Operations Manual for the McCormick Grist Mill

I. History of the McCormick Mill

Robert McCormick moved from Cumberland County, Pennsylvania in 1779 with his wife, Martha and their five children. He bought a log house and 182 ha (450 ac) on the Rockbridge and Augusta County line. He called his farm Walnut Grove. The farm and the McCormick name became famous when on a July day in 1831 Robert's then 22-year-old son, Cyrus demonstrated the world's first successful mechanical reaper. This important invention mechanized agriculture and made it possible for millions of people to leave the land and change the face of society worldwide.

Although Walnut Grove is best known as the location of the invention of the first successful mechanical reaper, it supported other enterprises besides production agriculture. Most notably was the operation of a gristmill on the farm.

The gristmill was built at Walnut Grove around 1800. The mill was operated until the late 1800's when it was phased out of operation. The McCormick family undertook a renovation of the mill in the 1930's. Local craftsmen were employed to restore the mill to its original condition. The mill was operated briefly and then allowed to become a static example of an early gristmill.

The McCormick family deeded their farm to Virginia Tech in 1954, and is now part of the Shenandoah Valley Agricultural Research and Extension Center. The mill underwent periodic repairs over the years to include replacing the wooden waterwheel axle with a metal axle in 1950's, replacing the shingle roof in 1993 and rebuilding the waterwheel in 1985. The waterwheel rebuilding was partially funded by a grant from the Society for the Preservation of Old Mills. Extensive rehabilitation and stabilization of the mill, dam and race were completed Spring 1997. A McCormick descendent, Mr. Hugh Trumbull Adams funded these improvements. As a result of this restoration, the mill is once again operational as it was in the 1800s.

II. Introduction to Water Powered Mills

Civilization owes a debt to milling because it is (agriculture excepted), the oldest industry in the history of man. Out of it has grown all other lines of manufacturing. The grinding of grain was the first incentive early man had to devise some sort of grinding apparatus powered other than by hand.

The word "mill" is used in connection with a place or apparatus where grain was ground. The miller is who attended the mill and performed the duty of grinding. The word mill now can be applied to a number of types of manufacturing buildings other than where grain is ground. However, the term miller has never been used by other callings. In early times, the miller was in most cases owner and operator, or in other words, both master and miller. Therefore, at times he was called the “master miller.”

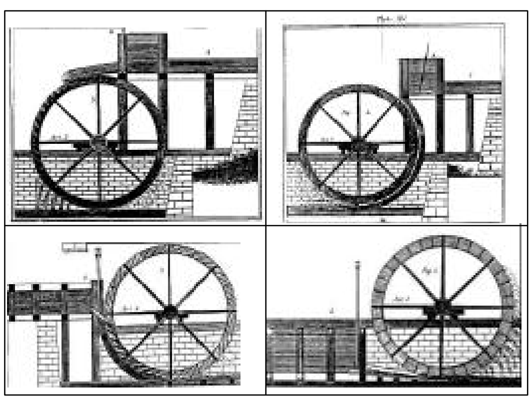
Water powered mills utilizing a horizontal waterwheel date back to Greek and Roman times. The horizontal mill was easy to construct and operate, and was efficient enough for small communities. Made almost entirely of wood, it consisted of a hub into which were mortised a number of blades or vanes. The shaft on which the hub was fastened passed up through a hole in the bottom stone and was attached to the runner stone. When water was directed from the millstream through a chute or inclined trough against the vanes or blades, it turned the waterwheel that made the upper stone revolve. Early settlers in America used horizontal mills, sometimes called “tub mills”.

The Romans utilized vertical mill wheels very early on. This type of mill involved a vertical water wheel attached to a horizontal drive shaft. Pinion gears were used to transfer power to the upper millstones, changing the direction of the drive 90°. This type of mill design is still utilized by most water-powered mills.

Early settlers to North America found an abundant supply of timber, grist, and streams with amble fall, to power mills. These factors combined with the daily necessity for bread resulted in the construction of untold numbers of small mills in the seventeenth and eighteenth century. Each community or outpost had a mill or mills.

The Shenandoah Valley was no exception. Early immigrants to the region found an abundance of water. The topography offered countless sites for sufficient waterfall to operate mills year around. This was the case with Marl Creek. The McCormick Mill is built near the headwaters of Marl Creek. By the time Marl Creek reached South River, a few short miles away, it once powered an additional four mills.

Water wheels are of four main types shown below: (1) overshot, upper left, (2) pitchback, upper right, (3) breastshot lower left, or (4) undershot, lower right. The names indicate the point on the wheel at which the water is fed.

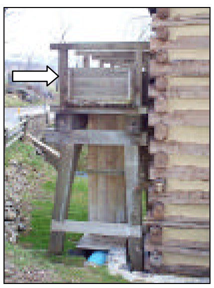


Adapted from:
Evans, Oliver. 1860.
The Young Mill-Wright and
Miller’s Guide.

Throughout the early period of the country, these vertical wheels were made almost entirely of wood. The shafts were generally of oak. In the ends of the shafts, iron gudgeons were inserted. The ends of the gudgeons ran on bearings often of wood, brass or bronze.

The arms and buckets were most often constructed of oak. Other types of timber such as certain types of pines were sometimes used. Due to exposure to water, ice, snow and sun, repairs of wooden water wheels were frequently necessary. Within five to ten years it would be necessary to repair or replace a wooden water wheel.

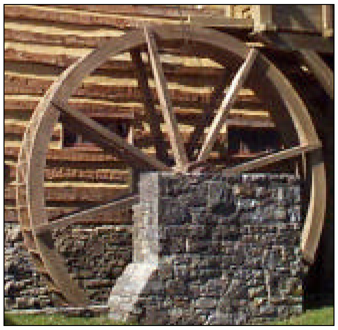
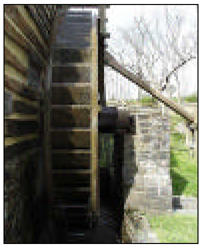
Most mill sites required the impounding or damming of a stream in order to obtain the necessary head of water. Where there was not sufficient flow to operate a mill, a millpond would have been constructed. Water was stored in the pond overnight and then drawn down during the day to operate the mill. However, most Shenandoah Valley mill sites utilized a dam to direct the water from the stream to a millrace that would convey the water to the mill. The millrace was sometimes a considerable length. The McCormick Mill utilizes a millpond. However, very likely the first dam construction would have allowed for the diversion of water from the stream without any significant impoundment behind it. The raceway of the McCormick Mill covers approximately 160 m (525 ft) from the dam to the mill.



From the millrace the water is delivered to the mill through a flume or forebay (see arrow at left). From the wheel the water leaves by way of the tailrace. For maximum efficiency, the tail water must leave the mill site as swiftly as possible.

III. Mill Structure

The McCormick Mill is a two and one-half story log structure. The mill house was restored originally in the 1930's and extensive repairs were carried out in the winter and spring of 1997.

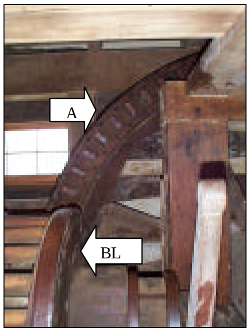



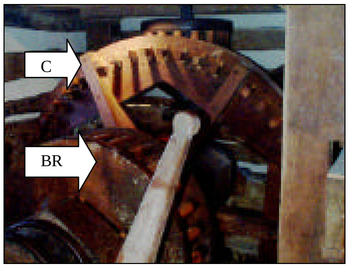
The mill is powered by a 5.2 m wide (17 ft.) overshot water wheel. During the 1997 reconstruction the forebay was also completely replaced. The forebay provides storage and additional head of water. Water is released over the wheel through a gate mechanism that is controlled from the inside of the mill. Opening a second gate which releases water over the overflow chute can drain the forebay allowing maintenance of the wheel and tail race.

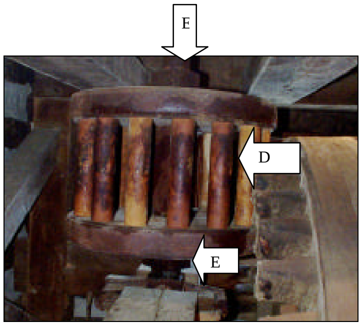
Water flowing from the wheel and any overflow from the forebay, return to Marl Creek by way of the tailrace (left and right below). It is important to note that water wheels should never turn in their tail water. High tail water results in greater drag on the moving wheel and also allows the wheel to take up water when it is static, thus making it out of balance. Tail water should leave the mill site as quickly as possible. Currently, the McCormick wheel operates well above the tail water. However, over a period of time sedimentation and debris can cause tail water to rise, therefore requiring periodic cleanouts of the tailrace.


Inside the mill and on the first level is found the grinding mechanism. The McCormick Mill has two sets of millstones that are mounted on the Hurst frame. The Hurst frame is built independent of the mill house. It is designed to isolate and absorb the movement of the millstones in order that the motion of the millstones is not transferred to the walls of the mill house. The Hurst frame is made up of a main mill beam (see arrow, below left) and supporting posts.

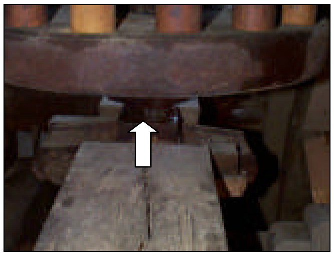
The gearing mechanism for the stones is mounted in the Hurst frame and consists of a bull gear or pitwheel, a wallower, a horizontal face gear and a vertical pinton gear (three photos below). The McCormick Mill utilizes a two step gearing known as “counter gearing.” The bull gear (A below) engages the left and right wallowers (BL and BR below). The wallower shaft turns a left and right face gear (right gear shown by C below) that engages a lantern pinion (D below) that turns the millstone spindle (E below). Face gears engaging lantern pintions are used to transfer the direction of the drive from horizontal to vertical and to increase the speed of the millstone spindle relative to the water wheel shaft.

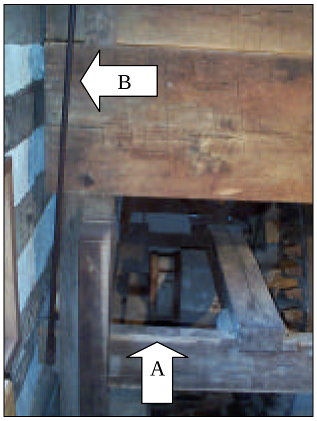






The bed stones are mounted above, in the floor of the second level of the mill. The mill stone spindle (arrow at right) is mounted in the vertical lantern pinion and extends through the eye of the bed stone and supports the runner stone. The spindle rests on a beam known as the bridge tree.

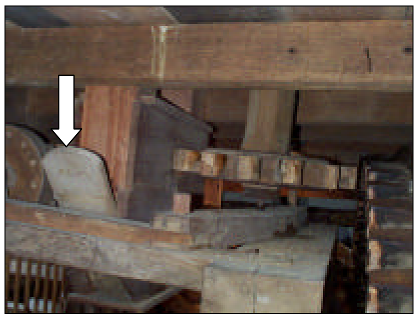




The bridge tree (A at left) can be raised or lowered by means of a threaded shaft connected on one end (B at left to the bridge tree and the other end to a screw mechanism on the second floor. By turning the screw the bridge tree is raised or lowered, therefore adjusting the distance between the bed stone and the runner stone, allowing the miller to adjust the consistency of the grind.

Also found on the first level of the mill is the boot (arrow at left) or bottom of the elevator leg. The elevator consists of a flat continuous belt with metal cups attached to it, allowing it to carry flour from the flour stone up to the third floor to the bolting reel.

The boot is equipped with a small cleanout door. This slides in and out allowing access to the bottom of the boot.



Flour from the wheat stone is transported to the elevator leg by way of a wooden screw auger. This wooden auger consists of a series of wooden paddles arranged in a spiral around a wooden shaft. The auger is enclosed and can be accessed for cleaning by lifting off its top cover.

A vertical shaft that runs off the bull gear powers the bolting reel, elevator and auger. This is engaged (pulling out) and disengaged (pushing in) by a lever (shown at left) extending out of the mill beam.

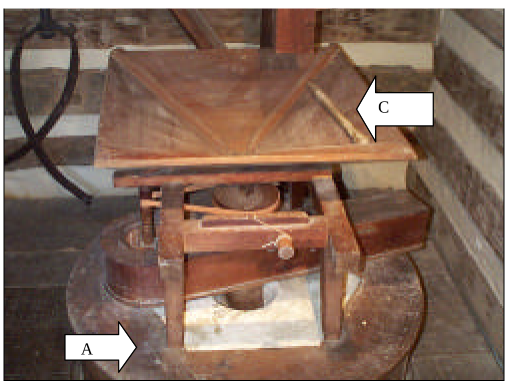
The remaining items of note on the first level are the bran chest (below left) and the cornmeal bin (below right). Bran from the bolting reel falls through a chute to the bran chest for storage.

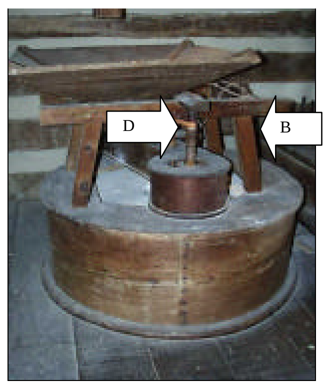
On the second level of the mill are located the millstones. The stones consists of a bedstone which is stationary and embedded in the floor, and a runner stone which is mounted on the millstone spindle (above the bottom stone) and turns.

The runner stone turns by means of a driver. The runner stone is attached to the spindle by means of a rynd (top on next page on left). The rynd is a thick curved iron bar that crosses the eye of the stone and fits into slots sunk into the stone. In the center of the rynd is a socket that is the supporting bearing for the runner stone. The pivot point (top of next page on right) of the millstone spindle fits into the socket.

The runner turns by means of a driver (left). This is a heavy piece of cast iron that fits over the end of the millstone spindle and fits into two recesses in the runner stone.

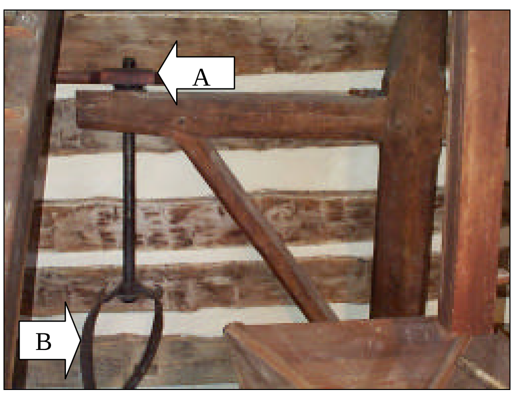
The stones are enclosed by the millstone furniture that includes the vat or hoop (A), the horse (B), the hopper (C), the shoe and damsel (D).





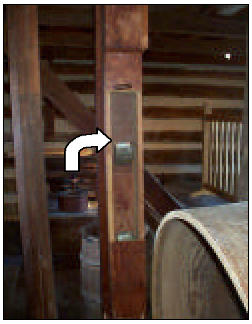
Facing the stones in the mill, one finds the corn stone on the South side (right) and the wheat stone on the North side, shown at left. The corn stones are a quartz stone with a coarser dress for making cracked corn or cornmeal. The wheat stone (left) is harder granite and has a fine dress for making white flour. Currently, only the corn stone is operational. Additional work is needed on the wheat stone at this writing. It is not recommended that operation of the wheat stone be attempted. Presently it should stay dismantled in order to provide visitors a better understanding of how the millstones work. The corn stone can be used to grind whole-wheat flour, as well as corn meal or grits.

Extending through the floor and beside each stone is the screw for adjusting the grind of the stones (right), e.g. the size of the product. To raise the upper stone, the screw is turned clockwise. A counter clockwise rotation will lower the runner stone closer to the embedded stone.

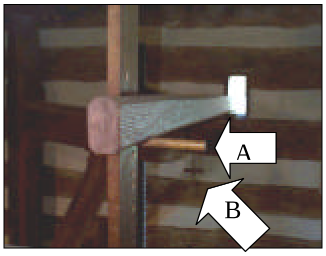


Two cranes are mounted on the second level of the mill. These are used to lift the runners off the embedded stones in order to sharpen or “dress” the stones. The crane consists of a screwjack (see A at left) onto which are attached bails (see B). The ends of the bails have holes that will receive a pin that extends into a hole on either side of the runner stone. Once the pins are secured in the bail and stone, the runner stone can then be lifted.

The elevator leg can be accessed on the second level. There is a small door that can be removed in order to check the amount of flour being carried by the cups. The photo at the right shows the door removed to expose the cups. (Note: The vertical shaft is to the left of the elevator leg in this photo.)



The control mechanisms for the gate valves are found on the second level. The gate controlling the flow of water over the wheel is controlled by the long lever extending from the forebay and through the wall of the mill (below left). A wooden pin (see arrow labeled A below left) is used to secure the desired setting or opening of this gate (below middle photo). Also located in the forebay is an overflow gate. This is used to drain the forebay or empty excess water. This is controlled by a rope mechanism that is attached to the wall of the mill near the wheat stone (visible behind and below the wooden pin, see B in the photo on the left below).



The last item on the second level is the flour chest. This chest receives the finished white flour from the bolting reel located on the third floor.

The bolting reel and elevator head are found on the third level of the mill. The bolting reel is enclosed in a large wooden chest (below left). The reel inside the chest is a cylinder covered with a fine mesh or “silk” and operating on a slight incline (below right).

As flour flows into the center of the reel, the fine flour falls through the silk and flows into the flour chest on the second level. The coarser material that cannot pass through the silk empties out the lower end of the reel and falls to the bran chest on the first level.

The last item to note on the third level is the head of the elevator (below, left). Here the top of the elevator leg can be removed (below right) to allow access for cleaning and repair.