International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 05, May 2016
www.ijates.com
ijates
ISSN 2348 - 7550

DESIGN AND ANALYSIS OF A TYPICAL DUPLICATING MACHINE

Dr. H. K. Amarnath[1], Ravi Kumar Bajantari[2], Raj Mundada[3]
Suyash Khot[4], Varun Manurkar[5]
[1,2,3,4,5]*Department of Mechanical Engineering*

ABSTRACT

A new duplicating machine that will allow individuals to easily and accurately cut the material, various shapes can be form; lettering and different type of materials can be cut or other work pieces. The invention has a unique and rigid duplicating mechanism, having a stylus and motorized cutter mounted upon a rigid "U"-shaped frame, combined with a simple and accurate alignment system, in which the U-frame pivots upon a transverse bar which is aligned upon side rails in the manner of a T-square, enabling the duplicator to easily and accurately other item from a three-dimensional master. The duplicating machine of the invention is very simple to set up and operate. The average craftsman will be able to quickly and precisely shape a work piece—any design from violin faces, electric guitar bodies or scroll work on cabinet doors, to airplane propellers, to name only a few. Only sanding is required to achieve the finished shape.

Keywords: Duplicating Machine, Letter Carvings, Multipurpose Operation, Small Scale, Design Of Various Components

Objectives

- To develop a device which can help in mass production and help out in to increase productivity
- To develop a device this can make work simple.
- To develop a device which can be used for multipurpose operations
- To develop a device which can work in many degrees of freedom
- To develop a device which can run cost efficient
- To make a device which is suitable economical for small Scale industries: taking in to consideration the cost factor this device is suitable for small scale as well as big scale industries.
- Taking safety as prime consideration: This device is safer in all respects

Components Of Device

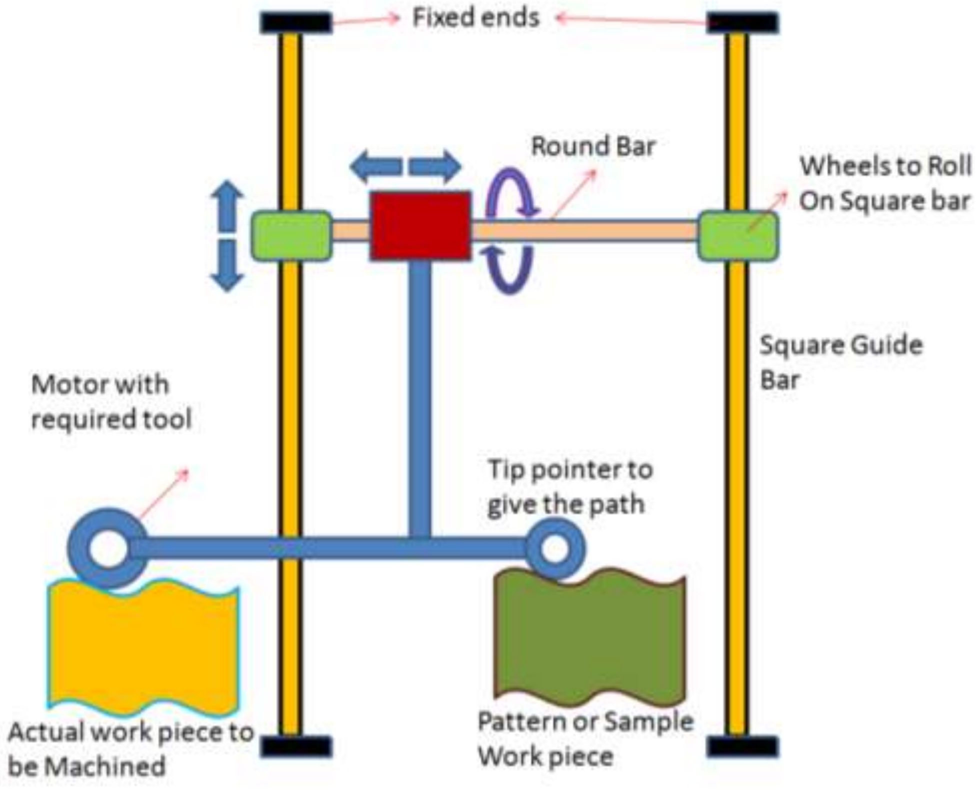
- Motor
- Cylindrical bearing
- L angle
- Rectangular tube
- Shaft

- Tube
- chuck
- chuck spindle
- wooden sheet
- Fasteners
- Spring

I. WORKING

This machine is specially meant to produce a duplicate of a object or and work piece in this machine works on simple mechanism the operation will be fast and with great accuracy can be achieved in traditional method the we use various machine for different operations but this machine can do many operation with great accuracy and saving the time and making work simple. This machine just consists a motor which runs on electricity and it is attached to one arm and another arm end a pointer or tip that tip is meant just to move on the required pattern and the motor or the tool is attached to the motor this tool will cut the material or trim the required shape according to the pattern the machine operation is very simple and any person can operate this machine we have thought this concept in order to overcome errors in the work piece and which can be used in increasing the productivity of an origination in which this machine can use a sample work piece, a rubber patter, plastic pattern, wax pattern, then cardboard and even drawing also can work out with this machine.

Diagram



1.1 Design Procedure

Before we proceed to the process of manufacturing, it's necessary to have some knowledge about the project design essential to design the project before starting the manufacturing. Maximum cost of producing a part of product is established originally by the designer. The product consists of:

- Functional Design.
- Product Design.
- Engineering Design.

1.2 Design procedure for a product:[5]

When a new product or their elements are to be designed, a designer may proceed as follows:

- Make a detailed statement of the problems completely; it should be as clear as possible & also of the purpose for which the machine is to be designed
- Make selection of the possible mechanism which will give the desire motion.
- Determine the forces acting on it and energy transmitted by each element of the Machine
- Select the material best suited for each element of the machine.
- Determine the allowable or design stress considering all the factors that affect the Strength of the machine part.
- Identify the importance and necessary and application of the machine.
- 7 Problems with existing requirement of the machine productivity and demand
- Determine the size of each element with a view to prevent undue distortion or breakage under the applied load.
- Modify the machine element or parts to agree with the past experience and judgment and to facilitate manufacture.
- Make assembly and detail drawings of machine with complete specification for the materials and manufacturing methods i.e. accuracy, Surface finish etc

II. DESIGN CALCULATIONS

2.1 Design Of Bolt[1,2,3]

The bolts are used for fixing the connections which can be used as temporary joints. Bolts are been used as they can be removed and properly adjusted as per the requirements.

Bolt is to be fastened tightly also it will take load due to rotation.

Stress for C-25 steel f_t =120 N /mm$^{2.}$ Std nominal diameter of bolt is 8 mm.

Let us check the strength: -

Also initial tension in the bolt when belt is fully tightened

P = 1420 d N

P = 1420 x 8 N

P = 1420 d N

P = 11360 N

Therefore the total load on bolts

P = 11360 + 500 N

P = 11860 N

Being the four bolts the load is shared as

P= 11860/4

=2965 N.

Also,

$2965 = (\Pi /4\ dxc^{2)})\ x\ f_t$

$2965 = (\Pi /4)\ (8x\ (0.84)^{2)})x\ f_t$

$f_t = 83.59\ N / mm^2$

The induced f_t 83.59 N / mm^2 is less than the maximum ft 120 N /mm^2 hence our design is safe.

2.2 Design of angles[2,3]

Here, The maximum load due to all factors = 450 kg (including friction)

F= 450kg = 450 x 9.81 = 4414.5 N.

We know that he load on each link,

F1 = 4414.5/4 = 1103.63N.

Assuming a factor of safety as 3, the links must be designed for a buckling load of

W_{cr} = 1103.63 x 3 = 3310.9 N

Let t_1= Thickness of the link

b_1= width of the link

So, cross sectional area of the link = A = $t_1 x\ b_1$

Assuming the width of the link is three times the thickness of the link, i.e.b_1= 3 x t1

Therefore

$A= t_1 x\ 3\ t_1 = 3\ t_1^2$

And moment of inertia of the cross section of the link,

$I = 1/12\ t_1 b_1^3$

$= 2.25\ t_1^4$

we know that $I = AK^2$, where k = radius of gyration.

$K^2 = I/A = 2.25\ t_1^4 / 3\ t_1^2 = 0.75\ t_1^2$

Since for the buckling of the link in the vertical plane, the ends are considered as hinged,

therefore, the equivalent length of the link

L = l = 600 mm.

And Rankin's constant, a = 1/ 7500

Now using the relation,

$$Wcr = \frac{f\ x\ A}{1 + a\ (\ L / K)^2}$$

with usual notation,

Here f = 100 N / mm^2

$$3310.9 = \frac{100 \times 3 \times t_1^2}{1 + (1/7500)\ (600^2/0.75t_1^2)}$$

$$3310.9 = \frac{300\, t_1^2}{1 + 64/t_1^2}$$

$300\, t_1^4 - 3310.9\, t_1^2 - 64 \times 3310.9 = 0$

$t_1^2 = 41.2$

$t_1 = 6.418$ mm

$b_1 = 3 \times t_1 = 3 \times 6.418 = 19.25$ mm.

But the standard angle available of 35x 35 x 3

Hence for safer side we have selected it. This can bear the impact loading. Hence our design is safe.

2.3 Design of Bearing[1]

Depending upon the nature of contact the bearing lies in I contact bearing .here contact is rolling one .the advantage of bearing here is that it has low starting friction due to this , we also call it an antifriction bearing.

The bearing used is cylindrical bearing

D =25mm

Fa =100 N

Fr = 250 N

Nd =150 rpm

Proposed bearing SKF

Required life =1000 hours

From table 24.60 for SKF 6204

Basic static load rating capacity C_{or} =7800 N

Basic load rating capacity C_r= 14000 N

Fa/C_{or}= 100/7800=0.01282

Assume minor shock & bearing works at normal temperature

Kt=1 from table 24.29. For minor shock load application factor Ka=1.5

Therefore Fe =Fr*Ka*Kt

=250*1*1.5

=375

Dynamic load rating C_r $= Fe\ \{(Ld/Lr)\ (Nd/Nr)\}^{1/m}$

Lr = Rated life =500 hours

Nr = Rated speed =33.33 rpm

C_r = 14000 N; m=exponent = 3 for ball bearing

14000 $=375\{(Ld/500)(150/33.33)\}^{1/3}$

$(14000/375)^3$ $= (Ld/500) *(150/33.33)\}^{1/3}$

International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 05, May 2016
www.ijates.com
ijates
ISSN 2348 - 7550

Therefore Ld = 1605.98 hours

Since designed life is more than the require life, the selected bearing is suitable. Hence the proposed SKF 6204 is suitable for the expected life of 1000 hours.

2.4 Design Of Spring[1,2,3]

For a rod of 25 mm the spring coil diameters chosen is

D =32mm

& wire dia of 2mm.

If a load of 350 N is applied then,

Solid length

$Ls = n^1 * d$

$n^1 = n+2$ for grounded ends.

Where as spring index,

C=D / d =32 / 2

= <u>16mm</u>

T = W x (D / 2)

= 350 x (32 / 2)

= 5600N-mm

$Fs = 8\ W\ D / \pi\ d^3$

$= (8 \times 350 \times 32) / \pi\ 2^3$

$= 3565.07\ N/mm^2$

The spring is going to fail in shearing

Direct shear force due to load

$= 4\ W / \pi\ d^2$

$= 4 * 350 / \pi\ 2^2$

$= 47.746 N/mm^2$

The defection of spring.

$\varsigma = 8\ W\ D3\ n / Gd^4$

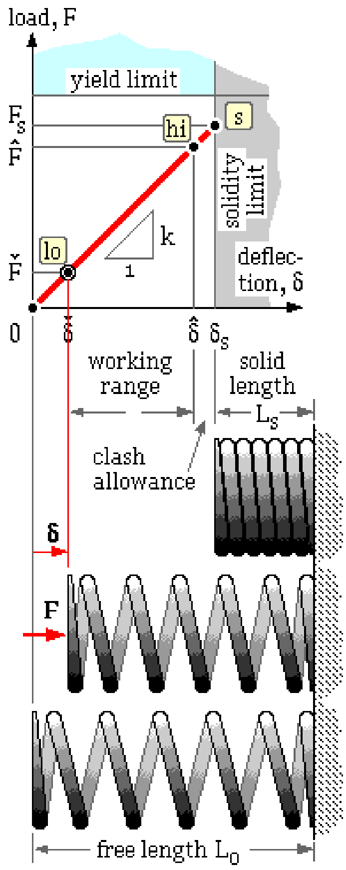
$\varsigma / n = 8WD3 / Gd^4$

Assuming G = modulus of rigidity = $80 \times 10^3\ /mm^2$

Defection per active turn

$\varsigma / n = 80 \times 350 \times (32)^3 / 80 \times 10^3 \times (2)^4$

= <u>71.68mm.</u>



© 2000 DOUG WRIGHT, UWA

DESIGN OF SPRING[1,2,3]

The outer coil diameter of the spring is chosen as 32 mm and wire diameter of spring is 3 mm

$D_0 = 32$ mm d = 3 mm

Mean dia of spring D = 32 - 3

= 29 mm

Spring index C = (D / d)

= 29/3

= 9.666

Considering effect of curvature, using WAHL's stress factor

K = ((4C -1) / (4C- 4)) + (0.615 / C)

= ((4 x 9.666-1) / (4 x 9.666 - 4)) + (0.615 / 9.666)

= 1.0636

Using maximum shear stress

For alloy steel f_s = 480 N/mm^2

$f_s = k\ 8\ w\ c / (\pi\ d^2)$

$480 = 1.0636 \times 8 \times w \times 9.666 / (\pi \times 3^2)$

W = 165.013 N

Since the load on the spring is less than the applied load, the design is safe.

Number of turns n =6

Deflection of the spring is given by

$\varsigma = (8wc^3n) / (Gd)$

$= (8 \times 165.013 \times 9.666^2 \times 6) / (84 \times 10^3 \times 3)$

= 28.38 mm

Solid length $L_s = n^l.d$

$n^l = n+2$ for square and grounded ends

= 6 +2=8

$L_s = n^l.d$

= 8 x 3

= 24 mm

Free length of the spring is given by

$L_f = nl.d + \varsigma + 0.15\ \varsigma$

= 24 +28.38 + 4.25

= 56.63 mm

Pitch of the coil is given by:

$P = L_f / (n^l -1)$

= 56.63/8-1

= 8.09 mm

2.6 Design Of Welded Joint[1]:

Checking the strength of the welded joints for safety

The transverse fillet weld welds the side angles.

The maximum load which the plate can carry for transverse fillet weld is

$P = 0.707 \times S \times L \times f_t$

Where, S = factor of safety, L = contact length = 35mm

The load is 50 kg = 500N

Hence, 500 = 0.707 x 3 x 35 x f_t

Hence let us find the safe value of 'f_t'

$$\text{Therefore } f_t = \frac{500}{0.707 \times 3 \times 25}$$

f_t = 9.42 N/mm^2

Since the calculated value of the tensile load is very smaller than

The permissible value as ft=56 N/mm^2. Hence welded joint is safe.

2.7 Motor shaft design[1]

The device is incorporated with 1 /10 HP motor, then

1/10HP = 0.0735KW

= 0.0135 X 10^3 w

= 73.5 w

Specifications

Using motors catalog for 1/10HP motor, N =1500rpm

P = 2ΠNT / 60

73.5 = (2Π x 1500 x T) / 60

T = (73.5 x 60) / (2Π x1500)

T = 0.4679N-m

T = 0.4679 X10^3 N-mm

T = 467.9155 N-mm

The material being used for the shaft is mild steel

Yield stress σ_y= 380 Mpa for M S Material

Shear stress f_s= σy / (2 x FOS) (FOS=factor of safety)

=380/242

= 95Mpa

T / J = GΘ/L = f_S/ R

T / J == f_S / R

T = (π/16) x f_S x d^3

467.9155 = (π/16) x 95x d^3

d= 2.9mm

d= 12mm

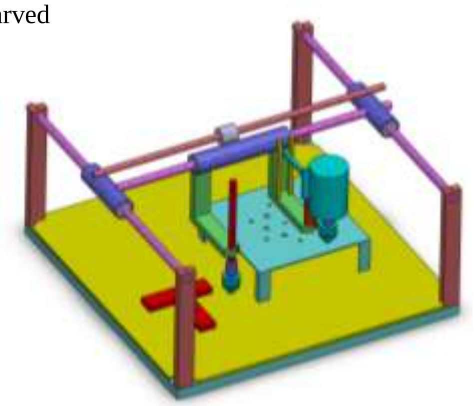
Taking diameter of shaft as 12mm for the motor because the bearing available is size id 12mm so we selected the diameter 12mm hence the design of the motor shaft is safe.

Advantages [6,7]:

- Easy in operation.
- High initial cost operating cost is less
- Simple construction.
- Adaptable.
- High capacity.
- High Performance.
- Time saving
- Easy to setup
- Light weight.
- Easy maintenance.
- No Skill worker required

Applications [6,7]:

- Wood patterns can be prepared
- Metal patterns or work pieces can be prepared with various shapes
- Plastic patterns can also be cut
- Thermocol patterns or shapes also can be prepared
- Different Lettering can be carved



REFERENCES

[1] H. G. Patil - Design Data Hand Book –Shri. Shashiprakashan, Belgaum,4th Edition 2007

[2] K Mahadevan and Balaveera Reddy- Design Data Hand Book- CBS Publication,3rd Edition, 2010

[3] R. S. Khurmi & J. K. Gupta - Machine Design- Eurasia publishing house New Delhi,14th Edition, 2008

[4] T.R. Banga & S. C.Sharma – Industrial Organization and Engineering Economic (Estimation & Costing) Published by Romesh Chander Khanna, New Delhi 24th Edition 2006

[5] Theory of Machine –Rattan S.S Tata - McGraw Hill Publishing Company New Delhi,2nd Edition,2006

[6] http://en.wikipedia.org/wiki/File:Pantograph_2X

[7] http://www.ebay.ca/sch/sis.html?_kw=Wood+carving+duplicating+machine+with+3+D+attachment

[8] CHEN Jie\ \ ZHANG Qing (Department of Mechanics,Anshan Teachers College,Anshan Liaoning 114005,China);Calculation of Cutter-position Point in Rough Process of Digital-control Lathe[J];Journal of Anshan Teachers College;2001-03

[9] ZHAO Ying cai, ZHANG Hong lian, ZHANG Jin (North China Electr.Power Univ.,Baoding 071003,China);The Application for Adaptive Cut Technique in the Steam Turbine Manufacturing Process[J];JOURNAL OF CHANGSHA UNIVERSITY OF ELECTRIC POWER(NATURAL SCIENCE);2000-01

[10] J.J Paulsen, J.M Giachino: "Powertrain sensors and actuators: driving towards optimized vehicle performance", IEEE Vehicular Technology Conference, San Francisco 1989, v.2 p.574

[11] N. Stanton, P. Marsden: "From fly-by-wire to drive-by-wire: safety implications of automation in vehicles", Safety Science, October 1996, v.24 n.1 p.35

[12] R.A. McCann, J.R. Suriano: "Optimized design and 3D Finite Elements Analysis of a Rotary Actuator", Industry Applications Society Conference, Orlando 1995, v.1 p.492

[13] F. Profumo, Z. Zheng, A. Tenconi: "Axial flux machines drives: a new viable solution for electric cars", IEEE Trans. on Industrial Electronics, February 1997, v.44 n.1 p.39

[14] T.T. Vekara, J.T. Eriksson, J.T. Tanttu: "Dynamic model of an electromagnetic massive core brake actuator", IEEE Trans. on Magnetics, May 1996, v.32 n.3 p.1970

[15] L. Zipser, L. Richter, U. Lange: "Magnetorheologic fluids for actuators", Sensors and Actuators Journal, Elsevier Sceince 2001, p.318