DI04006071: Railway, Harbour & Tunnel Engineering

Lecture 3.22: Principle and Methods of Interlocking and Devices used for interlocking (Part 2)

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Introduction to Advanced Interlocking Methods I

Interlocking is the cornerstone of railway signaling, ensuring that conflicting movements are never permitted. Advanced methods have evolved from rigid mechanical links to sophisticated microprocessor-based systems, increasing traffic density and safety.

Key Points

- Need for faster and safer route setting
- Transition from mechanical to electronic systems
- Reduction of human error through automated logic

Key Principles of Interlocking I

The fundamental principle requires that it shall not be possible to clear a signal for a route unless the entire route is properly set, locked, and clear of vehicles. Furthermore, any conflicting routes must be locked against opposing movements before a signal can be cleared.

Key Points

- Route locking and holding logic
- Approach locking prevents premature release
- Sectional route release to optimize traffic flow

Classification of Interlocking Systems I

Interlocking systems are broadly classified based on the technology used for logic execution and physical control of field gears.

System Type	Core Components	Speed	Maintenance
Mechanical	Tappets, locking bars, levers	Slow	High physical wear
Electro-mechanical	Electric levers, locks	Medium	Moderate
Relay	Electromagnetic relays	Fast	Low wear, high space
Solid State	Microprocessors, software	Very Fast	Minimal physical wear

Key Points

- Mechanical systems are obsolete in modern dense networks
- Relay interlocking remains widely used and robust
- Solid State Interlocking (SSI) is the current industry standard

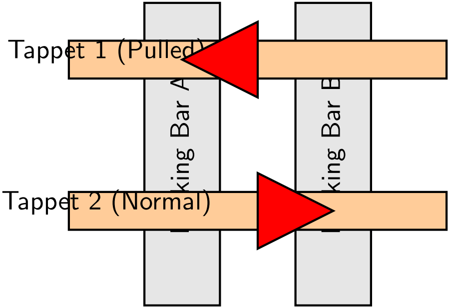
Mechanical Interlocking: Tappet and Locking Troughs I

In mechanical interlocking, the physical movement of levers on a lever frame translates to the movement of locking bars and tappets. The locking mechanism is housed in a locking bed, where dogs and wedges physically prevent conflicting levers from being moved.

Key Points

- Tappets are connected directly to the control levers
- Locking bars run perpendicular to the tappets
- Dogs attached to locking bars engage notches in tappets

Tappet and Wedge Locking Mechanism I



Tappet 1 wedge locks Bar B

Tappet 2 notch allows Bar B

Tappet and Wedge Locking Mechanism II

Key Points

- Physical obstruction by wedges prevents unsafe operations
- Visual inspection of locking bed confirms safety logic
- Subject to mechanical wear and requires regular lubrication

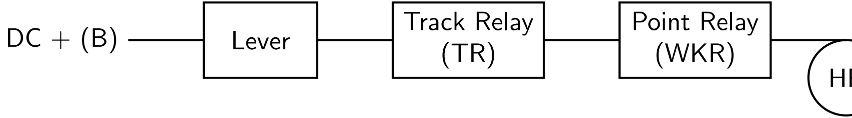
Electrical (Relay) Interlocking I

Relay Interlocking replaces physical lever locks with complex electrical circuits. Route logic is achieved by interconnecting the contacts of numerous safety relays. If any conflicting route is active, the electrical circuit required to clear the signal remains incomplete.

Key Points

- Failsafe design utilizing gravity-drop relays
- Panel interlocking allows centralized station control
- Miniature levers or push buttons replace heavy mechanical levers

Basic Relay Interlocking Circuit Logic I



Signal Relay (HR) energizes ONLY if Track is clear AND Points are

Key Points

- Relay contacts must be closed to complete the control circuit
- TR (Track Relay) ensures the section is free of trains
- WKR (Point Relay) ensures switches are correctly set and locked

Devices in Interlocking: Point Machines & Track Circuits I

Essential devices interface with the interlocking logic to execute commands and verify field status. Electric point machines operate and physically lock the switch rails. Track circuits detect the presence of trains, providing crucial input to the interlocking logic regarding track occupancy.

Key Points

- Point machines feature internal detection contacts
- Track circuits short-circuit when wheels bridge the rails
- Axle counters serve as an alternative detection device

Solid State Interlocking (SSI) I

Solid State Interlocking (SSI) or Electronic Interlocking (EI) uses dual or triple modular redundant microprocessors to evaluate signaling logic. Logic is programmed via boolean equations or geographic data, making route modifications easier compared to rewiring hardware relays.

Key Points

- Software-based interlocking logic replaces hardwiring
- 2-out-of-3 or 2-out-of-2 architecture for failsafe operation
- Data loggers continuously record all events, operations, and faults

Fail-Safe Mechanisms in Interlocking I

A core philosophy of railway signaling is the 'fail-safe' principle. Any failure of a component, power supply, wire breakage, or logic evaluation must result in the system reverting to its most restrictive and safe state—typically putting all signals to danger (red).

Key Points

- Closed-circuit principle: continuous power is needed to show clear
- Gravity drops mechanical signals and relay armatures
- Redundancy in electronic systems ensures continuous cross-checking

Summary I

This lecture covered the advanced principles and methods of railway interlocking. We examined mechanical interlocking via tappets, electrical relay circuits, and modern solid-state systems. Understanding these mechanisms highlights how civil and systems engineering combine to ensure absolute train safety.

Key Points

- Mechanical interlocking relies on physical locking beds
- Relay interlocking uses electrical logic and fail-safe relays
- SSI offers software flexibility and high reliability
- Fail-safe principles govern all interlocking device designs