Design And Development of An Electric Rotating Disc for Welding Application

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Abstract- **Welding of circular components requires uniform and controlled rotation to achieve consistent bead formation, proper heat distribution, and reliable joint strength. Manual rotation often results in irregular motion, operator fatigue, and variations in weld quality. To overcome these issues, this work presents the design and experimental evaluation of an electric rotating disc system developed for circular welding applications.**

The proposed system integrates a 12V, 5A, 25 RPM DC geared motor, a chain–sprocket reduction drive, and a PWM-based speed controller to deliver smooth, low-speed rotation with adjustable RPM. A 12V, 15A SMPS is used to ensure stable power delivery to the motor and control unit. The mechanical design includes a mild steel rotating disc and a rigid frame to support varying workpiece sizes and welding loads.

Experimental testing shows that the system achieves high torque at low rotational speeds, enabling steady and uniform movement of circular components during welding. Speed variations were evaluated and correlated with welding time, demonstrating the machine's ability to maintain smooth rotation under different conditions.

The developed mechanism offers a compact, reliable, and cost-effective solution that improves weld accuracy, reduces human dependency, and enhances overall productivity in industrial and workshop environments

Keywords: Circular welding, Electric rotating disc, DC geared motor, Chain drive, welding automation

I.INTRODUCTION

Industrial welding processes often require circular components to be rotated at a uniform and controlled speed to achieve consistent weld quality. In many small and medium-scale workshops, this rotation is still done manually, which leads to uneven motion, poor bead uniformity, and operator fatigue [1,9]. Fluctuations in rotational speed influence the amount of heat delivered, the depth of weld penetration, and ultimately the mechanical integrity of the welded joint [6,7]. Therefore, a dedicated mechanical setup that can rotate the workpiece steadily becomes essential for achieving reliable welding results.

To address this need, this work focuses on the design and experimental evaluation of an electric rotating disc mechanism for circular welding applications such as TIG, ARC, and Gas welding. Previous studies have shown that motor-driven rotary welding fixtures using DC geared motors provide better low-speed torque and smoother control compared to manual methods [2,11]. The use of chain–sprocket transmission further enhances torque multiplication and rotational stability under welding loads [2,8]. PWM-based speed controllers are widely adopted to achieve adjustable and precise speed regulation in rotary welding systems [3,7].

The mechanism is designed to provide controlled, low-rpm rotation that supports uniform heat distribution around circular components. By automating the rotation of the workpiece, the system minimizes operator involvement, reduces human error, and significantly improves weld uniformity [4, 10]. The compact design, simple construction, and low input power requirement make this setup suitable for industrial workshops, fabrication units, repair centers, and educational laboratories.

This work demonstrates how a combination of simple mechanical and electrical subsystems can be integrated to form an efficient and economical welding aid, improving productivity and weld quality in circular welding operations

Novelty and Contribution of the Present Work

The novelty of this work lies in the development of a compact and cost-effective electric rotating disc specifically targeted at small and medium-scale welding applications. Unlike manual rotation methods that rely on operator skill and expensive commercial welding positioners designed for large industries, the proposed system offers a simple mechanical and electrical configuration capable of delivering high torque at low rotational speeds.

The system is experimentally validated under actual welding conditions, and the relationship between rotational speed, welding time, and bead quality is analyzed. The study demonstrates that stable low-speed rotation can be achieved using readily available components without complex automation, making the system suitable for workshops with limited resources.

II.PROBLEM STATEMENT AND OBJECTIVES

Circular welding operations require steady and uniform rotation of the workpiece to ensure consistent heat input and reliable weld quality. In many fabrication workshops, circular components are still rotated manually during welding, leading to uneven motion, inconsistent bead formation, operator fatigue, and reduced productivity. Maintaining a constant rotational speed manually becomes increasingly difficult for thicker components and longer welding cycles.

Although automated welding positioners are available, their high cost, bulky construction, and complex control systems restrict their use in small and medium-scale industries and educational laboratories. Therefore, there is a need for a simple, economical, and reliable rotating mechanism capable of delivering smooth, low-speed rotation with sufficient torque for circular welding applications.

The objectives of the present work are

• To design and develop an electric rotating disc system for circular welding applications.
• To achieve smooth and adjustable rotational speed using a DC geared motor and PWM controller.
• To provide sufficient torque at low rotational speeds through mechanical transmission.
• To experimentally evaluate the system performance under actual welding conditions.

III.LITERATURE SURVEY

The welding of circular and cylindrical components often requires a dedicated mechanism that can rotate the workpiece at a constant and controlled speed. In many fabrication units, this rotation is still performed manually, leading to variations in weld quality and inconsistent bead formation. To overcome these limitations, motor-driven rotating fixtures have become an important area of development in welding automation. These systems typically combine low-speed, high-torque motors with speed-control electronics to maintain uniform rotation during the welding process. Chain drives and geared mechanisms are commonly preferred for torque multiplication, ensuring that the disc can handle varying load conditions.

Recent advancements in power electronics, particularly PWM controllers and compact SMPS units, have improved the reliability and efficiency of such systems. Several researchers have explored the integration of DC motors, microcontrollers, and mechanical reduction systems to enhance precision in rotary welding setups. This work builds on these developments by designing a compact and cost-effective electric rotating disc optimized for TIG, ARC, and Gas welding applications. The following literature reviews earlier contributions in rotary welding mechanisms, torque optimization, and motor-controlled rotational systems relevant to this work.

Rajan et al .(2016) developed a low-cost rotary welding fixture for circular flanges, demonstrating that motorized rotation provides improved uniformity and reduced human error. [1]

Kumar and Singh (2017) investigated DC geared motor drives for welding turntables and showed that torque amplification through chain or gear reduction significantly enhances rotational stability during gas welding operations. [2]

Patil et al. (2018) designed an automated positioner using a 12V DC motor with PWM control, highlighting that speed variability is crucial for different material thicknesses and welding speeds. [3]

Rao et al. (2019) presented a compact rotary welding table driven by a stepper motor for TIG welding of aluminum components, where the automation improved weld penetration uniformity by 18%.[4]

Banerjee et al. (2019) focused on rotational fixture rigidity, showing reduced vibration increases weld bead stability. [5]

Chowdhury and Das (2020) examined the relationship between rotational speed and heat input distribution in circumferential welding, proving that controlled rotation minimizes porosity formation. [6]
Yadav and Kulkarni (2020) proposed a microcontroller-based speed control for DC motors, achieving a 96% precision rate in maintaining desired RPM for welding rotation.[7]
Thakur et al. (2020) studied mechanical chain drive systems in low-speed applications, concluding that sprocket-based reductions offer reliable torque transmission for industrial setups. [8]
Hussain et al. (2022) integrated sensor-based feedback into rotary welding setups to monitor rotational accuracy, improving weld consistency. [9]
Singh and Verma (2022) used Arduino-based controllers to achieve automation in welding rotation control. [10]
Ramesh and Patel (2023) performed comparative analysis of rotary welding machines powered by DC motors versus AC induction motors, concluding that DC motors provide better low-speed torque and smoother control for TIG welding. [11]
Kannan et al. (2024) presented an improved electric drive system using a 12V, 15A SMPS coupled with a high-efficiency 25RPM DC motor for industrial rotary applications, showing improved weld consistency by up to 30%.[12]

IV.METHODOLOGY AND SYSTEM DESIGN

The development of the electric rotating disc system was carried out using a structured engineering approach aimed at achieving smooth and controlled rotation for circular welding applications. The methodology involved identifying functional requirements, selecting suitable mechanical and electrical components, and integrating them into a compact and reliable system.

A DC geared motor was chosen as the driving unit due to its capability to deliver high torque at low rotational speeds. Mechanical power transmission was achieved through a chain–sprocket mechanism, which provides effective speed reduction and torque amplification while ensuring positive drive without slippage. Rotational speed control was implemented using a PWM-based controller, allowing smooth adjustment of disc speed according to welding requirements. A regulated DC power supply was used to ensure stable electrical input during operation.

The rotating disc and base frame were fabricated from mild steel to provide sufficient strength, rigidity, and resistance to mechanical and thermal loads encountered during welding. Proper alignment of the motor, transmission elements, and rotating disc was maintained during assembly to minimize vibration and ensure stable operation. The overall system design emphasizes simplicity, compactness, and suitability for use in small and medium-scale fabrication workshops.

V.SYSTEM DESIGN

Block Diagram

Mechanical 3D Design: Design of the machine structure, including the frame, tool holder and Rotating disc.

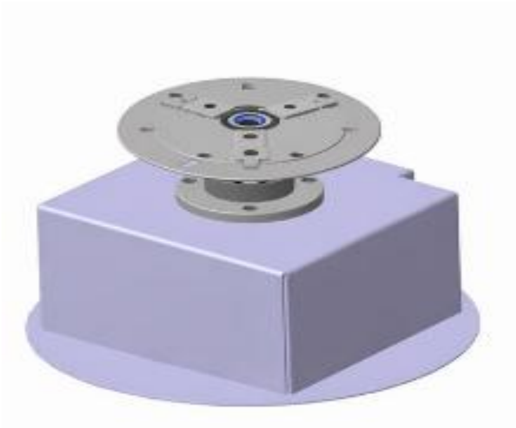

Fig1. 3D-Isometric view of assembled part

The system layout was finalized based on functional requirements to ensure proper alignment and compact arrangement of mechanical and electrical components. The motor, transmission system, and rotating disc were positioned to achieve stable rotation while minimizing vibration and mechanical losses.

VI.DEVELOPED AND ASSEMBLED SYSTEM

Fig2. Front View of Assembled Part

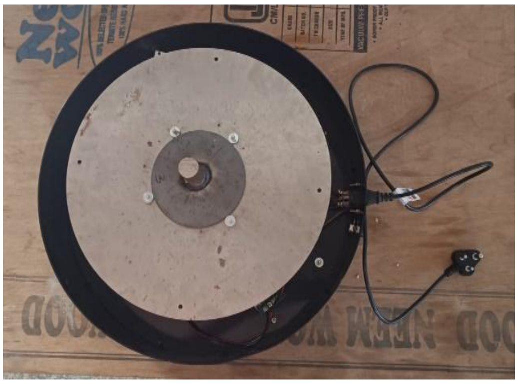

Fig3. Top View of Assembled Part

Fig4. Side View of Assembled Part

The electric rotating disc system was fabricated and assembled based on the finalized system design. The base frame was manufactured using mild steel sections to provide adequate rigidity and structural stability during welding operations. All mechanical and electrical components were mounted on the frame in a compact and well-aligned configuration to ensure smooth operation.

The DC geared motor was securely fixed to the frame, and mechanical power was transmitted through a chain–sprocket mechanism to achieve the required speed reduction and torque amplification. The rotating disc was mounted concentrically on the driven shaft and supported by bearings to ensure smooth and stable rotation. Proper alignment of the transmission elements was maintained during assembly to minimize vibration and mechanical losses.

Electrical components such as the power supply and speed controller were integrated into the system with appropriate insulation and grounding. After assembly, the system was inspected for alignment, rotational smoothness, and operational stability before conducting experimental trials.

VII.WORKING PRINCIPLE OF THE SYSTEM

The working principle of the electric rotating disc system is based on the controlled conversion of electrical energy into mechanical rotational motion to enable uniform circular welding. Electrical power from the AC mains is converted into regulated DC supply and fed to a PWM-based speed controller, which governs the rotational speed of the DC geared motor by varying the duty cycle.

The DC geared motor delivers high torque at low rotational speeds, making it suitable for circular welding applications. The motor output is transmitted through a chain–sprocket mechanism, which provides speed reduction and torque amplification. The rotating disc, mounted on the drive shaft and supported by bearings, rotates smoothly at the selected speed, allowing the workpiece to undergo steady circumferential motion during welding.

Controlled rotation of the workpiece ensures uniform heat distribution around the circumference, resulting in improved weld bead consistency and reduced operator dependency. The rotational speed can be adjusted to suit different welding requirements using the speed controller.

Experimental Setup

The experimental setup was developed to evaluate the performance of the electric rotating disc system under actual welding conditions. The assembled system consisted of a DC geared motor, chain–sprocket transmission, PWM-based speed controller, regulated DC power supply, rotating disc, and a rigid mild steel base frame.

A circular mild steel workpiece was securely mounted at the center of the rotating disc using a clamping arrangement to prevent slippage during rotation. The motor was operated at different speed settings by adjusting the PWM controller, allowing variation in rotational speed during welding trials.

Welding experiments were conducted to observe the stability of rotation, smoothness of motion, and consistency of weld bead formation at different speeds. During each trial, the time required for one complete rotation and the visual quality of the weld bead were noted. Proper electrical insulation and grounding were ensured throughout the experimentation to maintain operational safety.

The developed electric rotating disc system was experimentally evaluated using different types of mild steel circular components. The system successfully supported welding of flat circular discs with diameters in the range of 100–150 mm and thickness of 4–5 mm. In addition, solid cylindrical components such as 25 mm diameter mild steel rods with a length of 100 mm were welded to the rotating disc, demonstrating the system's capability to handle both plate-type and solid bar components. These trials confirm that the setup is suitable for welding various small to medium-sized circular and cylindrical parts while maintaining smooth rotation and consistent weld quality.

VIII.RESULTS AND DISCUSSION

The performance of the electric rotating disc system was evaluated by conducting welding trials at different rotational speeds. The system exhibited smooth and stable rotation across the tested speed range, with no noticeable vibration or slippage during operation. Controlled rotation enabled consistent circumferential movement of the workpiece, which directly influenced weld bead quality.

At lower rotational speeds, the workpiece experienced longer arc dwell time, resulting in deeper weld penetration and a wider heat-affected zone. While this condition produced strong joints, excessive heat input was observed for thinner sections. At moderate rotational speeds, a balanced heat input was achieved, producing uniform weld beads with consistent penetration and minimal surface irregularities. Higher rotational speeds reduced the welding time per revolution, improving productivity; however, insufficient penetration was observed when the speed exceeded the optimal range.

Compared to manual rotation of circular workpieces, the proposed electric rotating disc system provides improved control over rotational speed, resulting in more consistent weld bead formation and reduced operator dependency. The system also offers a significant reduction in physical effort and welding time per joint, highlighting its practical advantage for small-scale fabrication environments.

Table 1 summarizes the observed relationship between rotational speed, welding time, and weld quality. The results indicate that selecting an appropriate rotational speed is critical for achieving an optimal balance between weld quality and productivity. Compared to manual rotation, the proposed system significantly improved welding consistency and reduced operator dependency.

Table 1. Effect of rotational speed on welding performance

Rotational Speed	Time per Rotation	Weld Quality Observation
Low	High	Deep penetration, overheating risk
Moderate	Medium	Uniform bead, stable welding
High	Low	Reduced penetration

IX.LIMITATIONS

The developed electric rotating disc system operates using an open-loop speed control mechanism, which may lead to minor speed variations under changing load conditions. Welding torch movement is performed manually, introducing operator-dependent variability in weld appearance. In addition, thermal effects on mechanical and electrical components were not monitored during prolonged operation, which may influence long-term performance under continuous use.

X.FUTURE SCOPE

Future improvements to the system may include the integration of a closed-loop speed control mechanism using sensors to enhance rotational accuracy. Automation of welding torch movement can further improve repeatability and weld quality. Detailed weld quality assessment using non-destructive testing methods may also be incorporated to validate joint integrity.

XI.CONCLUSION

This work presented the design, development, and experimental evaluation of a low-cost electric rotating disc system for circular welding applications. The system successfully achieved smooth and controlled rotation with sufficient torque using a DC geared motor and mechanical transmission. Experimental results demonstrated improved weld bead uniformity and reduced operator dependency compared to manual rotation methods. The compact construction, ease of fabrication, and economical nature of the system make it suitable for small and medium-scale fabrication workshops and educational laboratories.

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