

# Mechanism and Machine Theory

## Design of a Hydraulic Circuit for a Two-Sided Shaper Machine

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<b>Corresponding Author:</b>	KUMARAN THANIKASALAM, BE Anna University Chennai, Tamil Nadu INDIA
<b>First Author:</b>	KUMARAN THANIKASALAM, BE
<b>Order of Authors:</b>	KUMARAN THANIKASALAM, BE
<b>Abstract:</b>	<p>This paper presents the design of a hydraulic circuit tailored for a two-sided shaper machine, leveraging a double-acting cylinder and a dual-pump setup to achieve efficient, automatic reciprocation. The primary objective is to enhance operational efficiency and. Key design features include a double-pump mechanism, which supports high-speed return and controlled forward strokes, and an automatic reciprocating circuit, enabling continuous, seamless operations without manual intervention. The proposed circuit is designed to deliver optimal flow and pressure regulation, thereby improving productivity and reducing downtime.</p>
<b>Opposed Reviewers:</b>	

**Cover Letter**

Kumaran T  
Final Year Student  
Department of Mechanical Engineering  
College of Engineering Guindy, Anna University  
Chennai, Tamil Nadu, 600025, India  
kumarantias09@gmail.com  
Contact: +91-7305310328  
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Editor-in-Chief  
Mechanism and Machine Theory

Dear Editor,

I am submitting our manuscript titled "Design of a Hydraulic Circuit for a Two-Sided Shaper Machine" for possible publication in your esteemed journal. This work presents a novel approach to enhancing productivity and precision in machining operations through an optimized hydraulic circuit. The proposed circuit, specifically designed for two-sided shaper machines, incorporates a dual-pump system and double-acting cylinder to facilitate automatic reciprocation. This unique configuration enables a high-speed return stroke and a controlled forward stroke, reducing manual intervention and ensuring continuous, efficient operation.

This study addresses challenges associated with traditional shaper machine setups by introducing a circuit that allows seamless automatic reciprocation while optimizing flow and pressure regulation. We believe this research offers significant contributions to hydraulic circuit design and industrial automation, providing an effective solution for high-demand applications.

Thank you for considering this manuscript for publication. I look forward to your feedback.

Sincerely,  
Kumaran T  
Final Year Student  
College of Engineering Guindy, Anna University

# Design of a Hydraulic Circuit for a Two-Sided Shaper Machine

## Highlights

- A hydraulic circuit specifically designed for a **two-sided shaper machine** improves automation and precision.
- **Dual-pump system** enables rapid return and controlled forward strokes, reducing manual oversight.
- The **automatic reciprocation feature** allows continuous operation, enhancing productivity.
- Circuit design optimizes **flow and pressure control**, ensuring consistent performance in industrial applications.
- Offers a **reliable solution** for high-precision shaping in metalworking and heavy manufacturing sectors.

# Design of a Hydraulic Circuit for a Two-Sided Shaper Machine

Kumaran T<sup>a,1,\*</sup>

<sup>a</sup>Department Of Mechanical Engineering, College Of Engineering Guindy, Anna University, Sardar Patel Road, Chennai, 600025, Tamil Nadu, India.

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## Abstract

This paper presents the design of a hydraulic circuit tailored for a two-sided shaper machine, leveraging a double-acting cylinder and a dual-pump setup to achieve efficient, automatic reciprocation. The primary objective is to enhance operational efficiency and. Key design features include a double-pump mechanism, which supports high-speed return and controlled forward strokes, and an automatic reciprocating circuit, enabling continuous, seamless operations without manual intervention. The proposed circuit is designed to deliver optimal flow and pressure regulation, thereby improving productivity and reducing downtime.

*Keywords:* Hydraulic circuit, Two-sided shaper machine, Automatic reciprocation

*JEL:* O33

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## 1. Introduction

In the realm of precision machining, shaper machines are indispensable tools, commonly applied in the processing of metal and other materials that require accurate, linear shaping. These machines operate by reciprocating motion, creating linear cuts with high precision. However, traditional shaper machines often require manual or semi-automated systems, which can be restrictive in terms of operational efficiency and continuous productivity. This study introduces a hydraulic circuit tailored to a two-sided shaper machine, designed to enhance automation and functionality through a dual-pump and double-acting cylinder setup.

The proposed hydraulic circuit incorporates a dual-pump mechanism capable of high-speed return and controlled forward strokes, enabling effective, continuous reciprocation without manual intervention. The integration of an automatic reciprocating circuit allows the machine to operate seamlessly, promoting consistent flow and pressure regulation essential for sustained, reliable performance in industrial applications. This circuit design aims to maximize productivity and minimize downtime, addressing key challenges in traditional shaper machine operations. Additionally, by adopting a hydraulic-driven approach, this setup ensures smoother, more efficient operations, contributing to the broader goals of industrial automation and productivity enhancement.

This paper details the hydraulic circuit's design and functionality, emphasizing its potential to improve the capabilities and reliability of two-sided shaper machines in manufacturing environments

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\*Corresponding author

Email addresses: [kumarantias09@gmail.com](mailto:kumarantias09@gmail.com) (KUMARAN T)

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## **2. Design and Components of the Hydraulic Circuit**

This section outlines the key components of the hydraulic circuit designed for a two-sided shaper machine, including the roles of each component and their contribution to achieving efficient, automatic reciprocation.

### **Overview of the Hydraulic Circuit Design**

The hydraulic circuit is engineered to enable the continuous, automated reciprocating motion required in a two-sided shaper machine. By utilizing a dual-pump mechanism in conjunction with a double-acting cylinder, the circuit achieves efficient control over both forward and return strokes. This design ensures high-speed operation with minimal manual intervention, aligning with industrial automation standards to enhance productivity.

### **Key Components and Their Functions**

#### **1. Double-Acting Cylinder**

The double-acting cylinder serves as the primary actuator within the hydraulic circuit, delivering the necessary reciprocating motion. It enables bidirectional movement, with hydraulic fluid alternately pushing the piston to create the forward and return strokes. This capability is essential in achieving the two-sided shaping operation, allowing for smooth and consistent motion throughout the machine's operation.

#### **2. Dual Pump Mechanism[1]**

The circuit incorporates a dual-pump setup, which allows for distinct flow rates during the shaping cycle. One pump is dedicated to supplying the high flow rate required for the return stroke, accelerating this phase and thus reducing the overall cycle time. The second pump provides a controlled flow for the forward stroke, ensuring precise cutting during the shaping operation. This dual-pump arrangement enhances the efficiency of the machine by optimizing the speed of non-cutting motions while maintaining control during the actual shaping phase.

#### **3. Automatic Reciprocating Circuit[1]**

The automatic reciprocating circuit is designed to sustain the machine's continuous operation without manual intervention. By maintaining a steady sequence of forward and return strokes, this system enhances workflow efficiency. The automatic functionality is particularly valuable in industrial settings where continuous operation is essential, minimizing downtime and labor requirements.

#### **4. Control Valves**

Control valves within the circuit regulate the direction and pressure of the hydraulic fluid. These valves play a crucial role in directing the flow to either side of the double-acting cylinder, enabling the alternation between forward and return strokes. Additionally, pressure-relief valves may be included to safeguard against over-pressurization, ensuring a safe and stable operation.

### Flow and Pressure Regulation

The hydraulic circuit is optimized for flow and pressure regulation, essential for maintaining consistent performance. Flow control valves ensure that the speed of each stroke is maintained as per operational requirements, while pressure regulation devices prevent fluctuations that could impact machining accuracy or lead to mechanical wear. This regulation not only improves productivity but also extends the lifespan of the machine by reducing stress on components during high-demand cycles.

### 3. Circuit Diagram

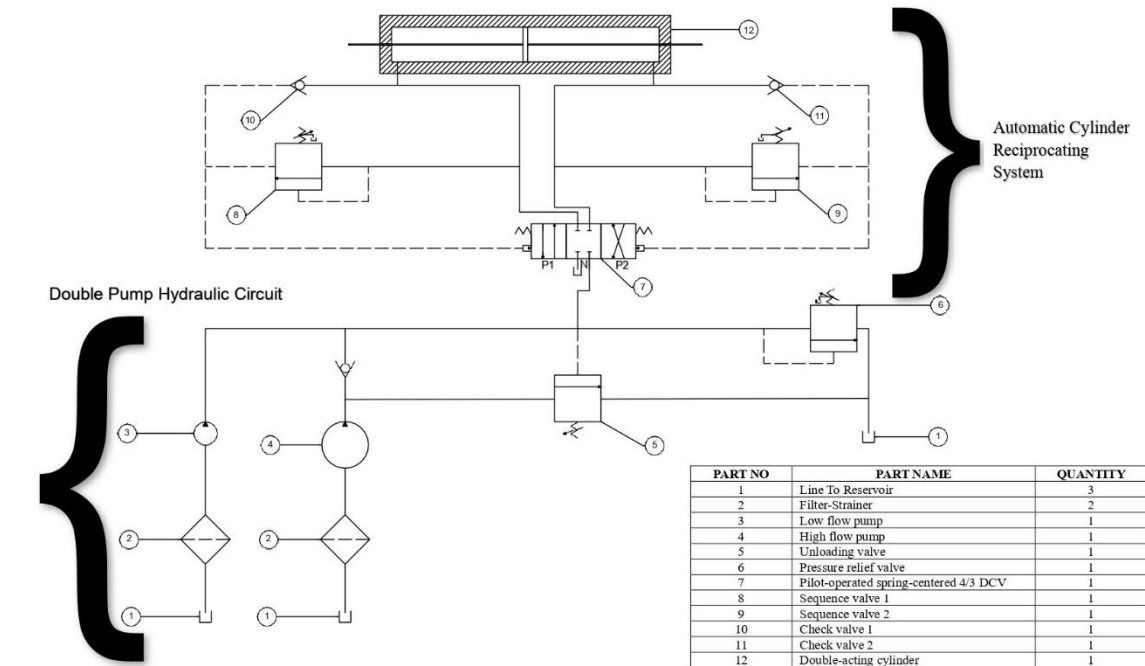


Figure 1: Circuit Diagram

### 4. Working

#### (i) At position 'N' of DCV

In this spring-centered, neutral position of the 4/3 DCV, both pumps are set to unload, allowing their entire flow to return directly to the tank.

#### (ii) At position 'P1' of DCV

In this position, fluid from the high-flow, low-pressure pump flows to the right side of the double-acting cylinder, causing the cylinder to extend leftward at an accelerated rate. As the shaping tools at both ends of the cylinder rod make contact with the material, pressure builds up, triggering the unloading valve, which unloads the low-pressure pump. This allows only the high-pressure, low-flow pump to engage, facilitating the shaping operation. Once the cylinder reaches full extension, pressure builds in sequence valve 2, causing it to open and generate a pilot signal (pressure). The check valve prevents the DCV from shifting to position P2 until the extension stroke is fully complete, at which point the pilot signal enables the DCV to shift to position P2.

#### (iii) At position 'P2' of DCV

In this position, fluid from the high-flow, low-pressure pump flows to the left side of the double-acting cylinder, causing it to retract rightward at an increased

speed. Since the shaping tools at both ends are not in contact with the material, pressure does not build up, leaving the unloading valve closed. As a result, only the high-flow, low-pressure pump supplies flow. Once the cylinder reaches full retraction, pressure builds in sequence valve 1, causing it to open and generate a pilot signal (pressure). The check valve prevents the DCV from shifting back to position P1 until the retraction stroke is fully complete, at which point the pilot signal enables the DCV to shift to position P1 and the sequence continues.

## 5. Application

### Automated Shaping and Machining

This hydraulic circuit is ideally suited for shaping and machining operations that require continuous, high-precision cuts. The automatic reciprocation enables smooth, uninterrupted operation, significantly reducing downtime and the need for manual intervention.

### Metalworking and Fabrication

Industries focused on metal fabrication—such as automotive, aerospace, and heavy machinery manufacturing—can benefit from this circuit through improved productivity in shaping metal components. Its efficient design enhances the speed and consistency of these processes.

## 6. Conclusion

The hydraulic circuit designed for a two-sided shaper machine demonstrates significant potential to enhance efficiency, precision, and automation across various industrial applications. By utilizing a dual-pump system and an automatic reciprocating circuit, this design enables continuous, high-precision shaping and machining operations, reducing downtime and minimizing the need for manual control. Furthermore, the circuit's capability to support high-volume production lines with rapid cycle times and consistent quality makes it an ideal solution for large-scale manufacturing. Overall, this hydraulic circuit offers a versatile, reliable, and efficient approach to meet the demands of modern industrial machining.

## 7. References

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### Competing Interest Statement

The author declares that there are no competing interests related to this research. The author has no financial, personal, or professional affiliations that could be perceived to influence the work presented in this manuscript.

**Declaration of interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

KUMARAN T reports administrative support was provided by Anna University. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.