Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 4, April-2017

DEVELOPMENT OF LEAF-SPRING OPERATED POWER HAMMER

Savant Akash[1], Shrimali Khushvant[2], Saundarva Vikas[3], Yadav Hukumchand[4], Mr. Vatsal Patel[5]

[1-4] Student, Department of Mechanical Engineering, Pacific School of Engineering
[5]Assistant Professor, Department of Mechanical Engineering, Pacific School of Engineering

***Abstract* — The manufacturing and fabrication process play a very important role in development of any organization or company as well as for our country. The fulfillment of any production activity based on the productivity of the system is to increase the productivity in industry, the human interruption or load on the worker should be minimum. With the objective of this work we will develop the power hammer based on the eccentric mechanism and using leaf spring as a lever. The purpose of the system is to assist in smithy work as well as forging/ Embossing of hard material.**

Keywords- Motor, Pulley (2", 18"), Axle, Eccentric-Mechanism, Mono Leaf-Spring, Hammer

I. INTRODUCTION

It is a special purpose machine which is made as per the customer's specific requirement. It is designed for getting higher efficiency and economy in desired condition. The recent development in digital technology have now embeds us to make low cost machines for real time application. As the hammers are useful tool that are capable of braking hard and soft metals.

A hammer is basically a force amplifier that works by converting mechanical work into kinetic energy and back.Power hammer are mechanical hammer that use a external power source (motor) to raise the hammer to striking and accelerate it onto the work being hammered.It minimizes the operation time, human fatigue due to repetitive operation, product cost, also increases the productivity and assures the quality.

The forging is the very old technique of manufacturing in which conventionally metal rod is heated and then hammered by black smith, but nowadays with improvement in technology that manual operation is replaced by power hammer which is normally electric motor. Speed of power hammer is adjustable as per requirement.

A typical power hammer consists of a frame, an anvil, and a reciprocating ram holding a hammer or die. The workpiece is placed on the lower anvil or die and the head or upper die strikes the workpiece

During the visit to engineering works, agricultural machinery division I have seen various process activity machines which they are using for production. We saw a worker hammering the component by manual with the help of hand held hammer, this process of hammering takes more time for the operation of other work. When the worker hammering the metal there was lot's of possibility of getting physically damaged.

During the visit of agriculture we saw that farmer cutting the crops with the help of agricultural tool after working some hours the tool gets dull/rub then the farmers uses stone for resharpening the tool, this take more time and there was also safety issue to get physical damage.

1.1.1 Objectives:

- To perform various operation faster and it will be time efficient.
- To increase the production rate hence productivity.
- It should be easily affordable.
- To perform smooth operation.
- Physical effort should be less.
- It should be easy to operate.
- Last but not least it should be safe for operator during operation.

II. MECHANISM FOR POWER HAMMER

Spring Helve or Feather Hammer

The spring helve was a popular design in Europe for commercial and DIY blacksmiths hammers and has only recently become popular in the US due to the plans for the Appalachian "Rusty" series. There are numerous variations but the geometry is always the same with the exception of the ram link shown. Springs are most often straight or slightly bowed and have extra leaves on both top and bottom. Couplings vary most often clamping to the springs and the front of many hammers simply have the leaf spring going through a slot in the ram. Sometimes this has roller bearings but most often not. The advantage of this arrangement is that it results in a short machine. The disadvantage is that it has a large footprint compared to vertically configured hammers.

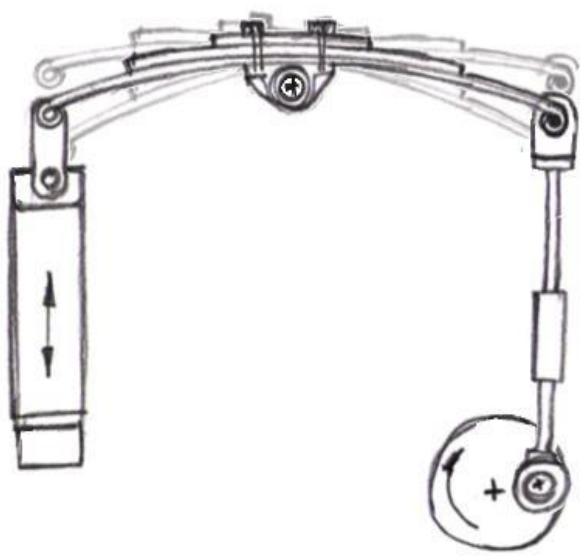

Fig 2.1 Springs Helve or Feather Hammer

III. DESIGN

3.1. CONSTRUCTION:

It consists of a motor of 0.5Hp having 1440rpm, a small pulley of dia. 2" is mounted on the motor shaft. The small pulley is connected to the 18" larger pulley via belt drive. The larger pulley is mounted on an axle which is supported by ball-bearings of 4no's. The other end of the axle mounts the eccentric mechanism which is a circular disc. The circular disc is connected to the lever with the help of connecting rod. The other end of lever supports a hammer.

WORKING:

Motor is started which rotates the pulley mounted on the motor shaft. The motor pulley is connected to the larger pulley with the help of single groove V-Belt drive. Larger pulley rotates at low speed than smaller pulley. The larger pulley is mounted on a shaft, while a circular disc called eccentric is mounted on the other side of the shaft.

The circular disc is connected to the lever with the help of connecting rod. When the disc rotates it convert the rotary motion into the reciprocating motion of lever, hence the lever starts oscillating. A hammer is provided to the other side of lever gives the strike continuously. The work-piece is placed on the die, the die is of two types one is for hammering and the other one is for embossing we can change it easily according to our need of operation.

3.2. COMPONENTS USED:

1) Phase Induction motor: The motor used in the machine is a 3-phase induction motor, Power-0.5 Hp, Speed-1440rpm, Foot mounted, Frame size-71.
2) Motor Pulley: The power transmission from motor to the main spindle is done by an open belt drive. Motor pulley is a cast iron pulley (2" diameter), single groove 'A-Section', keyed to the Motor shaft, wrap angle 132°.
3) Spindle Pulley: Spindle pulley is a cast iron pulley (18" diameter), single groove 'A-Section', keyed to the main spindle. Thus the transmission ration 1:9, i.e. the spindle rotates at 160 rpm, wrap angle 227°.
4) Belt: Dunlop "HI-SPEED" 878g duck Belt is an 'A-Section' belt with included angle 380 length 74 inches, hence the specification 'A-74'.
5) Large Spindle Housing: The large spindle housing is on axle, bolted to the I-frame. It carries the single row deep groove ball bearing 6005zz.
6) Small spindle housing: The small axle housing is on the motor shaft.
7) Ball Bearings:The spindle is held on the axle and the axle is supported with single row deep groove ball bearings 6005zz. Internal diameter of bearing is 25mm, outside diameter of bearing is 47mm and the width of bearing is 12mm
8) Axle: The axle is a high grade steel member (EN24), held in heavy duty ball bearings at either ends supported in the bearing housings. The axle carries the s18" pulley at the front end where as the eccentric mechanism at the rear end. The spindle and eccentric disc both runs at the speed of 160 rpm.

9) Connecting Rod: It is a simple rod made up of the medium carbon steel, the function is to transmit the motion from eccentric disc to lever.
10) Embossing Die: It is a special die which provide the embossing operation along with the hammering.
11) Work Table: Work table is made from medium carbon steel (EN9), it is basically a fixture to hold the job while carrying out the hammering operation.
12) Hammer: Hammer is made from mild steel, having cylindrical shape. When the leaf-spring oscillates it moves up and down hence strikes on the work piece.
13) Mono leaf-spring: Mono leaf-spring is basically used as a lever to move the hammer up and down while carrying out the hammering operation.

Table (IV) materials with thermal conductivity and their hardness

Material	Hardness (BHN)	Thermal conductivity (w/m*k)
High Carbon Steel	178	54
Cast Iron	480-555	80
Copper & Alloys	42-45	410
Brass	60-65	111
Mild Steel	130	56
Gunmetal	65-74	748
Babbitt Metal	77	48

3.3. 2D-DESIGN AND 3D-DESIGN

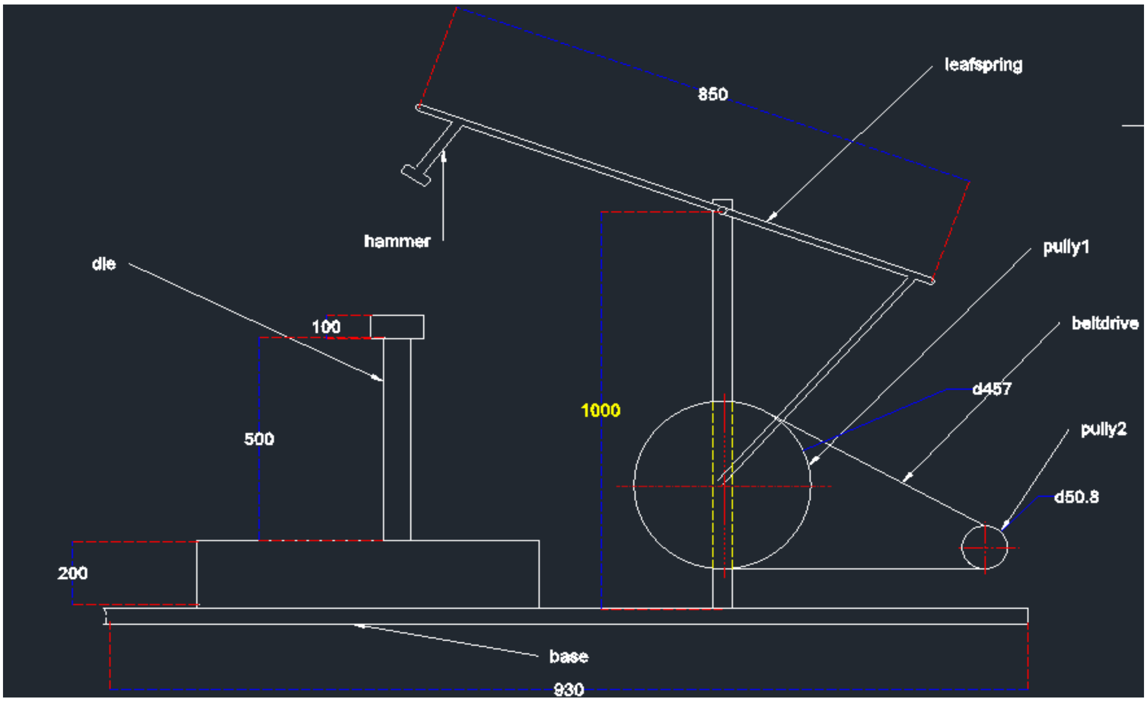

Fig 3.1. 2D Model of Assembly

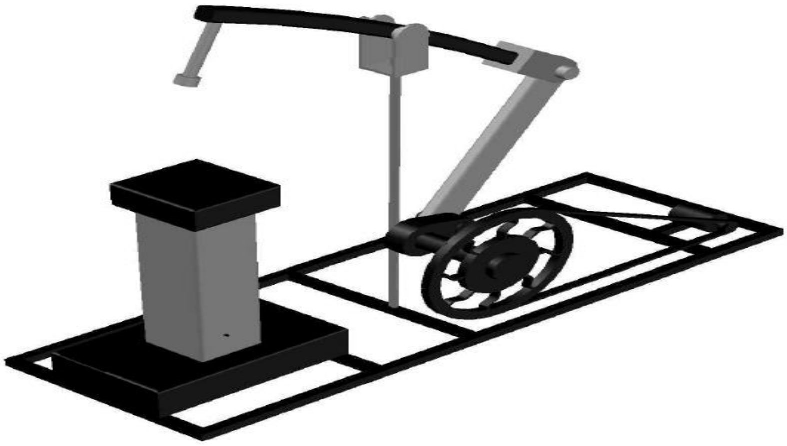

Fig 3.2. 3D Model of Assembly

IV. SELECTION OF BASIC PARAMETER

.

4.1. PULLEY DESIGN

P= 0.5Hp **N1=1440 rpm**
N1= speed of driving pulley
N2= speed of driver pulley
D= larger pulley dia.
d= smaller pulley dia.

Take d=2” and D=18”
(N1/N2) = (D/d)
N2= (1440×2)/18 = **160rpm**

Similarly If we take D=16” then..
N2= 180rpm (it produces more vibration)

Similarly If we take D=20” then..
N2= 144rpm (it is very slow so it takes more time)

That’s why we have taken larger pulley of dia.18”
(N1/N2) = (D/d)
d= (18×160)/1440
d= 2”
(N1/N2) = (D/d)
D= (1440×20/160
D= 18”

Max. velocity of Belt
V= πdN1 /60 m/s
V= 3.8302 m/s

Torque on pulley
Torque= (HP×5252)/rpm
(Torque)1= (HP×5252)/rpm = 0.5×5252/1440
(Torque)1= 1.8236 ft.lbs = 2.47 N.m
(Torque)2= (HP×5252)/rpm = 0.5×5252/160
(Torque)2= 16.4125 ft.lbs = 22.2523 N.m

4.2. MOTOR SELECTION

3- Phase induction motor (2 pole)
Make:-

415 volts, 50 Hz,
Power = 0. 5 hp (0.375) kW

Speed = 1440 rpm (synchronous)
Current = 1.70 amp
Torque= 0.17 kg. M

a) Torque Analysis:-

Torque at spindle is given by; $P = (2 \pi N Ts) /60$
Where;
Ts = Torque at spindle (kg.m)
P = POWER (Kw)
N = Speed (rpm)

$$Ts = \frac{0.375 \times 103 \times 60}{1440 \times 2\pi}$$
= 2.53 N-m
Ts = 2.53 N.m

Considering 25 % overload;
So, T design = 1.25 Ts
= 1.25 x 2.53
= 3.10 N.m
T design = 3.10 N.m

Planning an 1 stage transmission
Selection of an open belt drive using V-belt;

Motor pulley (D1) = 2”
Spindle pulley (D2) = 18”
Ratio = 1:9
Spindle transmission speed = 1440 rpm
Spindle Torque = T design x 9
= 27.9 N-m

4.3. DESIGN OF BELT DRIVE FOR MACHINE SPINDLE

Input Data
Input power = 0.375 kW
Input speed =1440rpm
Center distance = 500 mm
Max belt speed = 229.81 m/min = 3.8302 m/sec
Groove angle (2β) = 400
Coefficient of friction = 0.25
Between belt and pulley
Initial tension = 118.296 N
Bearing Force = 283.91041 N

4.3.1. Section of belt section

C/S SYMBOL	USUAL LOAD OF DRIVE (KW)	NOMINAL TOP WIDTH (W/mm)	NOMINAL THICKNESS T Mm	WEIGHT PER METER Kgf
A	0.75-5	13	8	0.106

Table (II) Belt Data

$\sin\alpha = \frac{R2-R1}{x} = \frac{D2 - D1}{2x}$

$= \frac{102 - 64}{2 \times 300}$ $\alpha = 4.540°$

Angle of lap on smaller pulley; i.e.; motor pulley;

$\theta 0 = 180 - 2\alpha$

$= 180 - 2(4.54)$

$\theta = 170.92°$

$\theta = 2.97$ rad

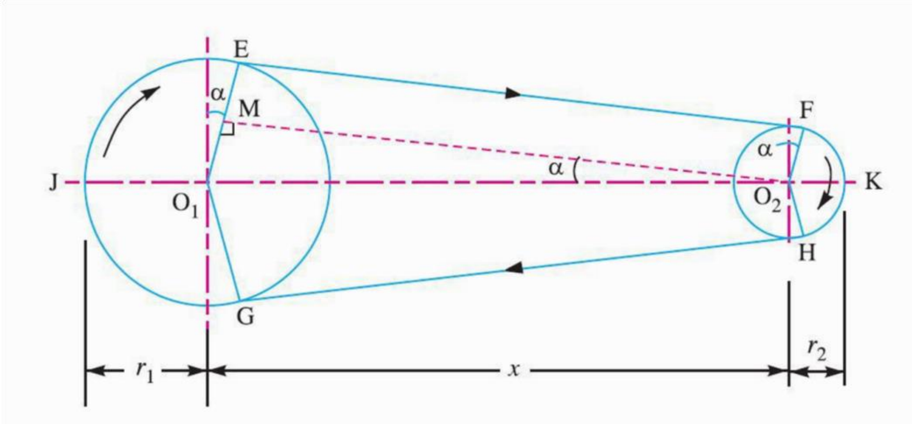

Fig 4.1 Open Belt Drive

Mass of belt /meter length = 0.106 kgf

Centrifugal Tension

(Tc) = Mv2

Tc = 0.106 (26.67) 2

Tc = 1.56 N

Min. Tension in belt (T) = σmin x b x t

= 44.61094 N

Max Tension in belt (T) = σmax x b x t

= 141.9545N

A) Tension in Tight side of belt = T1 = T-Tc

= 141.9545 – 1.56

T1 = 140.3945 N

B) Tension in slack side of belt = T

T1 / T2 = eμ θ cosecβ

= e0.25 x 2.97 x cosec 20

T1/T2 = 8.78

T2 = 15.991N

Power transmitting capacity of belt

P = (T1 - T2) v

= (140.3945 – 15.991) 3.8302

P = 79.145 kW

Length of belt

$$L = \pi (R2 + R1) + 2(X) + \frac{(R2 - R1)2}{X}$$

L = 1881.505 mm
L = 74.075”

4.4. DESIGN OF MAIN AXLE

T Design = 4.973 Nm.

Designation	Ultimate Tensile Strength N/mm2	Yield strength N/mm2
EN 24 (40 N; 2 cr 1 Mo 28)	720	600

Table (III) Property of spindle material

Allowable shear stress; is given stress;

τ_{all} = yield strength / FOS

= 600 / 3 =200 N/mm_2

τ_{all} = yield strength / FOS

= 720 / 4
= 180 N/mm_2 Considering minimum of the above values; τ all
= 180 N/mm2

As we are providing key way on shaft; Reducing above
value by 25%. τall = 0.75 x 180
= 135 N/mm_2
a)Considering pure torsion load;

Minimum section on the Axle as per system drawing is 20mm

$$\tau = \frac{16 \times 4973}{\pi \times 203}$$

τ = 3.1659 N/mm2

As $\tau < \tau$ all Axle is safe under pure torsional load

4.5. DESIGN OF WORK TABLE

Tool holder can be considered to be a hollow shaft subjected to torsional load.

Material selection. Designation	Ultimate Tensile strength N/mm_2	Yield strength N/mm_2
EN09	700	500

Table (IV) Property of tool holder material

fsmax = 108 N/mm2
Check for torsional shear failure:-

$$T = \frac{\pi \times fs_{act}}{16} \times \frac{(Do^4 - Di^4)}{Do}$$

$2.3474 \times 10_3 = \underline{\pi \times fs_{act}/16} \quad x \quad \underline{(42^4 - 20^4)/42}$fsact = 0.36N/mm2
As; fsact <fsall
Top work table is safe under torsional load.

V. CONCLUSIONS

In this project of special purpose machine for hammering as well as embossing perform on metal. In existing process required more time for completion of operation and fatigue on worker this problem is eliminating by providing a power hammer. This mechanism facilitates the faster rate, provides more control in operation and is time efficient. The wider use of this machine would give automotive industry the capacity for faster builds and the ability to better accommodate small volume production. It increases the production rate hence productivity.

Hence, the objectives underlying the present project work may get fulfilled to the desired extent.

VI. FUTURE SCOPE

- The machine will continue to be the subject of change and improvements or new innovation result from its use. Despite the volume of time and mental exhaustion that resulted from the project.
- We can use stepped pulley for speed variation.
- We can use high power source (motor) to raise the hammer to striking and accelerate it onto the work being hammered.

REFERENCES

[1] Ashish P. Borhade, Prof. Dr. J. T. Pattiwar “Dynamic Analysis of Steel Leaf Spring” International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 11, November-2014.

[2] Albert Hoeffleur “SPRING LOADED POWER HAMMER” [1970].

[3] Bohdan Kossowski “AN IMPROVED VIBRATING POWER HAMMER FOR DRIVING AND EXTRACTING PILES “ [1968] .

[4] F.Rausche “Modeling of vibratory pile driving” GRL Engineers, Inc., Cleveland, Ohio, USA [2002].

[5] Gokul Prassad. S “Design and Analysis of Mono Leaf Spring for Automobile Applications” International Journal of Engineering Research & Technology (IJERT) Vol. 4 Issue 04, April-2015

[6] Jamie Downie”Power Hammer Techniques and Applications for Creating Compound Curves in Sheet Metal” April [2010] International Specialised Institute inc.

[7] MR. SHUBHKUMAR M BHANDARI, PROF. RAJKUMAR B. CHADGE “Special Purpose Sheet Metal Cutting Machine”May [2014] International Journal of Pure and Applied Research in Engineering and Technology.

[8] Michael F Ashby, David R H Jones “Engineering Materials-1” second edition Volume 2, July [2016].

[9] Mr.V.Lakshmi Narayana “Design and Analysis Of Mono Composite Leaf Spring For Suspension in Automobiles” International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 6, August - 2012

[10] R.S. Khurmi, J.K. Gupta “A TEXTBOOK OF MACHINE DESIGN” Fourteenth Edition.

[11] Sandip S. Nehe, Dr. Sanjay B. Zope “A Review on Design Development & Analysis of Elliptical Leaf Spring Mount Vibration Isolation” [2015] International Journal of Science, Engineering and Technology Research (IJSETR) /Volume 4/ Issue 5.

[12] Tomi Ylikorpi, L. Scolamiero “EXPERIMENTAL TESTING OF LOW-POWER HAMMER-DRILLING TECHNIQUES IN A VARIETY OF ROCK MATERIALS” july [2006] 9th ESA Workshop on Advanced Space Technologies for Robotics Automation ASTRA.

[13] Vijaya Raghavan “Analysis of Performance of Jack Hammer to Determine the Penetration Rate on Different Rocks” [2014] International Journal of Engineering and Science (IJES) Volume ||3|| issue ||8||.

[14] Will B. Doerting “Reviving Blacksmithing with an Open Die Forging Hammer” [2012].