 Kg

4) V Blocks

Material Used-OHNS (Oil Hardened Nickel Steel)

Density = 8670 Kg/m^3

Volume = 50*56*15*10^{-6}

3.75*10^{-5} m^3

For 1 Mass= 0.3285 Kg

For 8 Mass= 0.3285*8

= 2.628 Kg

5) V Notch

Material Used – OHNS

Density = 8670kg/m^3

Volume= 50*50*25*10^{-9} m^3

= 625*$10^{-7}$$m^3$

For 1 Mass = 0.5475kg

For 8 Mass = 0.5475 *8

=4.38kg

6) Dowel Pins & Shaft

Material Used- En (8D)

Density = 7850kg/ m^3

Dim = 10^{-2} *100mm

Volume = (Π/4)*0.1^2*0.1 =7.85*$10^{-6}$$m^3$

Mass = 0.01615kg

Mass = 0.016164 Kg *4 =0.246615

7) Screw

Material Used – Mild Steel

S_{yt} = 400mpa

S_{ys} =0.5*400 =200mpa

Max Slot Size = 3mm*3mm

Power required at cutter:

HP at cutter = MRR/K

MRR = Ap1*Ae*V_fDepth of Cut= Ap1= 0.3cm =0.1181 Inch Width of Cut =Ae= 0.3cm=0.1181Inch
Feed=V_f= (1*8*16)/2.54V_f = 50.3937 inch/min

MRR = Ap1*Ae*Vf
= 0.1181*0.1181 *50.3937
=0.702871 Inch^3/Min

HPC = MRR/K

K– Power constant that means number of cubic inches of metal per minute that can be removed by one hp.
K– Varies depending upon hardness of the materials.

Material of Screws:-MS
BHN – 120 Hb
For Hb 0 = 0-120 Hb = Steel, Plain contain Alloy Steel
K = 1.64
HPC=0.702871/1.64
=0.4285 Hp
Power required at cutter is **0.4285 Hp**to cut slot.

Starting Torque Calculations:

Now starting torque:
W_1= 0 rad/sec
W_2= (2* Π*16)/60
= 1.6755 rad/sec

The plate should achieve this angular velocity within 10 sec.
Starting Acceleration:
= $(W_2-W_1)/t$
= (1.6755)/10
=0.16755rad/sec

Mass Moment Of Inertia:

1. For plates:
   V notch plate:
   $I = (MR^2)/2$
   $= (11.48*.125^2)/2$
   $=0.08968$ kgm^2
   V block plate:
   $I = (MR^2)/2$
   $=(5.7432*0.125^2)/2$
   $=0.044868$ kgm^2
2. V blocks:
   Mass of 8 blocks= 2.628kg
   $I = MK^2=2.628*(0.125-0.025)^2$
   $=0.2628$kgm^2
3. V notch :
   Mass of 8 notches = 4.38 kg
   $I = MK^2=4.38*(0.125-0.025)^2$
   $=0.0433$kgm^2
4. Dowels pins:
   Mass of total pins = 0.2466kg
   $I = MK^2=0.2466*(0.05)^2$
   $=6.165*10^{-4}$ kgm^2.

Torque required to rotate these parts

1. V Notch Plate
   Torque T_1 = I* α
   =0.08968*0.16755
   =0.015025 Nm
2. V Block Plate :
   Torque T_2 = I*α
   =0.044868*0.16755
   $=7.5178*10^{-3}$ Nm
3. V Block
   Torque T_3 = I*α
   =0.02668*0.16755
   $=4.47*10^{-3}$ Nm
4. V Notch Block
   Torque T_4 = I*α
   =0.0438*0.16755
   $=7.338*10^{-4}$ Nm
5. Dowels Pins :
   Torque T_5 =I*α
   $=6.165*10^{-4}*0.16755$
   $=1.0329*10^{-4}$ Nm

Total Starting Torque $=T_1+T_2+T_3+T_4+T_5$

$$= 0.015025+7.5778*10^{-3}+4.47*10^{-3}+7.338*10^{-3}+1.0329*10^{-4}$$

Total Starting Torque=0.034454 Nm

5. COMPONENT SELECTION

5.1 MOTOR

Motor is selected for required power for cutter and starting torque. Double shaft motor is selected, one shaft for automatic feed and other for cutter drive.

Motor with following specifications is selected,

1. Phase 3 phase
2. Speed 1440 rpm
3. Motor voltage 220 V
4. Frequency 50 Hz
5. Power 1 HP
6. Quantity 1 no.

5.2 BELT & PULLEY

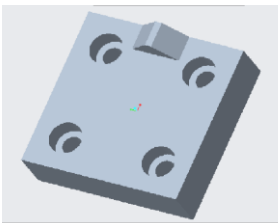
Cutter requires different speed for different work-piece material and different thickness of cutter i.e. for different slot size. To provide cutter with variable speed arrangement, step cone pulley arrangement is used. Step-pulleys of standard size are selected for speed range 1440-700rpm.

5.3 CHAIN DRIVE

Automatic feed mechanism is required to be rotated at relatively low speed up-to 16rpm. So motor speed is reduced in 2-stages by using gearbox and chain drive. Motor speed is reduced to 1220rpm by chain drive with 2:1 gear ratio.

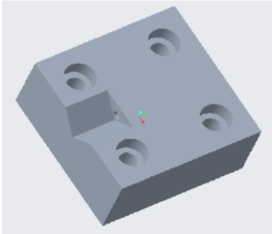
5.4 GEARBOX

Helical Gearbox with 1:46.9 reduction ratio is selected.



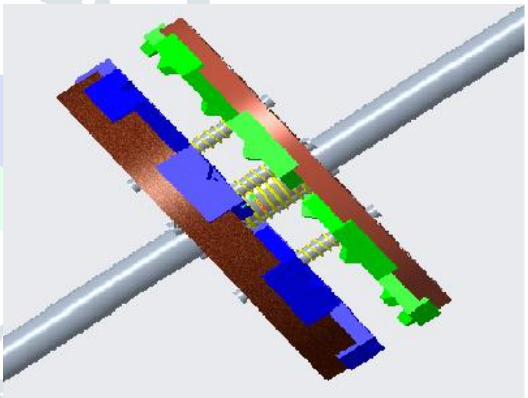
5.5 V-BLOCK

V-Blocks are precision metalworking jigs typically used to hold round screw shanks for performing milling operations. V blocks used are blocks of OHNSmaterial. V-blocks are of size 50*50 mm of are used.



5.6 HOLDING PLATE ASSEMBLY

Holding plate assembly consists of 2-plates of 250mmdia. Plates have 8 square slots of 50mm size for accommodating v-blocks. 2-plates are held together by locknuts. Helical springs are used to keep plates apart for inserting and unloading of screws. Two rollers are pressed against plates to apply pressure for holding screws during cutting process.



6.FUTURE SCOPE

Currently this machine is semi-automatic because screw inserting in the v blocks is done manually by the worker. To make machine automatic use of hopper is necessary to insert screws in V-blocks.

7.CONCLUSION

Using this slot milling machine we can achieve:

1. Better productivity
2. Accuracy
3. Precision with less worker fatigue
4. Initial investment cost is low.

8. REFERENCES

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