DESIGN AND FABRICATION OF SPRING ASSIST RAMMING MACHINE

A PROJECT REPORT

Submitted by

MOHAMMED SHAFI M **8115U23ME029**

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING
(AUTONOMOUS)
SAMAYAPURAM, TRICHY

ANNA UNIVERSITY
CHENNAI 600 025

DEC 2024

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Under the Guidance of

Mr. KARTHIKEYAN N, BE.,

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BONAFIDE CERTIFICATE

Certified that this project report title d **"DESIGN AND FABRICATION OF SPRING ASSIST RAMMING MACHINE"** is the bonafide work of **MOHAMMED SHAFI M, (8115UME23029)** who carried out the work under my supervision.

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(AUTONOMOUS)

Under

ANNA UNIVERSITY, CHENNAI

DECLARATION BY THE CANDITATE

I declare that to the best of my knowledge the work reported here in has been composed solely by myself and that it has not been in whole or in part in any previous application for a degree.

Submitted for the project Viva- Voce held at K. Ramakrishnan College of Engineering on _________

SIGNATURE OF THE CANDITATE

ACKNOWLEDGMENT

We thank the almighty god without his blessing it would not have been possible for us to complete this project.

At this moment of having successfully completed our project, we wish to convey our sincere thanks and gratitude to our management of our college and our beloved chairman **Dr. K. RAMAKRISHNAN, B.E., Ph.D., who** provide all the facilities to us.

We would like to express our sincere thanks to our Executive Director

Dr**. S. KUPPUSAMY, M.B.A., Ph.D**., for forwarding us to do our project and offering adequate duration in completing our project.

We are also grateful to our Principal **Dr. D. SRINIVASAN, Ph.D.,** for our constructive suggestion and encouragement during our project.

We wish to express our profound thanks to **Dr. H. RAMAKRISHNAN,ME., Ph.D**., Head of the Mechanical Engineering Department, for providing all necessary facilities for doing this project.

We wholeheartedly and sincerely acknowledgement our deep sense of gratitude and indebtedness to our beloved guide **Mr. KARTHIKEYAN N BE., Assistant professor,**Mechanical Engineering Department,Tiruchirappalli,
For his expert guidance and encouragement throughout the duration of the project.

We extend my gratitude to all the staff members of Mechanical Engineering Department, **K. RAMAKRISHNAN COLLEGE OF ENGINEERING (AUTONOMOUS)** for their kind help and valuable support to complete the project successfully. We would like to thank my parents, and friends who have always been a constant source of support in our project.

ABSTRACT

Our project, the Ramming Machine, is a medium-sized device that combines a spring mechanism and a cam and shaft mechanism. The shaft is turned by a motor, and the cam is turned by the shaft. The spring mechanism and links connect the rammer to the cam. Most of the frame is composed of mild steel. The motor has a power source, typically a battery. The cam is rotated by the motor. Appropriately sized links attached to a cam facilitate the transformation of rotating motion into reciprocating motion. The rammer moves up and down because to the reciprocating motion. The rammer's spring attachment aids in exerting more force on the device.

The rounded rod attached to the motor shaft revolves in tandem with the motor. As the motor rotates it also rotates the rounded rod connected to motor shaft. Now the cam also rotates with the rod movement which is linked to the rammer head with a spring. As the cam rotates the rammer head is pulled up and released, between center rod is released it is released with added pressure from the spring driving it into the bowl with more pressure.

Key Words: cam, mild, shaft mechanism.

TABLE OF CONTENTS

LIST OF THE TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

The method of casting involves using a mold cavity to create a product. mold cavity is the negative portion of the pattern, which is a copy of the finished casting with the appropriate modifications. Allowances are made on the pattern to remove defects caused by a variety of factors, such as mold wall damage during pattern extraction or casting shrinkage due to molten metal solidifying. Providing allowances such as shrinkage, draft, and machining allowances helps to eliminate this casting process problem.

There are still a lot of casting flaws that cannot be fixed by making any allowances. When molding sand is properly compacted, many of these defects might be experienced. flaws such as mold collapse (caused by low compaction forces), blow holes, porosity, and rough casting surfaces.Therefore, many flaws can be eliminated with just adequate compaction. Compaction forces vary depending on the type of Sand, sand-water mixture, casting surface finish, sand additives, etc. A rammer, which can be made of metal or wood, is used to complete the ramming process. Human-performed manual ramming cannot generate enough force to crush sand completely, process of ramming.

The final casting is further impacted by the inaccuracy introduced in the mold cavity by the variable forces during ramming. An electric motor drives the rammer in an automatic ramming machine via links, whereas a human operator operates a manual ramming rammer.

The current innovation suggests a novel design for the industrial sector that use casting as a production method. By cutting down on the time needed to make molds, this arrangement enables the producers to enhance production rates. Since the need to produce the product on a large scale is growing along with product consumption, our invention shortens the time needed to make molds. With the right battering, this configuration enables the sand to be compacted.

The ramming tool, which is powered by a crank and connecting rod mechanism, is used to ram sand. The ramming tool can move throughout the mold box's whole workspace. This arrangement includes a square threaded lead screw, ramming tool, and electric motor. The ramming tool can travel throughout the mold's work region because lead screws are positioned on two distinct horizontal planes that are perpendicular to one another.

CHAPTER 2

LITERATURE REVIEW

Kaveriappa M B, Kaushik N D et.al.. suggest Casting is a manufacturing process where usually a hollow cavity of the required shape called mould is poured with liquid material and then allowed to solidify. Usually the hollow cavities are made inside a cope and drag arrangement where it is filled with sand. This sand has to be packed compactly to get the required shape of cavity. To enable this compatibility a piece of equipment is used in foundry i.e. a Sand Ram.

Amanyu R N, Harikrishnan A, Milton P Mathew , RamizMuhammed A conventional Sand Ram used to have a calibrated sliding weight actuated cam, which used to be actuated manually on to the required specimen, but this method was not satisfactory when it comes to mass production with large mould. Hence several experimentation have been going on to improve the quality and reduce time used for ramming process, where pneumatically actuated Ram is one type of idea where the Ram is completely actuated with the help of pneumatic controls and the time used for ramming is also reduced to an effective duration Electric Motor Efficiency

.

Buschart (1999) presents the results of a motor-efficiency study conducted on a project that required nine medium-voltage motors and discusses motorefficiency economics, motor-design parameters that affect efficiency, motor application factors relevant to efficiency, and efficiency of 26testing to be adopted.

Hasuike (2001) describes 12 variable elements which affect the improvement of efficiency. With the objective to discuss the factors which etermine the efficiency and rating of poly-phase AC induction motors, Umans (1989) discusses the loss mechanismsand their relation to the performance and design characteristics of the motor.

Bonnett (1980) has discussed in detail the various design considerations affecting motor efficiency i.e. amount of copper wire in the slots, stator slot size, length of coil extension, lamination steel length, rotor bar size, rotor bar conductivity, bearing selection, increased air gap etc. Bonnett (1993) updates users on the opportunities available to achieve higher performance levels

He summarizes the actions that can be taken by those who specify and design electric motors to improve the efficiency. Numerous actions taken by those who specify the motor requirements that have far-reaching effects on the motor efficiency like System Voltage, Operating Voltage, Motor Size and Loading, Motor Speed, Load Shedding, AdjustableFrequency Drives applied to Centrifugal Pumps and Fans etc. have also been discussed.

CHAPTER 3

PROBLEM IDENTIFICATION

Most of the ram used for sand molding are pneumatically, hydraulically operated. Many more researchers found the best suitable way for ramming operation In this case instead of using above stated method we are using ‘Portable Ramming Machine by Using Electrically Operated Ram for Molding’. **The project is aims to achieve ramming operation with reduced human effort.** In this process of designing & fabrication of Portable ramming machine which is operated by means of crank and springs. The crank is the machine elements driven by the round disk, which in turn are driven by the DC electric motor.

DEFINITION

The ramming material is mainly an unshaped refractory material that is mainly made of aggregates and powders with a certain particle size distribution plus binders and additives, and is mainly constructed by manual or mechanical ramming. Automation and sophisticated electronic in ramming process help to improve the foundry environment and accuracy of the cast parts. Reliability of cast
product depends on various parameters like permeability, compactness, adhesiveness etc. Hence process of ramming in molding play a vital role in the process of casting. The defects occur in cast component leads to great problem in foundry and all associated industries. Hence this ramming machine found large application in manufacturing industry. The machine is operating on electric drive motor. Even though skilled labor is employed for ramming operation, the packing of molding sand will not be even throughout the molding box.

CHAPTER 4
OBJECTIVES

A spring-assisted ramming machine is a device designed to enhance the efficiency and precision of ramming or compaction tasks in various industries such as construction, manufacturing, and material processing. The machine utilizes a spring mechanism to store potential energy, which is then released to deliver consistent and controlled force. This ensures uniform compaction and reduces the reliance on manual labor, making operations more efficient.

The primary objective of the machine is to improve productivity while minimizing operator fatigue. By leveraging the energy stored in the spring, the machine conserves energy and reduces wear on mechanical components, thereby increasing its durability and lifespan. Additionally, the design prioritizes safety and ease of use, incorporating ergonomic features to lower the risk of injury during prolonged operations.

With its cost-effective and reliable performance, a spring-assisted ramming machine is a valuable tool in applications requiring repetitive and accurate ramming or compaction, ensuring consistent results with minimal effort.

CHAPTER 5

SELECTION OF MATERILS

5.1 DC MOTOR

A DC motor is an electromechanical device that converts direct current (DC) electrical energy into mechanical energy. The mechanical energy is typically used to perform work, such as driving a conveyor belt, fan, or pump. Here's how a DC motor works:

DC motors use magnetic fields to power a rotor that's attached to an output shaft. The rotor contains coil windings that are powered by the DC current, while the stator contains permanent magnets or electromagnetic windings. When the motor is powered, the stator's magnetic field attracts and repels the rotor's magnets, causing the rotor to rotate.

WORKING OF DC MOTOR:

1. Power Supply

When a DC voltage is applied to the motor, current flows through the armature windings (conductors) via brushes and the commutator**.**

2. Magnetic Field Creation

The stator (stationary part) provides a magnetic field. This field can be generated

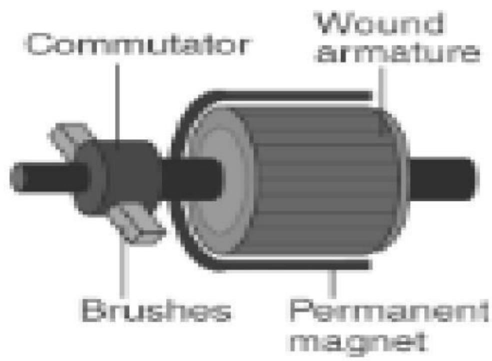
Permanent Magnets in smaller motors.

Electromagnetic Windings in larger motors

3. Force on the Armature

The current-carrying armature windings are placed in the magnetic field of the stator. According to Lorentz force, when current flows through a conductor in a magnetic field, a force is exerted on the conductor

The direction of this force is determined by Fleming's Left-Hand Rule.



5.2 CAM MECHANISM:

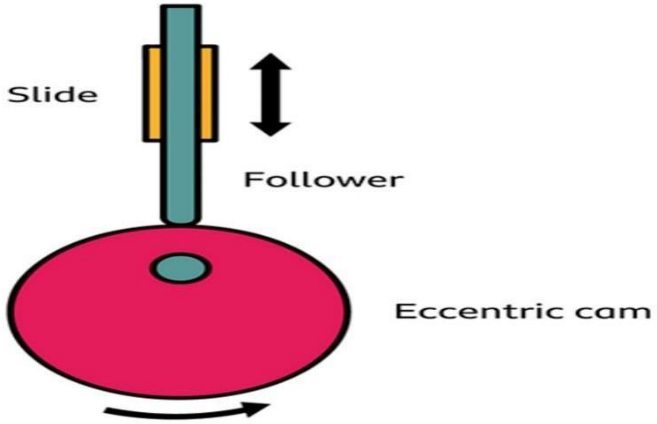
A cam is a simple mechanism that converts rotary motion (movement that goes round in a circle) into linear motion (movement in a straight line). These mechanisms can be found in car engines, printing machines and sewing machines. The cam's shape dictates the motion of the follower, allowing for precise control and coordination in various applications. Cam and Follower is also used in other machinery like Springs, rods, or gear systems. In the most basic form the system consists of three major components. A driving member is called the cam, a frame that holds the cam and the follower. The cam is controlled by the frame, and finally, the driven member is specified as the follower.

A cam and follower is a mechanism that converts rotary motion into linear motion. The cam is a rotating element with an irregular shape that interacts with a follower, which is a sliding or rolling element. The motion of the cam causes the follower to move, enabling the conversion of motion from one form to another. Cam and follower mechanisms are used in various applications, including engines, pumps, and automation systems. The cam is a profiled disc, cylinder or sphere that rotates. The shape or profile of the cam influences the motion of the follower.

The cam is directly in contact with the follower. A follower is another component of this machine, and it is made to oscillate or reciprocate by the cam.

5.3 Eccentric cam:

Eccentric means ‘not in the centre’. So, eccentric cams rotate at a point that is not the centre of the cam. This type of cam will make the follower move up and down. If a circular cam had a rod through its exact centre the follower would not move up and down. An eccentric cam is a type of mechanical device used to convert rotary motion into linear or oscillatory motion.



DESIGN CALCULATION

Velocity, Acceleration and Jerk in an Eccentric Cam:

A detailed mathematical formulation to derive the velocity, acceleration and jerk in a eccentric cam is discussed below.

A schematic representation of an eccentric cam

Let,

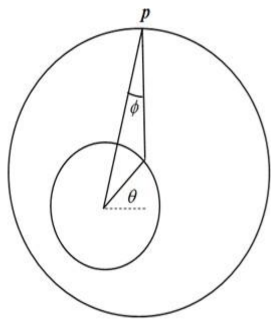
a = eccentricity

r = radius of circular cam

θ = angular position of cam

θ = angular position of eccentric cam with respect to normal

ω = angular velocity of the cam (assumed to be constant)



an eccentric cam is given by,

$$p = a\sin\theta + r\cos\phi \qquad (1)$$

$$p = \sin^{-1}(\frac{a}{r}\cos\theta) \qquad (2)$$

The velocity of reciprocation v, of the follower is the derivative of position p and is given by:

$$v = a\omega(cos\theta + \sin\theta\tan\theta) \qquad (3)$$

The acceleration of the follower acc, is also a derivative of velocity and it written as,

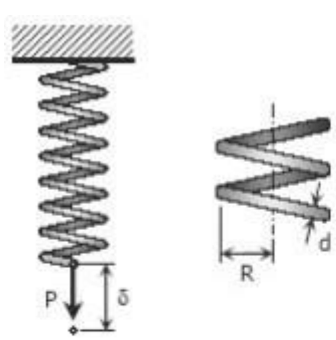
$$acc = a\omega^2\left[(-\sin\theta + \cos\theta\tan\phi - \frac{a}{r}\left(\frac{\sin 2\theta}{\cos\phi}\right)^2\right] \qquad (4)$$

The jerk is rate of change of acceleration and it is given by:

$$jerk = a\omega^3 \left(\begin{array}{l} -\sin\theta + \cos\theta\tan\phi - \dfrac{a}{2r}\dfrac{\sin 2\theta}{\cos\phi^3} - \dfrac{a}{r}\dfrac{\sin 2\theta}{\cos\phi^2} + \\ 2\left(\dfrac{a}{r}\right)^2 \dfrac{\sin\theta^3 * sin\phi}{\cos\phi^4} \end{array} \right) \tag{5}$$

5.4 HELICAL SPRINGS :

When close-coiled helical spring, composed of a wire of round rod of diameter d wound into a helix of mean radius R with n number of turns, is subjected to an axial load P produces the following stresses and elongation:



The maximum shearing stress is the sum of the direct shearing stress $\tau 1 = P/A$ and the torsional shearing stress $\tau 2 = Tr/J$, with $T = PR$.

$$\tau = \tau_1 + \tau_2 = \frac{P}{\pi d^2/4} + \frac{16(PR)}{\pi d^3}$$

$$\tau = \frac{16PR}{\pi d^3}\left(1 + \frac{d}{4R}\right)$$

This is used for light spring where the ratio d/4R is small. For heavy springs and considering the curvature of the spring, a more precise formula is given by: (A.M.Wahl Formula)

$$\tau = \frac{16PR}{\pi d^3}\left(\frac{4m-1}{4m-4} + \frac{0.615}{m}\right)$$

where m is called the spring index and (4m – 1) / (4m – 4) is the Wahl Factor. The elongation of the bar is

$$\delta = \frac{64PR^3 n}{Gd^4}$$

Notice that the deformation δ is directly proportional to the applied load P. The ratio of P to δ is called the spring constant k and is equal to

$$k = \frac{P}{\delta} = \frac{Gd^4}{64R^3 n} \text{ in N/mm}$$

5.5 SHAFT:

Shaft is a rotating member used to transmit power by torsion. An axle is a machine member loaded mainly on the bending and carries rotating parts such as wheels and gears. An axle may be either stationary or rotating. Short shaft and axle are called as spindle. Shafts may be classified as transmission shaft and main shaft. Transmission shafts are used to transmit power from the source of the machine. The main shaft are integrated with machine itself. Here, in our project we are using mild steel for main shaft. In case of our automated punching machine, both shafts are used namely transmission shaft and main shaft (camshaft), the transmission shaft is coupled with motor where as the main shaft is used to carry the cam. Hence it is otherwise called as camshaft

Design Of Main Shaft

1. Design torque, Td = 51.944 N-m
2. Belt tensions,T1 = 446.403 N, T2 = 215.5 N
3. Force Calculation
4. Wt. of bigger pulley, WpA = 60.82N
5. Wt. of smaller pulley, WpD = 30.41N
6. wt. of main shaft with blades,Wsh =82.4N
7. Rvc = 63.141 N-m
8. Rvb = 110.489
9. Resultant moment, Mc = 156.2N-m
10. Selecting shaft material SAE 1030
11. Tmax = 44.4 Mpa
12. Diameter of shaft , Dsh = 30mm
13. Pulley Hub diameter,Dh =70 mm
14. Pulley Hub length Lh =45mm

DC MOTOR - TORQUE OF MOTOR

Kv= RPM per volt.

Rm= motor resistance in Ohms.

Io= No load current.

From Hendershot and Miller:

Kq= 30/(pi Kv): Kq= Torque constant.(units = N m)

RPM and TORQUE at current I:

RPM= Kv(I – Io)

Q= Kq(I – Io)

MOTOR EFFICIENCY:

η= Mechanical power out/electrical work in

η= (V- I Rm)(I - Io)/(V I): V and I= working voltage and current.

CURRENT AT MAX EFFICIENCY:

Imax= sqrt(V Io/Rm)

Torque at max efficiency:

Qmax= Kq (Imax – Io)

RPM at max eff.

RPMmax= Kv(V – Imax Rm)

CURRENT AT MAX POWER OUTPUT:

Torque at max efficiency:

Ip= (V + Rm Io)/(2 Rm)

Torque at max power output

Qp= Kq (Ip - Io)

RPM at max power output.

RPMp= Kv(V – Ip Rm)

MOTOR MAXIMUM EFFICIENCY: (Better mechanical output to electrical work ratio)

η max= [1- Sqrt (Io Rm / V $)^2$]

As shown above ………..

$Q_{max} = K_q (I_{max} – I_o)$

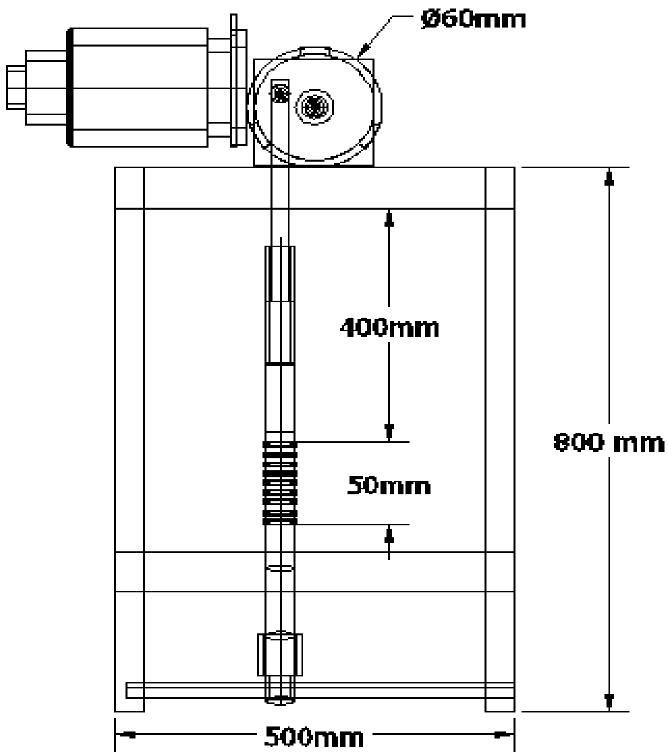
RPM at max eff.

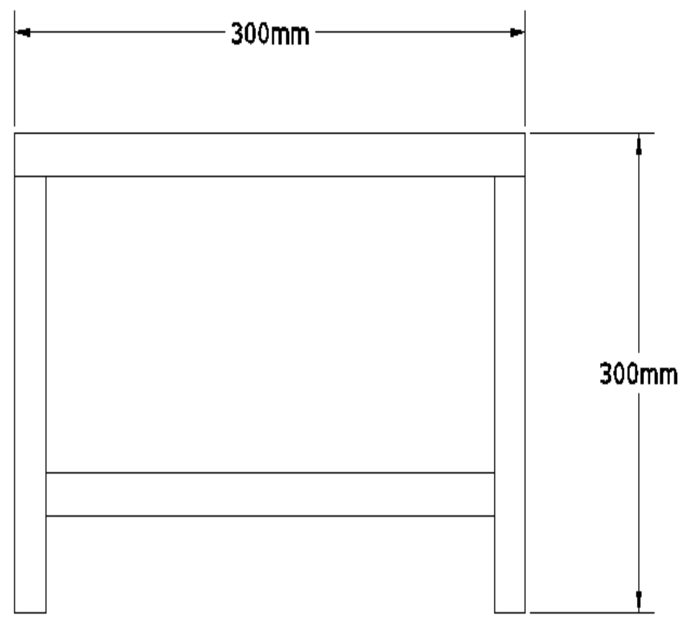
$RPM_{max} = K_v(V – I_{max} R_m)$

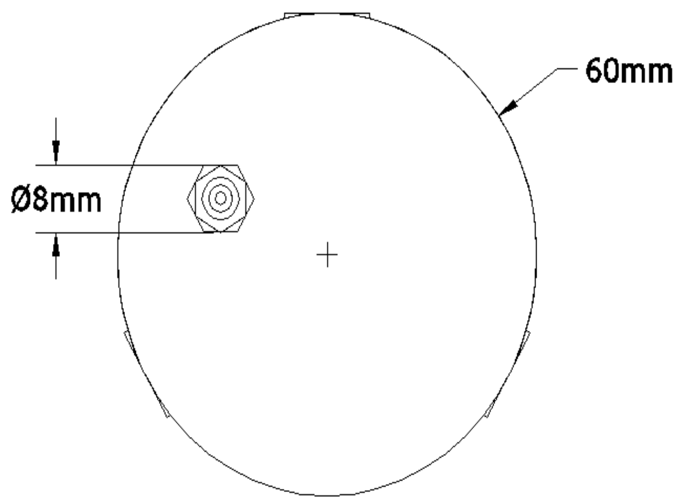
SO THE 30RPM 12V DC geared motors for robotics applications. It gives a massive torque of **9Kgcm**. AND THE torque of **0.8 kg-cm** at 1000 RPM.

100RPM 12V DC geared motors for robotics applications. It gives a massive torque of **27Kgcm**.

CHAPTER 6
DESIGN AND FABRICATION



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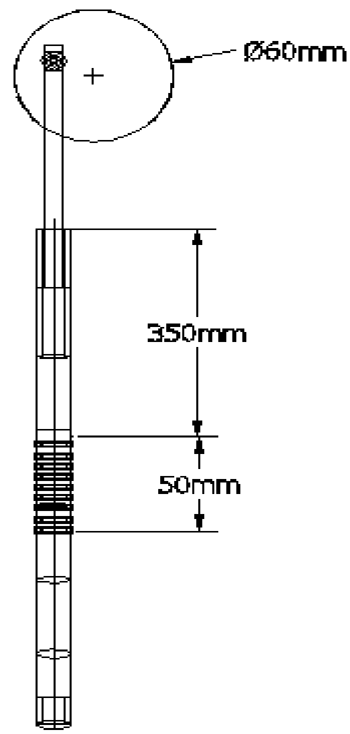
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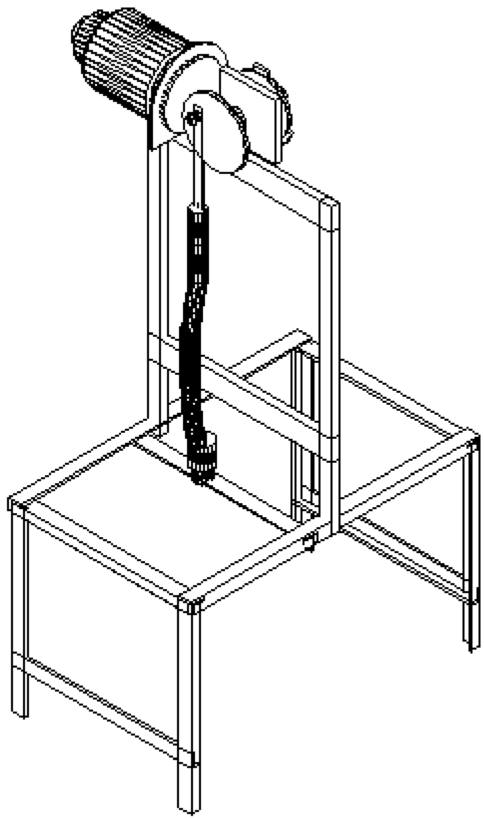

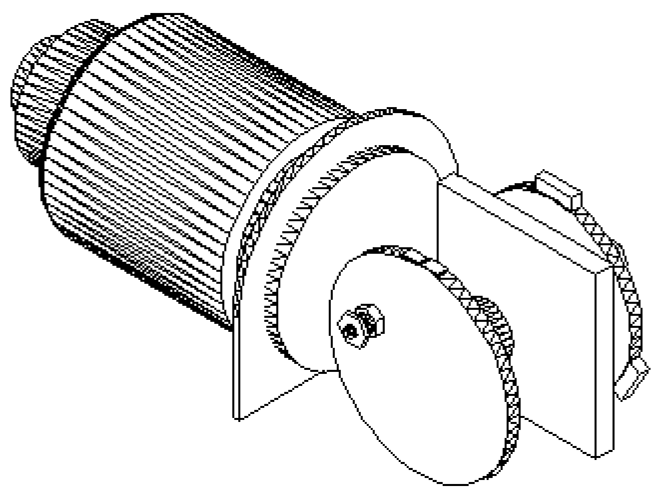

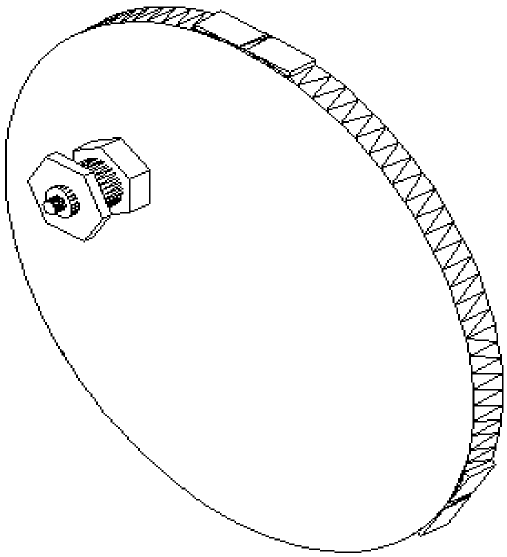

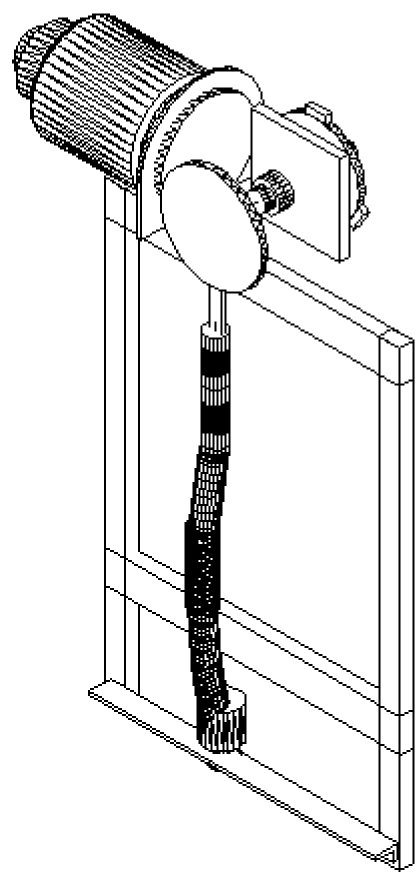

CHAPTER 7

FABRICATED MODEL

CHAPTER 8

COST ESTIMATION

SL NO	DESCRIPTION	AMOUNT
1	MATERIAL COST	2500
2	LATHE	400
3	DRILLING	300
4	WELDING	300
5	POWER HACK SAW	500
6	GAS CUTTING COST	300
7	OVERHEAD CHARGES	900
	TOTAL COST	5200

CHAPTER 9

WORKING PRINCIPLES

This project presents the design and fabrication of a spring-assisted ramming machine that utilizes a cam and follower mechanism for efficient and controlled ramming operations. The rotating cam converts rotary motion into linear movement, driving the ramming head with precision. A spring mechanism assists in resetting the ramming head, reducing manual effort and energy consumption . This machine demonstrates improved performance for industrial ramming tasks. The sand is uniformly rammed around the pattern using the ram. Even smallscale industries can use it.

This Ram requires an electric motor in order to work. This Ram is managed by an operator only by passing it over the sand for molding. The sand is consistently compacted after being pushed around by the butt in certain areas. This Ram cuts down on labor and ramming time. As a result, the price is significantly lower. Thus, this device is used in foundries for compact apparatus.

CHAPTER 10

RESULT

The design and fabrication of the spring assist ramming machine have successfully demonstrated significant improvements in both efficiency and performance within the foundry industry. By incorporating a spring-assisted mechanism, the machine effectively amplifies the force applied by the operator, reducing the physical effort required while maintaining a high level of compaction in the mold. The spring stores potential energy when compressed and releases it to deliver a powerful, uniform impact on the sand, resulting in consistent and dense sand compaction.

Through the fabrication process, it was found that the use of simple yet durable materials for both the frame and spring mechanism provided a reliable and cost-effective solution. The machine's lightweight design makes it easy to operate and transport, especially beneficial for small-scale foundries and workshops. The system has shown a reduction in operator fatigue and an increase in productivity due to its ability to maintain a continuous cycle of operation with minimal manual input.

In terms of mold quality, the spring assist ramming machine has demonstrated its capacity to produce well-compacted molds with fewer defects, thus improving the overall casting process. This enhancement in mold preparation not only ensures higher-quality casts but also reduces material wastage, contributing to cost savings in the long run.

CHAPTER 11
CONCLUSION

This project has successfully addressed the stated problems and achieved the objectives in providing efficient. Nevertheless, the work herein represents a working prototype of a real system. For commercialization, some enhancement need to be considered.

- We successfully performed ramming operation on a portable unit with the help of electrically operated Ram.
- We reduced size of the ramming machine required for smaller moulds, which otherwise were carried out on large, heavy duty machines.
- These large machines have high initial, operating and maintenance cost.
- We can implemented the use of Electric Mechanism over Hydraulic and Pneumatic mechanisms.