

John Stevens' 1825 "Steam Waggon" by artist Andrew Aldridge. Original Gouache rendering was presented to the Commonwealth of Pennsylvania by the Keystone Railway Equipment Co. in 1967.

JOHN STEVENS: THE MAN AND THE MACHINE James Alexander Jr.

Hard on the heels of his excellent narrative in the July 1993 MILEPOST of the Pennsylvania Railroad's flirtation with air travel and Charles Lindbergh following the young pilot's celebrated trans-Atlantic solo flight in 1927, Associate Editor Jim Alexander turned his attention to a railroad pioneer, John Stevens, and the replica locomotive named in his honor that is now on display in the Museum. Jim's Lindbergh article, the cover feature in the current issue of Locomotive & Railway Preservation, marks his second appearance in a national magazine. The following article also may be published nationally. (Remember—you saw it first in MILEPOST!) Congratulations, Jim, for your outstanding efforts. —WRR

When the nation entered the 19th century, it lacked the social and economic ties necessary to make it truly the "United" States. Transportation and communication among towns and states were at best rudimentary. America was then a land without railroads. Locomotives and tracks were to be seen only in England where they were being tentatively developed largely as an outgrowth of the established mining industry.

Travel in the United States at that time was by concord coach or horseback on poorly maintained roads that bore no resemblance to today's network of highways. A trip from Philadelphia to Baltimore took five days; from New York to Boston a week. Commerce between communities on the Atlantic seaboard involved ocean travel under sail.

To meet the needs of eastern markets and westward growth, a system of canals was under discussion, with New York's DeWitt Clinton championing construction of what would become the famous Erie Canal. But there was also another more innovative opposing idea being proposed:

So many and so important are the advantages which these [United] States would derive from the general adoption of the proposed steam railways, that they ought . . . to become an object of primary attention to the national government. . . . [Following a modest experiment with several short lines,] the necessary surveys [should] be made for the extension of these ways in all directions, so as to embrace and unite every section of this extensive empire. It might then . . . be truly said that these States would constitute one family, intimately connected . . . in bonds of indissoluble union.

So wrote John Stevens in his 1812 *Documents Tending to Prove the Superior Advantages of Railways and Steam Carriages over Canal Navigation*, America's first railroad publication. Lawyer, inventor, practical engineer, and a distinguished Colonel during the American Revolution, John Stevens became America's leading proponent of a rail system that he would not live to see.

Born in 1749, Colonel Stevens served as Treasurer of New Jersey during the Revolution and was involved in early land survey and commercial ventures. In 1788, he built a marine engine that incorporated the first multi-tubular steam boiler. His fascination with steam and steam engines led his biographer, Archibald Douglas Turnbull, to call him, more than 100 years later, "a genius of steam." (*)

Stevens' early steam experiments focused on boats, and for a time, his work paralleled that of steamboat pioneer Robert Fulton. He designed propellers and other maritime devices. His *Phoenix* was the first major American-built steamboat to engage in regular commercial transport of freight and passengers and the first to travel on the Atlantic Ocean.

Stevens advocated the use of higher boiler pressures—ultimately to more than 100 psi—pushing to the limits of technology (in England, James Watt's early studies had set 3 psi as the practical upper pressure). A tireless inventor, Stevens was also an unbridled advocate of his ideas, often in

(*) Archibald Douglas Turnbull's biography, *John Stevens, An American Record*, published in 1928, is the primary source of information used by subsequent writers on Colonel Stevens. Turnbull obtained access to Stevens family papers not previously available. The *New York Times* called Turnbull's work a "significant biography of a too long neglected figure." Although the scattered Stevens family papers have since been gathered and microfilmed, problems of legibility and organization make them a difficult source to use.

the face of derision. He argued with other early steam inventors including Robert Fulton and Oliver Evans.

Evans, a native of Delaware who was considered by some to have invented the first "high-pressure" steam engine in 1800, proposed a steam railway between New York and Philadelphia in 1813. He reportedly had built a multi-tubular boiler with water in the tubes as early as 1780. In 1804, he built a steam-powered amphibious vehicle having both wheels and a paddle wheel, which he called *Oruktor Amphibolos*. Although Oliver Evans, who died in 1819, received less public attention than Colonel Stevens and never built a steam locomotive, he did leave behind these prophetic words:

I do verily believe that carriages propelled by steam will come into general use, and travel at the rate of 300 miles a day.

Evans added pessimistically:

. . . one step in a generation is all we can hope for. If the present generation shall adopt canals, the next may try the railway with horses, and the third generation use the steam carriage.

To protect his inventions from argumentative competitors, Colonel Stevens lobbied Congress to enact a patent law. In 1791, he received one of the first patents issued (for a steam engine) and was subsequently called "Father of the Patent System."

In 1795, he built a steam locomotive of which little is known other than it was too large to be practical. By 1810, after turning over operation of his successful steamboat lines to his sons, John Stevens focused his attention on land transport—an obsessive effort that consumed his seemingly unlimited energies and continually drained his wealth.

Having acquired land in New Jersey that is now the city of Hoboken, "Colonel John of Hoboken" continued his arguments against canals and for steam railroads. It was an uphill fight. His biographer, Archibald Turnbull, referred to a Stevens proposal as "one of the many drops which the colonel continually let fall upon the stone of public ignorance and indifference."

Indeed, Stevens' efforts in 1812 led only to pity, scorn, or ridicule: "Heard John Stevens' latest? He's making a damned fool of himself over steam waggons!" (A century later, a PRR official declared that Stevens' *Documents Tending to Prove . . .* was "the birth certificate of all railroads in the United States.")

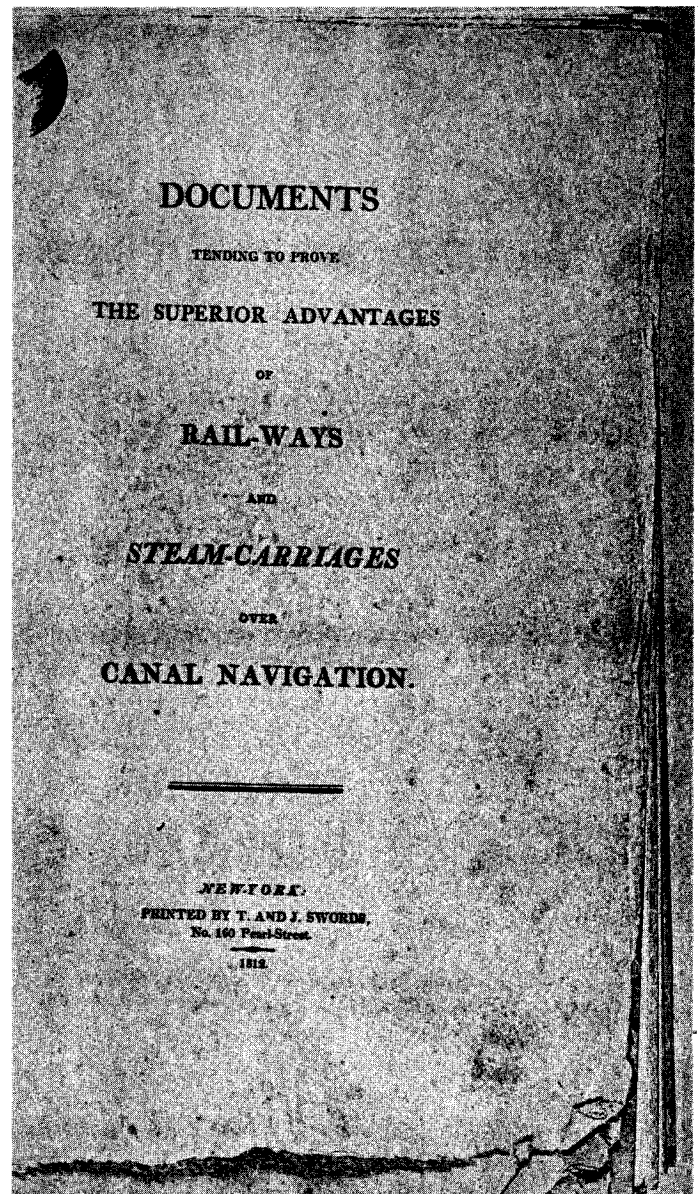
He did not give up. In 1815, the New Jersey legislature created a company to "erect a Rail-Road from the River Delaware, near Trenton, to the River Raritan, at or near New Brunswick." The railroad was not built and Stevens was furious. When a canal from the Delaware was proposed instead, he redoubled his opposition, writing:

A railroad . . . will insure to the farmer a fair price for what he brings to market . . . From the want of capital, and the great length of time navigation [on a canal] is closed, the farmer is compelled to sell on credit at reduced prices . . . The canal is useless at the very season when most wanted—when the farmer has leisure to thresh out his grain and bring it to market.

Diverging from a centre like the rays of the sun, railroads will diffuse light, heat, and animation to every extremity of the Commonwealth.

And in one of his most prophetic writings:

The wealth and prosperity of a nation may be said to depend, almost entirely, upon the facility and



America's first railroad book: "the birth certificate of all railroads in the United States."

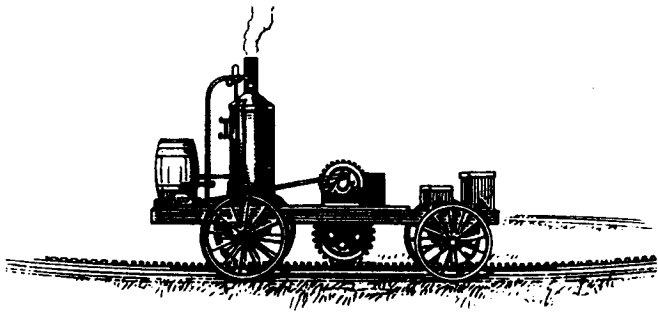
cheapness with which transportation is effected internally.

In 1823, "on the memorial and representation of John Stevens," Pennsylvania enacted a law establishing the "President, Directors, and Company of the Pennsylvania Railroad Company." The railroad, extending from Philadelphia to Columbia, was to be erected "under the superintendence and direction of John Stevens." As with the charter issued in New Jersey, the railroad was not constructed; those with the necessary wealth would not venture it.

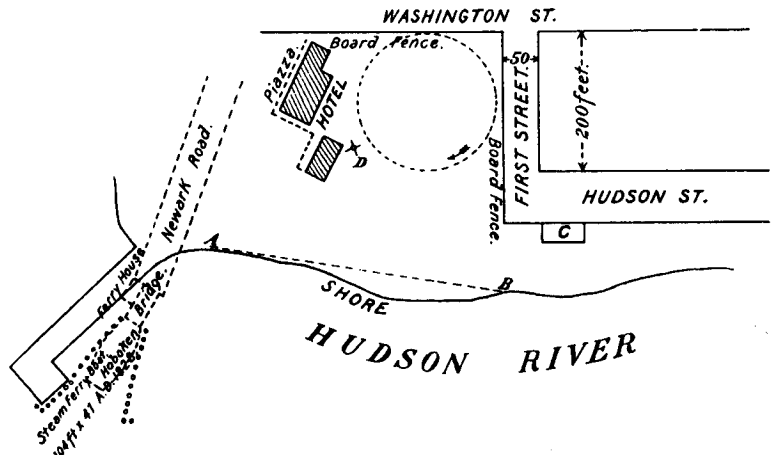
Still Stevens persisted. Evidently beginning to see the light, his old opponent, DeWitt Clinton, wrote to him:

I have just received your interesting letter relative to steam carriages . . . and am fully impressed with the importance of the project . . . Until your plan can be tested by actual experiment, on a small scale at least, I think it will be almost impracticable to procure an adequate investment of capital on the magnificent scale you have contemplated.

Colonel Stevens took up the challenge. In 1825, with an eye toward influencing the Pennsylvania Society for



*Here is a brave beginning:
A tiny engine, builded in Hoboken Town
by one John Stevens,
To sweep his way around a tiny track
Emboldened pioneer is he.*



MAP OF A PORTION OF HOBOKEN, N. J., 1825.
The circle and straight line A B indicate the track on which John Stevens' locomotive ran. 1825-26-27.

PRR MUSEUM OF PA/PHMC

(left) Sketch of the "Steam Waggon" from program for "Railroads on Parade," NY World's Fair, 1939. (right) John Stevens' mansion and track layout in Hoboken, 1825, from J. Elfreth Watkins' unpublished "History of the Pennsylvania Railroad Company, 1846-1896."

Internal Improvements, which was evaluating transportation alternatives, he built what he called his "Steam Waggon" which he had designed the previous year at age 75. He also erected a circular track for its operation described as approximately 110 feet in radius and 660 feet long on the lower lawn of his Hoboken estate. "Rail Roads have nowhere yet been made, on this side of the Atlantic," he wrote. "Let the experiment be fairly tried." Referring to his engine as an "ocular demonstration," he showed it to every guest at his estate as a sample of what he proposed to use on his Pennsylvania Railroad.

Hoboken, at that time a place of some 700 inhabitants, was known primarily as a resort to which residents of New York City could take one of Stevens' steamboats and enjoy the attractions of "Elysian fields," woods, and riverbank views.

The Steam Waggon served a dual purpose, attracting visitors to Hoboken and demonstrating steam traction. It was (arguably) the first steam locomotive to operate on a track in America and the first locomotive with a horizontal cylinder. It was the basis for the replica locomotive *John Stevens* now exhibited at the Railroad Museum of Pennsylvania (see Profile, page 11).

The original Steam Waggon is long gone. Colonel Stevens tinkered with it in various forms and on several track layouts from 1825 to apparently 1829. There are no known detailed plans or illustrations of the original locomotive. Documents provided to the author by the Stevens Institute of Technology for the preparation of this article or referred to in Turnbull's biography of John Stevens describe the Colonel's designs in ways that may be conceptual or evolutionary and thus cannot be construed as absolutely applicable to the Steam Waggon. For a description of the locomotive, we must rely instead on the recollections of Stevens' grandson, Francis B. Stevens, written many decades later in 1883 in a letter to J. Elfreth Watkins, Technologies Curator of what is now the Smithsonian Institution. The letter, which included a description of the locomotive, was included (with others) in Watkins' unpublished *History of the Pennsylvania Railroad Company, 1846-1896*.

Francis Stevens' letter was also the basis for a small

model of the engine that was exhibited by the PRR at the 1893 World's Columbian Exposition in Chicago. Much of the description was based on Francis Stevens' recollections of what he saw when he was less than 15 years old; he was around 68 when he wrote the letter.

What Francis Stevens remembered is what we see today in the Railroad Museum's replica Steam Waggon, appropriately called *The John Stevens*: a wooden flatbed carriage mounted on four wagon wheels, with a vertical tubular boiler and water barrel on the front and two benches for passengers at the rear. (Since the passengers rode on the locomotive, it could be called the first "doodlebug.") A single horizontal steam cylinder rotates a notched wheel that contacts a rack resting between two wooden, steel-topped rails.

Francis Stevens also recalled some kind of arrangement that held the wheels on the track in lieu of flanges, although he admitted that he lacked precise mechanical details. An interpretation of this arrangement as described by Francis Stevens is reflected in the Railroad Museum's replica and in several scale models. However, Colonel Stevens' own description of this arrangement, as quoted in Turnbull's biography, is at odds with his grandson's interpretation, thus suggesting that Francis (and therefore the Museum replica) is wrong:

... I made some experiments for propelling a carriage on railways, but did not succeed to my satisfaction owing to the great friction on the wheels against the sides I sent the carriage to Van Belsen's shop and directed him to insert rollers into each end of two bars; one to be placed in front of the fore-wheels and the other behind the hind wheels, extending beyond their track on each side, so as to roll against the upright pieces placed on the outer sides of the ways [tracks]. This improvement, as far as I know, is original. [Emphasis added.]

(It is possible, of course, that John Stevens later changed the arrangement described above to that which his grandson remembered seeing.)

Colonel Stevens' description suggests that the rollers were on horizontal bars rather than affixed to vertical pieces as in the Museum's replica, and that the tracks were of an "L" cross section similar to other very early

railroad track designs. This conclusion is further supported by a crude sketch of the wheel arrangement in a very faded letter written by Stevens in 1825. Despite differences in details, the basic principle of rollers rather than flanges holding the carriage wheels on the track appears accurate.

Later in 1825, the *Commercial Advertiser* described "the circle at the Hoboken Hotel":

The curve of this article [the track] was very rank, much more so than can be possibly required in pursuing the route of a road. This great deviation from a straight line gives rise to an enormous friction, the greater part of which, however, Mr. S. has contrived to obviate.

His engine and carriage weigh less than a ton, whereas those now in use in England weigh from eight to ten tons. His original intention was to give the carriage a motion of sixteen to twenty miles an hour, but he has deemed it more prudent to move, in the first instance, with a moderate velocity, and has accordingly altered the gearing, which renders it impracticable to move fast.

According to Francis Stevens' recollections, his grandfather's engine at times operated at about 12 miles per hour on the circular track at Hoboken. It apparently ran somewhat faster later on straight track. Regarding speed (before any locomotive existed in America), Colonel Stevens had written:

I can see nothing to hinder a steam engine from moving with a velocity of 100 miles per hour. In practice, it may not be advisable to exceed 20 or 30 miles per hour, but I should not be surprised at seeing carriages propelled to 40 or 50.

In another document written in 1826, Colonel Stevens conceptually described his locomotive and the rails in a way that raises a number of questions about the replica at the Museum. Aside from the matter of the track-holding rollers described above and the track design, there are at least two other questionable areas regarding the replica's validity—size and weight.

The contemporary description quoted above cites the locomotive's weight as "less than a ton." The records of the Pennsylvania Railroad which built the replica describe it as weighing "5,125 lb in working order." Although the replica at the Museum has not been weighed, the PRR figure appears correct, which suggests that the replica weighs considerably more than the original engine.

Adding to the confusion, Stevens' 1826 conceptual description mentions wheels "ten feet high." The replica's wheels are only 57 inches in diameter, which is more proportionate to the original's purported "less than a ton" total weight.

Probably with an eye toward the future when locomotives would have to climb the mountains in central and western Pennsylvania, Colonel Stevens' test track was constructed with one end raised on stone pillars to be 30 inches higher than the opposite end. The cog wheel arrangement allowed the the "waggon" to climb this grade, except when the steam pressure dropped.

The vertical boiler consisted of 20 tubes of 40-1/2 inches length arranged in a circular fashion around a central firebox with a header at top and bottom. This apparently was the same design John Stevens patented in 1803. Water was pumped into the boiler by hand, and the entire structure was surrounded by a sheet iron casing that narrowed at the top to form a smokestack. Wood was dropped into the firebox through an opening near the top and ashes were removed through an access door at the base of the casing.

Many questions have been raised regarding the steam pressure of the original locomotive, since no document has yet been found which provides this information. Stevens was an advocate of higher pressure than was generally accepted by his contemporaries. The replica of the Steam Waggon that was built in 1928 was rated by the Pennsylvania Railroad at 100 pounds. A Stevens Institute publication at that time commented that this was much higher than the original and was possible because of "tighter joints and better packing." The other replica, built in 1939, is rated at 150 pounds.

This, of course, does not resolve the question of the original locomotive's steam pressure. Visitors to the Smithsonian's Museum of American History will see, next to the original boiler which is on display there, a notation that "when new, the boiler reportedly could safely sustain steam pressures of 550 lbs." This assertion most likely came from a 1956 Smithsonian publication by Smith Hempstone Oliver, Land Transportation Curator, which makes the same statement.

Efforts to locate the source of Curator Oliver's assertion have been unsuccessful. However, a tantalizing piece of possible corroboration emerges from the specification submitted by Colonel Stevens' son, John Cox Stevens, in obtaining a boiler patent in Great Britain in 1805, a task assigned to him by his father.

In discussing the concepts of the vertical tube boiler, he described experiments in which the "elasticity of steam at the temperature of boiling oil . . . was found to equal 40 times the pressure of the atmosphere." If we understand this correctly, that means a pressure of about 588 pounds! A book by Robert Thurston, Professor of Mechanical Engineering at Stevens Institute in 1891, states that this type of boiler (the 1805 patent) was the type used on the Steam Waggon. Whether such theoretical pressure was practical in light of contemporary metal fabrication standards is open to conjecture, since boiler and pipe ruptures at much lower pressures were common at that time. Nevertheless, the pioneering nature of Colonel Stevens' work is manifested.

A review of selected correspondence between Colonel Stevens and his rival, Oliver Evans, reveals a lack of clarity between experimental and theoretical assertions. Overall, the absence then of today's established scientific measurement techniques and vast body of engineering knowledge emphasizes both the difficulties faced by Stevens and his scientific contemporaries and the possibility of misinterpretation by historians.

John Stevens' Steam Waggon operated on its circular track until around 1828, when it was removed and operated on a linear section of track nearer the waterfront of his Hoboken estate. At that time, the locomotive was fitted with an additional boiler of similar design, and the front wheels were strengthened to bear the added weight. This second boiler was on display at the Stevens Institute for several years after the original boiler was given to the Smithsonian Institution. It is not clear from the known documentation whether the second boiler augmented or replaced the first; no significant details of this change have been found to date. Given Stevens' well-known propensity to experiment, it is likely that this and many other changes were made to the original design.

Although Stevens expressed his hope that the Steam Waggon would eventually pull other carriages, the record does not show that this ever happened. However, there is

evidence of experiments involving the locomotive pulling weights on pulleys to demonstrate what we call today tractive force.

The ultimate fate of the original locomotive after 1829 is not clear. By that date, John Stevens was 79 years old. The Steam Waggon did not establish any design standards on which subsequent locomotives were based, nor did Stevens' many experiments lead to the immediate construction of any railroad. Hundreds of visitors to Hoboken must have viewed the engine, although many may have dismissed it as merely the amusement of a wealthy old man.

Yet in no way can John Stevens' Steam Waggon be called a failure. Representatives of the Pennsylvania Society for Internal Improvements saw it operate and were impressed. Among other visitors to Stevens' estate was John Jervis of the Delaware & Hudson Canal Company. Subsequently, in 1829, the D&H built a nine-mile section of track to connect its canal with coal mines that it owned. To pull the coal cars, the company ordered two locomotives from England, one of which was the famous *Stourbridge Lion*.

Colonel Stevens' full legacy to American railroad history was yet to unfold. In 1830, the State of New Jersey chartered the Camden & Amboy Railroad and Transportation Company. After years of unsuccessful advocacy of railways vs canals, one-million dollars of financing for the new venture was subscribed, reportedly in only ten minutes. Funding for the Delaware & Raritan canal venture, authorized at the same time, received only tepid interest—clearly, the climate had changed.

Robert Stevens was elected President/Chief Engineer and Edwin Stevens was elected Treasurer of the new company. Though no longer an active participant, Colonel Stevens' vision and inspiration now found expression through his sons.

Among the first orders of business for the new railroad was to acquire a locomotive. Robert Stevens traveled to England, and while aboard ship contemplating such things as primitive rail design, he designed the "T" rail still used today as well as the "fish bar" that connects sections of rail together.

While in England, Robert Stevens consulted with the Stephenson, who were locomotive builders, and witnessed the first trials of their new locomotive, *Planet*. Late in 1831, a similar locomotive that Robert Stevens had ordered arrived in America—the *John Bull* (so named in later years). (See *Museum Collection Profile No. 19 in MILEPOST, Vol. 11, No. 5, November 1993*. - ed.)

Commenting that Robert Stevens never patented his "T" rail design, biographer Turnbull wrote:

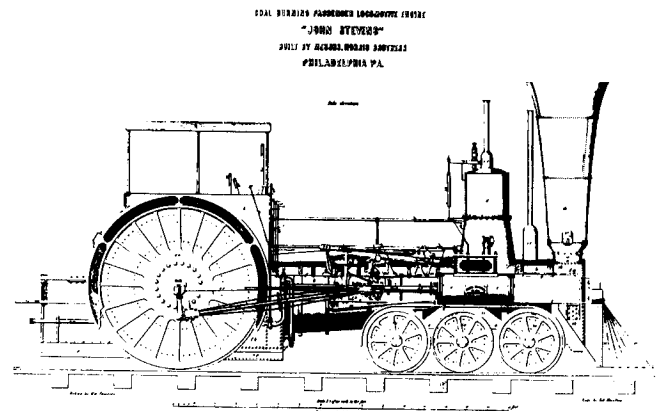
... the record is clear enough. Just as the labyrinth of threads on a railroad-map of the United States leads inevitably to John Stevens, so the miles of actual steel are Robert's imperishable monument.

When the *John Bull* arrived, the 82-year-old Colonel Stevens hosted a party to celebrate the occasion. His spirits that day were described as being "as sparkling and abundant as the champagne."

John Stevens died in 1838 at the age of 89. By then, "railway fever" had swept the land. Only 31 years later in 1869 rails linked the Atlantic and Pacific oceans,

binding the nation as he had foreseen.

The little Steam Waggon soon disappeared from the scene, gone but not forgotten. Its original boiler and safety valve were preserved and have been displayed at the Smithsonian Institution since 1888. Several scale models and two full-scale replicas of the locomotive were built primarily for exhibition, based largely on the recollections of Francis Stevens. Both of the replicas are named *John Stevens*. The interesting story of the replicas is told in *Museum Collection Profile No. 20* bound in this issue. Some years after John Stevens' death, another locomotive was named *John Stevens*. This was the Camden & Amboy's No. 28, built by Norris Brothers in 1849. A 6-2-0 Crampton design, it featured 96-inch drivers that were reminiscent of Stevens' 1826 advocacy of 10-ft drivers to sustain momentum for high speed.



The "other" John Stevens, built in 1849.

John Stevens has been called the father of the patent system, the father of American railroads, and the father of American engineering. Some may quibble over this; some railroad histories do not even mention him. But the ever-faithful Turnbull captured the essence of the man:

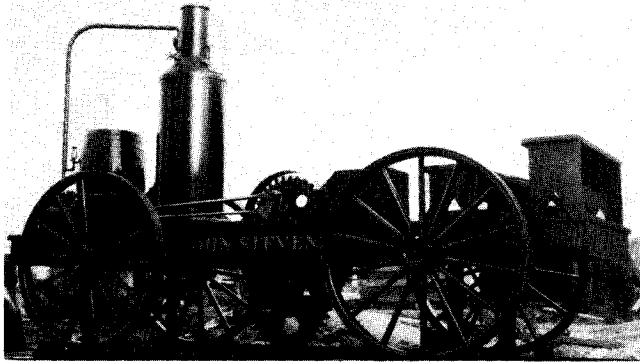
Some of his conceptions came too early in the history of the age of invention, when no country was prepared, mentally or mechanically, to appreciate them. This fact places his name among the dreamers of great dreams.

In 1871, Edwin Stevens' will carried out one of his father's greatest dreams when he endowed the creation of the Stevens Institute of Technology, located on the grounds of the Hoboken estate near the place where the little Steam Waggon once ran.

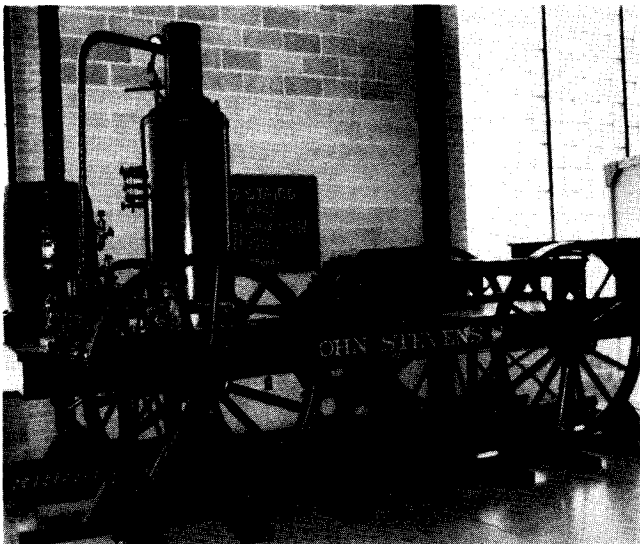
In 1928, the Pennsylvania Railroad joined in a massive celebration of the inauguration of the Institute's third president. That year, the PRR built the first full-sized replica of the Steam Waggon and also erected on the grounds of the Institute a running track that was faithful to Francis Stevens' description 45 years earlier. In a 1930 publication, the PRR stated:

Colonel John Stevens may properly be regarded as the father of the Pennsylvania Railroad, because he not only conceived the idea of a railroad from Philadelphia to Pittsburgh, but . . . obtained a charter for the original Pennsylvania Railroad Company . . . in 1823 . . . Stevens' vision . . . actually contemplated the expansion of the Pennsylvania Railroad into much the position it occupies today.

The 1928 replica now resides at the Museum of Science and Industry in Chicago. A second replica,



RR MUSEUM OF PA/PHMC



JAMES ALEXANDER, JR.

The Twin John Stevens replicas: 1928 (top) and 1939.



identical to the 1928 engine, was built by the PRR shops in 1939 for use at the New York World's Fair. This locomotive, named *John Stevens*, is now housed in the Railroad Museum of Pennsylvania, where it honors John Stevens' many pioneering contributions to railroading. A small model of the full-sized replica was built by the Smithsonian Institution to replace an earlier model and is still on display there along with the boiler and safety valve of the original Steam Waggon. At least one other model was built in the 1890s, but its present location (if it survived) is not known.

Although construction of the scale models and the two replicas was based on what railroad historian John H. White, Jr, called "the sketchiest information," they served well as the embodiments of an early inspiration, a determined mind, and ultimately, of a reality most relevant to American railroading. Viewed in that light, they must be considered as admirable and most effective aids in the teaching of history.

In July 1953, seven score years after John Stevens' 1812 predictions were greeted with derision, these words appeared in *Mutual Magazine*:

I am an empire builder and a promoter of unity. I have knit this far-flung nation together, linking north with south, east with west, in one great community of common interest and understanding.

I am the American Railroad System!

It would be nice to know where author Jim Alexander gets all his energy. Not only is he a tireless writer and researcher of articles featured in national rail publications (you read 'em first in MILEPOST), but he also participates in special events at the Museum, helps with hands-on conservation and restoration projects, and serves on the FRM Board of Directors. He's also a full-time Administrator for the State of New Jersey in Trenton, where he lives with his wife, Jo Ann.

Persuading Jim to be the Associate Editor of this publication was probably the smartest move we ever made. We know how to pick the winners! If this sounds like we're "crowing" a bit, that's because we are.

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