APPENDIX,

CONTAINING

A Description of a Merchant Flour Mill, on the most approved Construction, with the recent Improvements, with two additional Plates,

BY CADWALLADER AND OLIVER EVANS, ENGINEERS;

AND

EXTRACTS

FROM SOME OF THE BEST MODERN WORKS ON THE SUBJECT OF MILLS, WITH OBSERVATIONS BY THE EDITOR.

Description of a Merchant Flour Mill, driving four Pairs of five feet Mill-Stones; arranged by CADWALLADER *and* OLIVER EVANS, *Engineers, Philadelphia.*

PLATE XXVII.

1—A hollow cast-iron shaft, circular, 15 inches in diameter, except at those points where the water and main bevel wheels are hung, where it is increased to 19 inches in diameter. The water-wheel is secured on this shaft by 3 sockets, as represented in Plate XXVIII., fig. 3, and makes 10 revolutions per minute.

2—The main driving bevel-wheel, on the water-wheel shaft, 8 feet in diameter, to the pitch line; 100 cogs, 3 inches pitch, and 8 inches on the face; revolving 10 times per minute, and driving.

3—A bevel-wheel on the upright, 4 feet in diameter to pitch line; 50 cogs, same pitch and face of cogs as above, revolving 20 times per minute.

4—The large pit spur-wheel, making 20 revolutions per minute, 9 feet ⅕th inch diameter, to pitch line; 114

cogs, 3 inches pitch, face 10 inches; this wheel gives motion to

5, 5, 5, 5—Four pinions on the spindles of the mill-stones, 18,1 inches in diameter to pitch line, 19 cogs, same face and pitch.

6, 6, 6, 6—Iron upright shafts, extending the height of the building, and coupled at each story.

7, 7, 7, 7—Are 4 pairs of five feet mill-stones, making 120 revolutions per minute. Two of them shown in elevation; and the position of the 4, shown in Plate XXVIII. as represented by the dotted lines, fig. 1.

8—A pulley on the upright shaft, which, by a band, gives motion to

8—The fan for cleaning grain, revolving 140 times per minute, wings 3 feet long, 20 inches in width.

9—A bevel wheel 2 feet diameter, cogs 2 inches pitch, face 2,5 inches, on the upright shaft, gearing into a bevel wheel, the face of which is shown, drives the bolting screen 18 revolutions per minute.

10—A bevel wheel on upright shaft, 56 cogs, 2 inches pitch, 2,5 inches face, gearing into

10—A bevel wheel on the shaft of the bolting reels, 31 cogs, same pitch and face.

10, 10—Are two of four bolting reels shown, 18 feet long, 30 inches diameter, revolving 36 times per minute.

11—A large pulley on the upright shaft, which, by a band, gives motion to the rubbing stones 11.

12—A bevel wheel, on the top of the upright shaft, gearing into

12—A bevel wheel, on the horizontal shaft, at one end of which is

13—A bevel wheel, 1 foot diameter, gearing into a bevel wheel

14—of 5 feet diameter, which reduces the motion of the hopper-boy down to 4 revolutions per minute, which sweeps a circle of 20 feet.

15—Meal elevator attending 4 pairs of stones.

16—Grain elevator.

17—Packing-room and press.

PLATE XXVIII.

Figure 1.

A bird's eye view of the mode of giving motion to 4 pairs of mill-stones.

4—The large pit spur-wheel, driving at equal distances on its periphery, the pinions

5, 5, 5, 5—attached to the spindles of the mill-stones.

7, 7, 7, 7—Mill-stones, 5 feet diameter, represented by dotted circles.

Figure 2.

An enlarged view of the couplings of the upright shaft. They are of cast-iron, with their holes truly reamed, to receive the ends of the iron upright shafts.

2—The face of a coupling, divided into 6 equal parts, radiating from the centre: three of the parts project, and three are depressed; so that when two of them are coupled, the projections of one will fill the depressions in the other, as 1, the coupling connected.

Figure 3.

A cast-iron socket for the water-wheel; it is a plate $\frac{3}{4}$ths of an inch thick; the eye for the shaft to pass through, 1$\frac{1}{4}$ inch thick, and 12 inches deep: the sockets, for receiving the arms, are 14 inches long, and have projections 5 inches deep; 3 3 3, &c., are the projections; the intermediate space, between the sockets, are cut out to lessen the weight of metal, but in such a manner as to preserve the strength. It requires three of these sockets for a large water-wheel; the arms for receiving the buckets, are dressed to fit tightly in the sockets, and secured firmly by bolts, as 2 2.

Figure 4,

Is an arm for the water-wheel, as dressed; 1, the end to be bolted in the socket; 2, the end for screwing on the bucket.

The advantages of this mode of constructing water-wheels, is, that the shaft is not weakened, by having mortises cut in to receive the arm: that it is not so liable to decay, and if an arm, or bucket, be destroyed by accident, they can be dressed out, and the mill stopped, only while you unscrew the broken part, and replace it by a new one.

Figure 5.

An elevation of the flour press. 1, the barrel of flour; 2, the funnel; 3 3, the driver; 4 5, the lever; 4 3, the connecting bars, fastened by a strong pin to each side of the lever, at 4, and to the driver at 3. 6, a strong bolt, passing through the floor, and keyed below the joist: there is a hole in the upper part of the bolt, to receive a pin which the lever works on, which, when brought down by the hand, moves the pin 4, in the dotted circle; the connecting bars drawing down the driver 3 3, pressing the flour into the barrel; and as it becomes harder packed, the power of the machine increases; as the pin 4 approaches the bolt 6, the under sliding part of the lever is drawn out, to increase its length; and is assisted in rising by a weight fastened to a line passing over pulleys.

When the pin 4 is brought down within half an inch of the centre of the bolt 6, or plumb line, the power increases from 1 to 288; and with the aid of a simple wheel and axis, as 1 to 15, from 288 to 4320; or, if the wheel and axis be as 1 to 30, it will be increased to 4320; that is to say, one man will press as hard with this machine as 8640 men could do with their natural strength. It is extremely well calculated for cotton, tobacco, cider, or, in short, any thing that requires a powerful press.

Operation of the Mill:—The grain, after having been weighed, by drawing a slide, is let into the grain elevator 16, then hoisted to the top of the building, and by a spout moving on a circle, can be deposited into spouts leading to any part of the mill, when wanted for use: by drawing sliders in other spouts, converging to the grain elevator 16, it can be re-elevated, and thrown into the hopper of the rubbing stones 11; after passing through which, it descends into the bolting screen 9, and when screened, falls into the fan 8, is there cleaned, and from that descends into a very large hopper, over the centre of the four pairs of mill-stones, which are supplied regularly with grain. After being ground, the meal descends into a chest, is taken by the elevator 15, to the top of the building, there deposited under the hopper-boy, which spreads, cools, and collects it to the bolting reels, where the several qualities are separated, and the flour descends into the packing room 17, where it is packed in barrels.

By this arrangement, we dispense with all conveyers, and have only one grain, and one flour elevator, to attend two pair of stones; we also dispense with one-half the quantity of gearing usually put into mills, and, consequently, occupy much less space, leaving the rest of the building for stowing grain, &c.

All the wheels in this mill are of cast-iron, and the face of the cogs very deep; for experience justifies the assertion that depth of face in cog-wheels, when properly constructed, does not increase friction; and that the wheels will last treble the time, by a small increase of depth; we recommend the main driving wheels to be 10 inches on the face. The journals of all shafts, when great pressure is applied, should be of double the length now generally used; increase of length does not increase friction; say for water wheels, journals of from 8 to 14 inches.

Draughts of mills are furnished by the subscribers; and the cast-iron work can be obtained, at the Steam Engine Manufactory and Iron Foundry of Messrs. Rush & Muhlenberg, Bush Hill, Philadelphia.

CADWALLADER EVANS,
OLIVER EVANS.

June 15, 1826.

WATER-WHEELS.

On the Construction of Water-Wheels, and the Method of applying the Water for propelling them, so as to produce the greatest Effect.

The following article is from the pen of a practical engineer of experience and talents; his observations are, in general, in perfect accordance with those of the editor. The principles which he advocates are undoubtedly correct, and it is hoped that their publication in this work will induce some of our most intelligent mill-wrights to forsake the beaten track, and to practise the modes recommended. Let them recollect that Mr. Parkin was not a mere theorist, but a practical man, like themselves. The death of this gentleman has deprived society of the services of one of its members, from whose liberality, experience, and skill, much was expected.

[FROM THE FRANKLIN JOURNAL.]

In constructing water-wheels, especially those of great power, the introduction of iron is a most essential improvement; and if this metal, and artisans skilled in working it, could be obtained at reasonable rates, water-wheels might be made wholly of it, and would prove, ultimately, the cheapest; as, if managed with due care, and worked with pure (not salt) water, they would last for centuries; but, as the first cost would be an objection, I would recommend, in all very large wheels, that the axis be made of cast-iron; and, in order to obtain the greatest strength with the least weight, the axis or shaft ought to be cast hollow, and in the hexagon or octagon form, with a strong iron flanch, to fix each set of arms, and the cog-wheel, upon; these flanches to be firmly fixed in their places with steel keys.

On the adaptation of water-wheels to the different heights of the water falls by which they are to be worked, I will remark that falls of from 2 to 9 feet are most advantageously worked with the undershot wheel; falls of

10 feet and upwards by the bucket or breast wheel, which, up to 20 or 25 feet, ought to be made about one-sixth higher than the fall of water by which it has to be worked; and in wheels of both descriptions, the water ought to flow on the wheel from the surface of the dam. I am aware that this principle is at direct variance with the established practice, and perhaps there are few wheels in these States that can be worked, as they are now fixed, by thus applying the water; the reasons will be apparent from what follows.

In adjusting the proportions of the internal wheels by which machinery is propelled, it is necessary, in order to obtain the greatest power, to limit the speed of the skirt of the water-wheel, so that it shall not be more than from 4 to 5 feet per second; it having been ascertained by accurate experiments, that the greatest obtainable force of water, is within these limits. As a falling body, water descends at the speed of about 16 feet in the first second, and it will appear evident that if a water-wheel is required to be so driven, that the water with which it is loaded has to descend 10, 11, or 12 feet per second, at which rate wheels are generally constructed to work, a very large proportion of the power is lost, or, rather, is spent, in destroying, by unnecessary friction, the wheel upon which it is flowing.

In the common way of constructing mill work, and of applying water to wheels, it has been found indispensably necessary to have a head of from 2 to 4 feet above the aperture through which the water flows into the buckets, or against the floats of a water-wheel, in order to be able to load the wheel instantaneously, without which precaution, it could not be driven at the required speed: from this circumstance it has been erroneously inferred, that the impulse or shock which a water-wheel, so filled, receives, is greater than the power to be derived from the actual gravity of the water alone. This theory I have heard maintained among practical men; but it is, in fact, only resorting to one error to rectify another. Overshot wheels have been adopted, in numerous cases, merely for the purpose of getting the water more readily into the buckets; but confine the wheel to the proper working speed, and that difficulty will not exist.

In consequence of the excessive speed at which water-wheels are generally driven, a small accumulation of back water either suspends or materially retards their operations; but, by properly confining their speed, the resistance from back water is considerably diminished, and only amounts to about the same thing as working from a dam as many inches lower, as the wheel is immersed; and in undershot wheels worked from a low head, or situated in the tide-way, the resistance from back water may be farther obviated by placing the floats not exactly in a line from the centre of the wheel, but deviating 6 or 8 inches from it, so as to favour the water in leaving the ascending float.

In constructing water-wheels to be driven at the speed of 4 or 5 feet per second, it will be requisite to make them broader, to work the same quantity of water which is required to drive a quick-speeded wheel. Thus, if a person intending to erect a mill, has a stream sufficient to work a wheel 5 feet broad, the skirt to move 10 feet per second, it is evident that if he wishes to work all the water which such wheel takes, he must have his wheel 10 or 12 feet broad, instead of 5, otherwise the water must run to waste, as there would not be room, in a slow-moving wheel of 5 feet broad, to receive more than half of it. The principal advantages resulting from the proposed method of adapting wheels to the falls by which they are to be worked, and the method of applying water, are—

1. The lessening of friction upon the main gudgeons, (and first pair of cog-wheels) by which, with a little care, they may be kept regularly cool, and the shaft or axis be preserved much longer in use than when the gudgeons cannot be kept cool.

2. By working water upon the principle of its actual gravity alone, and applying it always at the height of the surface of the dam, its power is double what is obtained by the common method of applying it.

3. The expensive penstock required to convey the water to the wheels, generally used, will not be needed,

as one much shallower, and consequently less expensive, will be sufficient.

4. The resistance of back water is reduced as far as possible.

5. The risk of fire is less, as the friction is reduced.

W. Parkin, *Engineer.*

September 24, 1825.

That water, whenever the fall is sufficient, ought always to be applied upon the principle of its actual gravity, appears to be a conclusion so obvious, that it is astonishing it should ever be disputed. The acknowledged difference between the effect of overshot and undershot wheels, is an evidence of the truth of the principle. The whole moving power of water is derived from its gravity; it is this which causes it to fall, and although in falling from a given height it acquires velocity, its gravitating force remains the same, and all the effect which this might have produced, has been expended upon itself, and not in moving any other body. The force with which water strikes, after it has fallen from any height, is calculated to deceive those who are not well grounded in the principles of hydrostatics; but it is admitted, both by Mr. Evans and Mr. Ellicott, that the effect upon overshot wheels is diminished, by increasing the head, and the reason given for leaving the head so great as they prescribe, is the necessity of filling the buckets with sufficient rapidity; this necessity, however, is created by giving too much velocity to the wheel.

It has been stated by Mr. Evans, and is generally believed by mill-wrights, that it is necessary to give a much greater velocity to wheels, than that which is recommended by Smeaton and others, in order to cause the mill to run steadily, and prevent its being suddenly checked by any increased resistance. This is saying that the water-wheel ought to be made to operate as a fly-wheel, which it will not do if its motion be slow. The objection to this is twofold. By giving to the skirt of