PROJECT ABSTRACT

Whitworth Quick-Return Mechanism Demo Rig

A bench-top mechanical demonstrator of the Whitworth quick-return mechanism with an adjustable crank, slotted lever and horizontal ram, used to measure and verify the timing ratio of the cutting versus return stroke.

01. Introduction / Background

The Whitworth quick-return mechanism is one of the most widely taught mechanisms in Theory of Machines courses. It converts the continuous rotation of a crank into reciprocating motion of a ram, with the forward (cutting) stroke deliberately slower than the return (idle) stroke. It appears in shaping machines, slotting machines and early mechanical presses. Textbook diagrams of the mechanism are difficult to connect with its actual motion, so a working bench-top demonstrator is a standard requirement in engineering-college machine laboratories.

02. Problem Statement

Students of Theory of Machines rarely get to observe a quick-return mechanism in motion and measure its timing ratio directly. Most teaching relies on sketches and animations, so the relationship between crank radius, the length of stroke and the angle of contact remains abstract. A compact, motorised demonstrator that lets students adjust the crank radius and time both strokes is needed to make the concept concrete.

03. Objectives

- Build a bench-top Whitworth quick-return mechanism demonstrator with a motorised crank, slotted lever and guided ram.
- Provide crank-radius adjustment so students can observe its effect on stroke length and timing ratio.
- Enable measurement of the cutting-stroke and return-stroke times with a stopwatch and graduated scale.
- Verify the theoretical timing ratio (greater than one) and the stroke-length relationship against measured values.

04. Proposed Methodology

The mechanism is designed from standard kinematic relations: the crank radius is selected to give a stroke length suited to a bench-top rig, and the slotted lever proportions are chosen so the ratio of cutting-stroke angle to return-stroke angle is clearly measurable. The frame is fabricated from MS angle and flat sections, the crank disc is machined with a radial slot, and the ram slides in machined guideways. After assembly, the crank is run at a fixed speed, both stroke times are measured with a stopwatch, and the measured timing ratio is compared with the value predicted from the crank geometry.

05. System Architecture / Working

A single-phase motor drives the crank disc through a V-belt. A sliding block on the crank pin engages the slot of the slotted lever, which pivots about its lower pin. The top of the lever carries a connecting rod coupled to the ram, which slides horizontally in guideways. As the crank rotates at constant speed, the lever swings, driving the ram forward slowly during the longer crank angle (cutting stroke) and back quickly during the shorter crank angle (return stroke). A graduated scale alongside the ram and a stopwatch let students record stroke length and stroke times.

06. Hardware / Software Requirements

- MS angle and flat frame, machined crank disc with radial slot, slotted lever, connecting rod and ram with guideways.
- Single-phase motor with V-belt drive, plummer blocks and bearings.
- Graduated scale, stopwatch and hand tools for measurement.
- No software is required; the mechanism is purely mechanical.

07. Expected Outcomes

The demonstrator is expected to show a clearly measurable timing ratio greater than one, with the cutting stroke visibly slower than the return stroke. Students should be able to record stroke length and stroke times, compute the ratio, and verify it against the theoretical value derived from the crank geometry. The rig doubles as a permanent Theory of Machines laboratory demonstrator.

08. Applications

- Theory of Machines laboratory demonstrations in mechanical engineering colleges.
- Teaching aid for the quick-return mechanism chapter in kinematics courses.
- Project work on mechanism synthesis, timing-ratio analysis and fabrication.

09. Future Scope

The rig can be extended with a revolution counter and an automatic stroke timer for digital readout of the timing ratio, a second interchangeable crank disc for different ratios, or an instrumentation upgrade (proximity sensors and a display) for automated stroke-time logging.