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Scope of Research

The scope of research focuses on the comprehension of existing and previous propulsion systems in electric trains to predict the design of future systems. Contrasting the M-2 and M-8 railcars provides an analysis of the progression of propulsion technology. By observing the operation of the M-2 and M-8 railcars in revenue service and reviewing their individual design specifications, an effective comparison derives the evolution of the equipment. This assessment effectively forecasts the direction of electronic technology within the upcoming years. The proximity of the New Haven Line and its personal impact made it a prime candidate for this scope of research. The New Haven Line welcomes a wide variety of trains to run on its four main tracks. The transition of the New Haven's backbone fleet from M-2 to M-8 has been inspirational in analyzing their mechanical operation, contributions to the Northeast, and legacy in the railroad's rich history. The electric propulsion of the M-2 and M-8 railcars must promise the timely operation of the New Haven Line and overcome its curves and speed restrictions without compromising powerful acceleration and safety.

Methodology

The rate of acceleration is derived from field data collected in the cab of the Kawasaki M-8 railcar. In order to maintain a tight schedule and prevent the loss of time, the M-8 must be able to reach its Maximum Allowed Speed (MAS) at the specified rate. During this trial, it appears that the engineer applied a maximum power application. When the engineer applies power to the train, a stopwatch is activated. For every mile per hour the train increases, the "lap" button is depressed on the stopwatch. In this case, the train reached 70 MPH, which means that 70 laps were recorded. Each lap corresponds to a time interval that is used to calculate instantaneous acceleration. During this trial, the M-8 successfully:

- Reflected the rated 2.0 MPH/S
- Traveled 1.7 miles between Harrison and Mamaroneck, NY
- Timed under a minute to reach MAS

Microsoft Excel expedites the calculations and organizes the values into a table. The values are then plotted onto a graph to create an acceleration curve. The field data accurately represents the technical specification of the M-8 railcar. The curve creates a picture that describes the physical nature of the M-8 acceleration and reveals the speed at which the M-8 begins to lose its tractive effort, or ability to accelerate. A useful feature of the field data and its curve is the verification of the M-8's ability to meet its expected performance. It also shows how effective the AC traction motors accelerate the train.



The Backbone Fleet: New Haven Rolling Stock



M-2:

- First revenue run in April 1973
- Produced by General Electric Transportation Systems
- 162 HP DC Motors (648 HP total per car)
- Speed control by a camshaft-resistance relay-logic system
- 24 of 244 railcars remain in revenue service



M-8:

- First revenue run in March 2011
- Produced by Kawasaki Heavy Industries
- 265 HP AC Motors (1060 HP total per car)
- Speed control by a Variable Voltage Variable Frequency (VVVF) drive using Insulated Gate Bipolar Transistor (IGBT) inverters
- 405 total railcars: 190 pairs and 25 unpowered single units have been accepted for revenue service



Significance

The rail network in the Northeast remains a critical artery of the United States. Time is money on the railroad. In fact, when the flow of transportation is interrupted, it begins to effect economic activity. Reliable acceleration is critical to preventing the disruption of a train's time. Frequently, rail traffic is burdened with speed restrictions that disturb pace. When the seasons change, they are subject to chaotic wheel-slip conditions that create dangerous stopping conditions. The right of way between New York and New Haven spans across 72 miles. Its curves, existing infrastructure, and high traffic demands constantly bounce the trains between high speeds and restrictive speeds. The optimization of acceleration and traction performance is achieved through advancement in propulsion technology. A detailed analysis that explores the evolution of the New Haven Line equipment provides a forty year design history and insight on future designs and demands. As there is currently a demand for electric train procurement in the Northeast, this project proves the importance of investing development efforts into our transportation infrastructure. The continuing development of highly efficient electric motors will prove to be a noble asset to future railcar and locomotive procurements.

Looking Forward

The original goal of the research was to explore the feasibility of implementing linear motor technology into the propulsion system of a train. If proven feasible, this would transform the design of the traction motors without any major modifications of existing railroad infrastructure. The 10-week span of this project revealed the extraordinary complexity behind the traction control of railcars. Additionally, it uncovered the intricate procurement process that requires an adept understanding of railcar specifications. To move forward with the research, field data describing the tractive effort and power performance of the railcar may predict the success of a future design implementing linear motor technology.

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