Design, Construction & Performance test of an Automatic Portable Hammering Machine.

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Abstract: *The hammering process is required for producing the desired shape of object. Moreover, the grain structure of the metal is also improved. For various operations such as forging, hammering, cutting etc. various heavyweight equipment are used. There are some problems occurred by using this heavyweight machines such as huge labor, huge amount of electricity supply also safety is a big issue there. In this research an automatic portable hammering machine is designed to reduce the workload of the labors. Only one operator is required to operate this machine. It will reduce the time required for hammering operation besides it will be more safe than heavyweight machineries. Here, a suitable automated portable hammering machine is designed, fabricated. The torque force in different positions, impact velocity, shear stress in welded joints is also measured. The torque force when hammer moves downward is 76.375 Nm when hammer moves upward it is 61.67 Nm. Impact Velocity of the hammer is 0.36 m/s.*

Keywords: Automatic, hammering machine, reduce workload, reduce time required, Design, Torque force, impact velocity, Shear stress measured.

1.Introduction

Hammering is very important process in our day to day life. As it's have been done on manually so it's a very time consuming process so we should've developed a process by which we can do the hammering job done fast. We know that hammering is almost used in all types of industry so if we use to develop the conventional hammering process then it will be a successful project. We know that the hammering process not only produced the desired shape it also improves the grain structure of the metal. Forging is one of the oldest known metalworking processes. Traditionally, forging was performed by a smith using hammer and anvil.

Howard Terhune, Cleveland, Ohio, United States Patent office journals, Application – September 27, 1944, Serial no. 555977, Patented Oct. 28, 1947,[1] Published no. US2429780. From this paper It has been found that this invention relates to portable motor operated and manually controlled machine tools or implements, more specifically to an improved hammer tool and operating mechanisms of the reciprocating, rotary cam actuated type, and designed for using as a portable power operated hammer, wood chisel, scaling chisel, piercing punch, rock drill, and other similar power tools. The novel operating mechanism of the project is an attachment, is adapted for combination with and receives power from a motor, as an electric motor,

Harold S. Sheldon, Tekoa,Washington DC, United States Patent office journals, Application – October 15, 1947, Serial no. 779931, Patented – March 21, 1950, Published no. US2501542.[2] The invention herein disclosed relates to steam and air hammers of the pile driver type and in which, usually the motive fluid is just admitted to lift and then released to drop the ram to achieve a strong downward force to executing any hammering operations. The another objective of this invention is also taking less time and reducing the breaking probability of the load or other parts attached to the ram providing hammering action down the line. Ulrich Demuth, Erbach-Ernsbach;

Winrich Habedank, Diez, both of Germany, United States Patent office journals, Application - November 20, 1996, Patented - August 29,2000, Patent no. 6109364, Published no. US006109364A.[3] It relates to a hammer with a tool holder and a hammer mechanism for the transmission of impact energy onto the drilling and/or chiseling bit in the tool holder has a switching device which with a single actuator makes it possible to switch between pure drilling operation, rotary hammering operation and pure hammering operation. The cam part is provided at the section of the actuator projecting inwardly over the slide part. The object of the invention is to develop a rotary hammer and is particular its switching device in such a way that it has a compact structure and can be operated without being prone to disturbance.

2.Working Mechanism & Working Principle

In this machine slider crank mechanism is used to convert rotary motion into linear motion. A crank is an arm attached at a right angle to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It is used to convert circular motion into reciprocating motion, or vice versa. The arm may be a bent portion of the shaft, or a separate arm or disk attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod (con rod). The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion. [4] Here in this machine, An AC sewing machine motor is used in order to move the hammer. AC motor is powered by a power source. The AC motor connects with a disc in one end and in other end of the disc a shaft is connected with nut and bolt joints. One end of the hammer is connected to this connecting rod through a nut-bolt joint in order to achieve desired hammer motion with enough torque. The disc is used here to convert the lateral motion into rotary motion. Now use a suitable bed where work piece can be placed. The bed is placed on the top of a hollow bar.

3.Design and Fabrication

Design Layout:

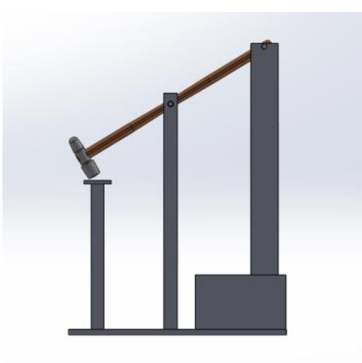

Fig 1: Design of Automatic Portable Hammering Machine.

In the **Fig:1** the Solidworks model of the automatic portable hammering machine is given and calculation procedure parameters have been taken into consideration from design data books or different journals and sources. The components have been selected by studying different journals and sources. The components are collected from local hardware shop. Fabrication of the hammering machine is done by using the machine shop.

4.1 Basic Components

The main components required for the fabrication of this machine are:

- AC Motor (shown in **fig: 2(a)**)
- Shaft (shown in **fig: 2(d))**
- Hammer (shown in **fig:2(b))**
- Mounts & Fixtures
- Supporting Frame
- Joints & Screws
- Disc (shown in **fig:2(c)**)

(a) An ac motor

(b) A Hammer

(c) a circular Disc

(d) Drive Shaft

Fig 2: Components which are required.

4.2 Fabricated Model

The automatic portable hammering machine is fabricated as given below:

Fig 3: Fabricated Automatic Portable Hammering Machine

4.3 Calculations

Assume the data:

- Total weight =5 kg.
- Hammer weight = 1.5 kg.
- Hammer length =450 mm.
- Hammer stroke height = 180 mm.
- Width = 350 mm.
- Height = 440 mm.
- Length = 560 mm.
- Disc thickness = 1 mm.
- Supply voltage =12v and 8 Ampere.
- Motor = DENSO INDIA LTD (SR05950-4772), 30 RPM, 12V. AC motor.
- Diameter of pulley =240 mm.
- Length of link rod = 180 mm.
- Typical operation = Common Riveting for 1.8 mm rivet.

A) To calculate maximum torque by motor

Motor rating,
Given Data: -
N = 30 RPM
I = 8 A
V = 12v

Power Transmitted by Motor,
P = V × I
= 12 × 8
Then P=96 W

$$P = \frac{2\pi NT}{60}$$

$$96 = \frac{2\pi 30T}{60}$$

T = 30.55 N-m

Distance of rod BA,

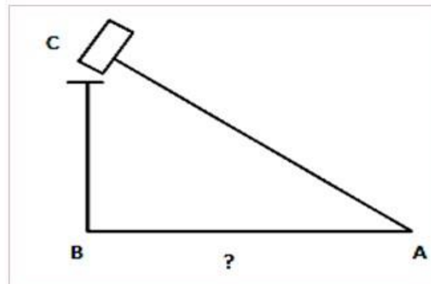

Fig 4: Free body diagram

To find the distance of BA,
By Pythagoras theorem
$(AB)^2 + (BC)^2 = (CA)^2$
$(AB)^2 + (180)^2 = (440)^2$
(AB) = 401.5 mm

B) To find torque force transmitted we have two cases

CASE 1: When Hammer Moves Downward.

Given: v
(BC) = h = 180 mm = 0.18 mm
Maximum torque, $T_{\max}$ = 30.55 N-m
= 30.55×10^3 N-mm
Length of hammer rod, l = 450 mm
= 0.45 m

Torque Force $T_f = \frac{T_{\max} \times l}{h}$

$$T_f = \frac{30.55 \times 0.45}{0.180}$$

$$T_f = 76.375\, Nm$$

CASE 2: When Hammer goes upward, torque force will be decreased,

$$T_f = \frac{T_{max}}{h} \times [l] - [w]$$

$$T_f = \frac{30.55}{0.180}[0.45] - [14.71]$$

$$T_f = 61.67\,Nm$$

C) TO FIND IMPACT VELOCITY OF HAMMER,

Given: -
H =180 mm = 0.180 m
T (time required for one re revolution of Disc) = 2 sec.
So,

$$V = h \times T$$

$$V = 0.18 \times 2$$

$$V = 0.36 m/s$$

So the impact velocity of hammer is 0.36 m /sec.

D) TO CALCULATE SHEAR STRESS IN BOLTED JOINT

We have bolted joints so there is torsional shear stress in joints,

We have,
T = 30.55 N-m.
d = Diameter of bolt 80 mm.
r = Radius of bolt 40 mm.
J = polar moment of inertia.

$$J = \frac{\pi}{64}(d)^4$$

$$= \frac{\pi}{64}(0.08)^4$$

$$J = 2.01 \times 10^{-6} m^4$$

$$\frac{T}{J} = \frac{\tau}{r}$$

$$\frac{30.55}{(2.01 \times 10^{-6})} = \frac{\tau}{0.04}$$

$$\tau = 608 \times 10^3 N/m^2$$

So the calculated value of shear stresses is $608 \times 10^3 N/m^2$.

4.4 Result: Thus for riveting of 1.8 mm rivet calculated the impact velocity is 0.36 m/sec with a torque force of 76.375 N-m is sufficient and it is calculated successfully. As the standard permissible value of shear stress for M10 bolt is $248 \times 10^6 N/m^2$ and the calculated value of shear stresses is $608 \times 10^3 N/m^2$. So Therefore the value of shear stress is less than permissible shear stress. So the design is safe. [5]

4.5 Result Discussion: Above mentioned calculation it has been seen that theoretically the impact velocity is 0.36 m/sec with a torque force of 76.375 N-m is sufficient in practical field. But in practically the impact velocity is 0.25 m/sec. One of the main reason of this deviation could be that there is used many screw joints to connect the shaft with the disc. So there is a frictional loose due to this type of joints. That is why the practical impact velocity is less than the theoretical value. Practical value of the torque force is ranges within 55-70 Nm. Those values are almost same as the theoretical values. The shear stress is also calculated as $608 \times 10^3 N/m^2$. This calculated value of shear stress is safe as the standard permissible value of shear stress for M10 bolt is $248 \times 10^6 N/m^2$. So this value of shear stress is safe. The plate where the object that should be hammered is placed it has also enough strength to restrain this type of force.

5. Conclusions

An Automatic Portable Hammering machine had made. For various cases the torque force was also calculated. When Hammer moves downward the torque force is 76.375 Nm, Practically the torque force is 70 Nm. When hammer moves upward the torque force is 61.67 Nm, in practical field the value is 55.56 Nm. For different situations the impact velocity of the hammer was also measured. Theoretically the Impact velocity is 0.36 m/s. But practically the impact velocity is 0.25 m/s. Shear stresses in the bolted joints were also measured. The shear stress is also calculated as $608 \times 10^3 N/m^2$. This calculated value of shear stress is safe as the standard permissible value of shear stress for M10 bolt is $248 \times 10^6 N/m^2$. So all the required values have been taken in both experimentally and theoretically.

6. References

[1] Howard Terhune, Cleveland, Ohio, United States Patent office journals, Application – September 27, 1944, Serial no. 555977, Patented Oct. 28, 1947, Published no. US2429780

[2] Harold S. Sheldon, Tekoa, Washington DC, United States Patent office journals, Application – October 15, 1947, Serial no. 779931, Patented – March 21, 1950, Published no. US2501542

[3] Ulrich Demuth, Erbach-Ernsbach; Winrich Habedank, Diez, both of Germany, United States Patent office journals, Application - November 20, 1996, Patented August 29, 2000, Patent no. 6109364, Published no. US006109364A

[4] David H. Myaszk, Mechanisms and machine analysis – 4th edition.

[5] R.S. Khurmi, J.K. Gupta. Theory Of Machines. New Delhi: S. Chand Publishing.

7. Nomenclature

Symbol	Meaning	Unit
V	Voltage	Volt
T	Torque	N-m
V	Velocity	m/s