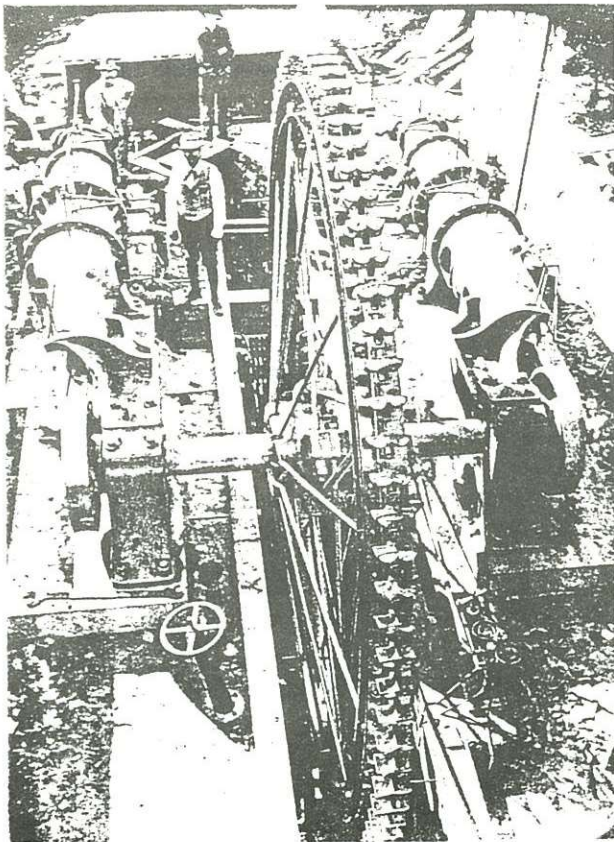


The Pelton Water Wheel

by Bob Kraft and Errol Christman

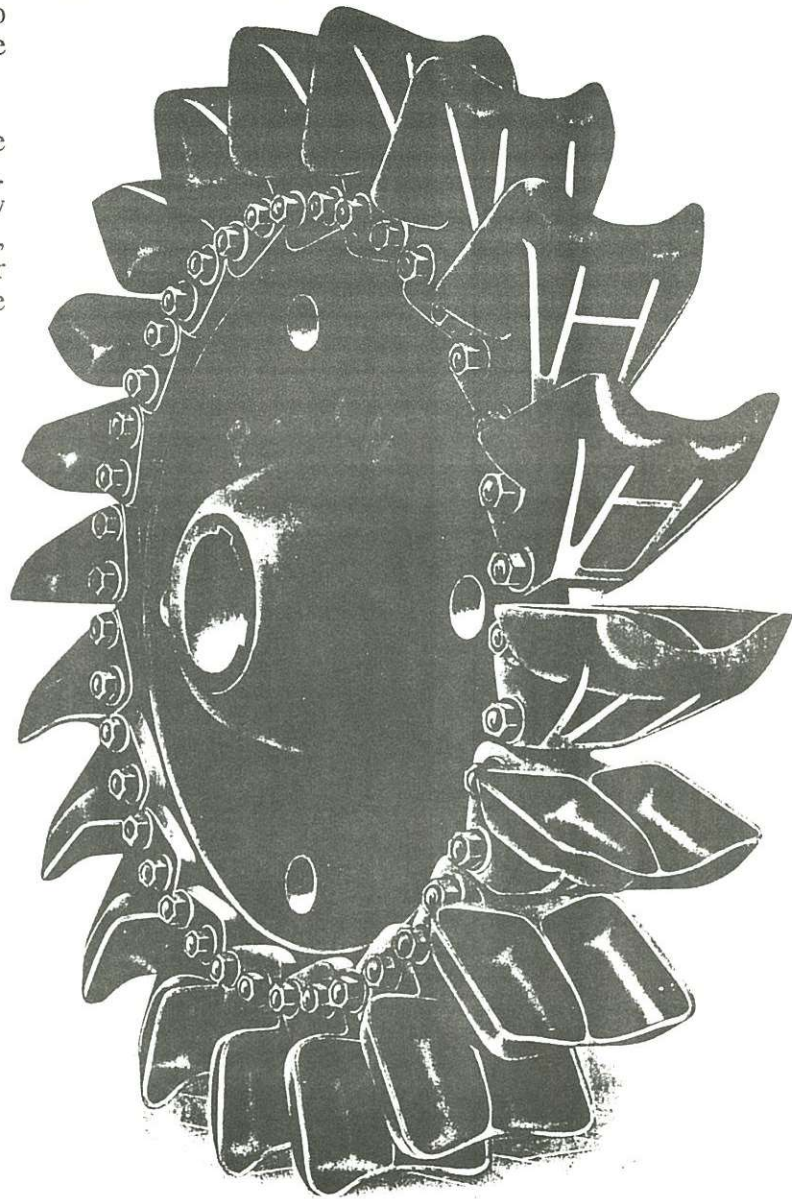
The Pelton water wheel was an impulse type hydraulic turbine, arising directly from California mining history. It became a primary low cost energy source for mining machinery and electric power generation from the latter 1880's into the twentieth century. Invented in 1878 by Lester Allen Pelton, a 49 year old hydraulic miner in Camptonville, California, the wheel took advantage of the water abundance and mountainous terrain of many mining sites. With the relative scarcity of wood fuel in many mining localities, the conversion from steam engines to water power was a welcome change. Conversion again to electricity for mining operations soon replaced the Pelton Wheel.

The Empire Mine in Grass Valley, California, used the Pelton Wheel for primary power from 1886 to 1891. Prior to 1886 twenty cords of wood were burned daily to produce steam at the Empire. The North Star Mine, also at Grass Valley, used its large thirty foot diameter Pelton for 37 years producing compressed air to drive hoists, pumps, and drills.



18 foot Pelton, North Star Mine, driving air compressors.

Departing from centuries-old water wheel designs, Pelton drove his wheel by high velocity water delivered to the periphery of the wheel by jet stream under water head pressures varying from 20 to 2100 feet. The genius of the Pelton Wheel was in the shape of the bucket or cup. Pelton discovered by trial and error that a double cup with a center splitter partition would partially reverse the incoming water stream, imparting more kinetic energy to the wheel. The divided water also reduced the splash interference with the incoming stream.

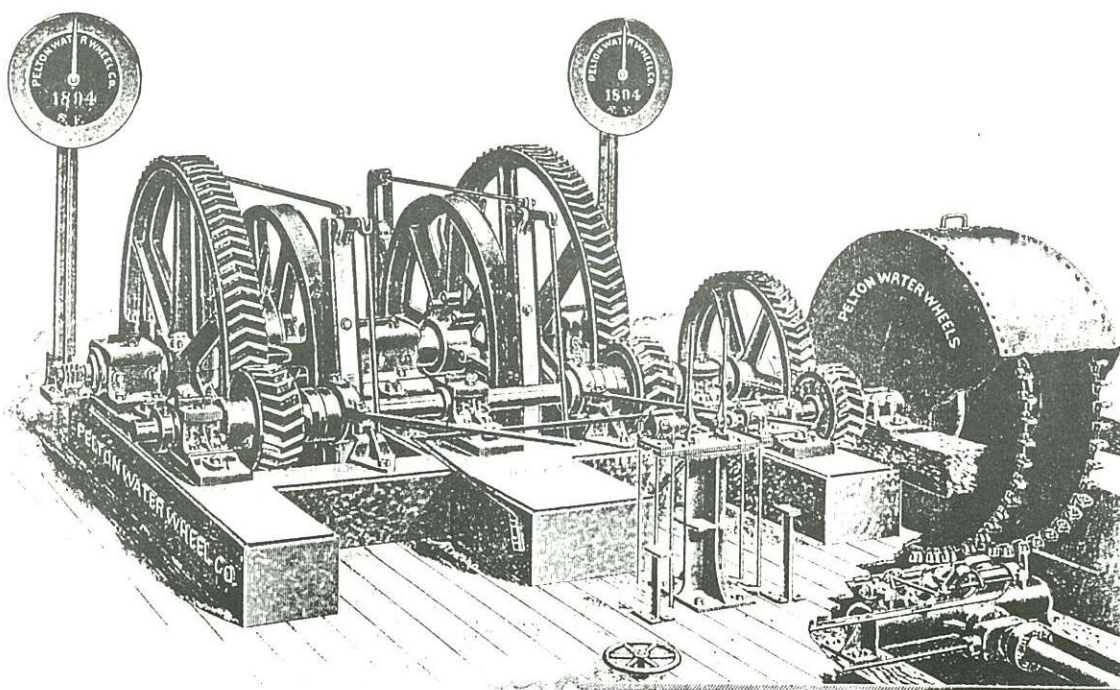


Ten foot Pelton, 5,000 horsepower at 865 feet of head.

Other inventors attempted to produce high velocity impulse wheels, but none achieved the efficiency of the Pelton. Tests of these water wheels were performed at the Idaho Mine, Grass Valley, in 1883 using a water head pressure of 368 feet. The results showed a water power conversion efficiency of: Pelton (Camptonville) 90.2%, Knight (Sutter Creek) 76.5%, Fredenburr (Grass Valley) 69.6%, and Taylor (Grass Valley) 60.5%. The Pelton showed clear superiority and became the predominant manufactured wheel. Pelton received awards of excellence at the 1893 Columbian Exposition and from the Franklin Institute in 1895. He was honored in 1973 by the American Society of Civil Engineers and was inducted into the California Inventors Hall of Fame in 1983. A Pelton Wheel diameter would depend on the horsepower size of the system and the angular velocity desired. A typical Pelton Wheel installation would be a three foot diameter cast iron wheel operating with a water head of 300 feet, using 180 cubic feet of water per minute, turning at 440 rpm and generating 88 horsepower. Such a wheel might generate electricity, pump water, ventilate a mine, power a machine shop or run the hoists of a mine. To actuate the hoists, opposing Pelton Wheels might be constructed on the same shaft, with the hydraulic controls giving water power to the respective wheel powering the upcoming skip or car. The hoist wheels of the Empire Mine were ten feet in diameter. One of the most dramatic installations was made at the Comstock Mines, Virginia City, Nevada, where a 36 inch steel and bronze Pelton Wheel was mounted at the Sutro Tunnel level of the California



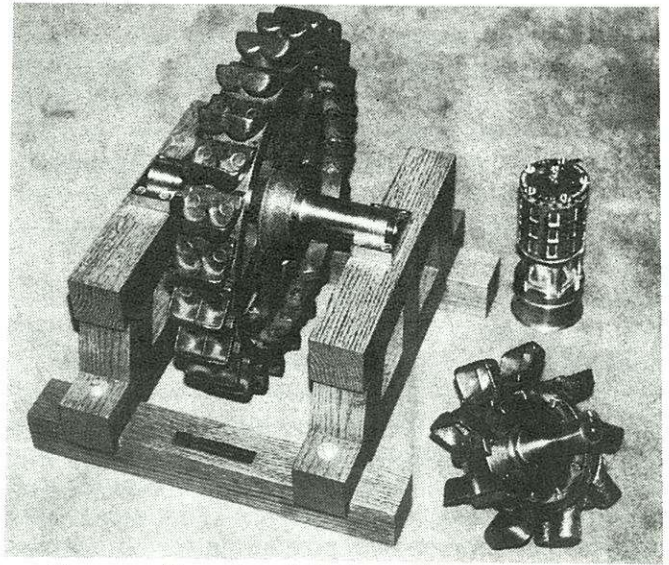
*Ten foot Pelton Wheel, Empire Mine.
Photo by Robert Cross.*



Hoist equipment powered by two Pelton Wheels.

Consolidated Virginia shaft 1640 feet below the surface. The vertical water head was 2100 feet, equivalent to 911 pounds per square inch pressure. The wheel turned at 1150 rpm which gave it a peripheral velocity of 10,800 feet per minute (120 miles per hour). The exhaust water passed four miles through the Sutro Tunnel.

By 1888 the demand for Pelton Wheels exceeded the production capacity of the Miners' Foundry in Nevada City and all production was moved to a newly formed Pelton Water Wheel Company of San Francisco. By 1895 over 850 wheels were being used throughout the world. These were manufactured in sizes varying from four inches to thirty feet in diameter (North Star powerhouse, Grass Valley). By 1909, the Pelton Water Wheel Co. of San Francisco and New York had manufactured over 12,000 wheels, producing an aggregate 1.3 million horsepower. Over 8,000 of these were in California, Oregon, and Nevada. Over 700 were installed in Washington, Idaho, and Alaska, and 241 in Utah, Colorado, and Montana. Less than 200 operated in the eastern United States. Close to 2,000 were located in foreign countries throughout the world. After the turn of the century the majority were used to develop electric power, and this became the major emphasis of the company, both in design and sales. Most major mines had become electrified by 1900. The source of this electricity continued to depend on the Pelton Water Wheel in many western mountain locations through the first half of the twentieth century. Lester Pelton died in Oakland, California in 1908.



Two small restored Pelton Wheels, from the collections of the authors.

- Calhoon, F.D. *California Gold and the Highgraders*. 1988.
Encyclopedia of Science and Technology. 1992
 Johnson, O.A. *Fluid Power for Industrial Use*. 1983.
 Kilroy, Elza J. "The Pelton Water Wheel." *Nevada County Historical Society*. Vol. 15, No. 2, 1961.
 Leshcoheir, Roger P. *Lester Pelton and the Pelton Water Wheel*. 1992.
 McQuiston, F.W., Jr. *Gold: the Saga of the Empire Mine*. 1986.
National Cyclopedia of American Biography. 1906.
 Peele, Robert. *Mining Engineers' Handbook*. Third Edition, 1941.
Pelton Water Wheels, Bulletin No. 6.
Pelton Water Wheel Company Catalog. Seventh Edition, 1898.
Pelton Water Wheel Company Catalog. Eleventh Edition, 1909.

