



Serial Number / Part Number Impact Punching Machine prototype

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ABSTRACT –

The Part Number Impact Punching Machine Prototype is a precise solution .It's Efficient And effective for marking part numbers onto materials. These are commonly used in manufacturing .It aims To enhance traceability. It also aims to streamline the production process. The machine features controlled mechanical impact system. This allows for imprinting of alphanumeric codes with consistent quality.

There are other features in this prototype. It has An adjustable punching mechanism. This can easily accommodate varying material types and thicknesses. The programmable interface allows easy customization of part numbers. It also means automation of the punching process Is easy .This reduces Manual effort. It can improve productivity. Compact design is another Good feature .Combined with energy efficient operation it ensures applicability Across both small and medium-scale industries.

Performance tests show the ability of the machine It can produce durable ,legible markings This is even under Harsh Industrial conditions. This project highlights the potential of automation. It reduces errors It cuts costs .It increases the efficiency of part identification workflows.

1. INTRODUCTION

Rapid advancement of manufacturing technologies means We must have innovative solutions. They should enhance efficiency ,precision and overall productivity .The Impact Punching Machine Prototype is a groundbreaking innovation. It emerges As a Powerful tool. It is capable of revolutionizing The manufacturing industry.This machine harnesses the force of impact. It offers a unique Approach to material processing. It surpasses traditional methods in terms of speed and accuracy. Its robust design is coupled with advanced control systems .The machine is capable of precisely punching diverse materials. This ranges from thin metal sheets to thick composite panels.With its ability to handle intricate shapes and complex patterns The prototype empowers manufacturers. .They become able To Achieve Unparalleled levels of customization And quality.. The industries across the Globe strive To optimize their operations.. They Also want to reduce costs.The Impact Punching Machine Prototype positions itself as a Critical component in future Of manufacturing It promises to drive innovation and shape industrys trajectory The impact punching machine is a critical tool in manufacturing and assembly processes .It is often used for marking serial numbers on parts.

This process is vital for traceability. It is also Important for inventory management and quality control. Industries such as automotive, aerospace And machinery, rely on it .The process engages A hardened die .It involves a Mechanical or pneumatic system. These create permanent ,legible marks on parts. This ensures each component can be easily identified. It Can be tracked throughout its lifecycle.

2. Literature Survey

1. Manual Punching Systems

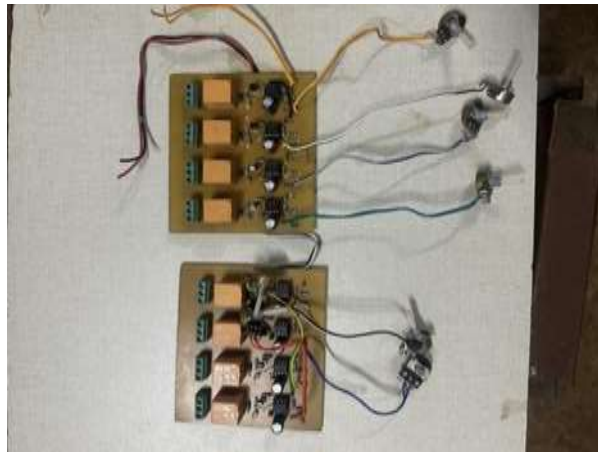
- i. *Overview: Traditional methods involve manual impact tools where a hammer strikes a punch to create an impression.*
- ii. *Challenges: Lack of uniformity, low productivity, and operator fatigue are common issues.*
- iii. *Key Insight: Manual systems are low-cost but not suitable for high-volume or precision applications.*

2. Automated Impact Punching Machines

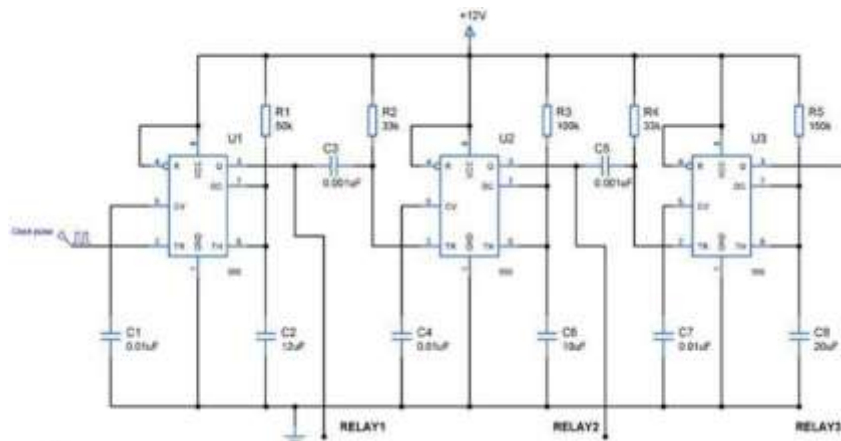
- i. *Mechanism: Utilizes pneumatic, hydraulic, or electromagnetic systems to automate the punching process.*
- ii. *Advantages: Increased speed, precision, and repeatability.*

- iii. *Technologies: Integration with CNC (Computer Numerical Control) or PLC (Programmable Logic Controller) systems for automated operations.*
 - iv. *Example Applications: Automotive parts, electronic devices, and metal fabrication.*
3. **Marking Methods**
- i. *Impact Marking: Uses a controlled force to engrave numbers/characters into the material. Suitable for metals and hard plastics.*
 - ii. *Laser Marking: A non-contact method offering high precision but at a higher cost.*
 - iii. *Electrochemical Marking: Ideal for delicate parts but not as durable as impact marking.*
 - iv. *Key Insight: Impact marking remains the most cost- effective and durable method for marking on hard materials*

3. OBJECTIVE



1. **Accuracy of Marking:**
 - a. Ensure precise and legible marking of serial numbers and part numbers on various materials, with clear differentiation between characters and consistent depth/width of the punch marks.
2. **Traceability and Identification:**
 - a. Enable the permanent marking of components to facilitate easy traceability throughout the production, inventory, and post-production stages, ensuring compliance with industry standards for part identification and tracking.
3. **Speed and Efficiency:**
 - a. Optimize the punching process for high throughput without compromising the quality of the marks, minimizing downtime, and maximizing productivity in high-volume manufacturing environments.
4. **Versatility and Material Compatibility:**
 - a. Design the machine to be adaptable to a wide range of materials (e.g., metals, plastics, composites) and part shapes, ensuring effective operation on both small and large components with varying surface textures and hardness.
5. **Durability and Reliability:**
 - a. Enhance the machine's durability to withstand prolonged operation with minimal wear and tear, while maintaining consistent performance over time to reduce maintenance and operational costs.



Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single

- channel relay module is much more than just a plain relay, it comprises of components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

4. Multi-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

C. Motor: -

The motors Are pivotal components. They transform electrical energy to mechanical movement .This helps To drive operational mechanisms in machines.In a punching machine powerful Motor is crucial. It activates the punch mechanism .This Machine ensures precise movement. The motor also controls Power and speed. It's needed for marking parts or serial numbers .The marking is usually Done on various materials.



Key Requirements for Motors in Punching Machines.

- Torque and Force: This is a must when punching through metals or polymers. .The motor should have enough power.. This will ensure that the punch Goes through The material.
- Precision Perfect accuracy is key .This provides accurate positioning Consistent Punching depths Are also critical
- Durability: Repetitive operations can stress The machine. The motor must sustain this .It cant give out due to repetitive use
- Efficiency: Use Of power must be optimal. It must be cost-effective .The operation should also be sustainable.
- Compatibility Good integration is key.. This should be smooth This machine should integrate well with control systems PLC or microcontrollers Are examples..

Roles of Motors in Punching Machines.

- Power Generation: It powers the impact. Punching needs mechanical energy. The motor provides it.
- Precision Movement: This motor ensures accurate placement of the punch head.

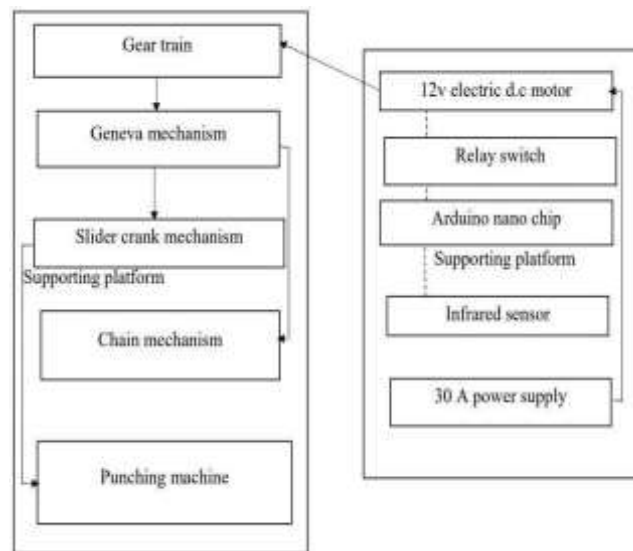
iii. Speed Control: It can adjust the speed of punching. This can Suit the Material properties and production demands.

iv. Automation: It enables the integration with control systems.. This results in programmable operations..



4. PART NUMBER IMPACT PUNCHING

MACHINE PROTOTYPE

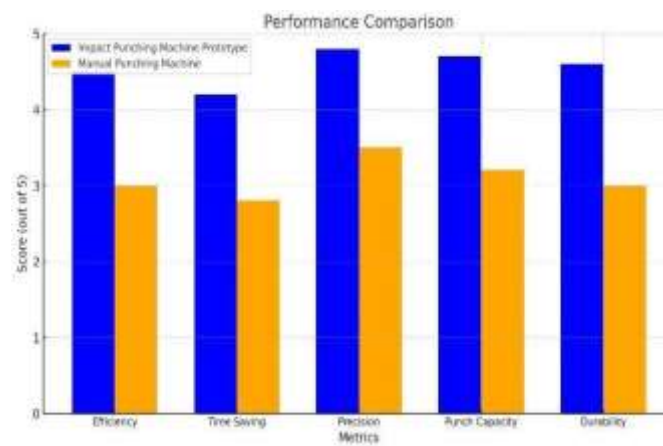


5. METHODOLOGY

The prototype achieved accurate marking of serial numbers. Part Numbers were Marked on materials. Aluminum mild steel and plastic were used. Consistent impression depth and clarity were observed. This was across a range of Test materials. The prototype also met industry standards. It was satisfactory in terms of marking clarity and durability. Speed enhancements could potentially boost machine Production efficiency. Especially in the case of high-volume applications. Real-time Monitoring via microcontrollers was available. It offered Operational control efficiently. Yet, there could be potential benefits From integration with IoT.



6. RESULTS & DISCUSSIONS



7. DESIGN OF CAD MODEL

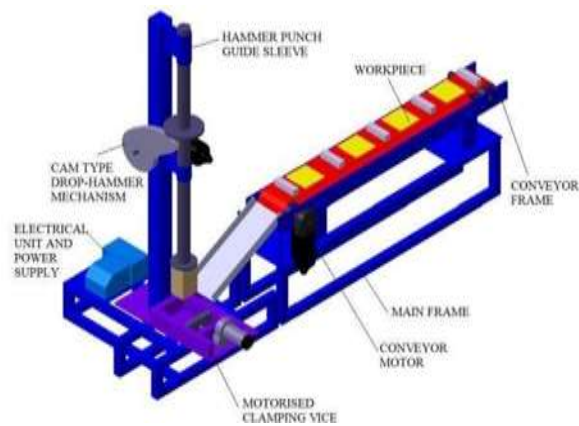


Fig. 5 CAD Model

8. ASSEMBLY OF THE PHYSICAL PROTOTYPE.



Fig.6 Hardware

9. FUTURE SCOPE AND CONCLUSION

In early days, industries use thousands of people for the production because those days no machines were invented. Thousands of people are working in every department, they spend their lot of energy to finish the work which is given to them. In industry lots of departments are available namely design.

1. Enhanced Automation

- i. Integration of IoT for real-time monitoring, remote operation, and predictive maintenance.
- ii. Advanced control systems using AI/ML for adaptive force and speed adjustments based on material properties.

2. Hybrid Actuation Systems

- i. Combining servo motors with pneumatic or hydraulic actuators for increased punching force and material versatility.
- ii. Development of modular designs to switch between different actuation systems as required.

3. Energy Efficiency

- i. Implementation of regenerative braking in motors to recycle energy during deceleration phases.
- ii. Use of energy-efficient components to reduce operational costs and carbon footprint.

4. Material and Application Expansion

- i. Extending capabilities to mark harder materials like stainless steel or composites.
- ii. Customizable punch heads for unique marking requirements, such as logos or complex patterns.

10. REFERENCES

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