

Alternating-Current Electrification of the New York, New Haven & Hartford Railroad 1907

A National Historic
Engineering Landmark

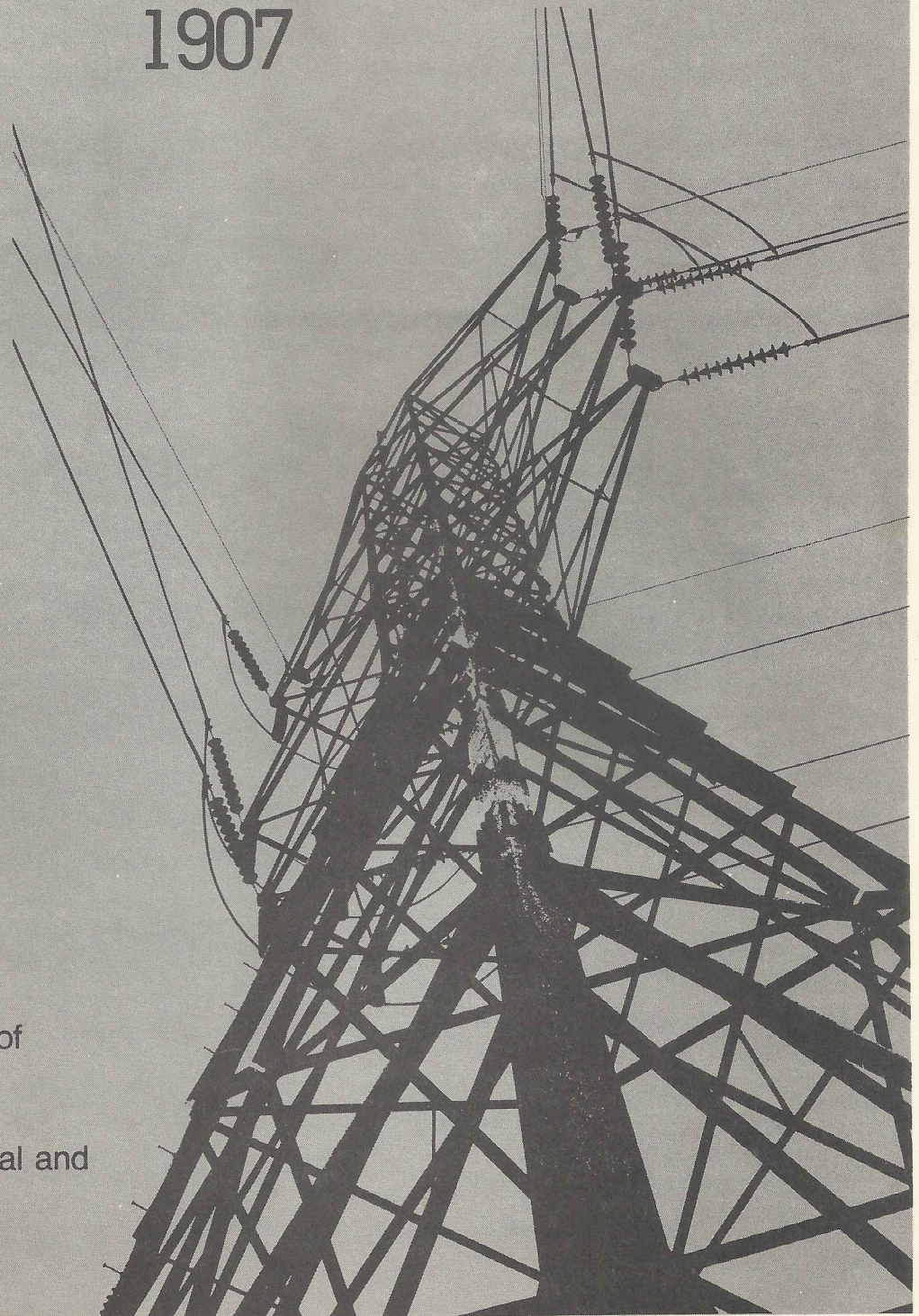


The American Society of
Mechanical Engineers
and



The Institute of Electrical and
Electronics Engineers

Designated 1982



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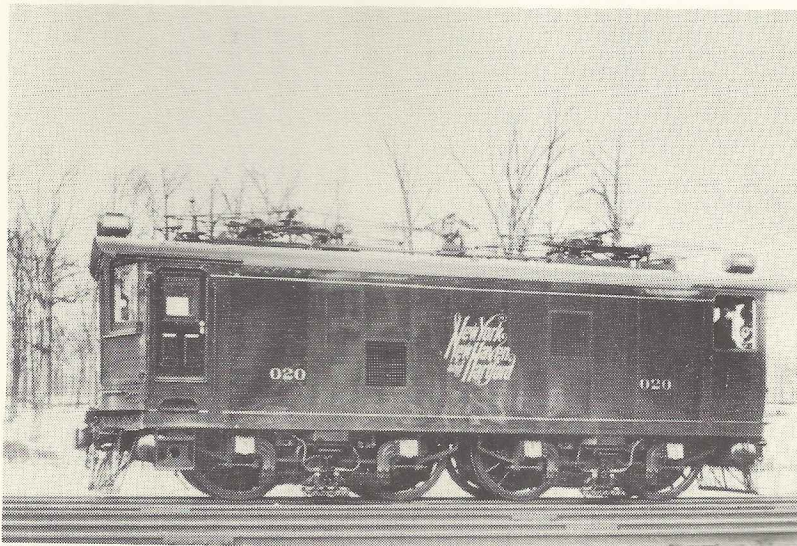
This was a pioneering venture in mainline railroad electrification.

It established single-phase alternating current as a technical and economical alternative to direct current. This concept exerted considerable influence over subsequent systems both in the United States and abroad.

The major components of the system were developed by the engineering staffs of the New York, New Haven & Hartford Railroad and the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pennsylvania.

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The first New Haven electric locomotive, denoted class EP-1, was built in 1905. It was a double-end, box cab design, 37 feet, 6½ inches long, weighing 102 tons.



With man now shuttling successfully into and out of space, it is difficult to imagine a not-so-distant time when shuttling man back and forth to work and play, from suburbia to metropolitan areas was just as new and exciting.

As major metropolitan areas began to grow in the late 19th century and industry and business gradually monopolized urban areas, Americans began to move to what came to be called the suburbs. Although the suburban movement has accelerated since World War II, its beginnings were observed as early as the 1880's. Living conditions outside the city seemingly were better; pollution already had begun to take its toll, and non-industrialized areas promised for many a better environment in which to live.

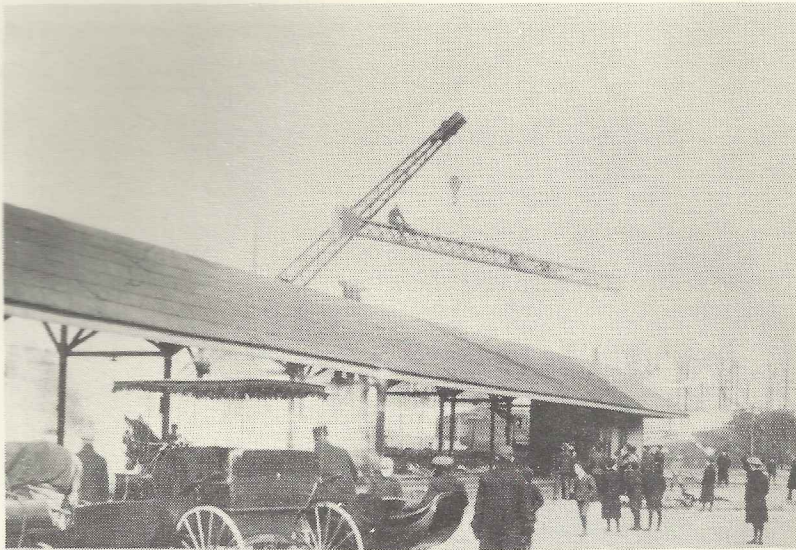
The movement involved very few people until the development of the electric train and streetcar in the late nineteenth century made intermediate-range commuting both economical and convenient. As metropolitan areas expanded outward along the railroad and streetcar tracks, Americans learned to commute, and have continued to do so in ever-increasing numbers since.

With the growing need for economical, longer distance mass transit, came the demand for new technologies to effectively move people to and from the metropolitan areas. Before the advent of the automobile, one of the boldest experiments attempted by engineers during that booming era was the alternating-current (ac) electrification of the New York, New Haven & Hartford Railroad. The electrification, begun in April 1905, overcame technological barriers. It served as a proving ground for the development of railroad electrification technology, and became a world-wide standard for more than half a century.

HISTORICAL BACKGROUND

The New York, New Haven & Hartford Railroad Company was formed August 6, 1872, by the union of the Hartford & New Haven Railroad with the New York, & New Haven Railroad. The latter controlled by lease the Shore Line Railway from New Haven to New London. Thus the operation between New York, New Haven, Hartford, Springfield and New London was united into one system.

In 1887, the New Haven added to its system three north-and-south lines known as the Northampton, the



A sight to behold—local residents watch as workers set a catenary girder over the station roof in 1906.

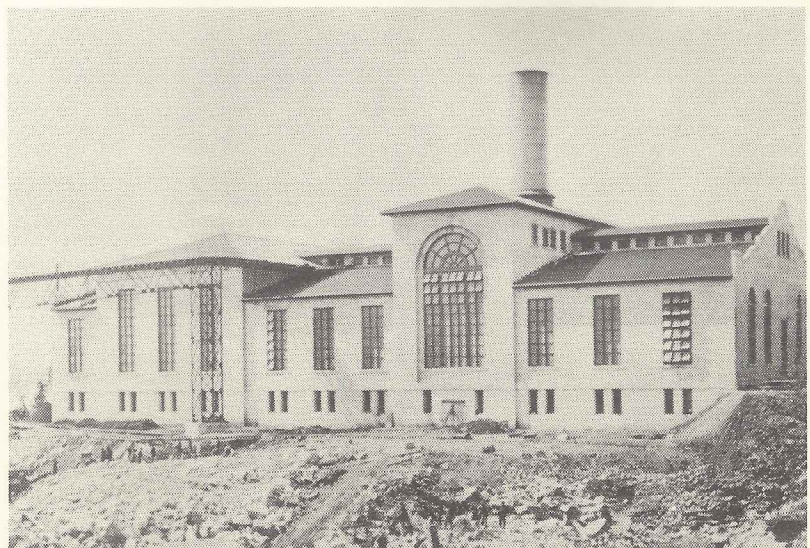
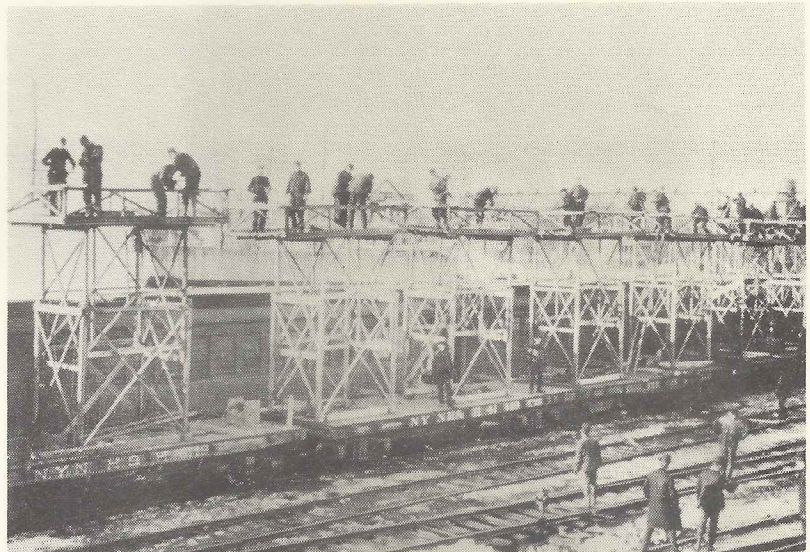
"Wire trains" were utilized to string the overhead catenary wire, circa 1906.

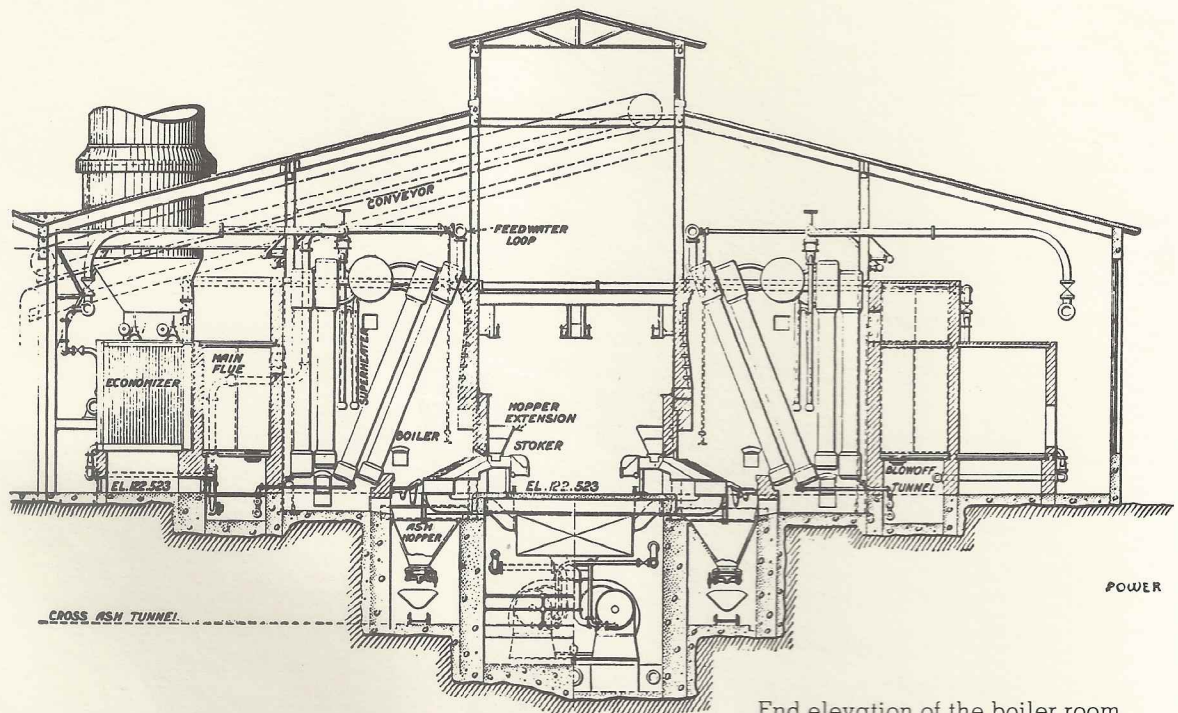
Cos Cob, Conn. power plant.

Naugatuck and the Valley. In 1892 and 1893, it added the remaining north-and-south line in Connecticut, the Housatonic, and reached into territory further east by other leases. In 1898, by its lease of the New England system extending from Boston to the Hudson River, with branches, the consolidation of the New York, New Haven & Hartford system was substantially completed—a steam system that reached over 2,000 miles, embracing a network of railroads serving nearly every city and village in southern New England.

The ac electrification program of the New Haven was the first major electrification of a steam railroad. The most important electrification up to that time, it permitted the New Haven to be the first major railroad in the United States to use electric locomotives over considerable distances in both local and high-speed service.

Until this electrification, nearly all railroad electric power experience had been with direct-current (dc) systems because the performance characteristics of the dc motor generally were considered superior for railroad service. The New Haven, however, decided on ac for its suburban region because, unlike dc, it allowed large-scale generation and long-distance transmission capabilities that were economically more favorable and would permit future expansion. After the initial program demonstrated the feasibility of the new system, it was broadened to include freight and switching operations, as well as passenger service, and was extended to New Haven and to





End elevation of the boiler room circa 1915.

Pennsylvania Station in New York City, and to a number of branch lines.

The unique feature of the New Haven Railroad's pioneering program was the extensive application of 11-kilovolt ac, 25-Hertz, single-phase power.

PROGRAM DEVELOPMENT AND CONSTRUCTION

The program was extensive, requiring construction of a complete generating plant, upgrading the mainline to four tracks, and the building of several branches, and a number of freight yards. The result was the efficient electric operation of freight, commuter, and express passenger trains, and even yard switchers. For service into Grand Central Terminal, locomotives had to be capable of drawing power from the New York Central's 600-volt-dc third rail as well as from the New Haven's trolley wire suspended above the track.

Construction of the historic system began in 1905 and the overhead wire from Cos Cob, Connecticut, to New York was energized in April 1907. On July 24, 1907 the first regular train to be operated under electric power completed a trip from Grand Central to New Rochelle, New York. The initial electrified region was extended to Stamford in October of that year.

The New Haven electrification served as a prototype for many railroad designs and practices that came to be widely



adopted in the United States and that still are in use. Following the success of the Westinghouse 11-kilovolt, 25-Hertz, single-phase system on the New Haven Railroad, a number of other railroads applied it to their operations. These included the Norfolk & Western and the Pennsylvania. The electrified region of the former Pennsylvania Railroad is the largest example, extending from Washington, D.C. to New York City and Harrisburg, Pennsylvania.

To provide the electrical power for its new system, the generating station was built on the bank of the Mianus River to facilitate coal delivery and to provide cooling water for the condensers, and fresh water for the steam boilers.

In a nation that has since become environmentally conscious, the revolutionary system provided a clean, reliable, efficient mass transit system for a densely populated and highly industrialized region of the United States for more than 70 years. The technological breakthrough provided a line that solved many problems that had developed and would have grown worse with the continued use of steam engines.

As early as 1903, the New York Legislature passed legislation prohibiting use of steam locomotives in New York City south of the Harlem River after 1908, because smoke and cinder problems had reached intolerable levels in New York's Grand Central Terminal. Beyond meeting this new requirement, the new electrification program permitted the New Haven to accommodate increasing interstate freight, passenger, and commuter traffic demands without having to expand to its four-track mainline. (By 1924 it carried the heaviest passenger traffic of any railroad of its length in the country, and today brings close to two-million commuters to New York City monthly.)

COS COB POWERPLANT

To provide the electrical power for its new system, the New Haven built a generating station in the Cos Cob section of the town of Greenwich, Connecticut. It was located on the bank of the Mianus River to facilitate coal delivery and provide cooling water for the condensers. Construction of the

the first phase was completed in the summer of 1907.

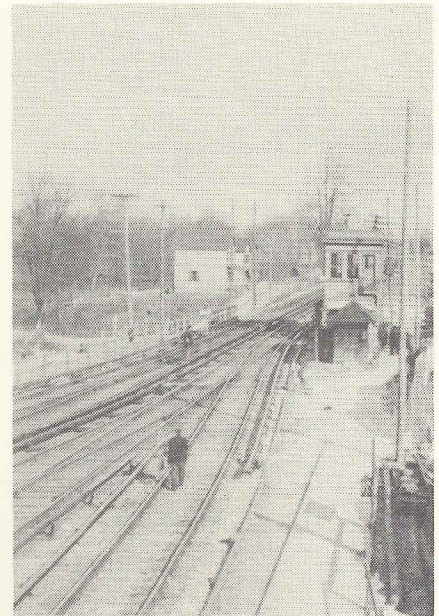
The initial equipment installed at Cos Cob consisted of 14 Babcock & Wilcox water-tube boilers and four Westinghouse-Parsons steam turbines connected to four Westinghouse single-phase, 11,000-volt, 25-Hertz generators. With extension of the electrification to New Haven, 14 Bigelow-Hornsby boilers were installed in a new boiler room, supplying four additional turbo-generators. Transmission voltage was raised to 22,000 volts by six oil-insulated, water-cooled auto-transformers.

ELECTRIC LOCOMOTIVES REPLACE THE "IRON HORSE"

The first New Haven electric locomotive was built in 1905 by Baldwin and Westinghouse as part of a 35-unit order. The New Haven units, denoted Class EP-1, were a double-end, box cab design, 37 feet 6½ inches overall length, weighing 102 tons, with a B-B wheel arrangement of two swivel trucks. Each locomotive was equipped with two pantographs for overhead ac power collection, one small dc pantograph for bridging third-rail gaps in the terminal, and eight third-rail shoes. The shoes and pantographs could be raised or lowered by the engineer to permit transition between ac and dc power sources without stopping.

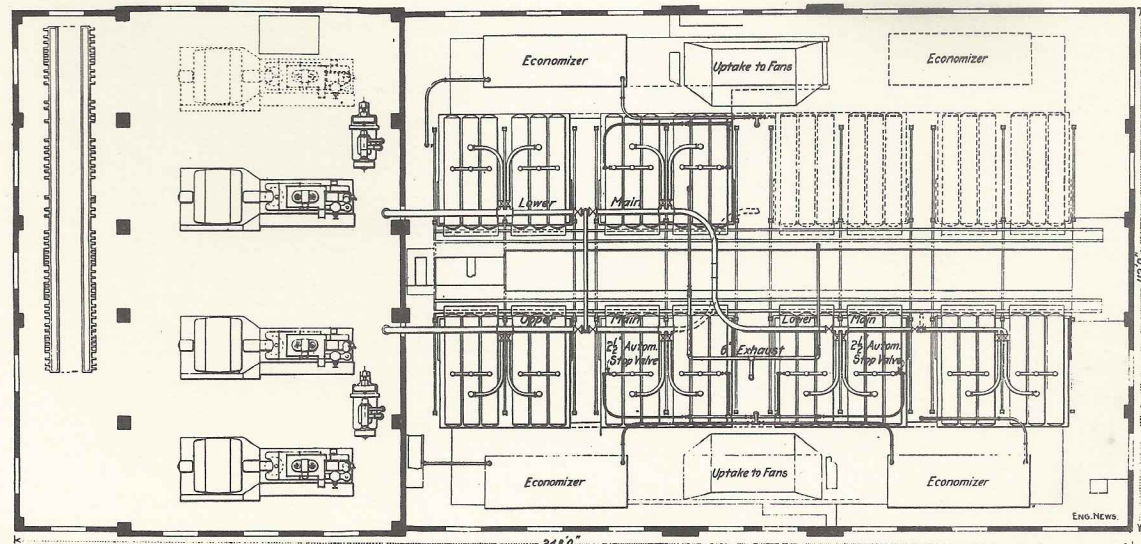
CALL TO ARMS

As a result of the success and reliability of the electrified New York, New Haven & Hartford Railroad, the railroad was strategically significant

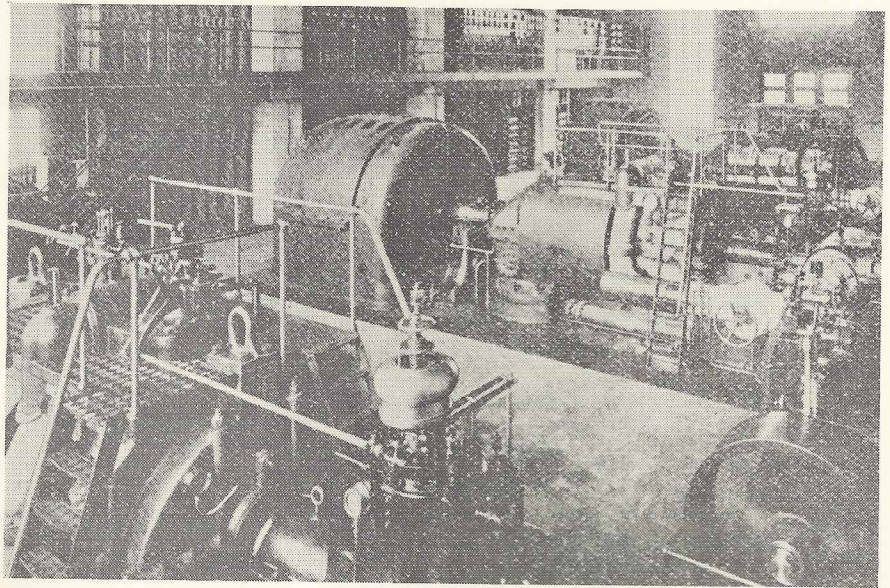


The overhead wire not yet in place, circa 1905, South Mount Vernon, N.Y., the third rail is pictured to the right at the beginning of the New York Central Railroad.

Floor plan of the Cos Cob power station showing relative arrangement of boilers and turbine units.



during World War II. Numerous troop trains, furlough trains, and war-prisoner trains traveled over the lines, furthering war-time mobilization. At the same time, the New Haven carried workers from all parts of the country who relocated to the area, and those who commuted to the many surrounding munitions plants and other defense industries. It transported defense equipment such as explosives, guns, aircraft, jeeps, trucks and tanks along with the necessary component parts and raw materials for their manufacture. Because of the threat of enemy submarines along the coast, the railroad supplied fuel oil, gasoline, kerosene, coal, and other products that otherwise would have been transported by coastal ships.



Interior view of the Cos Cob power station, circa 1907.

The first major railroad in the United States to use electric locomotives over considerable distances in both local and high-speed service, the New York, New Haven & Hartford Railroad was a forerunner of today's modern mass transit systems.

Central also became insolvent it was reorganized along with several other bankrupt railroads into the Consolidated Rail Corporation in April, 1976. The contractual service was continued by Conrail, and is now part of the U.S. Northeast Rail Corridor.

The bold new technological achievement that occurred more than 70 years ago still serves a busy and demanding public. It provides regular electric operations of modern Amtrak passenger trains and commuter trains traveling in and out of the nation's most densely populated regions. Without the successful undertaking of that dynamic experiment decades ago, the rapid growth of cities, the accompanying redistribution of population, and the changes in social organization certainly would have been delayed. Man once again had triumphed in his quest to make the world a better place in which to live. While largely taken for granted, and overshadowed by recent technological developments in other more publicly noticed fields, the railway engineers responsible for the electrification program so many years ago set the stage for today's modern mass transit systems.

It is for this reason that the American Society of Mechanical Engineers and the Institute of Electrical and Electronics Engineers designated the original ac electrification of the New York, New Haven & Hartford Railroad as a National Historic Engineering Landmark, noting it as a progressive step in railroad engineering history.

STILL SERVING

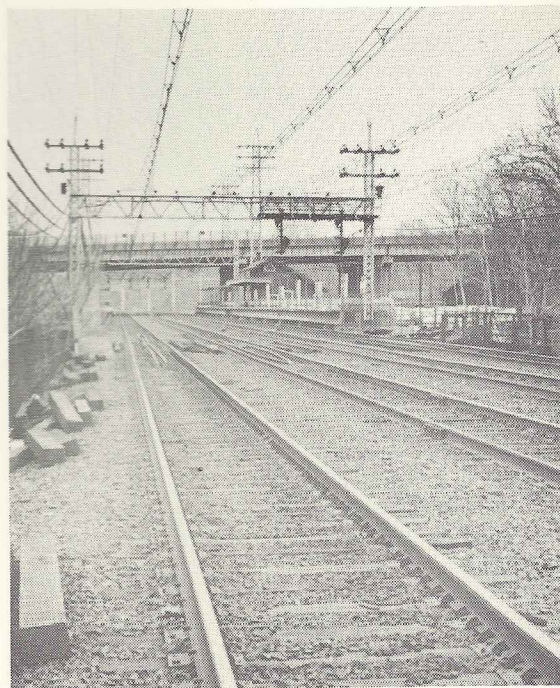
The present New Haven commuter service is a descendant of the railroad's original commuter service from Stamford to New York City. When the New Haven became part of Penn Central in 1968 the service was in jeopardy. The states of Connecticut and New York jointly contracted with the New Haven's successor, the Penn Central Railroad, to provide state-subsidized commuter service on the line.

Under the New Haven Suburban Passenger Train Service Agreement, Penn Central agreed to operate the service for a fixed management fee with the operating deficits being shared equally by the two states through the Connecticut Department of Transportation and the Metropolitan Transportation Authority. When Penn



The electrification program of the New York, New Haven & Hartford Railroad was a pioneer engineering effort in many ways. Some of the problems first addressed by the engineers of the New Haven railroad and the Westinghouse Company that led to development of new electrical and mechanical procedures were:

- Extensive undertaking of electric service by a steam railroad organization.
- Generation of single-phase power by large steam turbines.
- First use of gearless single-phase motors.
- Inauguration of service without benefit of a trial period for the powerhouse, line and locomotive components.
- Development of a selective system of circuit breaker protection to handle frequent short-circuits of relatively large magnitude as compared with those of existing commercial services.
- Satisfactory operation on both 11,000 V ac from an overhead trolley and 600 V dc from an under-running, over running or overhead third rail.
- Design of auxiliary apparatus (blowers, compressors, headlights, lamps, battery chargers, etc.) to operate on both ac and dc.
- Installation of high-voltage trolley wires that were exposed to the continuous exhaust of steam locomotives.
- Installation of an overhead conduction system on a four-track railroad.
- Provision of steam heat from electric locomotives for heating passenger trains.
- Design of the ac pantograph collector to permit its compact storage during operation in the dc zone.
- Design of the dc collecting shoes to fold up against the wheel truck sides to meet clearance requirements.
- Ability to maintain constant electrical contact between the conductors and the pantograph and shoes, even at high speeds.
- Design of systems to provide the main motors with resistance and series-parallel control on dc, and variable-voltage control on ac.
- The maximum automation of locomotive operation change-over between ac and dc. Multiple-unit trains required completely automatic change-overs.
- Push-button operation of auxiliary devices from either end of motor and trailer cars and locomotives.



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Information and Photographs

Mr. David Peters, New Haven Railroad Historical and Technical Association, Inc.
The Association of American Railroads
Cheryl Hoynowski, Public Affairs, Conrail
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Western Conn. Chapter

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Material for this brochure was compiled and edited by Jeffrey L. Christmas, Public Information, ASME.

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The Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th Street
New York, New York 10017