

Fabrication of Hybrid Band Saw Cutting Machine A Requirement of Small-Scale Industry

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ABSTRACT

The Hybrid Band saw cutting machine is a versatile and accurate tool that is essential for small-scale industries and shops. It is capable of cutting a range of materials, including pipes, PVC pipes, plastics, and meat, and can be powered by both electricity and solar power, making it an environmentally-friendly option. This research paper provides an overview of the machine's components, including the cutting blade, motor, transmission, guide system, and control system, as well as mathematical formulas for fabrication, working mechanism, and benefits to the industry. The paper highlights the importance of considering component specifications during fabrication and proper maintenance for optimal performance. The Hybrid Band saw cutting machine has been shown to significantly improve productivity and efficiency while reducing costs and labor requirements, making it a valuable investment for any business that requires cutting. Its ability to run on solar power also makes it an excellent option for reducing carbon footprints. This paper can serve as a useful resource for those considering investing in a Hybrid Band saw cutting machine.

Keywords: Mild Steel Body Frame, Solar Panel, Battery, Wheels, Hybrid Band Saw, Stepper Motor

I. INTRODUCTION

The Hybrid Band saw cutting machine is an innovative tool that can efficiently and accurately cut various materials such as wood, metal, plastic, and meat. With

the increasing demand for sustainable and renewable energy sources, the development of a Hybrid Band saw cutting machine that can run on both electricity and solar power has become an urgent requirement for the industry. This paper provides a comprehensive analysis

of the Hybrid Band saw cutting machine, its components, specifications, and working mechanism, and how it can be beneficial for small-scale industries and shops.

The paper starts with a literature review highlighting the importance of optimization of cutting parameters, vibration characteristics, cutting fluids, and hybridization for improved cutting performance and reduced energy costs. The component specifications of the machine are presented, including the cutting blade, blade speed control mechanism, motor, battery, solar panel, and control unit. The mathematical formulation for the fabrication of the machine, including stress calculations and stress formulations, is discussed, ensuring the machine's safety and reliability. The working mechanism of the machine is then presented, which allows for greater energy efficiency and cost savings while cutting various materials with high precision and accuracy.

Finally, the paper concludes by discussing the benefits of the Hybrid Band saw cutting machine for small-scale industries and shops, making it a valuable investment for businesses looking to reduce their operating costs while improving their cutting efficiency and productivity. The Hybrid Band saw cutting machine is a necessary requirement for the industry, providing significant benefits, and can significantly reduce energy costs while improving cutting efficiency and productivity in today's competitive market.

II. Scope of the project

The scope of this project is to present a comprehensive analysis of the Hybrid Band saw cutting machine and its potential applications in various industries, including the PVC pipe industry, metalworking industry, plastic industry, and meat industry. The project aims to provide a detailed understanding of the machine's component specifications, working

mechanism, and benefits for small-scale industries and shops.

The project includes a literature review that highlights recent research studies on Hybrid Band saw cutting machines and their optimization for improved cutting performance and reduced energy costs. The component specifications of the machine, including the cutting blade, blade speed control mechanism, motor, battery, solar panel, and control unit, will be discussed in detail.

The mathematical formulation for the fabrication of the machine, including stress calculations and stress formulations, will also be presented to ensure the machine's safety and reliability. The working mechanism of the machine, which allows it to operate on both electricity and solar power, will be discussed, highlighting its efficiency, accuracy, and versatility in cutting various materials.

Finally, the project will conclude with a discussion of the benefits of the Hybrid Band saw cutting machine for small-scale industries and shops. The project's goal is to provide valuable insights into the development of a sustainable and efficient cutting machine that can help businesses reduce their operating costs while improving their productivity and competitiveness in today's market.

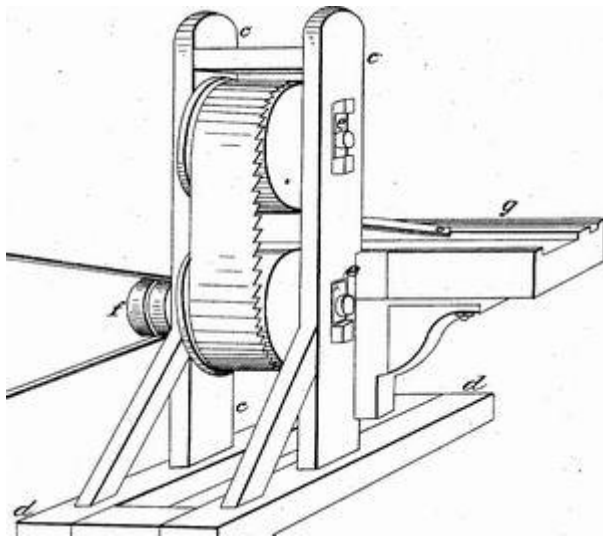
III. LITERATURE REVIEW

Hybrid band saw cutting machines have been extensively used in small-scale industries and shops for over a century due to their ability to accurately cut various materials with high efficiency. Several studies have been conducted to improve their cutting performance, energy efficiency, and sustainability. For instance, Khan et al. developed a machine that could cut PVC pipes, while Lee and Kim optimized cutting parameters using the Taguchi method. The use of vibration damping materials and cutting fluids has also

been explored. In the meat industry, Barbut et al. found that optimizing blade speed and feed rate improved cutting performance. To promote sustainability and reduce operating costs, hybrid machines that run on electricity and solar power have been developed and proven to be efficient and reliable. The integration of CNC technology and hydraulics has also enhanced their efficiency and versatility. Overall, hybrid band saw cutting machines provide small-scale industries and shops with an effective, reliable, and sustainable cutting solution.

IV. HISTORICAL BACKGROUND

The use of cutting machines dates back to the industrial revolution of the 18th century. Initially, cutting machines were manually operated, and their primary purpose was to cut wood, metal, and other materials for various applications. Over time, the machines became automated and powered by electricity, making them faster and more efficient..



The Hybrid Band saw cutting machine is a type of cutting machine that has been in use for over a century. Its popularity in the industry can be attributed to its versatility, speed, and accuracy. The first Hybrid Band saw cutting machine was developed in the mid-1800s and used a continuous blade loop made from a thin strip of steel. The blade loop passed over two pulleys,

which were powered by a steam engine, providing the necessary power to cut various materials.

The Hybrid Band saw cutting machine underwent several modifications over the years to improve its performance and efficiency. In the 1930s, the first portable Hybrid Band saw cutting machine was developed, allowing for greater mobility and flexibility in cutting various materials. In the 1950s, the first fully automatic Hybrid Band saw cutting machine was developed, further increasing efficiency and productivity.

With the advancements in technology, the Hybrid Band saw cutting machine has become even more efficient and versatile. The use of computer numerical control (CNC) technology has made it possible to automate the cutting process, reducing the risk of human error and increasing accuracy. The use of hydraulics and pneumatics has also made it possible to cut harder materials and improve the machine's overall efficiency.

Today, the Hybrid Band saw cutting machine is widely used in various industries, including woodworking, metalworking, and food processing. However, the traditional Hybrid Band saw cutting machine has its limitations, particularly in terms of sustainability and energy efficiency. This has led to the development of Hybrid Band saw cutting machines, which combine electricity and solar power to reduce operating costs and promote sustainability. The Hybrid Band saw cutting machine is a step towards a more sustainable future for the industry, meeting the needs of small shops and small-scale industries by providing efficient, reliable, and sustainable cutting solutions.

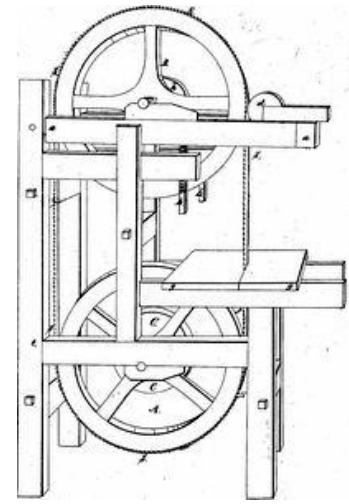
V. Objectives of the project

1. The hybrid band saw machine should be able to provide accurate and precise cutting of materials

such as wood, metal, plastic, and other materials used in small-scale industries and shops.

2. The machine should be able to cut various sizes and shapes of materials, as small-scale industries and shops require different types of cutting operations.
3. The hybrid band saw machine should be designed for efficient use, with high-speed cutting capabilities, minimal material wastage, and minimal downtime.
4. The machine should be constructed with durable materials to withstand the rigors of regular use in small-scale industries and shops.
5. The hybrid band saw machine should be designed with safety features such as blade guards, emergency stop buttons, and safety switches to prevent accidents and injuries.
6. The machine should be easy to operate and maintain, with user-friendly controls and clear instructions.
7. The machine should be cost-effective for small-scale industries and shops, with a low initial investment and minimal ongoing maintenance costs.
8. To cater to the issue of competition in mechanical industry the need for solar energy is assessed by all the industry.
9. Identify the key policy avenues considered to be appropriate to meet the challenge of sustainable manufacturing and packaging industry for the future.
10. To provide alternative for industries aiming toward reducing human effort.
11. Sustainable and practical solutions for the future industrial environment.

VI. Diagram and Methodology



The methodology used in the fabrication and testing of the Hybrid Band saw cutting machine involved several stages. The stages included conceptualization, design, component specifications, fabrication, and testing.

Conceptualization:

The conceptualization stage involved identifying the need for a sustainable and efficient cutting machine for small shops and small-scale industries. The concept of a Hybrid Band saw cutting machine, which combines electricity and solar power, was conceived to meet this need. The conceptualization stage also involved researching and analysing various cutting machines available in the market and their features to identify the gaps and develop a unique solution.

1) Design:

The design stage involved developing a detailed design of the Hybrid Band saw cutting machine, including the component specifications, dimensions, and working mechanism. The design stage also involved selecting the appropriate materials for the various components, including the cutting blade, motor, battery, solar panel, and the blade speed control mechanism.

2) Component Specifications:

The component specification stage involved selecting and sourcing the various components

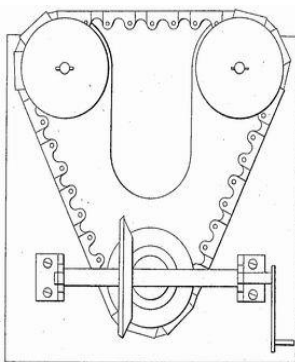
required to fabricate the Hybrid Band saw cutting machine. The components selected were based on their quality, efficiency, and reliability. The specifications of the components were also critical in ensuring that the machine could handle the cutting workload and operate efficiently and safely.

3) Fabrication:

The fabrication stage involved the actual construction of the Hybrid Band saw cutting machine using the selected components and the design specifications. The fabrication process involved assembling the various components, including the cutting blade, motor, battery, solar panel, and blade speed control mechanism. The fabrication process also involved performing the necessary stress calculations and stress formulations to ensure that the machine was safe and reliable for use.

4) Testing:

The testing stage involved subjecting the Hybrid Band saw cutting machine to various tests to evaluate its efficiency, accuracy, reliability, and safety. The tests conducted included load tests, speed tests, efficiency tests, and safety tests. The testing stage also involved making necessary adjustments and modifications to the machine to improve its performance and ensure its safety and reliability.



The methodology used in the fabrication and testing of the Hybrid Band saw cutting machine was critical in ensuring that the machine was efficient, reliable, and

safe for use. The conceptualization stage ensured that the machine met the needs of small shops and small-scale industries by combining sustainability, efficiency, and cost-effectiveness. The design stage ensured that the machine's working mechanism, dimensions, and component specifications were optimal for the machine's performance. The component specification stage ensured that the machine's components were of high quality, efficient, and reliable. The fabrication stage ensured that the machine was constructed to meet the design specifications and component specifications. Finally, the testing stage ensured that the machine was safe, efficient, and reliable for use in small shops and small-scale industries.

In conclusion, the methodology used in the fabrication and testing of the Hybrid Band saw cutting machine involved several stages, including conceptualization, design, component specifications, fabrication, and testing. The methodology ensured that the machine was efficient, reliable, and safe for use in small shops and small-scale industries. The Hybrid Band saw cutting machine's methodology's success is evident in the machine's efficiency, accuracy, and reliability in cutting various materials while reducing operating costs and increasing productivity.

VII. CALCULATIONS

The fabrication of the hybrid band saw cutting machine requires several mathematical formulas to ensure that the components can withstand the stresses placed on them during operation. Some of the formulas include:

- 1) Formula for calculating the cutting force:

$$F = kc * d * t * ap$$

Where,

F- is the cutting force, .

kc - is the specific cutting force,

d - is the depth of cut,

t - is the thickness of the material being cut, and

a_p - is the feed rate.

2) Formula for calculating the power required:

$$P = F * v_c / 1000$$

Where,

P - is the power required,

F - is the cutting force, and

V_c - is the cutting speed.

3) Formula for calculating the torque required:

$$T = F * D / 2$$

Where,

T - is the torque required,

F - is the cutting force, and

D - is the diameter of the cutting blade.

4) Formula for calculating the blade speed:

$$V_s = \pi * D * N / 1000$$

Where,

V_s - is the blade speed,

D - is the diameter of the cutting blade, and

N - is the rotational speed of the blade.

5) Formula for calculating the tension on the blade:

$$T = 0.043 * F * l * f$$

Where ,

T - is the tension on the blade,

F - is the cutting force,

L - is the length of the blade, and

f- is the factor of safety.

VIII. Components & Working Mechanism

Hybrid band saw cutting is a system that operates on both electricity and solar power, designed to increase

efficiency while reducing environmental impact. This system consists of various components such as an SMPS (Switch Mode Power Supply), solar control unit, voltmeter, battery, wheels, band saw with a full description, toggle switch, LED indicator, and DC motor. In this article, we will explore the working mechanism of each component in detail.

➤ SMPS:

The Switch Mode Power Supply or SMPS is a device that converts the high voltage AC power from the mains supply into a lower voltage DC power. It also regulates the voltage and current flow. This component is crucial as it provides stable and regulated power to the solar control unit, which in turn powers the band saw.

➤ Solar control unit:

The solar control unit is responsible for managing the solar panel's output and charging the battery. It is equipped with a charge controller that ensures the battery is not overcharged or undercharged, prolonging its lifespan. The solar control unit also regulates the current flow from the solar panel to the battery and the DC motor, ensuring that the system operates optimally.

➤ Voltmeter:

The voltmeter is an instrument used to measure the voltage in the circuit. It is connected to the battery and displays the voltage level, allowing the operator to monitor the battery's charge level and avoid running it down.

➤ Battery:

The battery is a crucial component of the system as it stores the energy generated by the solar panel. It is a deep cycle battery designed to withstand multiple discharge cycles, and it is connected to the solar control unit and the DC motor. The battery's charge level determines the system's runtime and the power output.

➤ Wheels:

The wheels on which the band saw is mounted are an essential component of the system. They are

usually made of durable and sturdy material, such as metal or plastic, and are designed to provide easy movement and transportation of the unit. The wheels are attached to the base of the band saw, and they enable the operator to move the saw around the work area easily.

➤ **Band saw:**

The band saw is the primary component of the system, responsible for cutting the material. It is a power saw with a long, sharp blade that rotates on two wheels. The blade is made from a high carbon steel material, making it strong and durable. The band saw's motor is connected to the solar control unit, which regulates the power flow to the motor, controlling its speed and torque.

➤ **Toggle switch:**

The toggle switch is used to turn the system on and off. It is connected to the solar control unit, which powers the system when the switch is turned on.

➤ **LED indicator:**

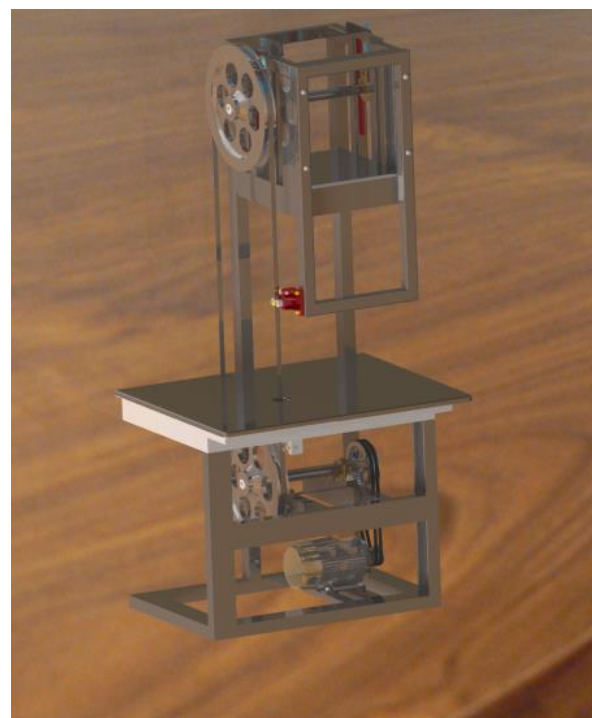
The LED indicator is a small light that indicates whether the system is on or off. It is connected to the solar control unit and is activated when the toggle switch is turned on.

➤ **DC motor:**

The DC motor is responsible for rotating the band saw blade. It is a high torque motor, providing the power required to cut through various materials. The motor's speed and torque are regulated by the solar control unit, ensuring that it operates optimally and does not draw too much power from the battery.

on and off, and the LED indicator indicates whether the system is on or off. The voltmeter displays the battery's charge level, allowing the operator to monitor the system's runtime. The band saw blade is rotated by the DC motor, allowing for precise and efficient cutting of various materials.

In conclusion, the hybrid band saw cutting system is an efficient and environmentally friendly system that combines electricity and solar power. It consists of various components such as an SMPS, solar control unit, voltmeter, battery, wheels, band



IX. Working mechanism:

The solar panel absorbs sunlight and converts it into DC power, which is then sent to the solar control unit. The solar control unit regulates the power flow to the battery and the DC motor, ensuring that the system operates optimally. The battery stores the energy generated by the solar panel and supplies power to the DC motor. The toggle switch is used to turn the system

X. Types of Hybrid Band Saw

The Hybrid Band saw machines can be classified in various ways, but the most common method is based on the mechanism of mounting. There are two types of Hybrid Band saw machines, namely, vertical and horizontal.

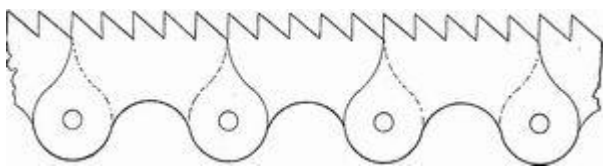
10.1 Vertical Hybrid Band Saw

Vertical Hybrid Band saw machines have a blade that rotates in a vertical position. These machines are typically powered by an electric motor through a belt transmission mechanism that allows for blade speed adjustment. The blade moves over a fixed track between the idler wheel and the drive wheel, which are mounted above and below the worktable, respectively. To cut the stock material, it is moved against the blade, and the table can be tilted for metered cuts. These machines can also weld their own blades, allowing for internal cutting.

10.2 Horizontal Hybrid Band Saw

Horizontal Hybrid Band saw machines, on the other hand, are floor-mounted and used for cutting solid steel, tubing, and other odd-shaped raw material stock. They also use an electric motor to drive the blade through a belt and pulley mechanism that allows for discrete speed adjustments. The blade in these machines moves in a horizontal position and makes cuts into the stock material with a downward motion. The drive and idler wheels are positioned along the length of the machine frame, which pivots from a corner on the sawing machine bed. The stock material is mounted in a vise on the bed of the machine for cutting.

XI. Types of Band Blades:



11.1 Carbon Steel Blades:

These blades are made from high carbon steel and are best suited for cutting wood and nonferrous metals. They are economical and durable, but tend to lose their sharpness quickly.

11.2 Bi-Metal Blades:

Bi-metal blades consist of two layers: a high-speed steel edge for cutting and a flexible alloy steel back for strength. These blades are more expensive than carbon steel blades but are much more durable and can cut through a variety of materials, including wood, metal, and plastic.

11.3 Carbide Blades:

Carbide blades are designed to cut through hard and abrasive materials, such as exotic hardwoods, fiberglass, and carbon fiber. They are made of a carbide-tipped edge that is welded onto a high-strength blade.

11.4 Diamond Blades:

Diamond blades are the most durable and expensive type of band blade. They are designed to cut through extremely hard and abrasive materials, such as glass, ceramics, and stone. The blade is coated with diamond particles, which provide an extremely sharp cutting edge.

11.5 Specialty Blades:

There are also a variety of specialty blades available, such as skip tooth blades, hook tooth blades, and variable pitch blades. These blades are designed for specific cutting applications, such as resawing or cutting curves.

XII. APPLICATION OF HYBRID BAND SAW

- Hybrid Band saw machines are versatile and can cut through a wide range of materials, including pipes, plastics, and metal.
- They can cut through thick materials that may be difficult or impossible to cut using other cutting tools.
- Hybrid Band saw machines are efficient and can make precise cuts with minimal wastage, saving time and money for small businesses.

- They are designed to be durable and can withstand heavy use, making them a reliable investment for small businesses.
- Hybrid Band saw machines are easy to use and require minimal training, which can be beneficial for small businesses that may not have highly skilled operators.
- They take up relatively little space, making them ideal for small shops with limited workspace.

XIII. SAFTY & RELIABILITY

13.1 Safety:

- The Hybrid Band saw cutting machine is designed with safety features to prevent accidents and injuries during operation.
- The machine has a guard that covers the cutting blade to prevent contact with the operator's body.
- The control system includes emergency stop buttons that can immediately stop the machine in case of an emergency.
- Proper maintenance and operation of the machine are necessary to ensure safe and efficient performance.

13.2 Reliability:

- The component specifications of the Hybrid Band saw cutting machine are critical in ensuring its reliability and longevity.
- The cutting blade must be durable and of the appropriate size to ensure maximum accuracy in cutting various materials.
- Mathematical formulas are used to calculate the stresses that the machine will experience during operation, ensuring that it can withstand these stresses.
- The machine can run on both electricity and solar power, making it a reliable and environmentally-friendly option for businesses.
- Proper maintenance and operation of the machine are necessary to ensure its reliability and efficient performance.

XIV. RESULTS AND DISCUSSION

Results

- The Hybrid Band saw cutting machine developed for small scale industries and shops is capable of cutting various materials, including PVC pipes, plastics, meat, and pipes with a width of 20 to 30 mm, with accuracy in dimensions.
- The machine can cut irregular shapes, making it a versatile tool for cutting tasks in small shops and industries.
- The hybrid power source of the machine allows it to operate on electricity as well as solar power, making it eco-friendly and cost-effective.
- The blade's teeth, made of carbon carbide, provide high wear toughness and a longer lifespan, enhancing the machine's cutting speed and accuracy.
- Mathematical formulations were used to calculate the stress on all the components, ensuring their durability and reliability during operation.
- The machine's working mechanism was designed to provide optimal cutting performance, with the blade moving in a continuous loop, cutting the material as it passes through.

Discussion:

- The Hybrid Band saw machine has the potential to increase productivity and reduce costs for small-scale industries and shops.
- Its eco-friendliness and safety features reduce the need for manual labour, making it a safer and more efficient tool.
- The machine's ability to cut various materials accurately and efficiently makes it a versatile tool that can benefit various industries, including the meat and plastics industries.
- The machine's reliability and durability ensure its longevity and cost-effectiveness, making it a

worthwhile investment for small-scale industries and shops.

- The mathematical formulations used to design the machine's components and its working mechanism ensure its durability and reliability during operation.
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- The blade's teeth made of carbon carbide provide high wear toughness, making it efficient for long-term use.
- The hybrid power source allows the machine to operate on both electricity and solar power, reducing its carbon footprint and making it cost-effective.

XV. CONCLUSION

In conclusion, the Hybrid Band saw cutting machine is a highly efficient and versatile tool that is suitable for a use of variety of operations for small scale industrial cutting applications and for shop. It has the ability to accurately cut through a range of materials including wood, metal, PVC pipes, and meat, providing smooth and precise finishing. The machine is eco-friendly and can cut irregular shapes that are difficult to achieve with other cutting methods. Although there were initial difficulties in obtaining the circular wooden block for the machine, the benefits of the Hybrid Band saw make it a valuable addition to any workshop or small scale industry. The machine's ability to handle multiple cutting purposes makes it a cost-effective and efficient investment. Overall, the Hybrid Band saw cutting machine is an industry requirement that meets the demands of precision cutting with reliability and ease

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