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Improvements in World War I Battleships Due to the Parsons Steam Turbine

Steam turbines provided a revolutionary change in the efficiency and capability of ships in the late 19th and early 20th centuries. Various types of turbines were introduced to shift from reciprocating engines to rotary engines. Due to its high efficiency, the Parsons steam turbine was incorporated into ships in the British and German navies during the pre-World War I naval arms buildup.

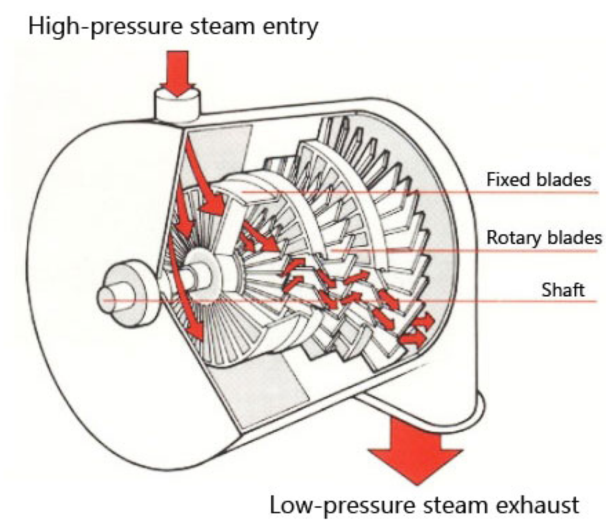

Figure 1: Steam flow through a Parsons turbine (edited from Reference 5)

Kinetic energy is the power source provided by steam turbines, derived from the heat energy of high-pressure steam. The enthalpy of the steam is converted to kinetic energy in a multi-stage process. As shown in Figure 1, hot steam at high pressure, accelerated through a nozzle, hits the blades on the turbine shaft with enough force to rotate the shaft. The rotary kinetic energy from the shaft is converted to mechanical energy to power the ship's engines. In

1853, French mining engineer Tournaire described the essential feature necessary for an efficient steam turbine: a wheel-like construct able to achieve very high rotary speeds using high-velocity steam. In a turbine, steam expands into a nozzle. Expansion of steam results in a jet that acts as a piston on the blades that rotate the turbine’s shaft.[1,5]

In 1906, the British Royal Navy introduced a new warship, HMS Dreadnought,[2] that stimulated a change to warships powered by Parsons steam turbines. Englishman Sir Charles A. Parsons first filed two patents in April 1884 and continued to develop turbines that were progressively smaller and more efficient. The combination of fixed and rotating blades in the Parsons turbine efficiently utilizes the steam. The fixed blades are attached to the turbine’s inner casing. The steam is funneled into high-velocity jets through the fixed blades. The bucket-shaped rotor blades are attached to the shaft. When these blades are hit by the jets of steam, the blades rotate about the shaft. [6] The motion of the shaft is coupled to the engine that moves the ship. As shown in Figures 2, steam travels through multiple rings of still and rotating blades. The orientation of the fixed blades causes the steam to travel at high velocity. When the steam hits the rotary blades, the energy is enough to rotate the shaft because of the steam’s high velocity that is generated by the fixed blades.[1]

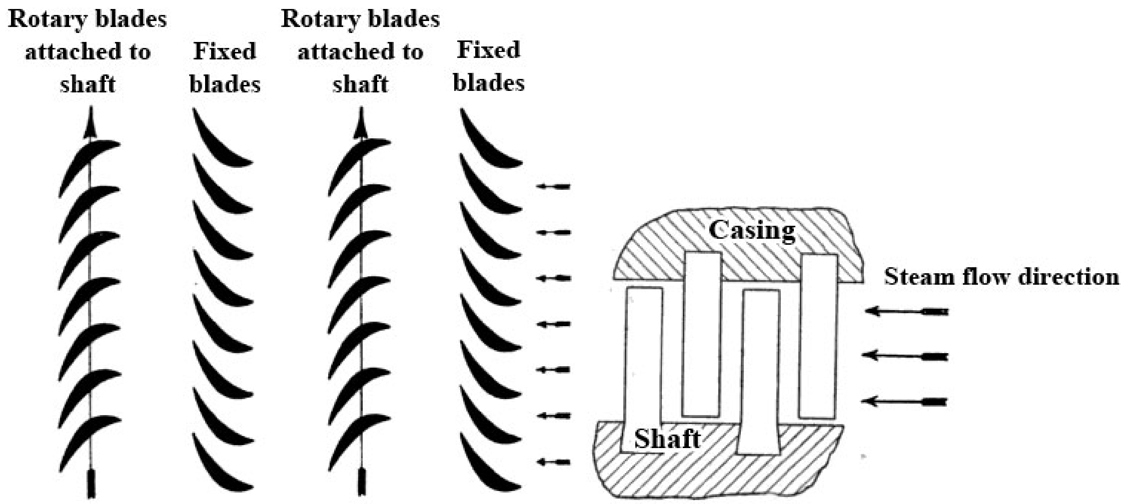

Figure 2: Blade arrangement (left) and steam flow schematic (right) of a Parsons turbine (edited from Reference 1)

The success of the Parsons steam turbine for generating electricity spurred Parsons' company to apply his turbine to power ships. The Parsons turbine became the main propulsion unit in many war vessels in World War I. Featuring four-shaft[a] Parsons turbines, HMS Dreadnought showcased improvements in the efficiency of naval turbines. During World War I, battlecruisers and light cruisers were also built with Parsons turbines that featured various numbers of shafts to vary the speed of vessel travel.[2] The sinking of the passenger-ship Lusitania in 1915 was a major event that raised public support for the United States to participate in World War I. The Lusitania was an example of civilian ships fitted with Parsons turbines.[3]

The Parsons steam turbine had a far-reaching influence on naval warfare in World War I. HMS Dreadnought marked a transition from small to large battleships. Beginning with HMS Dreadnought, the battleships of the Royal Navy were propelled by four-shaft Parsons turbines. In 1912, The Kaiserliche Marine, the German navy, installed Parsons turbines in its Kaiser class of dreadnought battleships because the Royal Navy had introduced dreadnoughts rapidly.[2]

[a] System of blades that rotate four propellers

From his post at the Whale Island gunnery school in 1903, Captain Percy Scott led the reform to improve the British Navy's long-range abilities in battle. The British navy had been practicing for naval battles with cannons that could fire with a range of 3,000 yards. This was shorter than the longer ranges that other navies had achieved. The British navy began to research larger battleships that could carry multiple cannons.[4] In ships, Parsons turbines were lighter than previous engine types. Battleship engines could support a certain amount of weight from cannons before the cost of the engines outweighed the benefit of many cannons. Compared to the weight of other engine types, Parsons turbines were a smaller fraction of the total weight of the battleship. This extra weight meant that more cannons could be installed on the ship.[1]

Due to its small weight and small volume, the Parsons steam turbine made ships capable of achieving faster speeds. With the Parsons turbines, the speed of the Dreadnought increased by approximately 15 percent relative to the speed of pre-dreadnought battleships.[4] The ships were also able to cruise without refueling for longer periods of time.[4]

The turbines placed the British navy ahead of the German navy; the Kaiserliche Marine was slower to build battleships with Parsons turbines.[4] The British navy was also able to build ships more rapidly because of the efficiency of British crews working in the shipyards.[2]

The combined improvements of speed and long-range cannon power set the British navy ahead of the German navy in the years leading to World War I. These changes in the British navy were influenced by advances made by other navies, including ships that could fire at longer ranges. In the years preceding World War I, the British and German navies were engaged in a naval arms race. The Parsons turbine was an integral component of the dreadnought class of battleships in World War I and beyond.

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