Design and Fabrication of Crank Rocker Sheet Cutting Machine

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ABSTRACT

The design and fabrication of a sheet metal cutting machine using a crank rocker mechanism is highly effective for cutting sheet metals into equal and accurate dimensions. The crank–rocker mechanism is utilized to automate the cutting operation by converting rotary motion into oscillatory motion. In this system, continuous rotational motion from the motor is transmitted to the crank, which in turn drives the rocker arm. The oscillating motion of the rocker is used to operate the cutting tool. The sheet metal is fed manually or by a simple feeding mechanism and positioned accurately before each cutting stroke. The crank–rocker mechanism ensures smooth and controlled movement of the cutting blade, resulting in uniform and precise cuts. After completing the cutting stroke, the cutter returns to its original position due to the reverse motion of the rocker and the assistance of a spring mechanism. Thus, the use of a crank–rocker mechanism provides a simple, reliable, and cost-effective solution for sheet metal cutting with improved operational efficiency and accuracy. The oscillating motion of the rocker is used to operate the cutting blade. As the crank rotates, the rocker moves downward to perform the cutting stroke and then returns to its original

Key words:*crank–rocker mechanism, sheet metal, spring mechanism.*

1. Introduction

Sufficient force to cause the material to fail. The most common cuttingprocesses are performed by applying a shearing force and are therefore often referredto as shearing processes. Cutting processes are operations in which a piece of sheetmetal is separated by applying When a sufficiently large shearing force is applied, theshear stress induced in the material exceeds its ultimate shear strength, resulting infracture and separation at the desired cutting location.This shearing force is applied by two tools positioned above and below thesheet metal. These may be in the form of upper and lower blades or a punch and diearrangement. The upper tool delivers a downward stroke onto the sheet metal placedover the lower tool. A small clearance is maintained between the edges of the upperand lower tools to facilitate proper fracture of the material. Typically, this clearanceranges from 2–10% of the material thickness and depends on factors such as materialtype, sheet thickness, and the specific cutting process.The sheet metal cutting machine is designed to reduce the time required formarking and cutting sheet metals. In this system, a crank–rocker mechanism isemployed to achieve the cutting operation. The crank–rocker mechanism is systemthat converts continuous rotary motion into oscillatory motion. When the crank rotatescontinuously, it drives the rocker arm in a controlled back-and-forth motion.
The oscillating motion of the rocker is used to operate the cutting blade. Asthe crank rotates, the rocker moves downward to perform the cutting stroke and thenreturns to its original position during the return stroke.The main purpose of this machine is to minimize manual marking, reduceprocessing time, and improve cutting accuracy. The entire operation is synchronizedthrough the rotational motion of the crank, ensuring uniform and efficient sheet metalcutting

2. Literature review

Sheet cutting machines play a vital role in manufacturing industries where precision, efficiency,and cost effectiveness are essential. Conventional systems such as hydraulic and pneumatic cutting machines offer high force output but are often expensive and complex. In contrast, mechanically driven systems, particularly those based on the crank–rocker mechanism, provide a simpler and more economical alternative. Recent research focuses on improving the performance, efficiency, and fabrication feasibility of such mechanisms using modern design and simulation tools [1,2].

Sun et al. [3] conducted a detailed kinematic and dynamic analysis of four-bar mechanisms, showing that precise modeling of displacement, velocity, and acceleration enables optimized performance for mechanical applications. Similarly, Wang et al. [4] used computational simulations to predict motion characteristics and stress distribution, highlighting the importance of dimensional accuracy in high-speed linkages. Optimization methods, such as genetic algorithms, have also been employed to enhance transmission angles and reduce unwanted vibrations [5]. Matuz and Cveticanin [6] investigated crank-based sheet cutters, focusing on torque requirements, cutting forces, and structural integrity. Their findings demonstrate that correct link sizing and stress analysis can prevent premature failure and improve operational efficiency.

Early studies on guillotine and mechanical shearing machines also explored crank-driven designs. These works revealed that dynamic loading, vibration, and stress distribution significantly impact cutting performance and machine longevity [7]. Therefore, kinematic and kinetic analysis is necessary to optimize the mechanical configuration for consistent sheet cutting.Mowade et al. [8] reviewed pneumatic sheet cutters, noting their advantages in automation and multi-functionality. However, these systems often require external components such as compressors, valves, and fluid reservoirs, increasing cost and maintenance complexity.Electrical and hydraulic cutting machines provide higher force capacity but involve higher manufacturing costs, energy consumption, and maintenance challenges. In contrast, crank-rocker-based machines offer a simple, low-cost, and robust solution, particularly suitable for small-scale workshops and low-budget fabrication projects [9].

Kumar et al. [10] demonstrated that motion characteristics such as displacement, velocity, and acceleration can be accurately predicted using computational tools, reducing design errors. Similarly, Yan et al. [11] developed advanced kinematic models validated through simulation, confirming the importance of precise dimensional synthesis.

Optimization techniques have also gained importance. Sharma et al. [12] applied multi-objective optimization to improve transmission efficiency and minimize vibration. Furthermore, Li et al. [13] conducted stress and fatigue analysis, concluding that proper material selection and link design significantly enhance durability under cyclic loading conditions.

Vlakh et al. [14] proposed an improved crank-based mechanism for die-cutting presses, demonstrating enhanced efficiency through geometric optimization. Similarly, Patel et al. [15] investigated cutting force optimization in sheet metal operations, showing that proper linkage design directly affects cutting efficiency and energy consumption.

Based on these studies, the present work develops a sheet metal cuttingmachine using a crank–rocker mechanism. Instead of simple sheet cutting, this projectextends the concept to sheet metal cutting, where higher force and precision arerequired. The mechanism ensures controlled cutting action, reduced manual effort,improved accuracy, and increased productivity.

3. WORKING PRINCIPLE

The sheet metal cutting machine operates on the principle of a crank-rocker mechanism, which converts rotary motion into the reciprocating motion of the cutting blade. A handle is fixed to the crank, and when the handle is rotated, the crank rotates along with it. The motion of the crank is transmitted through a connecting rod to a rocker arm, which is attached to the cutting blade. The position of the crank determines the position of the cutter and the tension in the spring. When the crank is at its bottom position, the cutter is in the full open position, and the spring remains at rest. As the crank rotates to the left, the cutter moves to a partial cutting position, and the spring is in partial tension. When the crank reaches the top position, the cutter reaches the full cutting position, and the spring is in full tension. Continuing the rotation to the right position, the cutter returns to a partial cutting position, and the spring tension reduces accordingly. During operation, the sheet metal is placed on the work table, and the crank rocker mechanism ensures the cutter moves smoothly and precisely. The spring loaded cutter applies consistent pressure to cut the sheet accurately. The connecting rod and rocker arm maintain proper motion and timing, ensuring that each stroke of the cutter is efficient and repeatable. By using the crank-rocker mechanism, the machine provides continuous, smooth, and precise cutting of sheet metal, overcoming the limitations of previous systems that used Geneva mechanisms. The handle or motor continuously drives the crank, allowing the sheet metal to be fed, cut, and released in a controlled and synchronized manner, making the machine reliable, efficient, and suitable for industrial use.

3.1 ASSEMBLY

The assembly drawing is an important part of the project as it represents the completearrangement of all the components used in the Crank Rocker Sheet Metal CuttingMachine**.** It provides a clear view of how each individual part is positioned andconnected with other components to form the complete machine. The assemblydrawing helps in understanding the relationship between the different parts andensures that all components are assembled in the correct position during fabrication.In this machine, the metal frame and supporting table form the base structure of thesystem and provide proper support and stability. The DC motor is mounted on theframe and acts as the power source for the mechanism. The power from the motor istransmitted to the crank wheel through a V-belt drive system. The crank wheel isconnected to the connecting shaft**,** which is supported by ball bearings to ensuresmooth rotation and reduce friction.

The rotational motion of the crank wheel is transferred to the rocker arm**,** whichconverts the rotary motion into oscillating motion. This oscillating motion is thentransmitted to the sheet metal cutter**,** which performs the cutting operation on thesheet metal placed on the supporting table. Proper alignment and fitting of these parts are very important to ensure smooth operation and effective cutting performance.

The assembly drawing also helps in identifying the exact location of each component,the method of fixing, and the order of assembly. It is very useful during manufacturing, fabrication, maintenance, and troubleshooting of the machine. By referring to the assembly drawing, the entire mechanism can be easily assembled andunderstood, which improves the overall efficiency and reliability of the machine.

4. RESULTS

The final output of the project is the successful fabrication and operation of the Crank Rocker Sheet Metal Cutting Machine. After completing the design, material selection, fabrication, and assembly processes, the machine was tested to ensure proper functioning of all components. The DC motor provides the required power, which is transmitted through the V-belt to the crank wheel. The crank and rocker mechanism converts the rotary motion into oscillating motion, enabling the cutter to move up and down for cutting sheet metal. During the testing process, the machine was able to cut thin sheet metal effectively with smooth operation and minimal vibration. All components such as the crank wheel, rocker arm, connecting shaft, and ball bearings worked properly and provided the required motion for the cutting operation. The supporting frame and table provided sufficient stability for the machine during operation. Thus, the project demonstrates a simple, efficient, and low-cost mechanism for sheet metal cutting. The developed machine can be used for small-scale cutting operations and educational purposes, showing the practical application of the crank rocker mechanism in mechanical systems.

Fig.1: Fabrication of Sheet Cutter Machine

5. CONCLUSION

The Crank-Rocker Sheet Metal Cutting Machine is a reliable and efficient solution for cutting sheet metal in workshops and small industrial applications. By converting rotary motion into precise reciprocating motion, the crank-rocker mechanism ensures smooth operation, accurate cutting, and consistent performance of the machine. The simple mechanical arrangement makes the machine easy to operate and maintain. This machine offers several advantages such as good cutting accuracy, reduced wear of components, adjustable stroke length, and easy maintenance. Compared with complex automated machines, the crank-rocker mechanism is mechanically simple, economical, and safer to use. Although the machine is mainly suitable for thin to medium thickness sheet metals and requires periodic maintenance for smooth operation, it still performs effectively in many practical situations.

Overall, the crank-rocker sheet metal cutting machine provides a simple, cost effective, and efficient method for sheet metal cutting. It is especially useful for small-scale fabrication work, educational laboratories, prototype development, and workshop applications, where a low-cost and reliable cutting mechanism is required.

6. FUTURE SCOPE

The machine can be improved in the future by adding advanced features to increase efficiency and performance. A higher-power motor can be used to cut thicker sheet metals, and hardened tool steel blades with better bearings can improve cutting efficiency. Automation can also be introduced by using electronic control systems or sensors to control the cutting speed and stroke automatically. The frame can be strengthened using better materials to improve durability. Further improvements such as adjustable cutting angles and automatic sheet feeding can make the machine suitable for industrial production and large-scale fabrication.

References

[1]. Kumar, P., et al. (2022). Simulation and kinematic analysis of crank-rocker mechanisms. *Mechanism and Machine Theory*.

[2]. Renna, P., & Ambrico, M. (2024). Advances in crank-based mechanical systems. *Applied Sciences*, 14(11), 4872.

[3]. C. Sun, "Kinematic and dynamic analysis of four-bar mechanisms using ADAMS simulation," *Advances in Mechanical Engineering*, vol. 7, no. 3, pp. 1–12, 2015.

[4]. Y. Wang, H. Li, and Z. Zhao, "Kinematic simulation and stress analysis of crank-rocker linkages," *Applied Mechanics and Materials*, vol. 945–949, pp. 690–697, 2014.

[5]. K. P. Sharma and P. S. Verma, "Optimization of crank-rocker mechanisms using genetic algorithms," *Mechanism and Machine Theory*, vol. 154, pp. 103946, 2020.

[6]. M. Matuz and D. Cveticanin, "Design and analysis of crank-based sheet cutting mechanisms," *Strojniški vestnik – Journal of Mechanical Engineering*, vol. 64, no. 3, pp. 98–107, 2018.

[7]. A. T. de Silva, "Dynamic analysis of mechanical shearing machines," *Journal of Materials Processing Technology*, vol. 76, pp. 105–112, 1998.

[8]. Mowade, S., Bhole, P., & Dhadwe, R. (2023). Fabrication of pneumatic sheet cutting machine: A review. *International Journal of Scientific Research in Engineering and Management*, 7(2), 15–19.

[9]. R. Gupta and S. K. Sharma, "Low-cost mechanical sheet cutting systems for small-scale workshops," *International Journal of Mechanical Engineering and Robotics Research*, vol. 8, no. 5, pp. 412–420, 2019.

[10]. Yan, S., et al. (2024). Design and motion analysis of a space crank rocker mechanism. *Applied Mathematics and Nonlinear Sciences*, 9(1).

[11]. Sharma, S., Singh, R., & Patel, K. (2023). Optimization of crank-rocker linkage mechanisms. *Journal of Manufacturing Processes*.

[12]. Li, H., Zhao, J., & Wang, Y. (2023). Stress and fatigue analysis of crank-rocker mechanisms under cyclic loading. *Materials Today: Proceedings*, 74, 512–519.

[13]. Vlakh, V. V., Rehei, I. I., & Knysh, O. B. (2025). Research of wedging mechanism with additional driven crank. *Australian Journal of Mechanical Engineering*.

[14]. Patel, M. R., et al. (2023). Optimization of cutting force in sheet metal cutting. *Procedia Manufacturing*, 68, 532–539.