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Review Paper on: SPM Milling Machine

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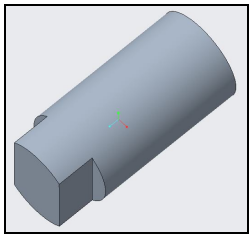
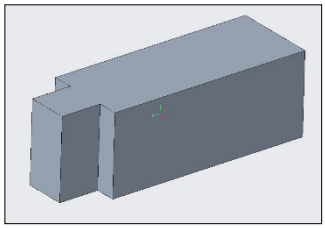
***Abstract:** In the modern manufacturing industry, automation plays a crucial role in increasing production efficiency, reducing labour costs, and ensuring consistent product quality. There is high requirement for such automated solutions in industries, that can deal with manufacturing of high-volume and small precise keys. Square keys and round keys made up of materials like Brass or Alloy Steel, are used in various mechanical applications. Which needs to be produced with good precision and high scale. These keys generally involve with special operation requirement like Saddle milling and cutting which cannot be performed on the single conventional machine without manual intervention. The traditional methods of saddle milling and cutting keys can be labour-intensive and prone to errors, leading to inefficiencies and reduced throughput. The outcome of this review is to Identify market gap and share general idea or understanding of SPM machine which can produce kind of key which has saddle milling and cutting operation requirement in mass production layout.*
Different types of keys as follows: -





***Keywords**: Saddle Milling and cutting, SPM milling, Key Manufacturing, Mass production, Automation.*

I. INTRODUCTION

A leading manufacturer of brass keys from Pune, has identified the need for a high-speed, automated solution that can perform the saddle milling and cutting operations on brass keys with minimal manual intervention. The company manufactures keys of 25-30mm in length, each weighing 2.5 to 3 grams. These keys require precision milling for saddle milling and cutting at varying distances. With an expected daily production demand of 3000 to 4000 units in a 10-hour shift, the need for automation is critical to meet customer requirements while maintaining cost-effectiveness and consistency.

II. PROBLEM STATEMENT

In the current market, conventional milling machines such as milling machines and band saws are commonly used for key production. These machines, however, comes with several limitations:

1) *Manual Intervention:* These machines often require manual loading and unloading of workpieces, making them less efficient and more prone to errors due to human involvement.
2) *Time Consumption:* The cycle time for conventional machines is typically much higher than desired. A Milling machine, for instance requires operator for multiple operations, including clamping, tool changes, and reloading, which adds significant time to each cycle. As a result, the time required for milling, chamfering, and cutting exceeds the target cycle time of 20 seconds per key.
3) *High Operational Costs:* Conventional milling machines require operators to be on-site, and their setup times and maintenance can be costly. The labour cost and machine downtime can considerably increase the overall production cost, which is a major concern for businesses looking to scale up
4) *Electricity Consumption:* An average Milling machine consumes around 5-20 Kw of electricity and bandsaw machine will consume up to 3Kw of electricity per hour.
5) *Limited Production Capacity:* With existing machines, production rates are constrained by the need for manual intervention and slower operation speeds. Achieving the required 3000-4000 keys per day would be challenging with conventional equipment.
6) *High Initial Cost:* An average milling machine cost 1.5-4 lakh INR and an average band saw machine costs 0.3-1 lack INR.

Therefore, while some other existing options in the market like VMC offer some degree of automation, but they do not meet the requirements of cycle time, power efficiency, and scalability that manufacturer seeks for their operations.

III. OBJECTIVES

The primary objectives of this SPM Milling machine are:

1) To design and develop an automated milling machine that can achieve the target cycle time of 20 seconds for brass pin milling and cutting operations.
2) To ensure high production capacity of 3000-4000 keys per day, operating efficiently for 10-hour shifts.
3) To minimize operational costs, ensuring the project stays within the allocated budget of ₹5-6 lakhs.
4) To optimize power consumption such that the machine operates with a power rating of no more than 5 kW/hr.
5) To ensure minimal manual intervention in the entire production process while maintaining high product quality and precision.

IV. INITIAL CONCEPT

The initial concept for the SPM Milling Machine involves below primary concepts.

A. 3 Primary Induction Motors

1st Induction Motor: - To drive horizontal axis cutter, use an induction motor which would power the Saw blade cutter. Cutter will be moved vertically upwards and downwards by the help of Warm screw gear box set up.
2nd Induction Motor: - Worm screw arrangement which would be driven by another induction motor.
3rd Induction Motor: - To drive the horizontal axis saddle milling tools mounted on a Arbor, another induction motor with belt pully arrangement needs to be employed. The axis of this saddle milling cutting Arbores will be intersecting perpendicularly with in parallel plane with axis of saw blade cutter. This motor will be mounted with same mounting plate which is followed by 1st induction motor to drive this arbor of saddle cutter.

B. Pneumatic key feeding and Clamping Mechanism:

Key will pass through a collet which would be tightened and released by pneumatic acting cylinders will be automated.
During the release point of the collect a horizontal acting clamping actuator will be activated which is mounted just right and left to the Pneumatic acting collect follow by the vertical clamping actuator. This will clamp key and will move forward for operation and collect will be tightened pneumatically.
This whole system of feeding and clamping will be mounted on one mounting plate which is manually driven by warm screw to adjust it position to left and right.
Total 5 pneumatic actuators will be used to completed and clamping and feeding mechanism for the machine.

- *Structure:* A mild steel structure with square channels will be used as a base structure to hold all the mechanism mentioned above. The base structure will be around 2.5 feet and total structure of machine will be max up to 5 feet.
- *Electronic control System:* To achieve proper automation microcontrollers, motor drivers, sensors and communication protocols can be used along with the control methods like PID, LQR or all other closed loop systems.

V. CONCLUSION

The SPM Milling Machine successfully identifies the feasibility of combining saddle milling and cutting operations on a single machine to meet manufacturer requirements and performance metrics. Key benefits include:

1) Increased productivity and efficiency
2) Improved product quality and consistency
3) Reduced labour costs and manual interference
4) Energy efficiency and cost savings

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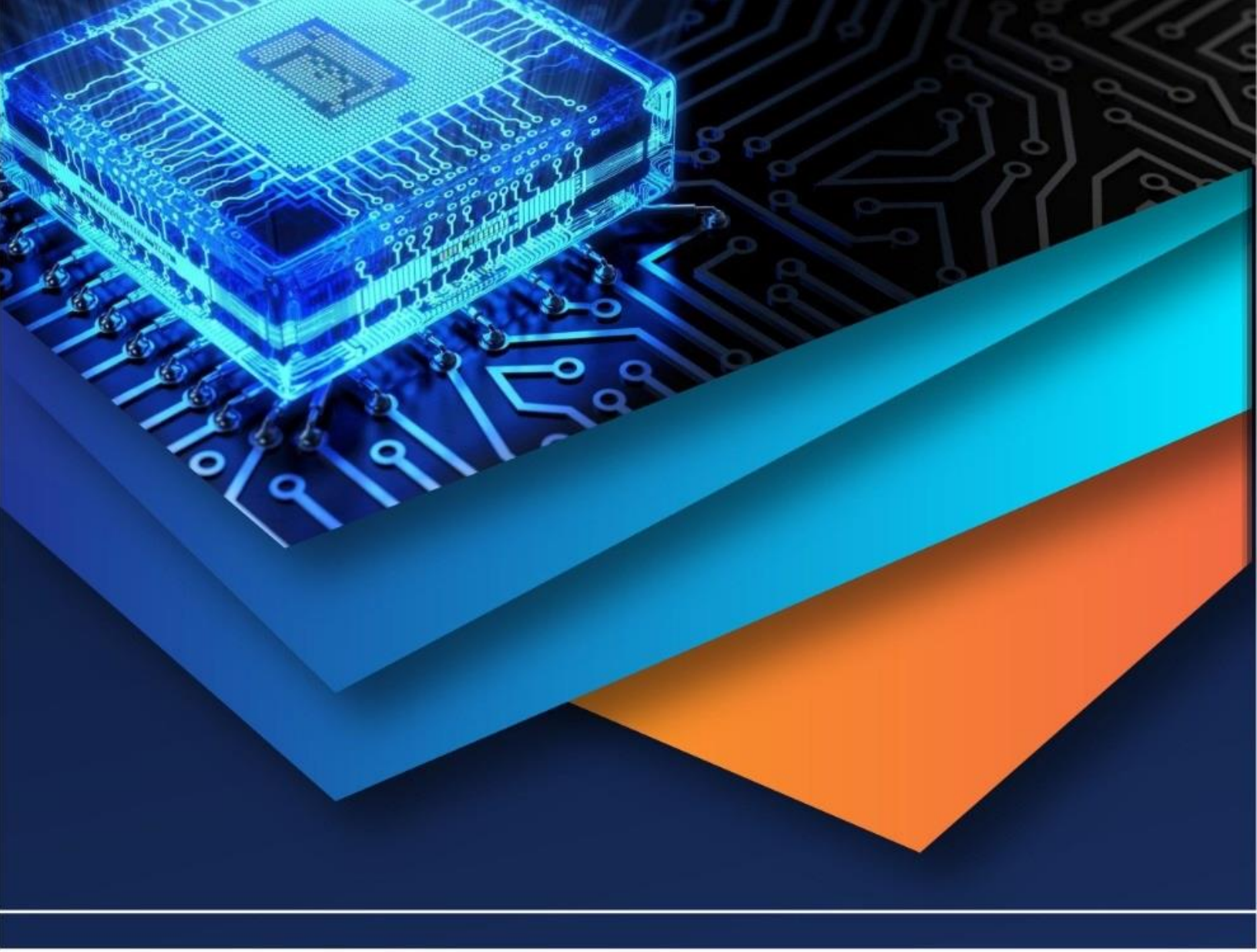

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