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Cam Operated, Paddel Driven Hammering Machine

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***Abstract*— Forging is the most common process in mechanical engineering and is also a business option for many people in India. The blacksmiths face problems like unavailability of electricity, less income etc. These problems are overcome in this research paper for such workers who carry out forging of light & medium metal objects. The project includes a cam which can be driven manually by chain-sprocket mechanism (paddle operated). The design of cam replicates hammering action producing impact blows. The construction of machine is simple, maintenance is easy, and is cost effective for blacksmiths. This machine is specially made for open die forging only.**

***Index Terms:* Forging, cam operated, paddle mechanism, hammer etc.**

1.INTRODUCTION

The Cam Operated Manual Hammering Machine is used in forging of light to medium jobs. The purpose of the machine is to provide a solution for forging workers to make forging convenient, less burdensome and superior. Currently this industrialization and the rapid growth in it has allowed the rich and wealthy producers to get ahead but the local level blacksmiths are highly affected by this growth. It also helps in reducing heating cycles since it completes the forging of given object in less time than by regular method of hand forging to boost their production and improve the quality of the forged components. The machine consists of a cam so designed to provide impact motion at regular intervals. A chain & sprocket is attached to cam and the cam is rotated using legs like one does cycling. This imparts rotary motion to cam and hammer moves up and down. The speed of the impact cycles can be easily controlled by controlling speed of pedaling.

2. PROBLEM DEFINITION:

Forging process is very rigorous and tiring process, though there are machines for carrying out forging operations but they are only suited for big size components and large-scale production used by big industries. Mechanization of any process is beneficial for the user yet no such solution exists for small blacksmiths. Many blacksmiths have comparatively high scale of production requirement but they cannot afford such machines. Also, these machines not only consume much space but also are expensive for these blacksmiths. The prices of maintenance and electricity require running these machines add to the burden of blacksmiths rather than aiding them.

3. METHODOLOGY

Before starting our research project, we surveyed and studied many different forging machines but none of the machines satisfied our described goals. There were two machines namely; Crank operated hammering machine. Motor operated hammering machine. Both machines have been described below:

3.1Crank operated hammering machine:

The crank operated hammering machine is the hammering machine in which the translation motion to the hammer is given using crank mechanism. The crank is attached to the motor, a connecting rod connecting the crank end and extreme tip of hammer rod. When motor rotates, the crank gives reciprocating motion to the hammer rod which is pivoted in middle. The only disadvantage of the machine was when size of the object subjected to forging changes, jerks are created which can break the crank or crank and connecting rod joints. Hence to eliminate this limitation of machine we decided to implement cam mechanism to provide the reciprocating motion to the hammer rod [1].

3.2 Motor operated hammering machine:
The motor operated hammering machine is similar to what we proposed to do. A cam is used in this machine to provide reciprocating motion to the hammer rod and 3 Phase AC motor with a gear box is used. The motor and gearbox are coupled directly with cam. Thus the motor &gearbox assembly rotates the cam[2].The gearbox is used because the minimum speed of AC motor is around 1200 rpm which is too large for this application. So to reduce the speed a worm drive gearbox is used which reduces the speed up to 100 rpm. The disadvantage of using gearbox is not only it increase the weight of machine but also the cost of gearbox is high which is around 20,000/- to 25,000/- Rs. Hence to make the machine more affordable, portable & light weight we decided to eliminate the use of motor and make it manual but ensuring that less effort is needed to do the job.

4.CONCEPT DRAWING AND ACTUAL MACHINE

The concept drawing is shown in Fig.1. The seat assembly is made detachable from the entire assembly. With the help of nuts and bolts we can adjust the height of the seat so that different users can sit and adopt ergonomic facility easily to the machine. The worker applies the force on the pedals and hence rotates it with his desired speed. Then the motion of the pedals causes the chain attached to the sprocket to rotate as shown in photograph 1.This motion is transferred to the other sprocket which is attached to the cam.
Due to this rotational movement of chain and sprockets, the cam rotates. The faster the worker will rotate the pedals the faster the cam will rotate and the impacts will be more.

Fig.1.Concept drawing of cam operated forging machine.

Photo.1 Pedal chain assembly

Photo.2(a) Actual machine

Photo. 2(b) Actual machine

The actual working of cam operated; paddle driven machine is shown in photograph Photo.2(a) and 2(b) respectively.

5. DESIGN CALCULATIONS

The design calculations of hammer, cam and impact force affects on performance of forging machine and cycle time. The calculations are given below [4,5,6].
Calculation of Impact force generated by the hammer
5.1 Impact Force by free fall of weight

F impact = W/d
Where,
F impact = Impact force generated in Newton;
W= Work done by free falling weight in Joules;
d=recoil displacement after impact in meters.

5.2. Kinetic energy & Potential energy attained by weight

Kinetic Energy = ½ mV2
Potential Energy = mgh
Where,
m = mass of free-falling weight in kg
V = Velocity attained by free falling weight in m/s
g = Acceleration due to gravity in m/s2
h = Height of free fall of weight in meter

5.3 Considered data:

Anvil Plate	: Wrought Iron 12-inch X 12-inch X 10 mm
Anvil Support	: M.S. square plate 1 inch X 1 inch X 2 mm
Hammer Head	: 7 kg

Required impact force for forging is approximately 200N to 300N.

5.4Calculations for impact force developed by 7 kg hammer:

For hand forging, required impact force is approximately 200 to 300 N.
Using conservation of energy theorem,
We calculate impact force and energy of free falling object.

Considering, m= 7 kg, h= 0.5m (1.2 ft) (drop height)
V= √2gh = √2*9.81*0.15 = 3.13 m/s
P.E= mgh
K.E= 0
Impact velocity= √2gh
K.E = ½ mv2
P.E = 0
P.E= mgh= 7 X 9.81 X 0.5= 34.33 J
K.E= ½ mv2= 0.5 X 7 X 9.79= 34.28 J
Considering recoil distance= 0.1m
By work energy theorem ,
W= ½ mv2 (final) – ½ mv2 (initial)
W= ½ X 7 X 9.79= 34.29 J
W= F X d
F= W/d = 34.28/0.1 = 342.9 N
Hence impact force of 342.9 N is developed.

6. Design of cam

The snail type of cam is selected as shown in Fig.2. The use of snail type cam produces a required sudden impact used for forging operation[3]. The value of impact force depends upon height of fall of hammer which in turn depends on the outer radius of the cam. In order to generate impact force of around 300 N it was necessary to design a cam with outer radius of 6 inches. Hence the designed cam has outer radius measuring 6 inches while base radius is 3 inches and produced as shown in Photo.3.

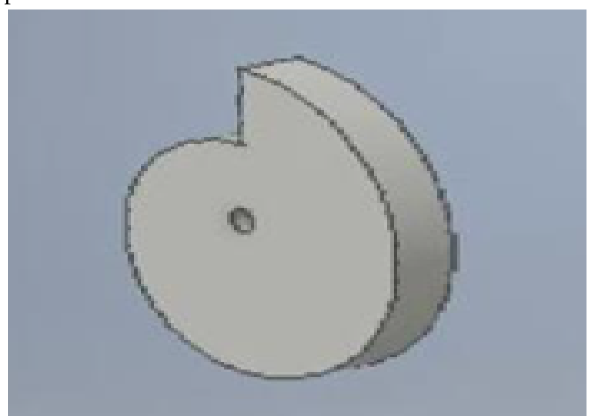

Fig 2. Design of cam

Photo 3. Actual cam

7. STRESS ANALYSIS

Fig.3 shows the stress analysis done on the hammer head to replicate the stress generated due to impact force when hammer hits the object. In this we have constrained on side of the hammer head and force is applied from the other end.

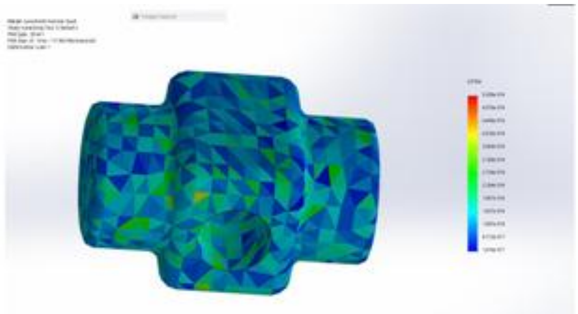

Fig.3.Stress Analysis of hammer head

Table no.1 Stress analysis results

Name	Type	Force	Min. stress	Max. stress
Hammer head	Stress	400 N	1.474e-017 N/mm2	5.305e-016 N/mm2

Table no. 1 shows hammer head stress analysis results for 400N force applied.

8. TEST RESULTS

The trail is taken with the help of a local blacksmith on weed hook. After completing the test, we concluded that our machine was much effective and easy to operate also it saved time. The raw material is of 25cm long and 5mm in thickness. The blacksmiths need to reduce the thickness up to 2mm. The test results are as follows shown in Table no.2.

Parameter	With Hand	With machine
No. of Strokes	45	28
Time	45 sec	28 sec
Reduction in thickness	3 mm	3 mm

Table no.2. Test results

9.CONCLUSION

After reviewing many solution and optimizing each one we were successful in designing and fabricating a hammering machine that would work as per our predictions in given set of conditions and environment. The solution worked well in forging light components in less time as compared to hand forging with good quality and less defects. The reduction of fatigue of worker has been the biggest outcome of our project. The Table no.3. denotes a comparison between forging by hand versus forging by machine in terms of percentage.

Parameters	With Hand	With Machine
1.Fatigue	More	Less
2.Operation Time	More	17 % less
3.No. of strokes to finish job	More	17 % less

Table No. 3. Comparison of performance in terms of percentage.

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