5—a weather-cock, turning on an iron rod.
6—the end of the shaft, for hoisting outside of the house, which is fixed above the collar-beams over the doors, to hoist into either of them, or either story, at either end of the house, as may suit best.
7—the dark squares, showing the ends of the girders.
8—the joists over the water-house.
9—the mill-stones, with the spindles they run on, and the ends of the bridge-trees as they rest on the brays a a. b b show the ends of the brays, that are raised and lowered by the levers c c, called the lighter-staffs, for raising and lowering the running stone.
10—the water-wheel and big cog-wheel.
11—the wall between the water and cog-wheel.
12—the end view of the two side walls of the house.
Plate XXII. is explained in the Preface.

CHAPTER XXIII.

ARTICLE 158.

OF SAW-MILLS.

Construction of their Water-Wheels.

The wheels for saw-mills have been variously constructed; the most simple, where water is plenty, and the fall above six feet, is the flutter-wheel; but where water is scarce, or the head insufficient to give flutter-wheels the requisite motion, high wheels, double geared, will be found necessary. Flutter-wheels may be adapted to any head above six feet, by making them low and wide, for low heads, and high and narrow for high ones, so as to have about 120 revolutions, or strokes of the saw in a minute: but rather than double gear, I would be satisfied with 100.

A TABLE

OF THE

DIAMETER OF FLUTTER-WHEELS FROM OUT TO OUT, AND THEIR WIDTH IN THE CLEAR, SUITABLE TO ALL HEADS, FROM SIX TO THIRTY FEET.

Head of water.	Diameter.	Width.
feet.	ft. in.	ft. in.
6	2 : 8	5 : 6
7	2 : 10	5 : 0
8	2 : 11	4 : 8
9	3 : 0	4 : 3
10	3 : 1	4 : 0
11	3 : 2	3 : 9
12	3 : 3	3 : 6
13	3 : 4	3 : 3
14	3 : 5	3 : 0
15	3 : 6	2 : 9
16	3 : 7	2 : 6
17	3 : 8	2 : 4
18	3 : 9	2 : 2
19	3 : 10	2 : 0
20	3 : 11	1 : 10
21	4 : 0	1 : 9
22	4 : 1	1 : 8
23	4 : 2	1 : 7
24	4 : 3	1 : 6
25	4 : 4	1 : 5
26	4 : 5	1 : 4
27	4 : 6	1 : 3
28	4 : 7	1 : 2
29	4 : 8	1 : 1
30	4 : 9	1 : 0

N. B.—The above wheels are proposed to be made as narrow as will well do, on account of saving water; but if this be abundant, the wheels may be made wider than directed in the table, and the mill will be the more powerful.

Of Geared Saw-Mills.

Of these I shall say but little, they being expensive and but little used.—They should be geared so as to give the saw 120 strokes in a minute, when at work in a common log. The water-wheel is like that of any other mill, whether of the overshot, undershot, or breast kind; the cog-wheel of the spur kind, and as large as will clear the water. The wallower commonly has 14 or 15 rounds, or such number as will produce the right motion. On the wallower shaft is a balance-wheel, which may be made of stone or wood; this is to regulate the motion. There should be a good head above the water-wheel to give it a lively motion, otherwise the mill will run heavily.

The mechanism of a complete saw-mill is such as to produce the following effects; namely:—

1. To move the saw up and down, with a sufficient motion and power.
2. To move the log to meet the saw.
3. To stop of itself when within 3 inches of being through the log.
4. To draw the carriage with the log back, by the power of the water, so that the log may be ready to enter again.

The mill is stopped as follows; namely:—When the gate is drawn the lever is held by a catch, and there is a trigger, one end of which is within half an inch of the side of the carriage, on which is a piece of wood an inch and a half thick, nailed so that it will catch against the trigger as the carriage moves, which throws the catch off the lever of the gate, and it shuts down at a proper time.

Description of a Saw-Mill.

Plate XXIII. is an elevation and perspective view of a saw-mill, showing the foundation, walls, frame, &c., &c.

Fig. 0, 1—the frame uncovered, 52 feet long, and 12 feet wide.

Fig. 2—The lever for communicating the motion from

the saw-gate to the carriage, to move the log; it is 8 feet long, 3 inches square, tenoned into a roller 6 inches diameter, reaching from plate to plate, and working on gudgeons in them; in its lower side is framed a block, 10 inches long, with a mortise in it two inches wide throughout its whole length, to receive the upper end of the hand pole, having in it several holes for an iron pin, to join the hand pole to it, to regulate the feed; by setting the hand-pole nearer the centre of the roller, less feed is given, and, farther off, gives more.

Fig. 3, the hand-pole-or feeder, 12 feet long, and 3 inches square, where it joins the block, (Fig. 4,) and tapering 2 inches at the lower end, on which is the iron hand, 1 foot long, with a socket; the end of this is flattened, steeled, and hardened, and turned down half an inch at each side, to keep it on the rag-wheel.

Fig. 5—the rag wheel. This has four cants, 4½ feet long, 17 by 3 inches in the middle, lapped together to make the wheel 5 feet diameter; is faced between the arms with 2 inch plank, to strengthen the laps. The cramp or ratchet iron is put on as a hoop, nearly 1 inch square, with ratchet notches cut on its outer edge, about 3 to an inch. On one side of the wheel are put 12 strong pins, 9 inches long, to tread the carriage back, when the backing works are out of order. On the other side are the cogs, about 56 in number, 3 inches pitch, to gear into the cog-wheel on the top of the tub-wheel shaft, with 15 or 16 cogs. In the shaft of the rag-wheel are 6 or 7 rounds, 11 inches long in the round part, let in nearly their whole thickness, so as to be of a pitch equal to the pitch of the cogs of the carriage, and gear into them easily: the ends are tapered off outside, and a band is driven on them at each end, to keep them in their places.

Fig. 6 is the carriage; a frame 4 feet wide from outsides, one side 29 feet long, 7 by 7 inches; the other 32 feet long, 8 by 7 inches, very straight and true, the interties at each end 15 by 4 inches, strongly tenoned and braced into the sides to keep the frame from racking. In the under side of the largest piece are set two rows of cogs, 2 inches between the rows, and 9 inches from the

foreside of one cog to that of another; the cogs of one row between those of the other, so as to make $4\frac{1}{2}$ inches pitch, to gear into the rounds of the rag-wheel. The cogs are about 66 in number; shank 7 inches long, $1\frac{3}{4}$ inches square; head $2\frac{3}{4}$ long, 2 inches thick at the points, and $2\frac{1}{4}$ inches at the shoulder.

Fig. 7—the ways for the carriage to run on. These are strips of plank $4\frac{1}{2}$ inches wide, 2 inches thick, set on edge, let $1\frac{1}{2}$ inches into the top of the cross sills, of the whole length of the mill, keyed fast on one side, made very straight both side and edge, so that one of them will pass easily between the rows of cogs in the carriage, and leave no room for it to move sideways. They should be of hard wood, well seasoned, and hollowed out between the sills to keep the dust from lodging on them.

Fig. 8—the fender posts. The gate with the saw plays in rabbets $2\frac{1}{2}$ deep and 4 inches wide, in the fender posts, which are 12 feet long, and 12 inches square, hung by hooked tenons, to the front side of the two large cross beams in the middle of the frame, in mortises in their upper sides, so that they can be moved by keys to set them plumb. There are 3 mortises, 2 inches square, through each post, within half an inch of the rabbets, through which pass hooks with large heads, to keep the frame in the rabbets: they are keyed at the back of the posts.

Fig. 9—the saw, which is 6 feet long, 7 or 8 inches wide, when new; hung in a frame 6 feet wide from the outsides, 6 feet 3 inches long between the end pieces, the lowermost of which is 14 by 3 inches, the upper one 12 by 3, the side pieces 5 by 3 inches, 10 feet long, all of the best dry, hard wood. The saw is fastened in the frame by two irons, in form of staples; the lower one with two screw pins passing through the lower end, screwing one leg to each side of the end piece: the legs of the upper one are made into screws, one at each side of the end piece, passing through a broad, flat bar, that rests on the top of the end piece, with strong burrs, $1\frac{3}{4}$ inches square, to be turned by an iron spanner, made to fit them.

These straps are made of flat bars, 3 feet 9 inches long, 3 inches wide, $\frac{3}{4}$ths thick before turned; at the turn they are 5 inches wide, square, and split to receive the saw, and tug-pins, then brought near together, so as to fit the gate. The saw is stretched tightly in this frame, by the screws at the top, exactly in the middle, at each end, measuring from the outside; the top end standing about half an inch more forward than the bottom.

Fig. 10—the forebay of water, projecting through the upper foundation wall.

Fig. 11—the flutter-wheel. Its diameter and length according to the head of water, as shown in the table. The floats are fastened in with keys, so that they will drive inward, when any thing gets under them, and not break. These wheels should be very heavy, that they may act as a fly, or balance, to regulate the motion, and work more powerfully.

Fig. 12—the crank, (see it represented by a draught from a scale of 1 foot to an inch, fig. 17, Plate XXIV.) The part in the shaft 2 feet 3 inches long, $3\frac{3}{4}$ by 2 inches, neck 8 inches long, 3 thick, and 12 inches from the centre of the neck to the centre of the wrist or handle, which is 5 inches long to the key hole, and 2 inches thick.

The gudgeon at the other end of the shaft is 18 inches in the shaft, neck $3\frac{1}{2}$ long, $2\frac{3}{4}$ diameter.

The crank is fastened in the same way as gudgeons. (See Art. 132.)

Fig. 12, 13—the pitman, which is $3\frac{1}{2}$ inches square at the upper end, $4\frac{1}{2}$ in the middle, and 4 near the lower end; but 20 inches of the lower end is $4\frac{1}{2}$ by $5\frac{1}{2}$, to hold the boxes and key, to keep the handle of the crank tight.

Pitman Irons of an improved Construction.

(See fig. 10, 11, 12, 13, 14, 18, Plate XXIV.) Fig. 10 is a plate or bar, with a hole in each end, through which the upper ends of the lug-pins 11—11 pass, with a strong burr screwed on each; they are 17 inches long,

$1\frac{1}{8}$ inch square, turned at the lower end to make a round hole $1\frac{1}{8}$ diameter, made strong round the hole.

Fig. 12 is a large, flat link, through a mortise near the lower side of the end of the saw frame. The lug-pins pass one through each end of this link, which keeps them close to the gate sides.

Fig. 14 is a bar of iron 2 feet long, $3\frac{1}{2}$ inches wide, $\frac{1}{2}$ inch thick at the lower, and $1\frac{1}{8}$ at the upper end. It is split at the top and turned as in the figure, to pass through the lug-pins. At fig. 13 there is a notch set in the head of the pitman bar 14, $1\frac{1}{2}$ inch long, nearly as deep as to be in a straight line with the lower side of the side-pins, made a little hollow, steeled and made very hard.

Fig. 18 is an iron plate, $1\frac{1}{2}$ inch wide, half an inch thick in the middle, with 2 large nail-holes in each end, and a round piece of steel welded across the middle and hardened, made to fit the notch in the upper end of the pitman, Plate XXVI., and draw close by the lug-pins, to the under side of the saw-frame, and nailed fast. Now, if the bearing part of this joint be in a straight line, the lower end of the pitman may play without friction in the joint, because both the upper and lower parts will roll without sliding, like the centre of a scale beam, and will not wear.

This is the best plan for pitman irons, with which I am acquainted. The first set, so made, has been in my saw-mill 8 years, doing much hard work, and three minutes have not been required to adjust them.

Fig. 14—the tub-wheel, for running the carriage back. This is a very light wheel, 4 feet diameter, and put in motion by means of the foot or hand, at once throwing it in gear with the rag-wheel, lifting off the hand and clicks from the ratchet, and hoisting a little gate to let water on the wheel. The moment the saw stops, the carriage begins to move gently back again with the log.

Fig. 15—the cog-wheel on the top of the tub-wheel shaft, with 15 or 16 cogs.

Fig. 16—the log on the carriage, sawed partly through.

Fig. 17—a crank and windlass, to increase power, by

which one man can draw heavy logs on the mill, and turn them, by a rope passing round the log and windlass.

Fig. 18—a cant hook for rolling logs.

Fig. 19—a double dog, fixed into the hindmost head-block, used by some to hold the log.

Fig. 20 are smaller dogs to use occasionally at either end.

Figs. 21, 22, represent the manner of shuting water on a flutter-wheel by a long, open shute, which should not be nearer to a perpendicular than an angle of 45 degrees, lest the water should rise from the shute and take air, which would cause a great loss of power.

Fig. 23 represents a long, perpendicular, tight shute; the gate 23 is always drawn fully, and the quantity of water regulated at the bottom by a little gate r, for the purpose. There must be air let into this shute by a tube entering at a. (See Art. 71.) These shutes are for saving expense where the head is great, and should be much larger at the upper than at the lower end, else there will be a loss of power. They must be very strong, otherwise they will burst. The perpendicular ones suit best where a race passes within 12 feet of the upper side of the mill.

OPERATION.

The sluice drawn from the penstock 10, puts the wheel 11 in motion—the crank 12 moves the saw-gate, and saw 9, up and down; and as they rise they lift up the lever 2, which pushes forward the hand-pole 3, which moves the rag-wheel 5, which gears in the cogs of the carriage 4, and draws forward the log 16 to meet the saw, as much as is proper to cut at a stroke. When it is within 3 inches of being through the log, the cleet C, on the side of the carriage, arrives at a trigger and lets it fly, and the sluice gate shuts down; the miller instantly draws water on the wheel 14, which runs the log gently back, &c.

ARTICLE 159.

DESCRIPTION OF A FULLING-MILL.

Fig. 19, Plate XXIV., is the penstock, water-gate, and spout of an overshot fulling-mill, the whole laid down from a scale of 4 feet to an inch.

Fig. 20—one of the 3 interties, that are framed with one end into the front side of the top of the stock-block; the other ends into the tops of the 3 circular pieces that guide the mallets; they are 6 feet long, 5 inches wide, and 6 deep.

Fig. 21 are two mallets; they are 4 feet 3 inches long, 21 inches wide, and 8 thick, shaped as in the figure.

Fig. 22—their handles, 8 feet long, 20 inches wide, and 3 thick: a roller passes through them, 8 inches from the upper ends, and hangs in the hindermost corner of the stock post. The other ends go through the mallets, and have each, on their underside, a plate of iron faced with steel and hardened, 2 feet long, 3 inches wide, fastened by screw-bolts, for the tappet-blocks to rub against while lifting the mallets.

Fig. 23—the stock-post, 7 feet long, 2 feet square at the bottom, 15 inches thick at the top, and shaped as in the figure.

Fig. 24—the stock where the cloth is beaten, shaped inside as in the figure, planked inside as high as the dotted line, which planks are put in rabbets in the post, the inside of the stock being 18 inches wide at the bottom, 19 at the top, and 2 feet deep.

Fig. 25—one of the 3 circular guides for the mallets; they are 6 feet long, 7 inches deep, and 5 thick; are framed into a cross sill at bottom, that joins its lower edge to the stock-post. This sill forms a part of the bottom of the stock, and is 4 feet long, 20 inches wide, and 10 thick.

The sill under the stock-post is 6 feet long, 20 inches wide, and 18 thick. The sill before the stock is 6 feet long, and 14 inches square.

Fig. 26—the tappet-arms, 5 feet 6 inches long, 21

inches each side of the shaft, 12 inches wide, and 4 thick. There is a mortise through each of them, 4 inches wide, the length from shaft to tappet, for the ends of the mallet handles to pass through. The tappets are 4 pieces of hard wood, 12 inches long, 5 wide, and 4 thick, made in the form of half circles pinned to the ends of the arms.

Fig. 27—an overshot water-wheel, similar to those in other mills.

Fig. 28—one of the 3 sills, 16 feet long, and 16 inches square, with walls under them, as in the figure.

OPERATION.

The cloth is put in a loose heap in the stock 24; the water being drawn on the wheel, the tappet-arms lift the mallets, alternately, which strike the under part of the heap of cloth, and the upper part is continually falling over, and thereby turning and changing its position under the mallets, which are shaped as in the figure, to produce this effect.

Description of the Drawings of the Iron-work, Plate XXIV.

Fig. 1 is a spindle, 2 the balance ryne, and 3 the driver, for a mill-stone. The length of the spindle from the foot to the top of the neck is about 5 feet 3 inches; cock-head 8 or 9 inches from the top of the neck, which is 3 inches long, and 3 diameter; blade or body $3\frac{1}{2}$ by 2 inches; foot $1\frac{1}{4}$ inch diameter; the neck, foot, and top of the cock-head, steeled, turned, and hardened.

Fig. 2—the balance-ryne is sometimes made with 3 horns, one of which is so short as only to reach to the top of the driver, which is let into the stone directly under it; the other to reach nearly as low as the bottom of the driver: of late, they are mostly made with 2 horns only; this may be made sufficiently fast by making it a little wider than the eye, and letting it into the stone a little on each side, to keep it steady, and prevent its moving sideways. Some choose them with 4 horns, which fill the eye too much.