

The Triple Expansion Engine

From the 1880s until after World War II, the visual landscape of the Great Lakes was defined by smoke. An observer at any of the high points surrounding Lake Superior – Brockway Mountain on Michigan’s Keweenaw Peninsula, Split Rock on Minnesota’s North Shore, the Sleeping Giant on Ontario’s Sibley Peninsula – would have gazed out across the sparkling blue waters of the big Lake on a clear day in 1915 and have seen smudges of smoke as far as the eye could see. The smoke was generated by the coal-fired boilers of the hundreds of Lake vessels that plied the shipping lanes between the Soo and the Head of the Lakes and the Canadian Lakehead. The boilers provided the steam that powered the steam engines that turned the crankshaft connected to the screw propellers. By 1900, most of the newer steel bulk carriers on the Great Lakes utilized triple expansion steam engines for their propulsion systems.

The earliest steamships used a single-cylinder steam engine connected to a paddlewheel or a propeller shaft. The single-piston engine was inefficient, losing much of its high-pressure steam as the piston traveled the length of the cylinder wall. The solution involved the introduction of compound piston engines that captured much of the waste steam lost to re-evaporation in single-piston systems.¹ By the late 1860s, double-piston engines were beginning to make their appearance on the Lakes. But the development of the triple expansion engine in 1874 by A.C. Kirk in Great Britain and its adoption by the British maritime industry in the early 1880s had a major impact on Great Lakes shipping before the decade was out.² The widespread changeover in the 1870s and 1880s of flue boilers to marine tubular boilers – also known as “scotch boilers” – provided added steam efficiency that was required for the triple expansion engine.³

The first triple expansion engines began to appear on the Great Lakes in the late 1880s.⁴ Within a decade, every new vessel coming down the ways in the Great Lakes sported some variation of the triple expansion engine.⁵ Typical was the *J.B. Ford*. Launched at Lorain, Ohio in December 1903 as the *Edwin F. Holmes*, the 440-foot bulk freighter boasted a triple expansion power plant with 22-, 35- and 58-inch cylinders and a 40-inch stroke. Ninety years later, the renamed *Ford* was still hauling cement on the Great Lakes, propelled along by her original triple expansion engine.⁶



The J. B. Ford, built with a triple expansion engine in 1903, stayed in active service until the 1990s. She now serves as a floating storage facility for Lafarge Cement in Superior, as seen in this January 2004 photo. (Duluth Shipping News Photo)

The triple expansion engines dominated marine engineering on the Lakes from the launch of the steamer *Cambria* in 1887 until the advent of steam turbine propulsion systems in the mid-1920s, although the longevity, durability and practicality of the bulk freighters introduced at the turn of the 20th century meant that the triple expansion engine was still common on the Lakes until well into the 1950s.

The typical 500-foot bulk freighter launched at the turn of the new century had a carrying capacity of about 10,000 tons of cargo and could make the journey from the Twin Ports to the Lower Lakes and back in eight to 10 days, cruising at an average speed of 10 to 11 knots.⁷ Part of the above-deck complement of able-bodied seamen that had characterized the days of sail on the Great Lakes moved below decks during the conversion to steam. The representative bulk freighter with a triple expansion engine carried a crew of 36 in 1910. Nearly half the crew was assigned to the engine room.

A scotch boiler for a triple expansion engine consumed between one and two tons of coal per hour. The care and maintenance of the power plant required coal passers to feed coal to the firemen, firemen to shovel coal into the boilers, oilers to keep the moving pistons lubricated and wipers to soak up the excess oil that coated much of the engine compartment.⁸ It was hot, grimy work, and many a mate or captain or chief engineer sailing the Lakes in the twilight of his career got his start maintaining a triple expansion engine 30 years before.

The triple expansion steam engine was the workhorse of Great Lakes maritime commerce that provided the motive power for the Twin Ports' emergence as one of the world's great harbors.

¹ Louis C. Hunter, *Steam Power: A History of Industrial Power in the United States, 1780-1930* Volume 2: Steam Power (Charlottesville: University Press of Virginia, 1985), p.632. Boiler pressures on vessels using single piston engines on the Great Lakes in the 1870s averaged between 60 and 75 pounds per square inch (p.s.i.). Dual piston engines increased the pressure to around 100 p.s.i, and triple expansion system engines used pressures of anywhere from 125 to 180 p.s.i.

² *Ibid.*, p.644n. The triple expansion engine cut consumption of coal in half and had the added benefit of producing more power in a smaller engine room space.

³ *Ibid.*, pp.644-645. The scotch or "fire-tube" boiler was essentially a pressure vessel with numerous small tubes that conducted hot combustion gases through the water, converting it to steam. Older "water-tube" boilers had a few large tubes or "flues" that forced water through the hot gases above the boiler's firebox.

⁴ S.S. *Milwaukee Clipper*, <http://www.retrocom.com/retromilw/clipper1.htm> Quadruple expansion engines, which utilized four pistons, were introduced to the Lakes in the mid-1890s, principally for bulk freighters towing large consort barges. The "quads," however, never gained the widespread acceptance of the triple expansion engine.

⁵ Wayne H. Garrett, "What Makes a Steamboat Go? Lentz-Poppet and Compound Inclined Engines," *Detroit Marine Historian*, v.49, no.5, January 1996. Triple expansion inclined compound engines, in which the cylinders were inclined at a downward angle, were particularly popular for the turn-of-the-century paddlewheel steamers which offered day and overnight cruises on the Lower Lakes. The *City of Toledo*,

Tashmoo, *Toronto*, *Kingston*, *Western States* and *Eastern States*, all launched between 1891 and 1902, utilized the triple expansion inclined compound power plants.

⁶ LeRoy A. Rubinas, "J.B. Ford: An Inspiration," *The Nor'Easter*, v.17, no.4, July-August, 1992, pp.1-3. The *Holmes* was renamed the *E.C. Collins* when she joined the Pittsburgh Steamship fleet in 1916. In 1958, she was sold to the Huron Cement Company and renamed the *J.B. Ford*. Coal-fired for 73 years, the *Ford's* owners converted the vessel's boilers to oil firing in 1976.

⁷ Interview with Captain Ray Skelton, Duluth, Minnesota, November 5, 2000, pp.1-3. A "knot" or nautical mile is equivalent to 1.15 statute miles.

⁸ *Ibid.*, p.3. The wipers, oilers, firemen and coal-passers were all unlicensed members of the engine room crew.