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.

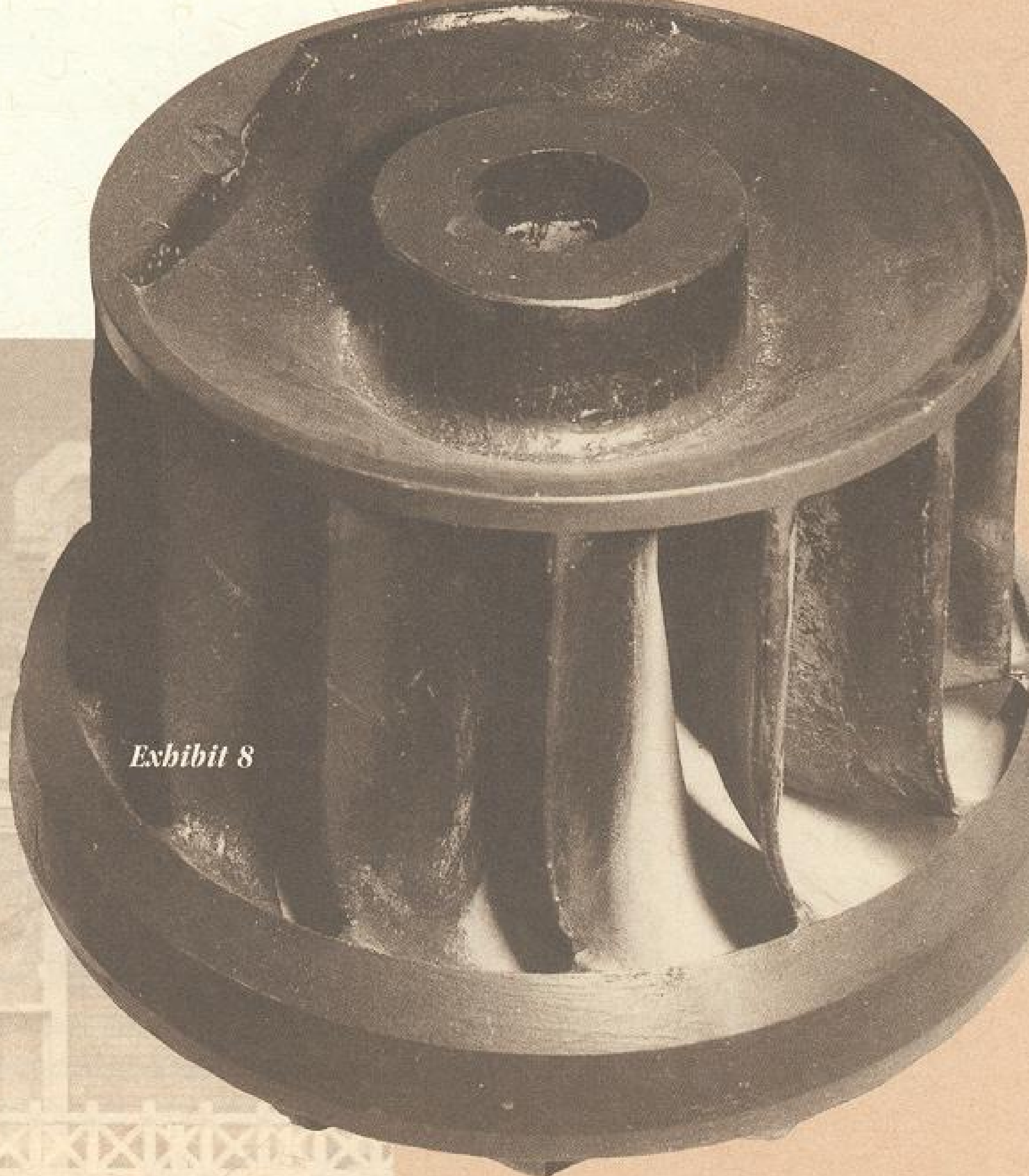
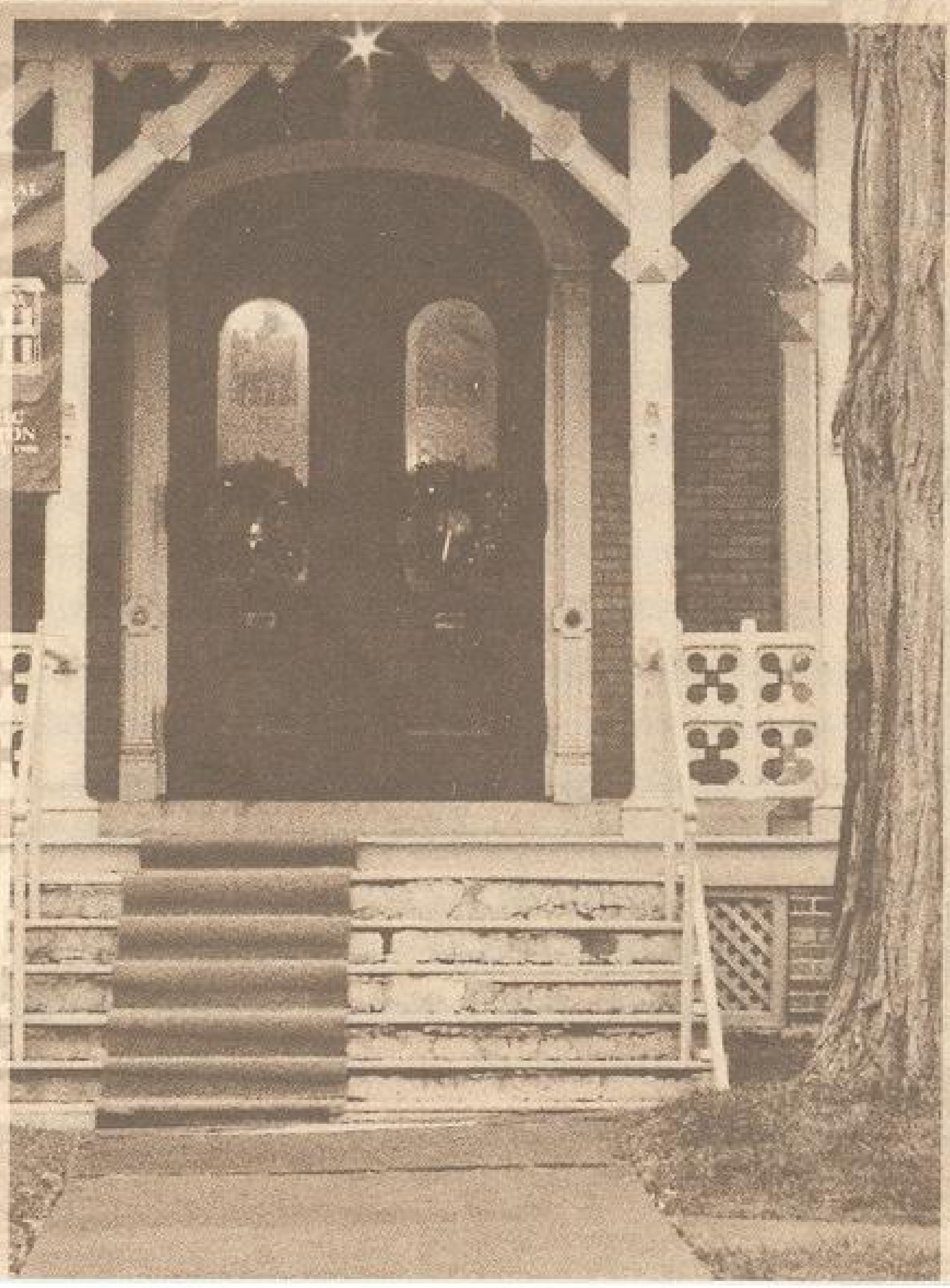


Exhibit 8

Exhibit 39



The Jefferson County Historical Society Museum
228 Washington Street,
Watertown NY

ASME International

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.

Exhibit 2

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.

Exhibit 6

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 turbulently reversing direction and flowing out the bottom. Poncelet's wheel and the modifications

Exhibit 1
Iron Reaction Waterwheel
This waterwheel was made in 1840, in George W. Wood's Foundry and Machine Shop, in Camden, Oneida County, New York. It was used by Clarence Kinne's uncle, Amos Kinne in a saw mill on Intervale Brook in the town of Camden. The wheel's diameter is 34 inches at the top and 28-1/2 inches at the bottom for an average of 31-1/4 inches. It weighs 300 pounds. Its 14 inch diameter shaft is made of red birch wood. The wheel was mounted horizontally at the bottom of a flume. Water entered through the top of the wheel and discharged down and out through the six buckets. No guide vanes or chutes were used. The top of the vertical shaft was connected to a crank which powered a drag-saw.

Exhibit 2
Iron Reaction Waterwheel
This 31 inch diameter waterwheel was cast under Kinne's supervision at the Bagley & Sewall Company, Watertown, New York in 1928. He used the wooden pattern displayed next to the wheel to make the mold. The pattern was made in 1852 by Tripp & Fifields (Eagle Foundry and Machine Shop) in Camden, New York. Two similar but older waterwheels powered a Muley (up and down) saw mill near McConnellsville, Oneida County, New York. The wheels were mounted flush to the sides of open flumes. They were connected by a seventeen inch diameter horizontal wooden shaft.

Exhibit 3
Truax Green Mountain Turbine
This turbine was manufactured in Essex Junction Vermont, under patents of 1860 and 1871. It operated in an open flume and did not require guide cases or chutes to direct water into the wheel. Some installations used a draft tube to produce a vacuum below the wheel. Some did not. This turbine is a forerunner of the modern propeller wheel.

Exhibit 4
14-1/2 Inch Austin Wheel
This was the very first wheel made by Henry R. Austin of Norwood, St. Lawrence County, New York, and is a forerunner of the propeller wheel. A patent for this wheel is said to have been granted in 1878. The wheel operated a machine shop on the Racquette River owned by S. W. Davis of Norwood. This wheel was tested in 1922 in Lowell, Massachusetts.

Exhibit 5
Iron Center Discharge Wheel
This waterwheel was originally used in the flour mill of A.H. Herrick and Son, Watertown, New York. It is an early type of center discharge wheel, made of iron. It is 35 inches in diameter and has four curved arms. Water came to the wheel through a spiral wooden curb which surrounded the wheel. It may have been installed in 1844 when the flour mill was established.

Members of the hydraulic division to the National Electric Manufacturers Association inspect the Kinne collection under the guidance of Clarence Kinne during an October, 1948 visit.

he proposed, influenced his countryman 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 became 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. Jonval 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 waterpower 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.

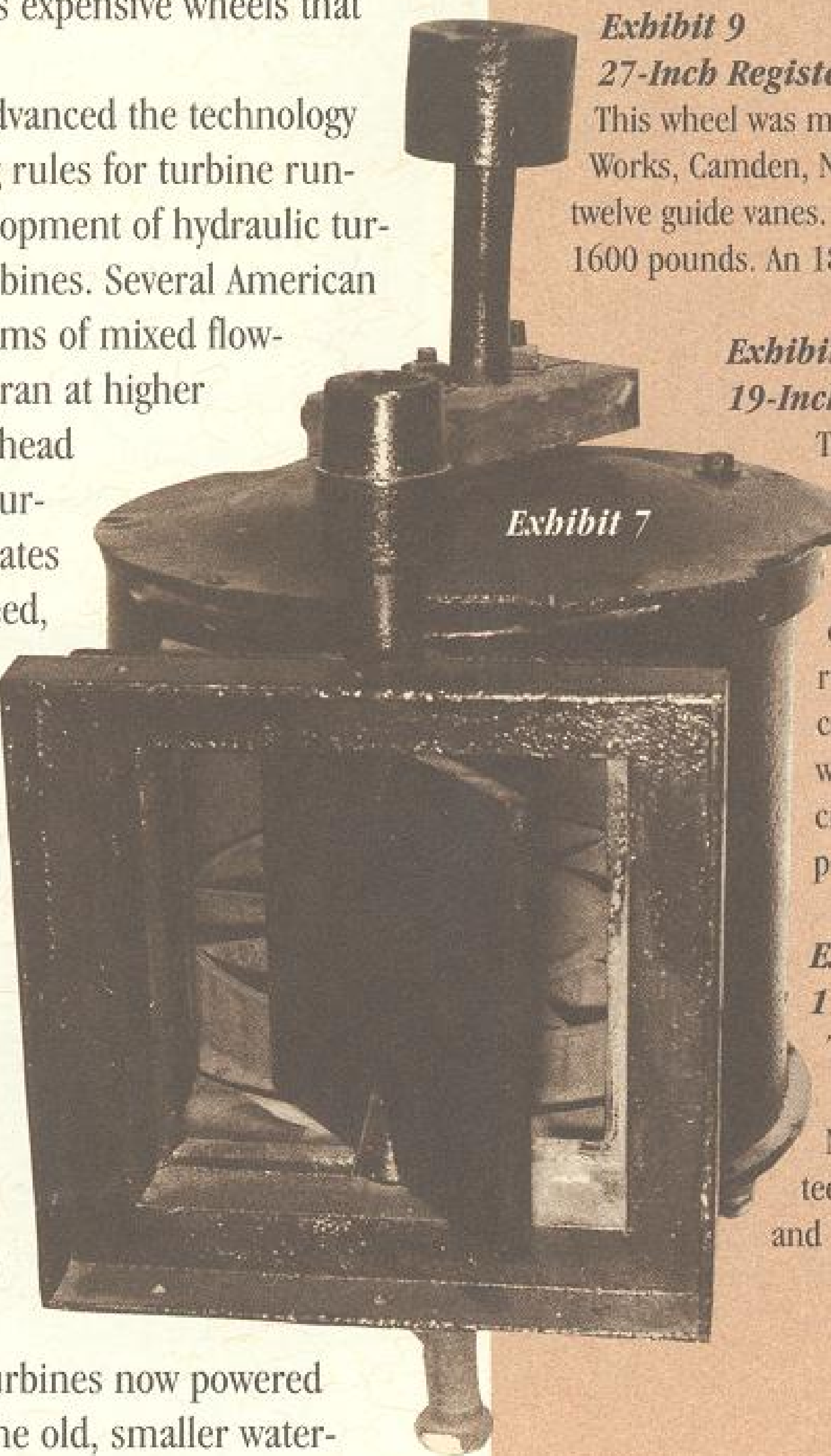


Exhibit 7

Exhibit 6
Burnham Register Gate Turbine
This 24-inch turbine was built by Nathan Burnham of York, Pennsylvania. Various U.S. patents were issued to him between 1859 and 1894. This is an inward and downward flow wheel. It has twelve register-gate guide vanes in the case and twelve buckets in the runner. The register gates directed and controlled the flow of water through the turbine by varying the size of the openings between the fixed outer portion of the guides and the rotating inner portion.

Exhibit 7
18-Inch Jonval Wheel in Iron Case
This axial flow wheel was made about 1877 by Ryther & Pringle in Carthage, New York. It was used in the Ager Saw Mill and Paper Mill in Lyonsdale, New York on the Moose River. The Jonval turbine, originally of French design, was introduced into this country about 1850 and became one of the most important forms of turbine of early American manufacture.

Exhibit 8
25-Inch Victor Turbine
This turbine was made by the Stilwell-Bierce Company in Dayton, Ohio, about 1891. It has nineteen buckets, eleven inches high. The runner and case weigh 2335 pounds. The 1891 Stilwell-Bierce catalog lists its price as $435.00

Exhibit 9
27-Inch Register Gate-Wheel
This wheel was made by the Camden Water-Wheel Works, Camden, New York. It has twelve buckets and twelve guide vanes. It is 13 inches deep and weighs 1600 pounds. An 1893 catalog lists its price as $195.

Exhibit 10
19-Inch Jonval Wheel
This wheel was originally used about 1870 in a gristmill in Lorraine Village, Jefferson County, New York. It has nine guide vanes in the case on top and twelve buckets in the runner below. Jonval wheels were compact high speed machines that were efficient at full gate, but less efficient than some Francis turbines at partial gate.

Exhibit 11
11-1/2-Inch Jonval Wheel
This wheel was originally used by the LeRay Mansion Farm in Leraysville, New York (now Fort Drum). It has fifteen guide vanes in the case on top and fifteen buckets in the runner below.

Exhibit 12
56-Inch Center Discharge Waterwheel
One of the oldest waterwheels in the collection, this wheel was made by millwright Thomas Matthews in 1852 for the Slater Machine Shop in Black River, New York. It had six radial oak blades, fourteen and a half inches wide and two inches thick. The blades were mortised into a cast-iron hub. This wheel operated in a wooden scroll case with a sixteen-inch-square inlet and a thirty seven inch diameter outlet on its bottom. The wheel rotated at approximately 65 revolutions per minute at a flow rate of 2315 cubic feet per minute.

Exhibit 13
25-Inch Center Discharge Waterwheel
This waterwheel has six tangent oak blades connected to a cast-iron hub. It operated in a wooden scroll case or curb with a 12-inch square opening and a 16-½-inch outlet. It powered a gristmill built in 1810 in Lorraine Village, Jefferson County, New York.

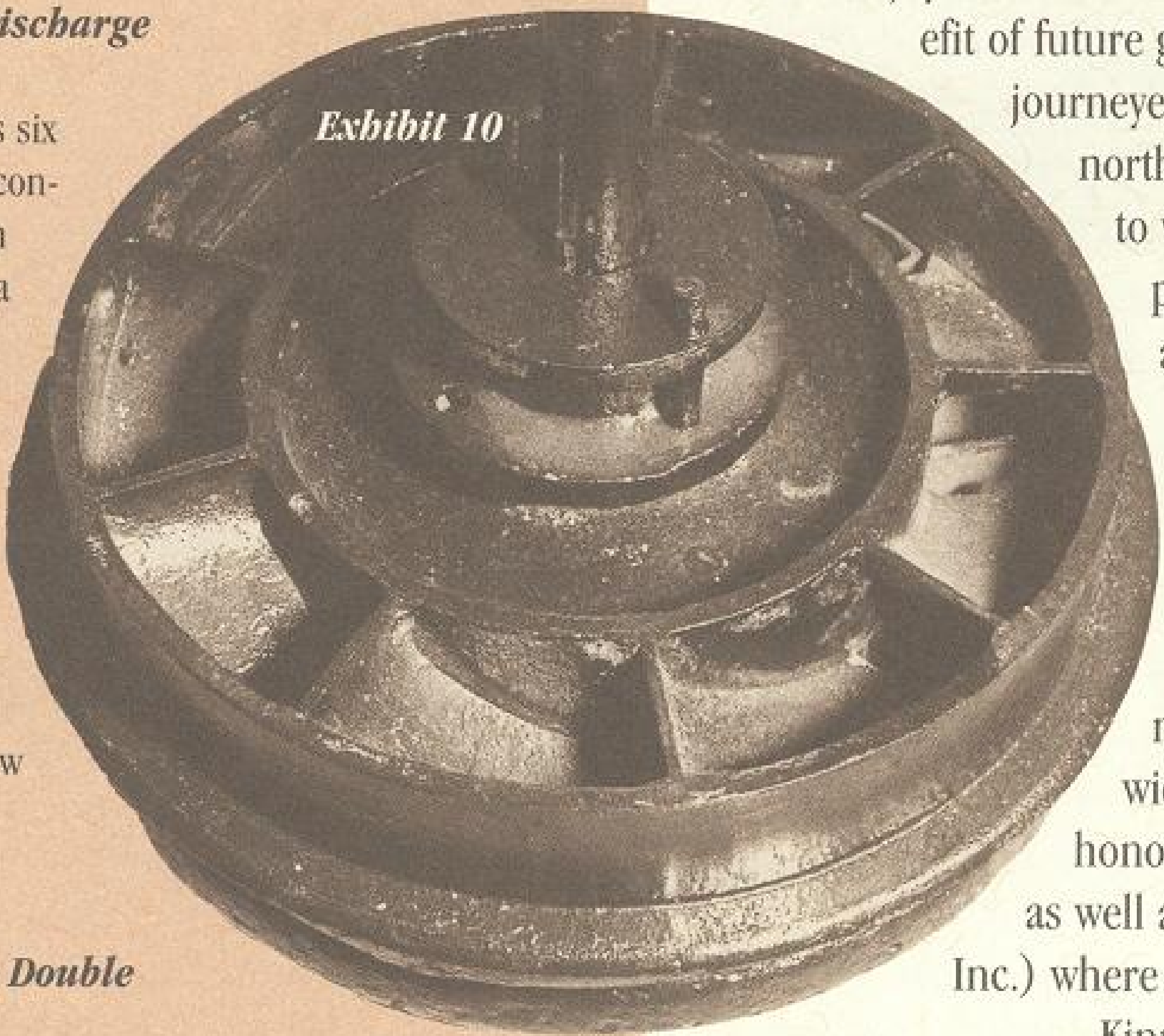


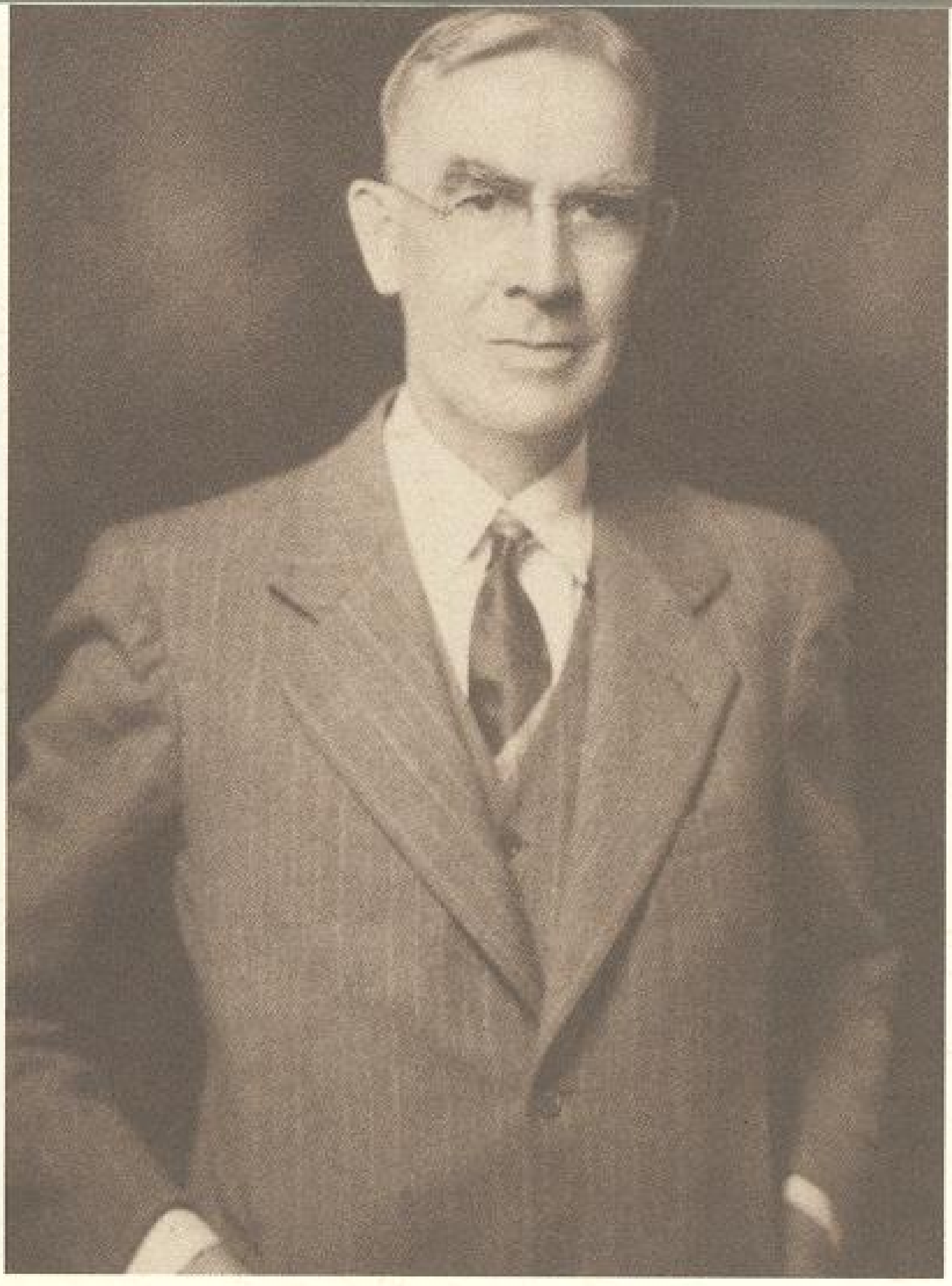
Exhibit 10

Exhibit 14
18-Inch Reynolds Double Discharge Wheel
S. Reynolds, from Oswego, New York, was granted a U.S. Patent in 1857 for a water-wheel having buckets which discharged at the top and on the bottom. This wheel was built under that patent by the Kingsford Foundry and Machine Works in Oswego. The wheel operated the paper mill of Whitesides and Duryee in Champlain, Clinton County, New York. The bottom of the wheel has been chipped off.

Exhibit 15
42-Inch Smith's Success Wheel
This downward discharge mixed flow wheel was built by the S. Morgan Smith Company in York, Pennsylvania about 1888. It has a cast iron body with fourteen steel buckets cast in place and a steel band shrunk around the bottom of the buckets. It was not actually installed in a mill until 1893. The wheel is displayed on its side with its bottom in the foreground.

Exhibit 16
30-inch Curtiss Wheel
Gates Curtiss of Ogdensburg, St. Lawrence County, New York, made this mixed flow wheel and was granted both a United States and Canadian patent for its design in 1873-1874. A similar wheel operated Mudge's Mill at Omar, New York.

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 GL&V/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.

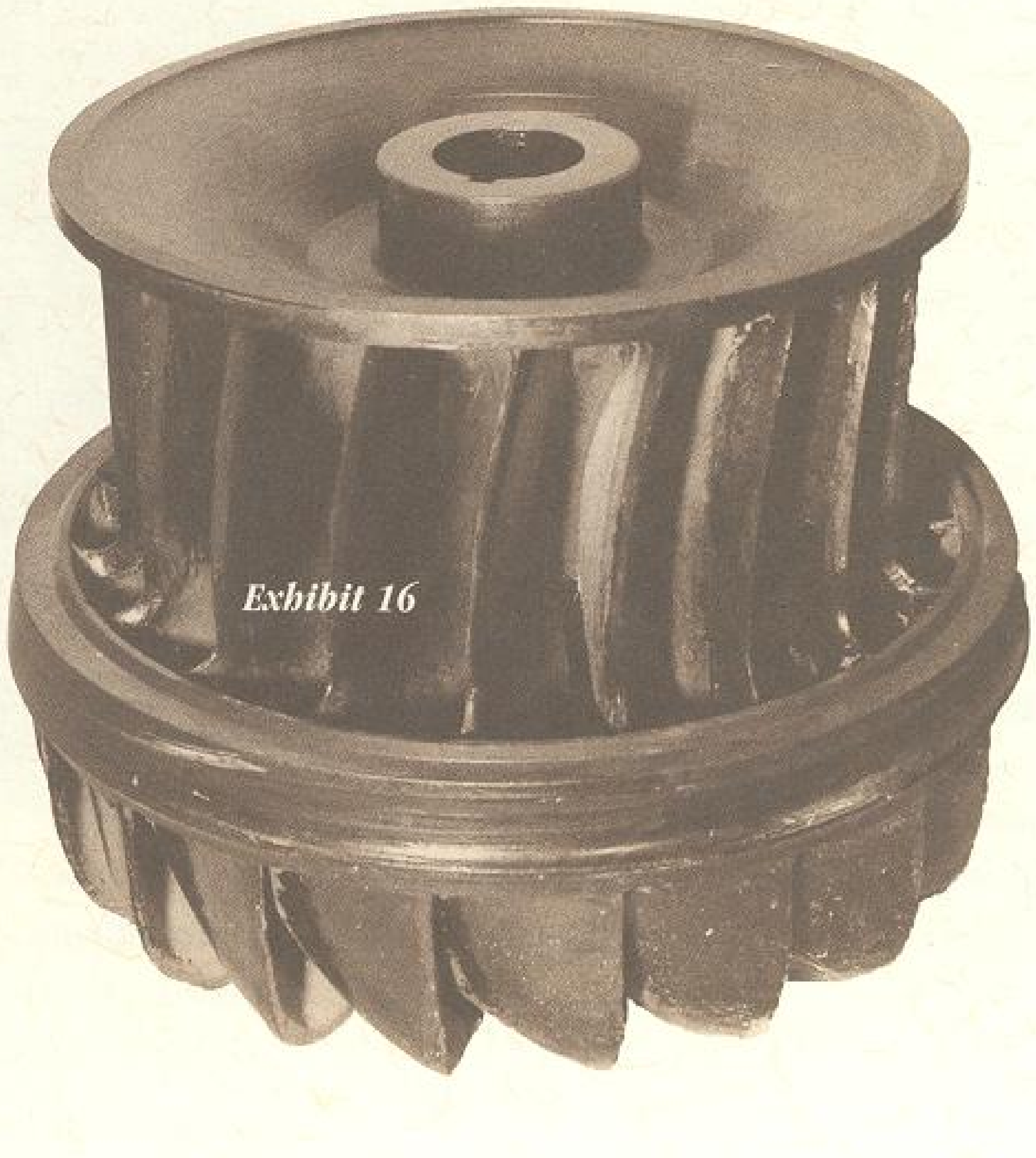


Exhibit 16

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" descendent 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.

Exhibit 22

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 hydro-electric 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 23

Exhibit 17
20-Inch Double Bucket Leffel Wheel

James Leffel of Springfield Ohio was granted a patent in 1862 for this type of wheel. The wheel has two rows of buckets. The upper row gives an inward radial flow to the water and the lower row gives a downward axial flow.

Exhibit 18
35-Inch Double Bucket Samson Turbine

This waterwheel was built by James Leffel and Company from Springfield, Ohio. Like the wheel in Exhibit 17, its upper row of buckets produce radial flow while its lower row has axial flow.

Exhibit 19
25-Inch American Turbine

The American Turbine was manufactured by Stout, Mills & Temple in Dayton, Ohio. Its runner had twelve buckets and an outside diameter of 25 inches. In an evaluation of waterwheels in 1873, James Emerson indicated that the American turbine was the "best of the early wheels". The American turbine evolved from the Francis radial flow turbine. Flow in the American turbine was "mixed" i.e. radial inward and down.

Exhibit 20
Whitelaw & Stirrat Reaction Wheel

This wheel, patented in 1843, was invented in Scotland, and was known as the "Scotch Turbine". It was an improvement on "Barker's Mill", an experimental device described by Desaguliers in 1744. The wheel is powered by the reaction to exiting water, like a giant rotating lawn sprinkler. This wheel was one of 3 similar wheels used to power a stone gristmill in Rossie, St. Lawrence County, New York. A "Scotch Turbine" more than twice this size powered the Rossie Iron Works located across the river from the stone gristmill.

Exhibit 21
High Head Inward Flow Wheel In A Scroll Case

Mr. William H. Phillips from De Ruyter, Madison County, New York, designed and built this wheel about 1907. It has twenty 2-7/8-inch high buckets and a 36 square inch discharge area. It drove a pair of mill stones that ground 40 bushels of corn per hour into fine corn meal. The wheel was located at Mather's Mill near Belleville, New York.

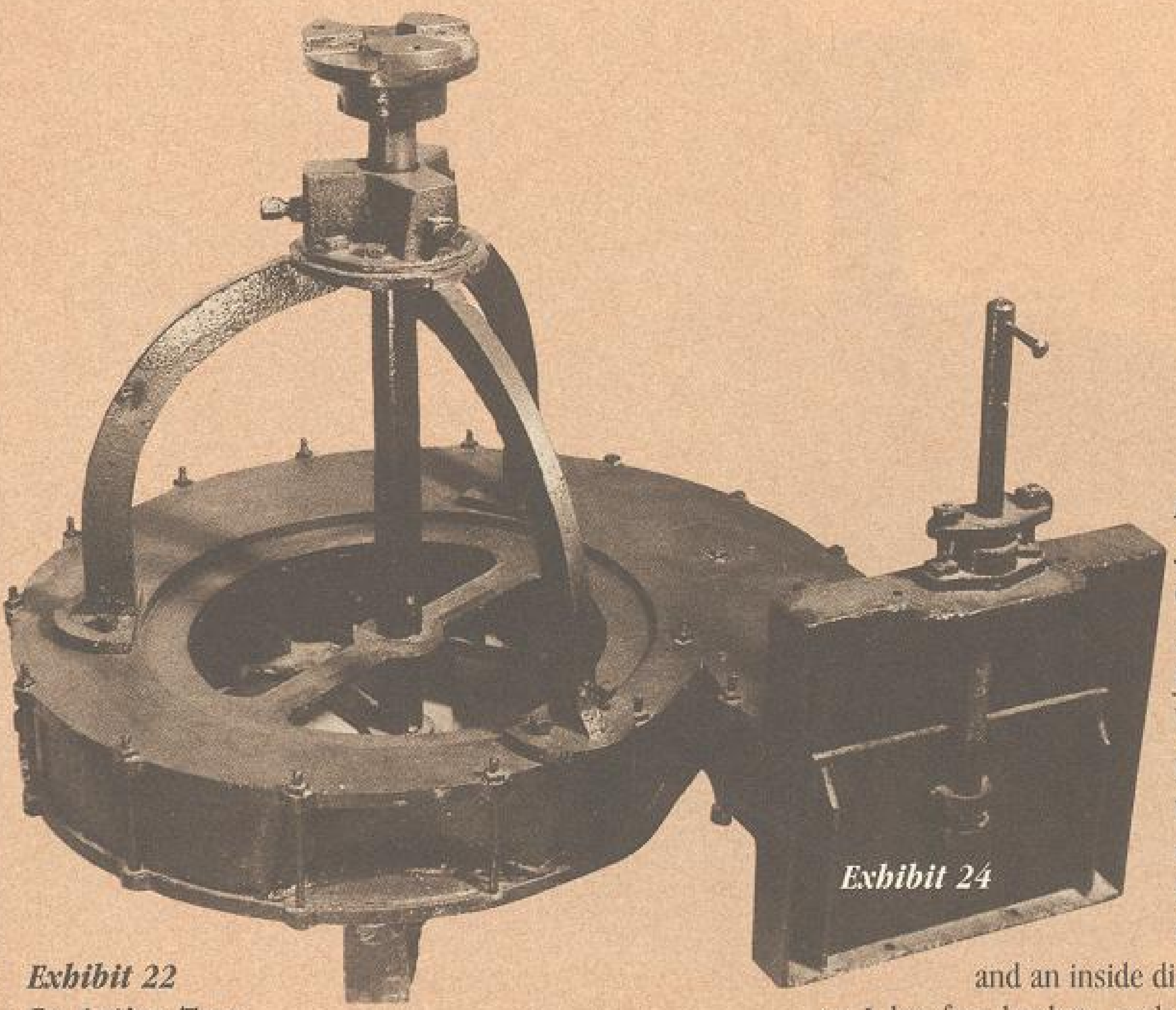


Exhibit 22
Re-Action Type
Runner & Jonval Type Case
This axial flow turbine is a combination of a Re-Action runner and a Jonval case. The case has thirteen guide vanes and the runner has seven buckets, It was probably built around 1858 or 1860. It drove a "Run of Stone" in the flour mill of A. H. Herrick & Son, Watertown, New York.

Exhibit 23
Weaver Spiral Case & Jonval 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 Jonval axial flow wheel without guide vanes. The wheel has eleven buckets. The wheel upgraded the power to operate a stone gristmill 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 from the design and patterns of William H. Phillips of Belleville, New York. The wheel had eighteen 4-3/4-inch high buckets. It drove a pair of mill stones in the gristmill known as Mather's Mill of 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 Racquette 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 "The Proprietors of Locks and Canals on the Merrimack River" at Lowell Massachusetts.

Exhibit 27
Hughes Centrifugal Waterwheel
The Charles W. Leete 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.

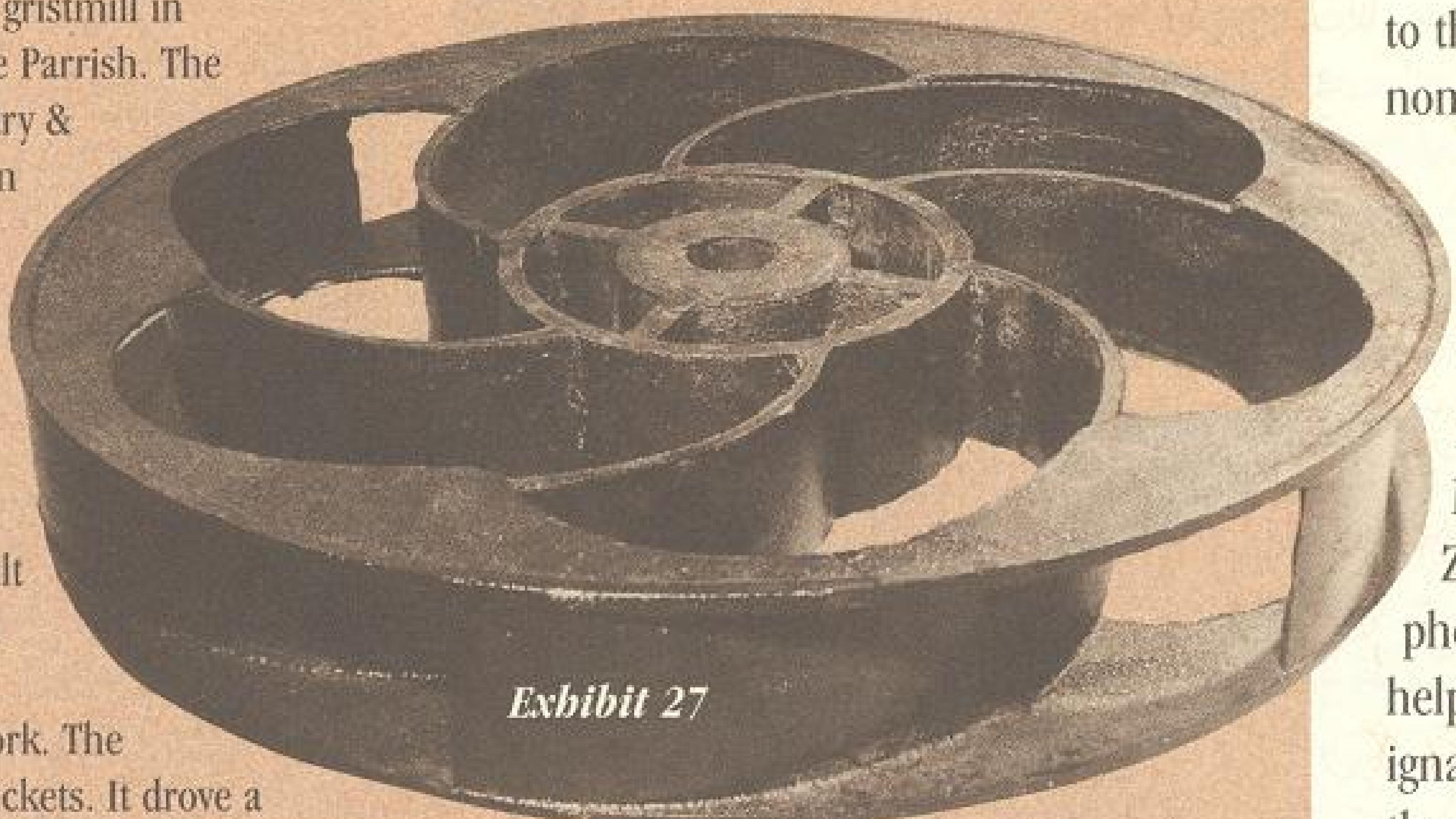


Exhibit 28
18-Inch Center Discharge Wheel in Spiral Case
This turbine was originally used in the broom handle factory of Daniel Cummings in Osceola, New York. It drove an electric generator which powered the factory's lights. The scroll case around the wheel imparts a tangential component to flow into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

No.	Type	Date Mfg	Head ft	Flow cfm	Power hp	Eff. %	Speed rpm	Specif. Speed	Dia. ft
1	Iron Reaction Waterwheel	1840	5	729	3.4	50	82	20	2.6
2	Iron Reaction Waterwheel	1852	9	1200	10.0	49	141	29	2.58
3	Truax Green Mountain Turbine		5.64	1700	9.0	50	266	92	2.31
4	14-1/2-Inch Austin Turbine		12		3.0		420	33	1.21
5	Iron Center Discharge Wheel			1765	12.0		95	21	2.92
6	Burnham Register Gate Turbine		10	1003	15.6	82	160	35	2
7	18-Inch Jonval Wheel in Iron Case	c.1877	30	387	18.0	82	512	31	1.5
8	25-Inch Victor Turbine		20	2518	80.9	85	219	47	2.08
9	27-Inch Register Gate Wheel		10	1942	30.0	82	197	61	2.25
10	19-Inch Jonval Wheel	c.1870	12	250	5.5	97*	322	34	1.58
11	11-1/2-Inch Jonval Wheel				1.6				0.96
12	56-Inch Center Discharge Waterwheel	1852	9	2315	15.8	40	65	17	4.67
13	25-Inch Center Discharge Waterwheel		12	1318	12.0	40	147	23	2.08
14	18-Inch Reynolds Double Discharge Wheel		19	716	18.0	70	291	31	1.5
15	42-Inch Smith's Success Wheel		16	4833	124.5	85	123	43	3.5
16	30-Inch Curtiss Wheel		18	1439	39.1	80	182	31	2.5
17	20-Inch Double Bucket Leffel Wheel		16	632	16.0	84	276	35	1.67
18	35-Inch Double Samson Turbine		16	6440	158.0	81	186	73	2.92
19	25-Inch American Turbine								2.08
20	Whitelaw & Starret Reaction Wheel	c.1844	16	489	11.0	74	106	11	4.5
21	High Head Inward Flow Wheel In A Scroll Case	1907	72		17.0		600	12	1.96
22	Reaction Runner In a Jonval Case	c.1859	9		15.0		95	24	3
23	Jonval Wheel In A Weaver Spiral Case	1844?	19	832	16.5	55	232	23	2.5
24	Francis Inward Flow Wheel In A Scroll Case	1866	18	800	20.0	73	215	26	2
25	44-Inch Austin Wheel		9.5	1570	18.0	64	136	35	3.67
26	32-Inch Truax Green Mountain Turbine		5.64	1	11.9	48	209.3	83	2.89
27	Hughes Centrifugal Water Wheel		8	2012	15.0	49	54	16	5
28	18-Inch Center Discharge Wheel in Spiral Case								1.5
29	12-Inch Register Gate Wheel								1.0
31	Bastion 42-Inch Register Gate Wheel		12	2314	37.0	70	106	29	3.5
32	33-Inch Victor Turbine		20	4390	136.0	82	170	47	2.75
33	36-Inch New American Turbine		16	3369	81.5	80	136	38	3
34	35-Inch Crocker Turbine		20	5736	172.2	79	159	49	2.92
39	36-Inch Diameter Saw-Mill Wheel	1839	8.5	873	7.0	50	80	15	3

** Suspiciously High*

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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 this type wheel were made at Canton, New York and some at Theresa, New York. The exhibited wheel operated at the flour mill of Snell & Makepeace, 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 4390 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 gate 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.

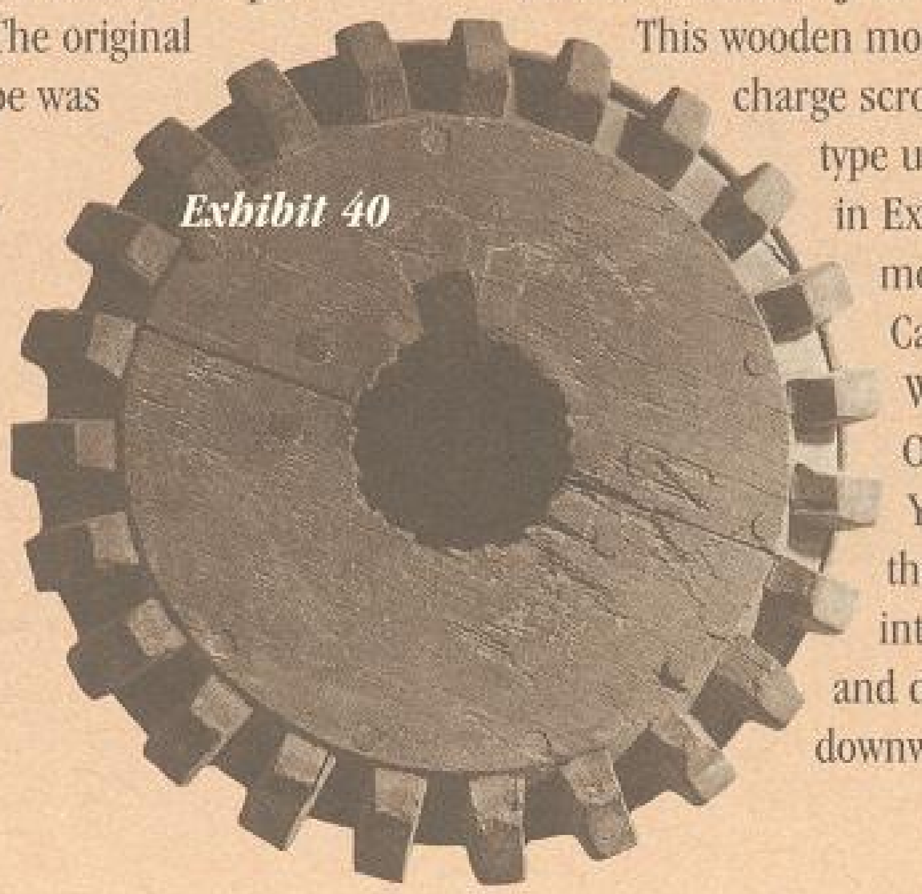
Exhibit 34
35-Inch Crocker Turbine
This wheel has fourteen 15-½-inch high buckets. It is displayed upside down on the museum's south lawn. The "Crocker" design of hydraulic turbine has been built by the following manufacturers: E.D. Jones & Sons Company, Pittsfield, Massachusetts; William Clark & Company, Pittsfield, Massachusetts; Turners Falls Machine Company, Turners Falls, Massachusetts; Jenks Machine Company, Sherbrooke, Quebec

Exhibit 39
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 Solon Cook 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 a 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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