Urban Circulators – Streetcar Electrification

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INTRODUCTON

Introduction

- What does an urban circulator do?
- Streetcar vs. light rail - how does electrification differ?
- What questions should be answered before final design begins?
- How do the parts work together?

CURRENT COLLECTORS

PANTOGRAPH

TROLLEY POLE

Current Collectors – Pantograph

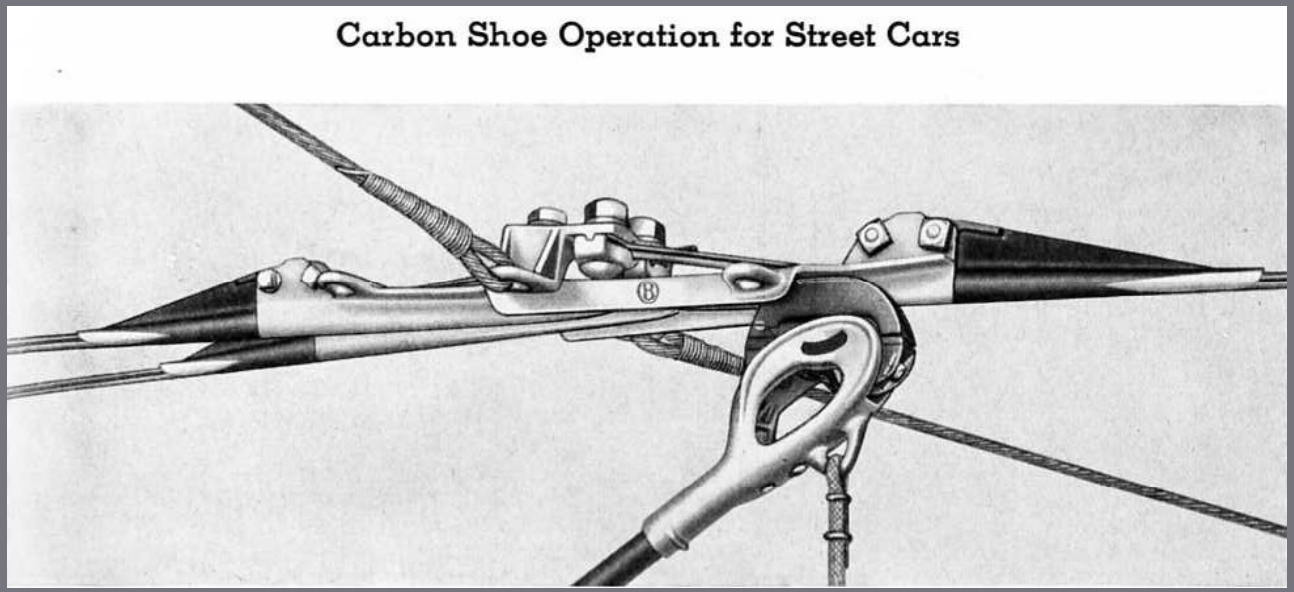
- Accommodates high currents.
- Guided by the vehicle.
- Uses carbon strips for contact.

Current Collectors – Pantograph

- Contact point moves across the carbon as the car proceeds.
- At curves: OCS is positioned to the outside of the track center line.
- At junctions: diverging wire crosses the straight or runs parallel.

Current Collectors – Trolley Pole

- Used on legacy and heritage streetcars.
- Contact shoe is guided by the OCS.



Current Collectors – Trolley Pole

- Slants upward in the trailing direction; double-end car has two poles.
- At curves: OCS is positioned to the inside of the track center line.
- At junctions: diverging wire ends at a frog.

OVERHEAD CONTACT SYSTEM (OCS)

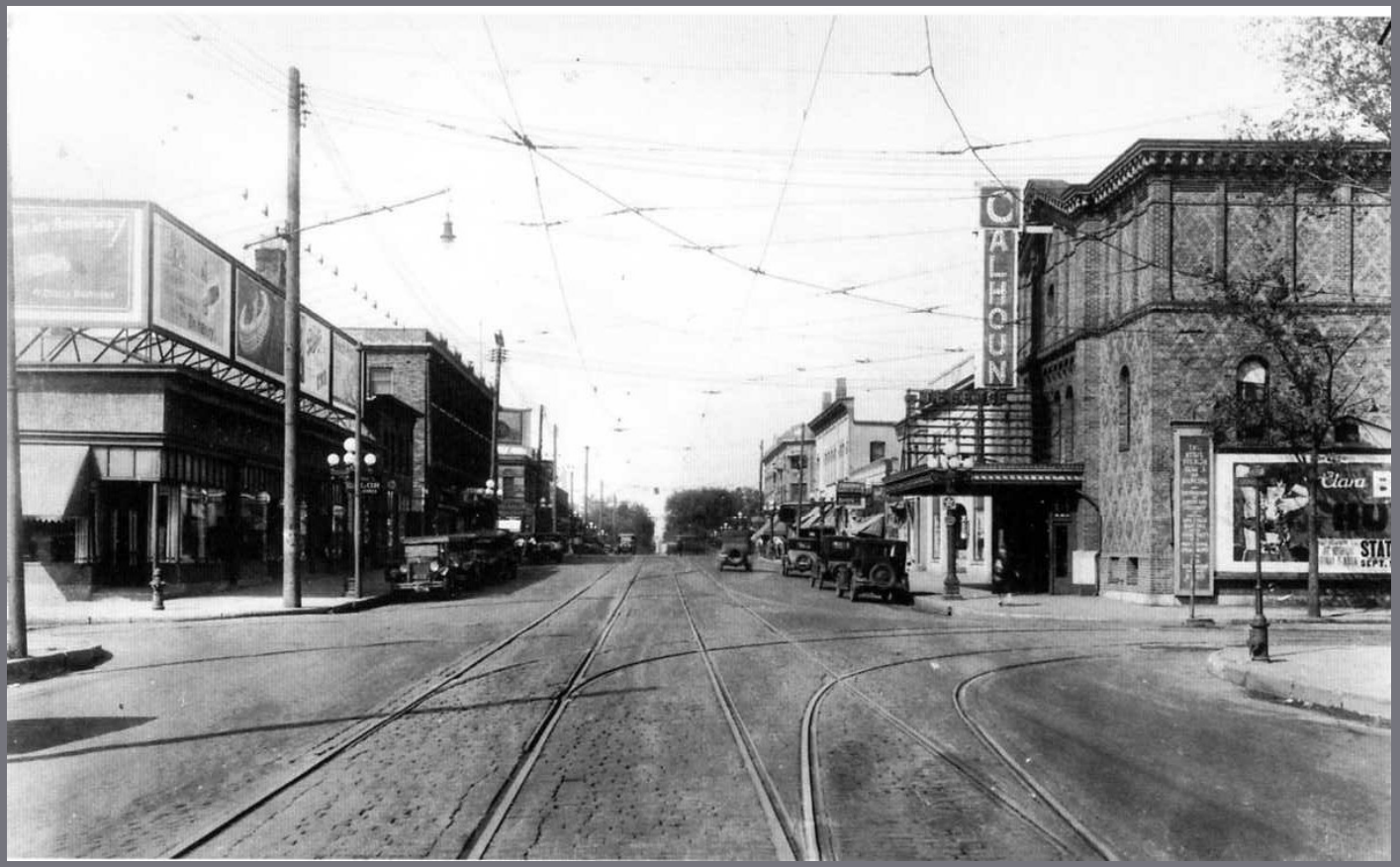
OCS

- People have always objected to overhead wires for electric streetcars.
- Good design minimizes visual impact.
- Reference: *Reducing the Visual Impact of Overhead Contact Systems*, 1995, John S. Kulpa and Arthur D. Schwartz. TCRP Report TC007, TRB, ISBN 0-309-05710-8.

OCS

Uptown in Minneapolis, 1920s

FROM *TWIN CITIES BY TROLLEY*
BY JOHN W. DIERS & AARON ISAACS



OCS

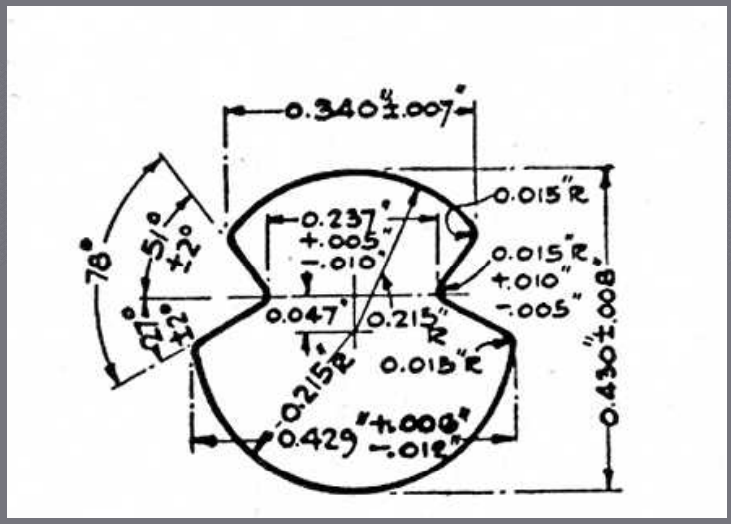
Contact Wire
Hardware & Support

OCS - Contact Wire

- Voltage drop depends on current and resistance.
- Volts equal Amperes times Ohms.
  E = I * R (Ohm's Law)
- Resistance is proportional to length, inversely to cross sectional area.

OCS - Contact Wire

- Shaped to fit trolley clamps.
- Hard-drawn copper or bronze alloy.
- Size 4/0 AWG:
  for 1000 feet
  weight = 642 lbs.
  resistance = .0507 ohms.



OCS - Contact Wire

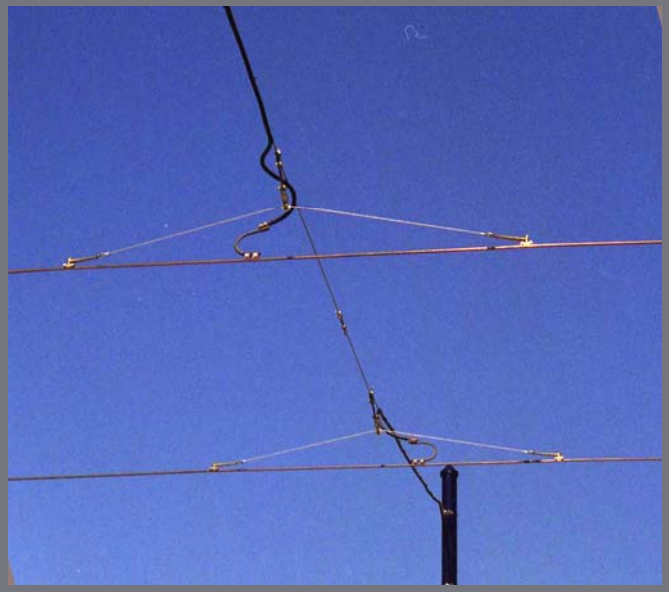
- Wire expands & contracts with temperature.
- Weights keep tension constant, or frequent support mitigates sag.

OCS – Hardware & Support

- Nominal wire height above rail 18 feet.
- Height may vary from 13 to 23 feet.
- The OCS is double-insulated.
- Hangers can provide one level, additional levels from strain insulators.

OCS – Hardware & Support

RESILIENT CLAMP
W/FEEDER



PLAIN CLAMP
BUILDING BOLT

OCS – Hardware & Support

LOOP INSULATOR
GALVANIZED ROUND POLE

ROD INSULATOR
BUILDING BOLT

OCS – Hardware & Support

- Poles
  - Round steel, direct-burial (picture), with epoxy paint.
  - Round steel, with foundation & bolt circle.
  - **Less Common:** Wood – Concrete – Glue laminated wood – Steel H-beam.

OCS – Hardware & Support

SUBSTATIONS

Substations

- Substations convert a-c utility power to d-c, at 600 or 750 Volts.
- Power ratings together must provide the power used by all the cars on the line.

Substations

- Can be supplied pre-wired in weather-proof housings.
- Rated 400-800 kilowatts.
- Nominal voltage is at 100% load.

Substations

- Plan for maintenance,
- Operate with a substation shut down,
- OCS can be maintained with power on.
- How many substations, and where?

TRACTION POWER DISTRIBUTION

Traction Power Distribution

- Feeder wires connect substations to OCS.
- Feeders can parallel the OCS to reduce voltage drop.
  - Buried – May be expensive.
  - Aerial – Has visual impact.
- The OCS may be able to carry the load.

Traction Power Distribution

- Traction current returns through the rails.
- Stray current can damage structures.
- Insulate, bond, and cross-connect tracks.
- Keep rails at ground potential.

ROLLING STOCK

Rolling Stock

- The type and number of streetcars affect the electrification.
- Heritage cars have trolley poles, draw 60 to 300A at 600V.
- Modern cars have pantographs, draw 500A at 750V.

Rolling Stock

ORIGINAL PCC CAR IN SAN FRANCISCO

REPLICA LIGHTWEIGHT CAR IN TAMPA

Rolling Stock

"TRIO" CAR IN TACOMA

"FLEXITY" IN VANCOUVER

AUXILIARY ELECTRICAL DEVICES

Auxiliary Electrical Devices

- Waiting Shelters
  - Lighting
  - Information Signs
- Fare Collection
- Track Switches
- Signals & Communication

NO OVERHEAD WIRES?

No Overhead Wires?

- Overhead wire system is proven, operates reliably with zero emissions, and has reasonable maintenance cost.
- Alternatives include diesel power, batteries, ultra-capacitors, and surface contact or inductive systems.

CONCLUSION

CONCLUSION

- Urban Circulator
  - Mixed Traffic
  - 40 mph max.
  - Single Cars
  - Simple Trolley Wire
  - Frequent Support
  - Substation 750 KW
- Light Rail Transit
  - Dedicated Lanes
  - 55 mph max.
  - Trains 2 or 3 Cars
  - Catenary OCS
  - Weight Tensioning
  - Substation 1500 KW

Conclusion

- Electrification with d-c and overhead contact is suitable for both Urban Circulators and Light Rail Trains.
- Streetcar systems use smaller components than light rail.
- Electrification must deliver needed power; be attractive and maintainable.

THE END