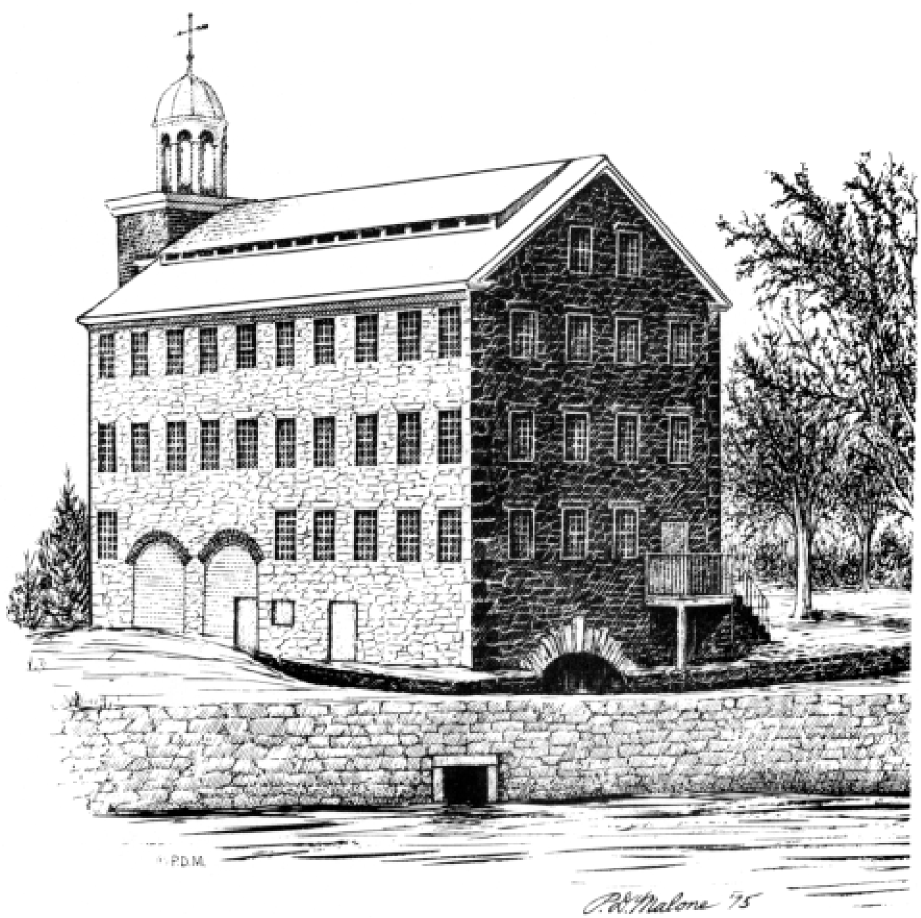
A National Historic Mechanical Engineering Landmark

The Wilkinson Mill

1811

Pawtucket, Rhode Island



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THE WILKINSON MILL

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Slater Mill Historic Site

The Wilkinson Mill, situated on the west bank of the Blackstone River in Pawtucket, RI, was built between 1810 and 1811 by the Pawtucket machinist Oziel Wilkinson. Constructed in stone rubble, three and one-half stories high, the Wilkinson Mill is one of the most important landmarks in the history of American mechanical engineering. The mill played a critical role in the history of textile technology, in steam power generation, and in the development of the machine tool industry.

The primary importance of the Wilkinson Mill derives from its association with the Wilkinson family. Oziel Wilkinson, a skilled and successful blacksmith, migrated with his family from Smithfield to Pawtucket in the 1780's. As early as 1777, Wilkinson produced hand-cut nails which were headed in a small pinch press. These were among the first hand-cut nails produced in America. In 1784-5, Wilkinson opened an anchor shop in Pawtucket. The water-powered shop was located on a power canal known as Sargeant's Trench in the area of the present Hodgson-Rotary Park, on the grounds of the Slater Mill Historic Site. Here the family forged anchors for the Providence and Pawtucket shipbuilding trade. The Wilkinsons also moulded and then cut large iron screws using a wooden pattern screw to guide the cutting tool. The screws were used in the manufacture of paper, in clothiers' presses, and in oil mills.

The emergent textile industry needed machinery and was dependent on the skills of talented mechanics like the Wilkinsons. Oziel made the iron work for a cotton carding machine that was eventually set up in Providence, and his son, David, forged and ground the spindles for a spinning jenny used in East Greenwich. The younger Wilkinson described the grinding machine he built, "which had a roller of wood to roll on the stone, which turned the spindle against the stone, and so ground the steel spindles perfectly." Robert Woodbury, noted historian of machine tools, has recently pointed out that this machine may have been the first center-less grinder.

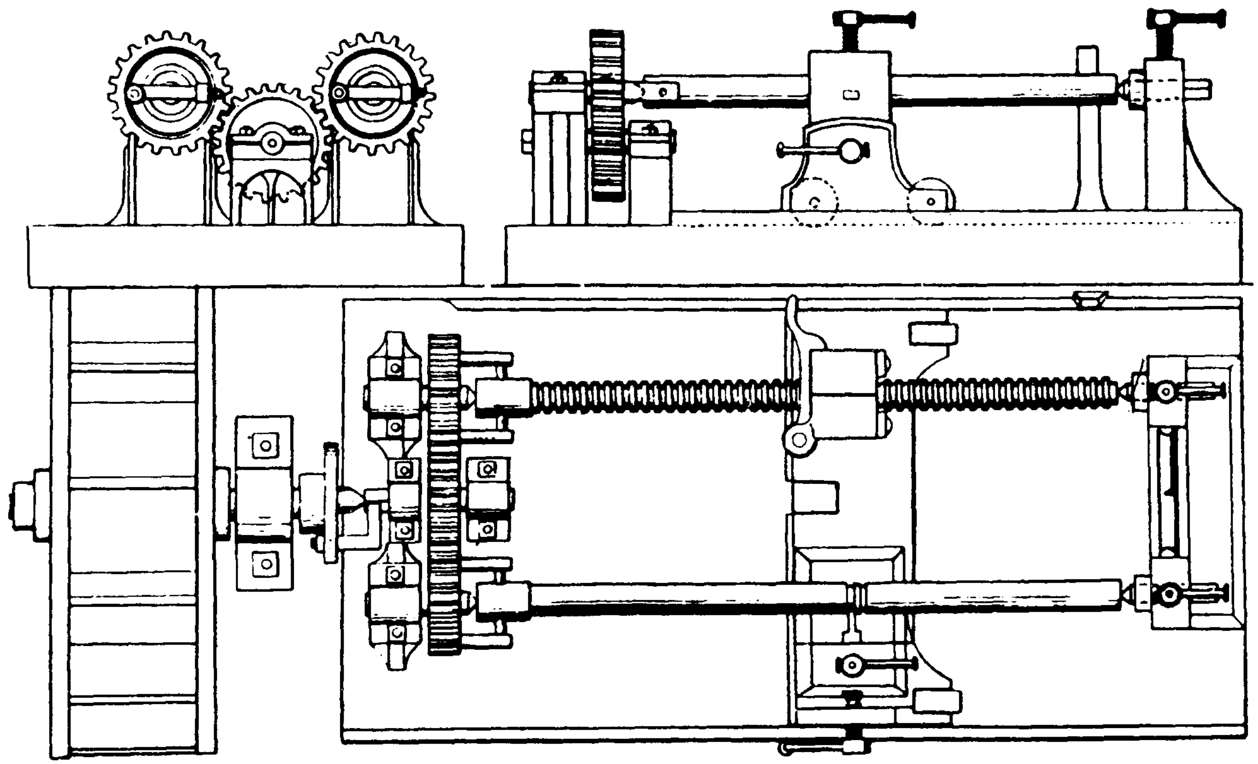
When Samuel Slater arrived in Pawtucket in 1790 to build the first successful water-powered textile machinery in North America, it was natural that he should turn to the Wilkinsons. David made the iron forgings and castings for Slater's first carding and spinning machines. All the turning of rollers and spindles was done with hand tools on a lathe cranked by hand power. After a period of trial and error, the machinery was successfully operated in a clothier's shop near the Pawtucket Falls in December, 1790. Slater's success led to the building of the Old Slater Mill in 1793, the rapid growth of the American textile industry, and the introduction to America of mass production technology and the factory system. Slater's relationship to the Wilkinsons remained close throughout his life. He not only formed a business partnership with family members, but married Oziel's daughter, Hannah.

Though Samuel Slater has received much more attention from historians, the little-known Wilkinsons played an equal role in making Pawtucket the most important industrial village in America in the years from 1780 to 1820. Their work with iron was widely respected and often highly innovative. In 1791, Oziel built a reverberatory air furnace, with which he cast iron gudgeons for Slater's factory. David later claimed that these wing-gudgeons for the shaft of a water wheel were the first made in this country. A few years later, the Wilkinsons helped Loammi Baldwin on his ambitious Middlesex Canal project. Their wheels, racks, and other metal parts made the operation of the locks possible. Cargo moving up the Charles River, after leaving the canal, passed under a drawbridge with operating machinery by the same Pawtucket family.

David Wilkinson applied his talents to steam engineering with striking success. Using parts cast in Pawtucket from his own patterns and finished in his father's shop, he produced one of the first steam engines for propelling a vessel. Elijah Ormsbee helped him to install the engine in a boat equipped with goose-foot paddles. The successful testing of this vessel on the Providence River in 1793 was fourteen years before Robert Fulton's famous demonstration of the Clermont. In fact, Daniel French, one of Fulton's engineers, had come to Rhode Island to examine Wilkinson's early steamboat. As an old man, Wilkinson remarked that he "never thought Fulton an inventor, but simply a busy collector of other people's inventions."

The most difficult task in constructing a steam engine in the 1790's was boring the iron cylinder. Although we don't know the exact process that David Wilkinson used to make his first cylinder, there is good evidence that he soon became very adept at boring metal with power machinery. In the early nineteenth century, he manufactured cannons which were cast solid and then "bored out with water power." This technique, unusual in early America, involved the use of a stationary drill and a water-powered mechanism for rotating the work piece. The steam engine which David built for the Wilkinson Mill in 1810 may have had a cylinder made by his cannon-boring method.

In 1794-95, Oziel Wilkinson constructed a water-powered rolling and slitting mill just south of the Slater Mill on the same "Great Flume" which ran beneath the textile factory. The small mill produced primarily rolled plate and nail rods, but by 1796, it housed a large screw-cutting lathe designed by David Wilkinson and mounted on the gudgeon of his father's water wheel. This specialized machine tool, which the young inventor patented in 1798, could only cut screws with the same thread pitch as the lead screw. Both the workpiece and the lead screw were mounted on dead centers and driven by dogs, with apparently no provision for change gears. The most important element of Wilkinson's design was the heavy carriage supported on three rollers. In 1846, he wrote that his "screw machine. . . was on the principle of the gauge or sliding lathe now in every workshop almost throughout the world; the perfection of which consists in that most faithful agent gravity, making the joint, and that almighty perfect number three, which is harmony itself. I was young when I learnt that principle. I had never seen my grandmother putting a chip under a three legged milking stool; but she always had to put a chip under a four legged table, to keep it steady."



David Wilkinson's Screw-Cutting Lathe, 1798
(from American Machinist)

While working on Slater's textile machinery, David Wilkinson asked to make a general purpose lathe with the same slide principle as his screw-cutting machine. Slater refused him permission and turned instead to an Englishman who produced an unsatisfactory lathe for turning the rollers of textile machines. Wilkinson then developed his own lathe for general industrial use, a lighter and more versatile machine tool than his very heavy capacity screw machine. He completed the new lathe by 1806 but did not patent it. This was the first lathe with both a screw-driven carriage and the ability to do heavy industrial work; it pre-dated the famous industrial lathes of the great English machinist, Henry Maudslay. Wilkinson's improvements in this lathe included the abandonment of the rollers on the slide rest. He still relied on weight and the principle of the three-point bearing to steady his slide rest but must have added change gears in order to vary the pitch of screw threads while using the same lead screw.

Wilkinson's industrial lathe was a major advance in the history of machine tools and in the development of American industry. The principle of this lathe was widely copied when Wilkinson failed to patent the new machine or to renew his original 1798 patent. He made almost no profit from his development of the industrial lathe until long after its widespread use in shops, factories, and federal arsenals. Finally, in 1846, a Senate committee commended him for the invention of "the guage (sic) or sliding lathe," which they found "a most powerful and striking illustration of the force of American genius." On the strong recommendation of the committee, the U.S. Congress voted to reward him for the great value of his invention to government industries. In 1848, he received $10,000, a long overdue remuneration.

The nail-making industry was more immediately profitable to the Wilkinson family than David's lathe improvements. In the rolling and slitting mill, the Wilkinsons rolled iron plate which was made into nails with hand shears and hammers. Iron rods were cut into various lengths and hand-forged to form both spikes and nails. Oziel's son, Daniel, was in charge of the mill until after the elder Wilkinson's death in 1815. Two years later, he and David set up two newly purchased nail-making machines and began production on a large scale. They soon erected six or eight more machines and turned out about four thousand pounds of nails a day.

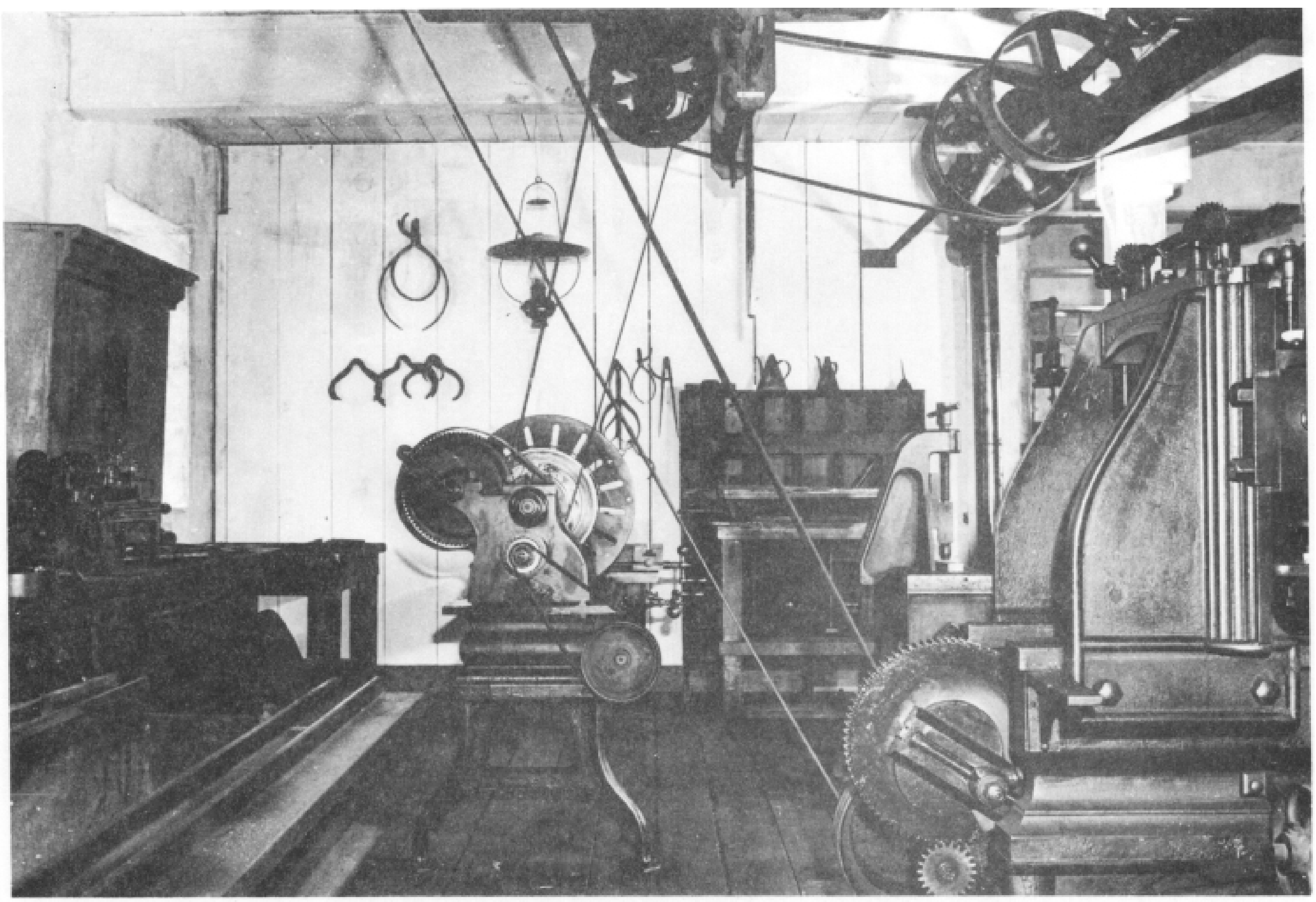
The Wilkinson Mill was built beside the Great Flume, just across from the rolling and slitting mill. This stone factory, originally designed for cotton spinning, was partially powered by a steam engine constructed by David Wilkinson. His nephew, Edward, who worked in the mill, wrote about the steam power but gave no details of the engine. It was probably used as an assist to the breast wheel, which was located in the basement and driven with water from the Blackstone River. David, who was largely responsible for the operation of the mill, had a machine shop on the first floor for the manufacture and repair of textile machinery.

David Wilkinson achieved a reputation as a master builder of textile machinery. About 1817, he built the first successful power loom in Rhode Island from patterns supplied by the inventor, William Gilmour. This was the loom which eventually dominated power weaving in New England for much of the nineteenth century. The Wilkinsons built machinery, not only for New England, but for "almost every part of the country." They sent machinery as far south as Georgia, as far west as Pittsburgh. They also helped to train a substantial number of the region's first generation of textile machinists. Ira Gay, Larned Pitcher, James Brown, John Thorp, and Asa Arnold all worked in Pawtucket in the early nineteenth century. They were collectively responsible for major innovations in textile technology, i.e., Arnold's differential gearing for roving frames, Thorp's system of ring spinning, Brown's work on the self-actor mule - a machine for fine spinning. Most of these nationally prominent machinists got their start with David Wilkinson.

In August, 1819, the Wilkinson Mill achieved further historic note. It was the site of one of the first worsted manufactories in the U.S. English immigrant, William Wilson Wood, working for David Wilkinson, set up the machinery, a spinning frame of seventy-two spindles, and employed seven workers in its operation. Wood produced, according to the census taker of 1820, "neftings of a very superior texture; and many other kinds of worsted and silk cloths."

Adequate power for manufacturing was apparently difficult to maintain in the Wilkinson Mill, even with a steam engine to back up the water wheel. The wheel was a "breast" type, with a wooden breast, or apron, that fit close to the buckets and prevented the water from spilling out until the lowest point of rotation. It was less than nine feet long and twelve feet in diameter, with a gate that delivered water just above the mid-point of the wheel. The relatively small size of the breast wheel and the low "head," or elevation of water, meant limited power even in the best seasons. Another problem was an inefficient tailrace that forced water to make an immediate turn of over one hundred degrees after exiting the wheel. This helped to promote "backwater" conditions in which the water level rose in the wheelpit until the rotation of the wheel was impeded. Sometime after 1825, the water power system was improved when the original wheel was replaced by one of larger size and a second tailrace was added to the mill.

The exact date of installation of the second wheel is unclear, but court records show that it was between 1826 and 1835. Archaeological evidence proves that the new breast wheel was thirteen feet long with the same diameter of twelve feet. The new tailrace had a smooth, curved wall and a plain wood floor to speed the exit of discharged water from the wheel pit. Although this second wheel was almost half again as powerful as the first, it produced less than ten horsepower and required considerable gearing to deliver acceptable shaft speeds to the floors above. Cast iron shafting with a square, or "diamond," cross section was the main element of the power transmission system, and pieces broken at an earlier date were installed as lintels above the exit of the second tailrace. Within a few years, even the larger water wheel apparently proved inadequate for the mill and was removed. Power was then delivered by a long shaft from a water wheel in the old slitting mill.



Machine Shop in the Wilkinson Mill

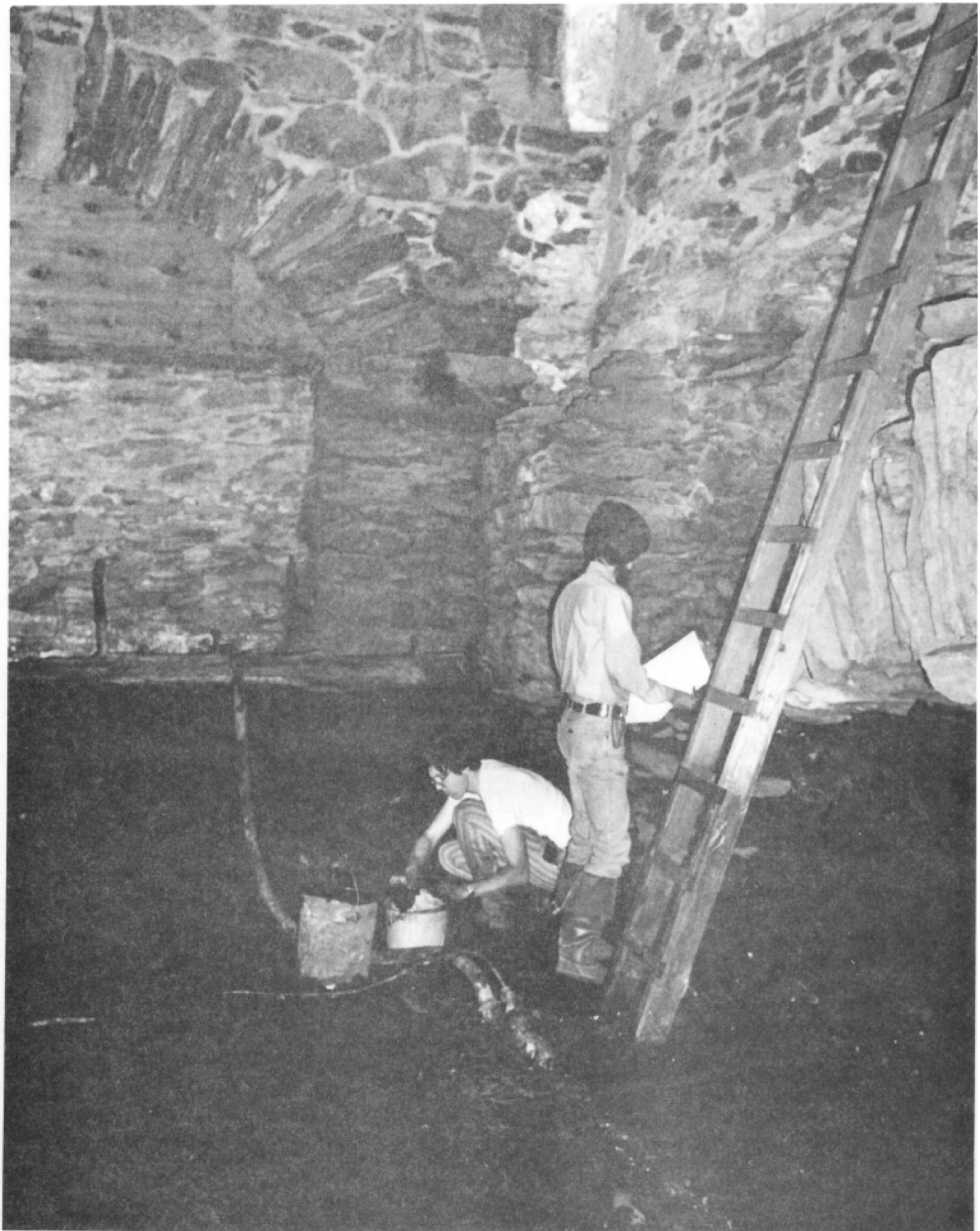
The mill was probably under new management when the second wheel was removed. In 1829, in the midst of a serious textile depression, David Wilkinson lost his business and eventually left Pawtucket. The Wilkinson Mill was sold on 1 Jan. 1831 to Wm. Field and Thomas LeFavour. The final inventory underlines the mill's importance in the history of textile technology. One entry mentioned the existence of two "circular" spinning frames of one hundred twenty-eight spindles each. These frames were likely early examples of John Thorp's system of ring spinning, the most important innovation in spinning technology in the nineteenth century.

The Wilkinson Mill was never to be as close to the center of textile innovation again. From 1831 to 1861, the mill remained in the LeFavour family. Sometime in the 1860's, it was used as a woolen mill, and in the same period, knitting machines were introduced. From 1873 to 1887, the machine shop was operated by a tenant, Lorenzo P. Bosworth, who was engaged in the manufacture of leather machinery and jeweler's tools. In 1884, cotton braid was manufactured on the second and third floor. The braiding company continued to operate in the mill until 1901, after the building had been sold to the Pawtucket Electric Lighting Company. In the twentieth century, the mill was used for a time as a hydroelectric generating plant (the turbines were placed in an addition to the west side of the mill built in 1970 and since dismantled), and most recently as a furniture warehouse. The Pawtucket Redevelopment Authority acquired the mill in the mid-1960's and subsequently sold it to the Old Slater Mill Association for restoration and adaptive reuse.

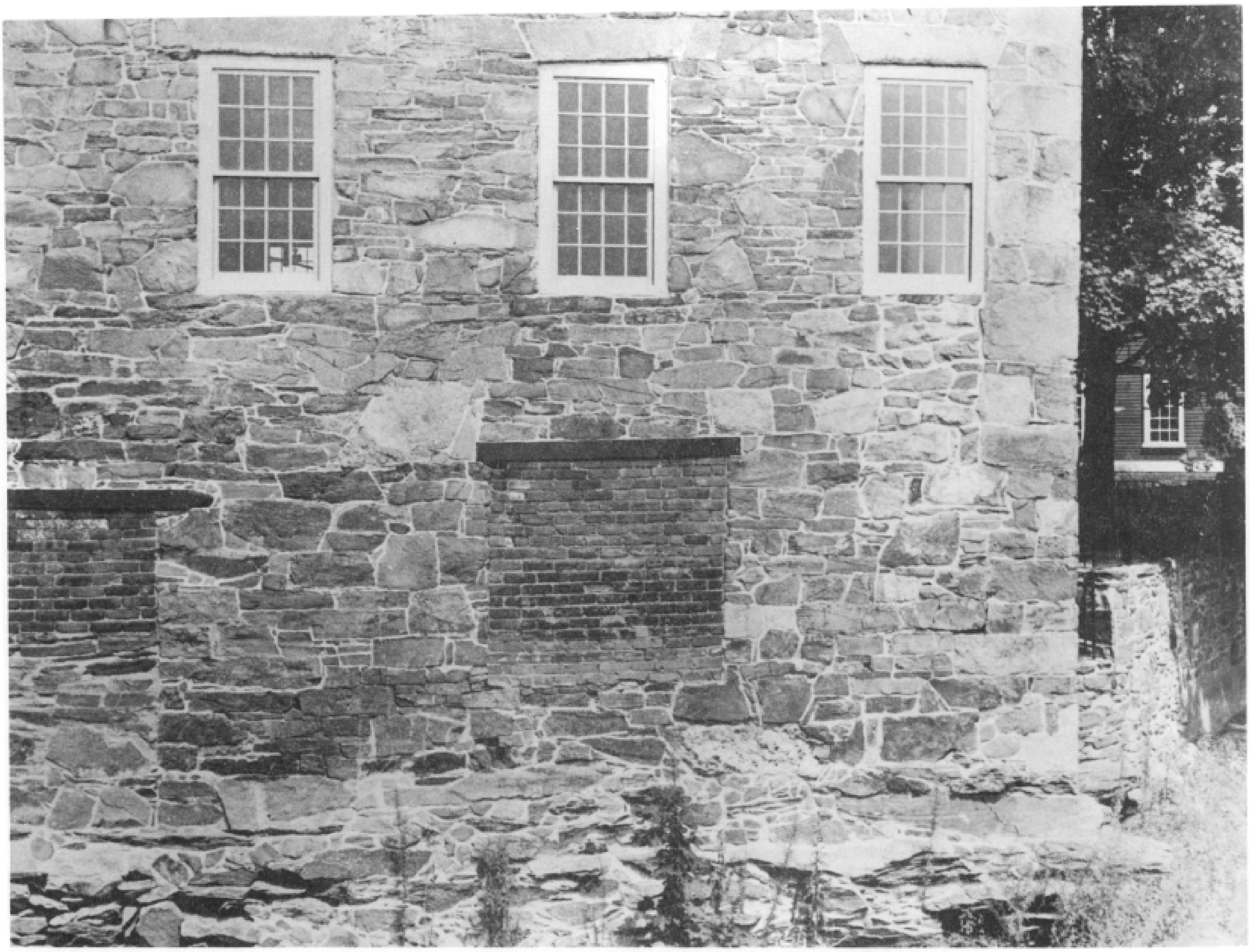
In the early 1970's, the Old Slater Mill Association undertook the restoration of the Wilkinson Mill. All exterior alterations were made in keeping with documentary and photographic evidence of the mill's nineteenth-century appearance. New windows, a new belfry, and a recreated trap-door monitor in the gable roof were all added. The west wall was rebuilt in rubble stone, scrupulously designed to match the original stone work. The restoration of the Wilkinson was so successful that, in 1975, the New England Regional Council of the American Institute of Architects presented the Museum its prestigious honor award.

Today the Wilkinson Mill houses the offices of the Slater Mill Historic Site, a museum devoted to American industrial and social history, which includes the Old Slater Mill built in 1793 and the Sylvanus Brown House (1758), the home of a skilled artisan. The Wilkinson Mill also contains an operating machine shop on the first floor. The shop includes a nationally important collection of nineteenth-century machine tools, measuring devices, and wood-working equipment. Saws, planers, lathes, millers, and other machines are operated by leather belts connected to overhead shafting. The shop is a tribute to the inventive genius of the Wilkinson family and is located in the same space used by David Wilkinson, "the founder of the American machine tool industry."

In the early 1970's, an archaeological investigation revealed the existence of the old breast wheel pit in the basement of the Wilkinson Mill. The wooden "breast" of the second wheel was in place, and floor boards had been remarkably preserved by the wet silt that covered them. In addition to the vertical cast iron shafting used as lintels over the



Excavation in the Wheel Pit



Cast Iron Shafting Used as Lintels

tailrace opening and over several windows, a long section of horizontal shafting was found with one end turned round for a journal bearing. Timbers used in the framing of the wheel and gearing supports were in the pit. One timber even had a mortice which fit a cast iron bearing block perfectly. A wide variety of cultural and industrial artifacts, including parts of early textile machines, were discovered in the wheel pit, beneath the stone arch of the original tailrace, and in the exterior raceways leading to and from the mill. When the wooden breast was dismantled for analysis, the archaeologist found a fifty cent piece inside, with the clear date of 1826. The careful archaeological investigation and a long program of historical research led to a plan for the restoration of the entire water power system.

Soon the machine shop of the Wilkinson Mill will once again operate with power supplied by the Blackstone River. A wheel of the same size as the second breast wheel is being designed. Power will be taken off a perimeter gear which will be cast in segments and bolted on the rim of the water wheel. A unique fly-ball governor will sense the rotation of the wheel and raise or lower a sluice gate to keep the wheel at an optimal speed. A vertical shaft rising through the floor to the machine shop above will transmit mechanical power to the existing belting, shafting, and machinery. The completion of the water power project will mark the final step in the restoration of the Wilkinson Mill and will preserve for generations to come the heritage of one of the nation's finest mechanical engineers – David Wilkinson, a man responsible for critical advances in textile technology, machine tools, and steam engineering.

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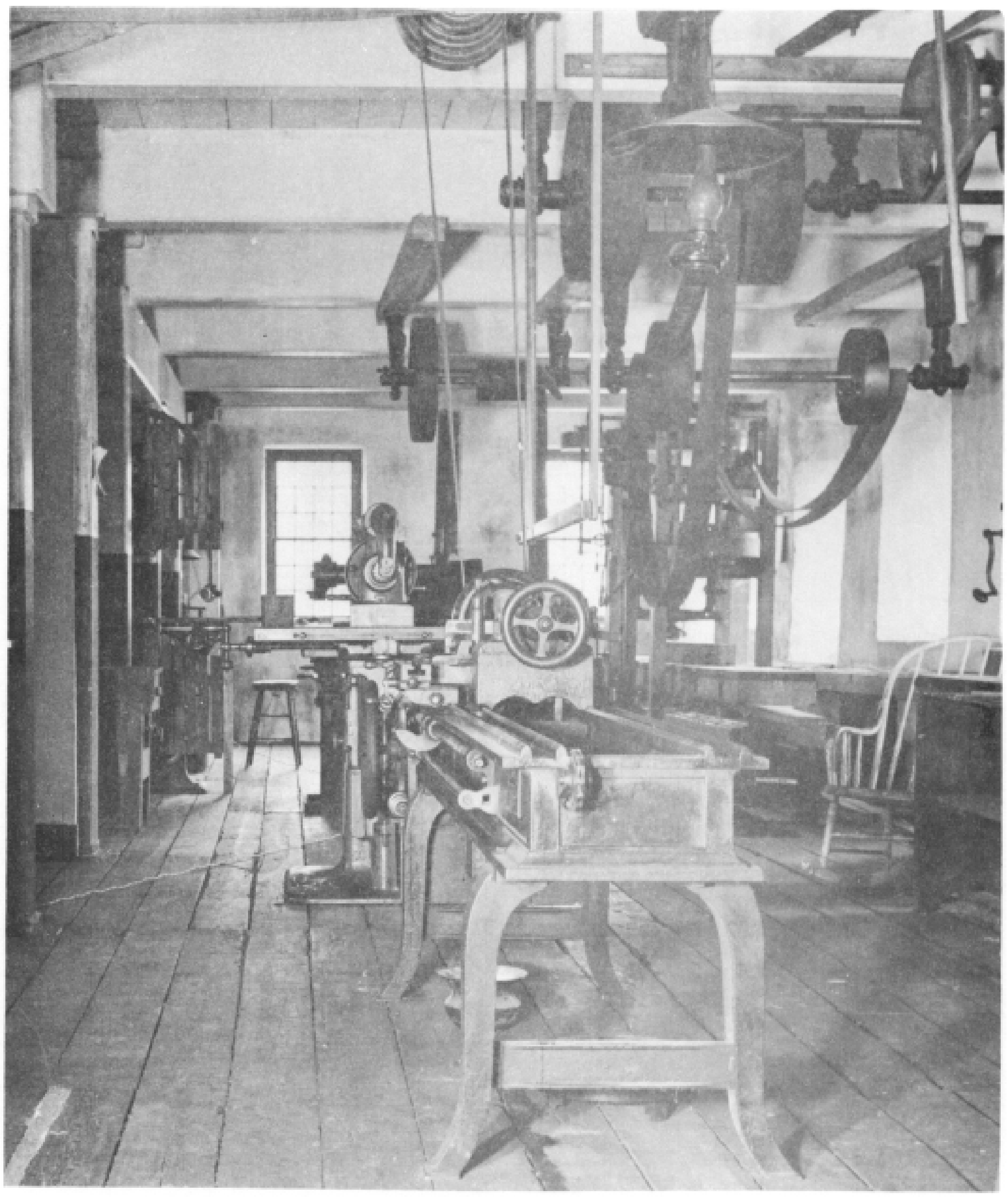
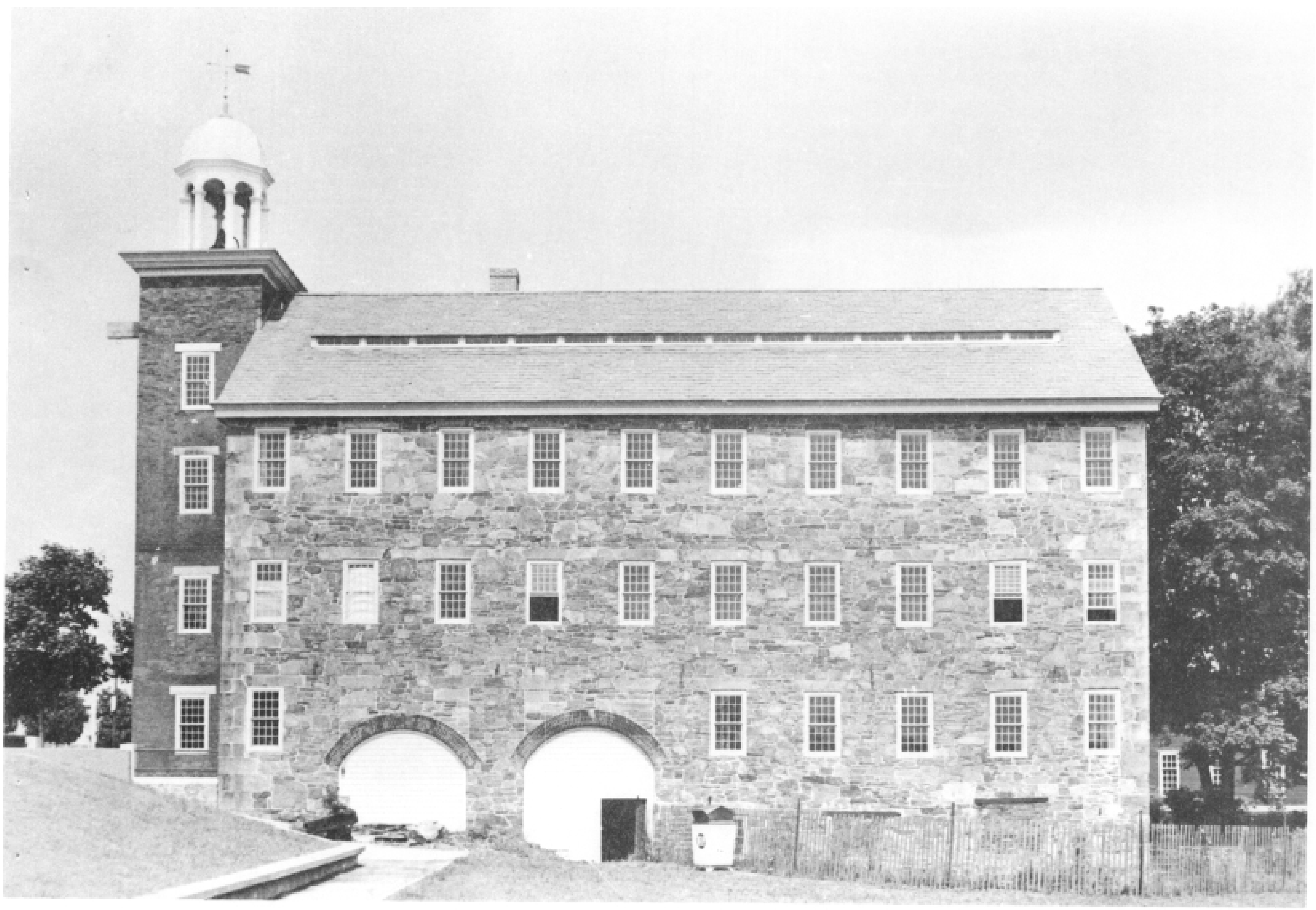
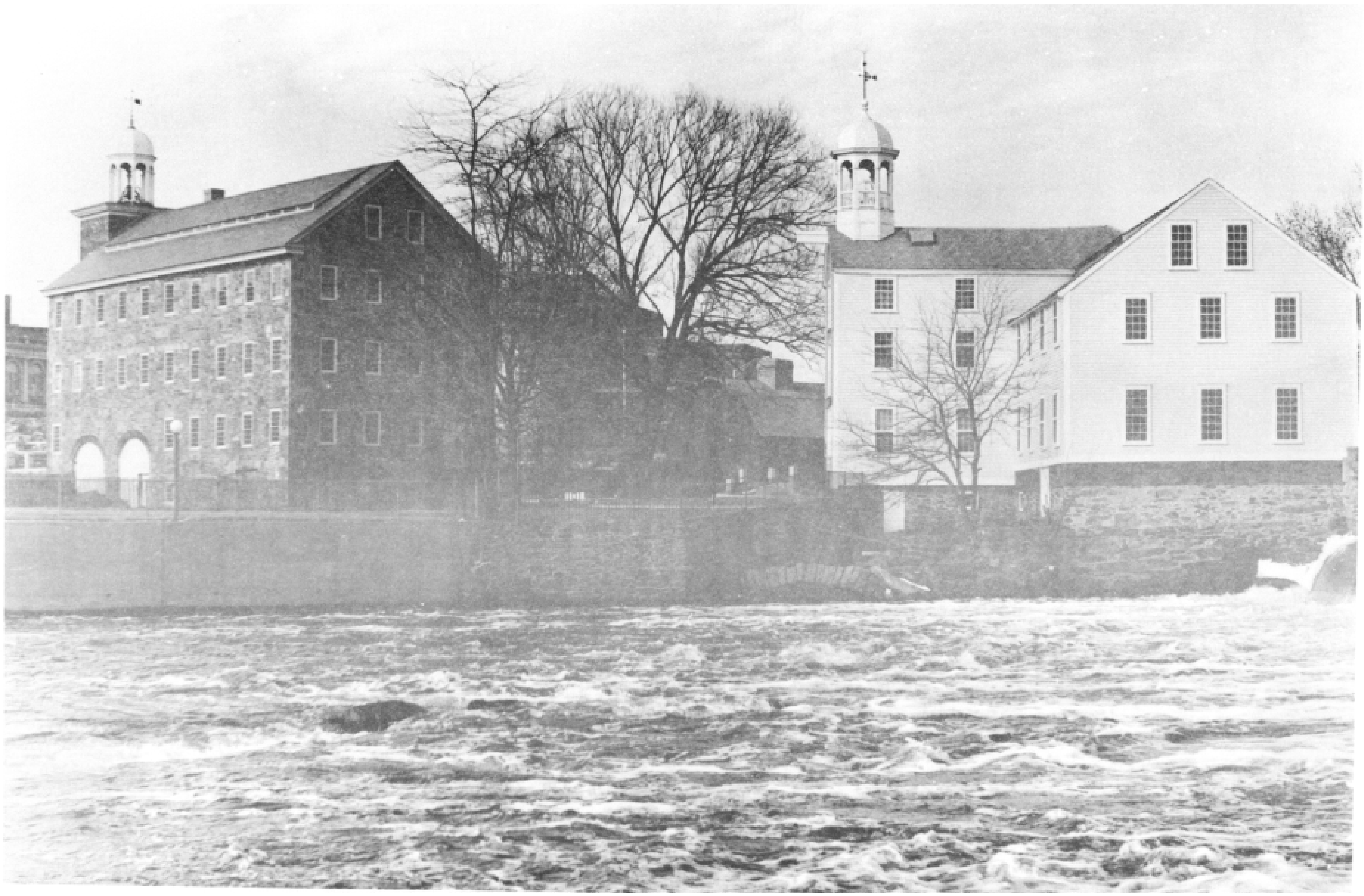


Machine Shop in the Wilkinson Mill



Wilkinson Mill - 1810



Wilkinson Mill
1810

Slater Mill Historic Site

Sylvanus Brown House
1758

Slater Mill
1793