The Kinne Collection of Water Turbines

A Mechanical Engineering Heritage Collection

Designated June 19, 1999 by
The American Society of Mechanical Engineers

This collection, assembled by engineer Clarence E. Kinne (1869-1950) between 1907 and 1937, is believed to be the largest in the world. Most of the turbines powered machine works, factories, and saw, grist, and paper mills in the northern counties of New York. Examples range from crude, one-of-a-kind wheels, designed and built by their users based largely on instinct and observation and incorporating parts of wood, to sophisticated, high-efficiency, all-metal machines by large builders dedicated solely to turbine work.

The collection represents American development from a time well before the invention of the “true” turbine to the evolution of the inward-flow reaction turbine used in today’s largest hydroelectric plants.

The Jefferson County Historical Society Museum
228 Washington Street,
Watertown NY
**Description of the Landmark**

The Kinne Collection of Water Turbines is owned by the Jefferson County Historical Society and displayed at their museum at 228 Washington Street, Watertown NY 13601. All but four of the exhibits are located in the Stuart Lansing Memorial Room in the basement of the museum. Exhibits 31, 32, 33 and 34 are displayed on the museum's south lawn.

**Historical Perspective**

Water power has played a critical role in the development of technology and society for over two thousand years. The earliest usage is shrouded in antiquity, but lifting water and milling grain were prominent early applications. The Romans built water powered mills on Janiculum Hill across the River Tiber from Rome to produce flour for inhabitants of their city. By the fifth century AD, Roman engineers, spread the use of waterwheels and aqueducts throughout their empire. At Barbegal in southern France, they built a complex of sixteen water powered mills on the side of a hill. Total output from these mills has been estimated at 28 tons of flour per day.

After the fall of the Roman Empire, use of water mills continued to expand in Europe as feudal lords discovered that building gristmills and requiring peasants to use them provided a convenient method for taxation. Use of water powered mills grew to the point where they impaired inland navigation. A census ordered by William the Conqueror near the end of the eleventh century listed 5624 water mills at 3000 locations in England. This was an average of one water mill for every fifty households. Most of these mills utilized vertical wheels with horizontal shafts. Vertical waterwheels were more efficient and produced larger amounts of power than early horizontal waterwheels.

Europeans brought the technology of waterwheels with them when they settled in America. They used water to power the gristmills and other industries of the colonies. By 1860, water power predominated as the source of energy for industry in the United States. Water was used to power sawmills, paper mills, textile mills, forges and machine shops. Towns and cities grew up around these sites. Watertown, New York grew into a city largely as a result of water power harnessed from the Black River, which drops one hundred feet within the city limits.

Near the start of the nineteenth century, the application of scientific methods of analysis and experimentation, along with the increased availability and reduced cost of iron, led to many improvements in the design of water wheels and to the development of hydraulic turbines. In France, Jean Victor Poncelet introduced the use of curved blades which more than doubled the efficiency of an undershot wheel. Curved blades reduced the hydrodynamic turbulence losses from the water impact on the wheel. In 1826 Poncelet suggested turning his wheel on its side to permit the water to exit smoothly through the center instead of turbulent reversing direction and flowing out the bottom. Poncelet's wheel and the modifications...
he proposed, influenced his countrymen Benoit Fourneyron, who in 1827 built the first successful water turbine. It was an outward-radial-flow device with guide vanes inside the wheel. Its efficiency was 80% at full gate. Samuel B. Howd of Geneva, New York also implemented Poncelet's suggestion, but retained his inward flow arrangement to produce the first successful inward-flow turbine, in 1838. Inward flow resulted in smaller, less expensive wheels that ran at higher speeds than outward-flow wheels.

Around 1849, James B. Francis improved Howd's design, and advanced the technology by performing accurate tests, publishing the results, and formulating rules for turbine runner design. He helped the United States become a leader in the development of hydraulic turbines and his name became synonymous with inward-radial-flow turbines. Several American manufacturers improved on the Francis design, evolving different forms of mixed flow turbines that combined radial and axial flow. The mixed-flow wheels ran at higher speeds and produced more power. They were well suited for the low-head applications common in the eastern United States. Jomval axial-flow turbines, developed in France in 1837, were introduced to the United States around 1850 and enjoyed extensive use. The smaller size, higher speed, higher power, lower cost, and ability to operate efficiently with variable water levels caused these and other types of hydraulic turbines to replace the vertical waterwheel as the primary source of power in American industries. The term waterwheel persisted, however, and is applied to many of the turbines in the Kinne Collection.

During the latter half of the nineteenth century, steam and electric power made inroads into the virtual monopoly that waterwheels and hydraulic turbines had as a source of mechanical power. These new technologies permitted mill locations away from rivers and streams. They also supplied larger amounts of power than were available at many waterpowe sites and they were not limited by seasonal variations in water flow. By the middle of the twentieth century waterwheels and turbines had practically disappeared from use as sources of direct mechanical power for industry in America. Water turbines now powered electric generators instead of directly powering factories and mills. The old, smaller waterwheels that had powered mills directly were cast aside, abandoned in place, or tossed onto scrap piles.
Clarence E. Kinne

Clarence E. Kinne (1869-1950) observed the decline in dependence on water power as a direct source of mechanical power during his lifetime. He recognized the historical and technical significance of old water turbines as they were being cast aside by others and resolved to preserve representative samples of the old machines for his own enjoyment as well as for the benefit of future generations. He journeyed throughout northern New York to visit old water-powered mills and corresponded with almost anyone who might help him in his search for water turbine information and artifacts. He purchased a variety of old turbines with his own funds and was given others. He gathered an extensive collection of trade catalogs that described many of the water turbines in his collection. In 1928 he loaned his collection to the Jefferson County Historical Society for display in their museum's newly renovated basement. Mrs. Stuart E. Lansing, the widow of Kinne's former employer, funded the basement remodeling in honor of her late husband who had been president of the historical society as well as president of Bagley & Sewall (now GLV/Black Clawson-Kennedy, Inc.) where Kinne spent most of his career.

Kinne's appreciation of waterwheels and turbines started early, probably at age 16 when he apprenticed at a machine shop in Camden, New York, that later became the Camden Waterwheel Works. At the age of 24 he began work as a draftsman at Bagley & Sewall, manufacturers of paper-making machinery in Watertown, New York. He spent the remainder of his career there, becoming in succession: Chief Draftsman, Mechanical Engineer, Superintendent, Secretary, Vice-President, and President of the company. He was a Life Member of ASME and served as President of the Jefferson County Historical Society from 1935 to 1947.
Technical Background

The Kinne Collection illustrates the wide variety of water turbines produced in nineteenth-century America. It includes center discharge wheels, Jonval axial-flow turbines, radial inward and mixed-flow turbines, register-gate and wicket-gate turbines, centrifugal wheels, and many combinations. The collection even includes a "Scotch turbine" descendant of "Barker's wheel", which works like a spinning lawn sprinkler. The diversity of wheels is significant to anyone interested in the study of hydraulics. The evolution of designs exhibited in the collection provides an object lesson in the methods of engineering development, which apply as much today as they did in the era in which turbines in the collection were being developed.

All the turbines and waterwheels in the collection except Exhibit 2 were produced between 1810 and 1916. Their output power ranged from 3 to 172 horsepower at heads between 5 and 72 feet. Diameter of the wheels or runners ranges from approximately 1 to 5 feet. The collection is a record of our industrial past and represents the forerunners of the large modern hydroelectric turbines with outputs exceeding 800,000 horsepower.

Water turbines are generally categorized as either reaction or impulse turbines, depending on whether they convert any of the potential energy from hydraulic pressure into kinetic energy within the turbine runner itself. If they do they are called reaction turbines. If they perform all this conversion within nozzles aimed at the runner they are called impulse turbines. The turbines in the collection are all reaction turbines. The higher head requirements of impulse turbines made their use rare in the northeastern United States.

Higher efficiency units in the collection had guide vanes to impart a tangential component to the flow of water into the runner. Some units such as the Improved American Turbine in Exhibit 33 employed swiveling wicket gates that controlled the rate of flow while directing it smoothly into the runner. Register gates as in Exhibits 6 and 31 also combined gates with guide vanes, but were less efficient at partial gate.

Specific speed is a parameter used to select the optimal type of turbine or pump for a given service. It is independent of diameter, but depends on geometric proportions. It can be dimensionless, but Kinne used customary units involving, rpm, feet and horsepower. With these units the specific speed equals the optimal speed of a turbine scaled to produce one horsepower, when operating with one foot of head. High-specific-speed turbines operate most efficiently at low heads. Most of the turbines in the collection have specific speeds between 12 and 73. Exhibits number 3 and 26 are notable exceptions. They are axial-flow Truax Green Mountain turbines with specific speeds of 92 and 83 respectively. The design of these machines was patented in 1860 and 1871 by J.D. Truax, a resident of Vermont. Turbines of this type were the forerunners of the propeller turbine, that ultimately developed into the adjustable-blade Kaplan turbine used for low head installations today.
Exhibit 22
Re-Action Type
Runner & Jowntype Case
This axial flow turbine is a combination of a Re-Action runner and a Jowntype case. The case has thirteen guide vanes and the runner has seven buckets. It was probably built around 1858 or 1860. It drove a "Run of Stone" in the flour mill of A. H. Herrick & Son, Watertown, New York.

Exhibit 23
Weaver Spiral Case & Jowntype Wheel
W. W. Weaver of Rossie, St. Lawrence County, New York was granted a patent for this "Volute Case for Waterwheels" in 1872. The volute case conveys water over the top of a Jowntype axial flow wheel without guide vanes. The wheel has eleven buckets. The wheel upgraded the power to operate a stone grit mill in Rossie that was built in 1844 by George Parrish. The wheel was probably made at the Foundry & Machine Shop located across the Indian River from the mill.

Exhibit 24
Francis Inward Flow Wheel in a Scroll Case
The Gilderoy-Lord Machine Shop on Bebee Island, Watertown, New York built this 24 inch central discharge wheel in 1866. It was designed by the engineer, William H. Phillips of Belleville, New York. The wheel had sixteen 4-3/4 inch high buckets. It drove a pair of mill stones in the grit mill known as Mother's Mill on Sandy Creek between Adams and Belleville, New York.

Exhibit 25
44-Inch Austin Wheel
Henry R. Austin of Norwood, New York made this wheel. It has two buckets each 12-11/16 inches wide and 10 inches deep. Similar wheels with two, three or four buckets were used in saw mills on the Lacquette and DeGrasse Rivers. This wheel is a forerunner of the modern propeller turbine.

Exhibit 26
32-Inch Truax Green Mountain Turbine
J. W. Truax of Richford, Vermont received patents for this type of waterwheel in 1860 and 1871. This wheel has an outside diameter of 34-5/8 inches and an inside diameter of 32-7/8 inches. It has four buckets, each 5-1/2 inches deep and 13-1/4 inches wide. The wheel was installed in a mill in Potsdam, St. Lawrence County, New York. It was tested in 1922 by the "Proprietors of Locks and Canals on the Merrinack River" at Lowell Massachusetts.

Exhibit 27
Hughes Centrifugal Waterwheel
The Charles W. Leetie Foundry & Machine Shop in Potsdam, St. Lawrence County, New York made this wheel to drive the shop's blower and tumbling barrels. This 60 inch diameter wheel was mounted on a vertical shaft and was located under a 44 inch diameter opening on the bottom of a wooden flume. It had no guide vanes. Water discharged from six openings in the outer rim of the wheel.

Exhibit 28
18-Inch Center Discharge Wheel in Spiral Case
This turbine was originally used in the broom handle factory of Daniel Cummings in Oscoda, New York. It drove an electric generator which powered the factory's lights. The scroll case around the wheel imparts a tangential component to flow into the wheel. The tangential component of flow produces the wheel's output torque and power.

Acknowledgements

The initial effort to designate the Clarence E. Kinne Water Turbine Collection an ASME Mechanical Engineering Heritage Collection came from Euan F. C. Somerscales, former Chairman of the ASME History and Heritage Committee. Dr. Somerscales prepared the original draft of the collection's nomination with the assistance of Jane Mork Gibson of Philadelphia, Pennsylvania. Ms. Gibson has an unrivaled knowledge of Clarence E. Kinne and his water turbine collection, having presented a paper entitled "Water Power in the North Country: Clarence E. Kinne and His Turbine Collection" at the 21st Annual Conference of the Society for Industrial Archeology in Buffalo, New York on June 6, 1992.

Dr. Persis Kolberg, former Director of the Jefferson County Historical Society, graciously permitted Dr. Somerscales to examine in detail and photograph the Kinne Collection.

Edward K. Parker, Clarence Kinne's grandson, provided invaluable information about his grandfather and the collection. T. Ureld Walker, a Historical Society trustee and member of the Syracuse Section of ASME kept the nomination moving forward. Fred H. Rollins, Director of the Jefferson County Historical Society, and Elise Davis Chan, Curator of Collections of the Society, lent their support and the museum's resources to the preparation of the revised submittal of the nomination and of this brochure.

Several members of the Syracuse Section of ASME provided time and effort to the designation. History and Heritage Chairman William A. Knehoe revised and submitted the nomination, with assistance from Bruce Marcham, the Section Chairman. W. Robert Zeigler, Northern Coordinator for the Section photographed the exhibits in the collection and helped to coordinate, fund, and expedite the designation process. Fredric Wenthen, PE, compiled the text in this brochure with the help of Bruce Marcham, Francis J. Kelly, Ernest Wass, and W. Robert Zeigler. Design of this brochure was donated by Catherine Wenthen.

We also wish to acknowledge the following organizations that have contributed to the renovation of the Stuart Lansing Memorial Room where the Kinne Collection is displayed: Northern New York Community Foundation; Sweetgrass Foundation; Snow Foundation; New York Air Brake Company- A Knorr Company.
### Exhibit Statistics

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* Suspiciously High

### References

- Emerson, James, *Hydro-Dynamics*, sixth edition, 1894
Exhibit 29
12-Inch Register Gate Wheel
Like Exhibit 28, this turbine was originally used in Daniel Cummings’ broom handle factory. Six register gates around the case direct and control the flow of water into the wheel. The gates consist of a set of guide vanes which are split into inner and outer parts. The inner part rotates to control the size of the opening between vanes.

Exhibit 31
Bastion 42-Inch Register Gate Wheel
J. Bastion of Canton, New York was granted a U.S. patent on this wheel in 1870. Some of these type wheels were made at Canton, New York and some at Theresa, New York. The exhibited wheel operated at the flour mill of Snell & Malaperon, on the Indian River in Theresa, New York.

This wheel measures 38 inches diameter at the top and 50 inches diameter at the bottom rim. It has sixteen buckets, twelve guide vanes and twelve gate openings.

Exhibit 32
33-Inch Victor Turbine
Built by Stillwell-Bierce Company, Dayton, Ohio, this wheel has twenty buckets and is 15 inches high. It is upside down, perhaps to show the intricate formation of the buckets at the bottom of the wheel. An 1891 catalog lists its speed as 170 rpm at 4500 cubic feet of water per minute.

Exhibit 33
36-Inch New American Turbine
This turbine was built by Dayton Globe Iron Works Co., Dayton, Ohio, under U.S. patents granted to J. Temple of Middletown, Ohio in 1859 and to J. Temple, W.M. Mills and A.L. Stout, in 1863. The turbine operated one of the mills of the Remington Paper Company, Watertown, New York. This is an improved version of the American Turbine in Exhibit 19. Its outstanding feature is its swiveling guide mechanism which smoothly controlled and directed the flow of water into the runner with either partial or fully opened gates. The original gate mechanism of this type was patented in 1854 by Elijah Roberts, of Rochester, New Hampshire. This wheel has six gates and chutes in the case and thirteen buckets in the runner.

Exhibit 34
35-Inch Crocker Turbine
This wheel has fourteen 15½-inch high buckets. It is displayed upside down on the museum’s south lawn. The “Crocker” design of hydraulic turbine has been built by the following manufacturers: E.D. Jones & Sons Company, Pittsfield, Massachusetts; William Clark & Company, Pittsfield, Massachusetts; Turners Falls Machine Company, Turners Falls, Massachusetts; Jenks Machine Company, Sherbrooke, Quebec.

Exhibit 36
36-Inch Diameter Saw-Mill Wheel
This wheel has fourteen buckets and an outside diameter of 36 inches. It weighs 275 pounds. It was made for Seldon Cut by George Wood in Camden in 1839. It powered a “Muley” (up and down) saw mill on Spring Brook in Camden, Oneida County, New York, from 1839 to 1865.

Exhibit 40
Wooden Bevel Gears
Bevel gears are used to transfer power from the vertical shaft of a turbine to a horizontal shaft of a mill. The wooden bevel gears absorbed shock to prevent breakage of gears in the mill.

Exhibit 41
Lignum Vitae Step
This step supported a turbine shaft and was often submerged in water. It is made of Lignum Vitae, a very strong hardwood that is highly resistant to deterioration caused by friction and water.

Exhibit 43
Wooden Model Of A Scroll Case
This wooden model of a center discharge scroll is similar to the type used with waterwheels in Exhibits 23 and 24. This model was made at Camden Water-Wheel Works in Camden, Oneida County, New York. It illustrates how the scroll directed water into the rotating buckets and discharged them downward.

The ASME History and Heritage Program

The ASME History and Heritage Program began in September 1971. To implement and achieve its goals, ASME formed the History and Heritage Committee, initially composed of mechanical engineers, historians of technology, and the curator of mechanical and civil engineering at the Smithsonian Institution. The committee provides a public service by examining, noting, recording and acknowledging mechanical engineering achievements of particular significance. The History and Heritage Committee is part of the ASME Council on Public Affairs and Board of Public Information.

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