CHAPTER XXI.

ARTICLE 129.

DIRECTIONS FOR CONSTRUCTING UNDERSHOT WHEELS, SUCH AS SHOWN IN FIGURE 1, PLATE XIII.

1. Dress the arms straight and square on all sides, and find the centre of each; divide each into 4 equal parts on the side; square, centre, scribe, and gauge them from the upper side across each point, on both sides, 6 inches each way from the centre.

2. Set up a truckle or centre-post, for a centre to frame the wheel on, in a level piece of ground, and set a stake to keep up each end of the arms level with the truckle, of convenient height to work on.

3. Lay the first arm with its centre on the centre of the truckle, and take a square notch out of the upper side 3-4ths of its depth, wide enough to receive the 2d arm.

4. Make a square notch in the lower edge of the 2d arm, 1-4th of its depth, and lay it in the other, and they will joint, standing square across each other.

5. Lay the 3d arm just equi-distant between the others, and scribe the lower arms by the side of the upper, and the lower edge of the upper by the sides of the lower arms. Then take the upper arm off and strike the square scribes, taking out the lower half of the 3d arm, and the upper half of the lower arms, and fit and lay them together.

6. Lay the 4th arm on the others, and scribe as directed before; then take 3-4ths of the lower edge of the 4th arm, and 1-4th out of the upper edge of the others, and lay them together, and they will be locked together in the depth of one.

7. Make a sweep-staff with a gimlet hole for the centre at one end, which must be set by a gimlet in the centre of the arms. Measure from this hole half the diameter of the wheel, making a hole there, and another the depth of the shrouds towards the centre, making each edge of this sweep at the end next the shrouds, straight

towards the centre hole, to scribe the ends of the shrouds by.

8. Circle both edges of the shrouds by the sweep; dress them to the proper width and thickness; lay out the laps 5 inches long; set a gauge to a little more than one-third their thickness; gauge all their ends for the laps from the outsides; cut them all out but the last, that it may be made a little longer, or shorter, as may suit to make the wheel the right diameter; sweep a circle on the arms to lay the shrouds to, while fitting them; put a small draw-pin in the middle of each lap, to draw the joints close; strike true circles both for the inside and outside of the shrouds, and 1½ inches from the inside, where the arms are to be let in.

9. Divide the circle into 8 equal parts, coming as near the middle of each shroud as possible; strike a scribe across each to lay out the notch by, that is to be cut 1½ inches deep, to let in the arm at the bottom, where it is to be forked to take in the remainder of the shroud. Strike a scribe on the arms with the same sweep that the stroke for the notches on the shrouds was struck with.

10. Scribe square down on each side of the arms, at the bottom, where they are to be forked; make a gauge to fit the arms, so wide as just to take in the shrouds, and leave 1½ inches of wood outside of the mortise; bore 1 or 2 holes through each end of the arms to draw-pin the shrouds to the arms when hung; mark all the arms and shrouds to their places, and take them apart.

11. Fork the arms, put them together again, and put the shrouds into the arms; draw-bore them, but not too much, which would be worse than too little; take the shrouds apart again, turn them the other side up, and draw the joints together with the pins, and lay out the notches for 4 floats between each arm, 32 in all, large enough for admitting keys to keep them fast, but allowing them to drive in when any thing gets under the wheel. The ends of the floats must be dove-tailed a little into the shrouds; when one side is framed, frame the other to fellow it. This done, the wheel is ready to hang, but remember to face the shrouds between the arms

with inch boards, nailed on with strong nails, to keep the wheel firmly together.

ARTICLE 130.

DIRECTIONS FOR DRESSING SHAFTS, &c.

The shaft for a water-wheel with 8 arms should be 16 square, or 16 sided, about 2 feet diameter, the tree to make it being 2 feet 3 inches at the top end. When cut down, saw it off square at each end, and roll it on level skids, and if it be not straight, lay the rounding side down and view it, to find the spot for the centre at each end. Set the large compasses to half its diameter, and sweep a circle at each end, plumb a line across each centre, and at each side of the circle, striking chalk lines over the plumb lines at each side from end to end, and dress the sides plumb to these lines; turn it down on one side, setting it level; plumb, line, and dress off the sides to a 4 square; set it exactly on one corner, and plumb, line, and dress off the corner to 8 square. In the same manner dress it to 16 square.

To cut it square off to its exact length, stick a peg in the centre of each end, take a long square, (which may be made of boards,) lay it along the corner, the short end against the end of the peg, mark on the square where the shaft is to be cut, and mark the shaft by it at every corner line, from mark to mark; then cut it off to the lines, and it will be truly square.

ARTICLE 131.

TO LAY OUT THE MORTISES FOR THE ARMS.

Find the centre of the shaft at each end, and strike a circle; plumb a line through the centre at each end to be in the middle of two of the sides; make another scribe square across it; divide the distance equally between them, so as to divide the circle into 8 equal parts, and strike a line from each of them, from end to end, in the middle of the sides; measure from the top end about 3

feet, and mark for the arm of the water-wheel, and the width of the wheel, and make another mark. Take a straight-edged 10 feet pole, and put the end even with the end of the shaft, and mark on it even with the marks on the shaft, and by these marks measure for the arm at every corner, marking and lining all the way round. Then take the uppermost arms of each rim, and by them lay out the mortises, about half an inch longer than they are wide, which is to leave key room; set the compasses a little more than half the thickness of the arms, and set one foot in the centre line at the end of the mortise, striking a scribe each way to lay out the width by; this done, lay out 2 more on the opposite side, to complete the mortises through the shaft. Lay out 2 more, square across the first, one-quarter the width of the arm longer, inwards, towards the middle of the wheel. Take notice which way the locks of the arms wind, whether to right or left, and lay out the third mortises to suit, else it will be a chance whether they suit or not: these must be half the width of the arms longer, inwards.

The 4th set of mortises must be three-fourths longer inwards than the width of the arms; the mortises should be made rather hollowing than rounding, that the arms may slip in easily and stand fair.

If there be 3 (which are called 6) arms to the cog-wheel, but one of them can be put through the sides of the shaft fairly; therefore, to lay out the mortises, divide the end of the shaft anew, into but 6 equal parts, by striking a circle on each end; and without altering the compasses, step from one of the old lines, six steps round the circle, and from these points strike chalk lines, and they will be the middle of the mortises, which may be laid out as before, minding which way the arms lock, and making two of the mortises one-third longer than the width of the arm, extending one on one side, and the other on the other side of the middle arm.

If there be but 2 (called 4) arms in the cog-wheel, (which will do where the number of cogs does not exceed 60) they will pass fairly through the sides, whether the shafts he 12 or 16 sided. One of these must be made one-

half longer than the width of the arms, to give room to put the arm in.

ARTICLE 132.

TO PUT IN THE GUDGEONS.

Strike a circle on the ends of the shaft to let on the end bands; make a circle all round, $2\frac{1}{2}$ feet from each end, and saw a notch all round, half an inch deep. Lay out a square, round the centres, the size of the gudgeons, near the neck; lay the gudgeons straight on the shaft, and scribe round them for their mortises; let them down within one-eighth of an inch of being in the centre. Dress off the ends to suit the bands; make 3 keys of good, seasoned white oak, to fill each mortise above the gudgeons, to key them in, those next to the gudgeons to be $3\frac{1}{4}$ inches deep at the inner end, and $1\frac{1}{2}$ inches at their outer end, the wedge or driving key 3 inches at the head, and 6 inches longer than the mortise, that it may be cut off, if it batter in driving; the piece next the band so wide as to rise half an inch above the shaft, when all are laid in. Then take out all the keys and put on the bands, and make 8 or 12 iron wedges about 4 inches long by 2 wide, 1-3d inch thick at the end, not much tapered except half an inch at the small end, on one side next the wood; by means of a set, drive them in on each side the gudgeon extremely hard, at a proper distance apart. Then put in the keys again, and lay a piece of iron under each band, between it and the key, 6 inches long, half an inch thick in the middle, and tapering off at the ends; then grease the keys well with tallow, and drive it well with a heavy sledge: after this, drive an iron wedge, half an inch from the two sides of each gudgeon, 5 inches long, about half an inch thick, and as wide as the gudgeon.

ARTICLE 133.

OF COG-WHEELS.

The great face cog-wheels require 3 (called 6) arms, if the number of cogs exceed 54; if less, 4 will do. We find by the table, example 43, that the cog-wheel must have 69 cogs, with $4\frac{1}{2}$ inches pitch, the diameter of its pitch circle 8 feet $2\frac{1}{3}$ inches, and of its outsides 8 feet $10\frac{1}{3}$ inches. It requires 3 arms, 9 feet long, 14 by $3\frac{3}{4}$ inches; 12 cants, $6\frac{1}{2}$ feet long, 16 by 4 inches. (See it represented, fig. 1, Plate XVII.)

To frame it, dress and lock the arms together, (fig. 6, Pl. XVII.) as directed, Art. 129, only mind to leave one-third of each arm uncut, and to lock them the right way to suit the winding of the mortises in the shaft, which is best found by putting a strip of board in the middle mortise, and supposing it to be the arm, mark which way it should be cut, then apply the board to the arm, and mark it. The arms being laid on a truckle, as directed, Art. 129, make a sweep, the sides directing to the centre, 2 feet from the outer end to scribe by; measure on the sweep, half the diameter of the wheel; and by it circle out the back edges of the cants, all of one width in the middle; dress them, keeping the best faces for the face side of the wheel; make a circle on the arms half an inch larger than the diameter of the wheel, laying 3 of the cants with their ends on the arms, at this circle, at equal distances apart. Lay the other three on the top of them, so as to lap equally; scribe them both under and top, and gauge all for the laps from the face side; dress them out and lay them together, and joint them close; draw-pin them by an inch pin near their inside corners: this makes one-half of the wheel, shown fig. 5. Raise the centre level with that half; strike a circle near the outside, and find the centre of one of the cants; then, with the sweep that described the circle, step on the circle 6 steps, beginning at the middle of the cant, and these steps will show the middle of all the cants, or places for the arms. Make a scribe from the centre across each; strike another circle exactly at the corners, to place the corners of the

next half by, and another about 2½ inches farther out than the inside of the widest part of the cant, to let the arms in by; lay on three of the upper cants, the widest part over the narrowest part of the lower half, the inside to be at the point where the corner circle crosses the centre lines. Saw off the ends, at the centre scribes, and fit them down to their places, doing the same with the rest. Lay them all on, and joint their ends together; draw-pin them to the lower half, by inch pins, 2 inches from their inner edges, and 9 inches from their ends. Raise the centre level with the wheel; plane a little of the rough off the face, and strike the pitch circle, and another 4 inches inside, for the width of the face; strike another very near it, in which drive a chisel, half an inch deep, all round, and strike lines, with chalk, in the middle of the edge of the upper cants, and cut out of the solid, half of the upper cants, which raises the face; divide the pitch circle into 69 equal parts, 4½ inches pitch, beginning and ending in a joint; strike two other circles each 2½ inches from the pitch circle, and strike central scribes between the cogs, and where they cross the circles put in pins, as many as there are cogs, half on each circle; find the lowest part on the face, and make the centre level with it; look across in another place, square with the first, and make it level with the centre also; then make the face straight, from these four places, and it will be true.

Strike the pitch circle, and divide it over again, and strike one circle on each side of it, 1 inch distance, for the cog mortises; sweep the outside of the wheel and inside of the face, and two circles ¾ths of an inch from them, to dress off the corners; strike a circle of two inches diameter on the centre of each cog, and with the sweep strike central scribes at each side of these circles for the cog mortises; bore and mortise half through; turn the wheel, dress and mortise the back side, leaving the arms from under it; strike a circle on the face edge of the arms, equal in diameter to that struck on the face of the half wheel, to let them in by; saw in square, and take out 4½ inches, and let them into the back of the wheel 1¼ inches deep, and bore a hole 1½ inches into each arm, to pin it to the wheel.

Strike a circle on the arms one inch less than the diameter of the shaft; make a key 8 inches long, $1\frac{1}{2}$ thick, $3\frac{1}{4}$ at the butt, and $2\frac{1}{2}$ inches at the top end, and by it lay out the mortises; two on each side of the shaft, in each arm, to hang the wheel by.

ARTICLE 134.

OF SILLS, SPUR-BLOCKS, AND HEAD-BLOCKS.

See a side view of them in Plates XIII., XIV., XV., and XVI., and a top view of them, with their keys, at the end of the shaft, Plate XVIII. The sills are generally 12 inches square. Lay them on the wall as firmly as possible, and one 3 feet farther out; on these lay the spurs, which are 5 feet long, 7 by 7 inches, 3 feet apart, notched and pinned to the sills: on these are set the head-blocks, 14 by 12 inches, 5 feet long, let down with a dove-tail shoulder between the spurs, to support keys to move it endwise, and let 2 inches into the spurs with room for keys, to move it sidewise, and hold it to its place; see fig. 33 and 34, Plate XVIII. The ends of the shaft are let 2 inches into the head-blocks, to throw the weight more on the centre.

Provide two stones 5 or 6 inches square, very hard and clear of grit, for the gudgeons to run on, let them into the head-blocks, put the cog-wheel into its place, and then put in the shaft on the head-blocks in its place.

Put in the cog-wheel arm, lock them together, and pin the wheel to them; then hang the wheel, first by the keys to make it truly round, and then by side wedges, to make it true in face; turn the wheel, and make two circles, one on each side of the cog mortises, half an inch from them, so that the head of the cogs may stand between them equally.

ARTICLE 135.

OF COGS; THE BEST TIME FOR CUTTING, AND MANNER OF SEASONING THEM.

Cogs should be cut 14 inches long, and 3¼ inches square; this should be done when the sap runs at its fullest, at least a year before they are used, that they may dry without cracking. If either hickory or white oak be cut when the bark is set, they will worm-eat, and, if dried hastily, will crack; to prevent which, boil them and dry them slowly, or soak them in water, a year, (20 years in mud and fresh water would not hurt them;) when they are taken out they should he put in a hay-mow, under the hay, where, while foddered away, they will dry without cracking; but this often takes too long a time. I have discovered the following method of drying them, in a few days, without cracking. I have a malt kiln with a floor of laths two inches apart; I shank the cogs, hang them shank downwards, between the laths, cover them with a hair cloth, make a wood fire, and the smoke prevents them from cracking. Some dry them in an oven, which ruins them. Boards, planks, or scantling, are best dried in a kiln, covered so as to keep the smoke amongst them. Instead of a malt kiln, dig a cave in the side of a hill, 6 feet deep, 5 or 6 feet wide, with a post in each corner with plates on them, on which lay laths on edge, and pile the cogs on end, nearly perpendicular, so that the smoke can pass freely through, or amongst them. Cover them slightly with boards and earth, make a slow fire, and close up the sides, and renew the fire once a day, for 12 or 15 days they will then dry without cracking.

ARTICLE 136.

OF SHANKING, PUTTING IN, AND DRESSING OFF COGS.

Straighten one of the heart sides for the shank, make a pattern, the head 4 and shank 10 inches long, and 2 inches wide at the head, 1¾ at the point; lay it on the cog, scribe the shank and shoulders, for the head, saw in

and dress off the sides; make another pattern of the shank, without the head, to scribe the sides and dress off the backs by, laying it even with the face, which is to have no shoulder; take care in dressing them off, that the axe do not strike the shoulder; if it do, it will crack there in drying, (if they be green;) fit and drive them in the mortises exceedingly tight, with their shoulders foremost, when at work. When the cogs are all in, fix two pieces of scantling, for rests, to scribe the cogs by, one across the cog-pit, near the cogs, another in front of them; fix them firmly. Hold a pointed tool on the rest, and scribe for the length of the cogs, by turning the wheel, and saw them off $3\frac{1}{2}$ inches long; then move the rest close to them, and fix it firmly; find the pitch circle on the end of the cogs, and, by turning the wheel, describe it there.

Describe another line $\frac{1}{4}$th of an inch outside thereof, to set the compasses in to describe the face of the cogs by, and another at each side of the cogs to dress them to their width; then pitch the cogs by dividing them equally, so that, in stepping round, the compasses may end in the point where they began; describe a circle, in some particular place, with the pitch, that it may not be lost; these points must be as nearly as possible of a proper distance for the centre from the back of the cogs; find the cog to the back of which this point comes nearest, and set the compasses from that point to the back of the cog; with this distance set off the backs of all the cogs equally, on the circle, $\frac{1}{4}$th of an inch outside of the pitch circle, and from these points, last made, set off the thickness of the cogs, which should, in this case, be $1\frac{1}{8}$ inches.

Then describe the face and back of the cogs by setting the compasses in the hindmost point of one cog, and sweeping over the foremost point of another, for the face, and in the foremost point of one, sweeping over the hindmost of the other, for the back part; dress them off on all sides, tapering about $\frac{1}{8}$th of an inch, in an inch distance; try them by a gauge, to make them all alike; take a little off the corners, and they are finished.

ARTICLE 137.

OF THE LITTLE COG-WHEEL AND SHAFT.

The process of making this is similar to that of the big cog-wheel. Its dimensions we find by the table, and the same example (43,) to be 52 cogs, $4\frac{1}{4}$ pitch; diameter of pitch circle 5 feet $10\frac{1}{3}$ inches, and from out to out, 6 feet 6 inches.

It requires 2 arms, 6 feet 6 inches long, 11 by $3\frac{1}{4}$ inches; 8 cants, 5 feet 6 inches, 17 by $3\frac{1}{2}$ inches. (See it, fig. 4, Plate XVII.)

Of the Shaft.

Dress it 8 feet long, 14 by 14 inches square, and describe a circle on each end 14 inches diameter; strike two lines through the centre, parallel to the sides, and divide the quarters into 4 equal parts, each; strike lines across the centre at each part at the end of these lines; strike chalk lines from end to end, to hew off the corners by, and it will be 8 square; lay out the mortises for the arms, put on the bands, and put in the gudgeons, as with the big shaft.

ARTICLE 138.

DIRECTIONS FOR MAKING WALLOWERS AND TRUNDLES.

By example 43, in the table, the wallower is to have 26 rounds $4\frac{1}{2}$ pitch: the diameter of its pitch circle is 3 feet $1\frac{1}{4}$ inches, and 3 feet $4\frac{1}{4}$ inches from outsides: (see fig. 3, Plate XVII.) Its head should be $3\frac{1}{2}$ inches thick, doweled truly together, or made with double plank, crossing each other. Make the bands 3 inches wide, $\frac{1}{6}$th of an inch thick, evenly drawn; the heads must be made to suit the bands, by setting the compasses so that they will step round the inside of the band in 6 steps; with this distance sweep the head, allowing about $\frac{1}{10}$th of an inch outside, in dressing, to make such a large band tight. Make them hot alike all around with a chip fire, which swells the iron; put them on the head while hot, and cool them with water, to keep them from burning the wood too much,

but not too fast, lest they snap; the same mode serves for hooping all kinds of heads.

Dress the head fair after banding, and strike the pitch circle and divide it by the same pitch with the cogs; bore the holes for the rounds with an auger of at least $1\frac{1}{2}$ inches; make the rounds of the best wood, $2\frac{3}{8}$ inches diameter, and 11 inches between the shoulders, the tenons 4 inches, to fit the holes loosely, until within 1 inch of the shoulder, then drive it tight. Make the mortises for the shaft in the heads, with notches for the keys to hang it by. When the rounds are all driven into the shoulders, observe whether they stand straight; if not, they may be set fair by putting the wedges nearest to one side of the tenon, so that the strongest part may incline to draw them straight: this should be done with both heads.

ARTICLE 139.

OF FIXING THE HEAD-BLOCKS AND HANGING THE WHEELS.

The head-blocks, for the wallower shaft, are shown in Plate XVIII. Number 19 is one called a spur, 6 feet long and 15 inches deep, one end of which, at 19, is let 1 inch into the top of the husk-sill, which sill is $1\frac{1}{2}$ inches above the floor, the other end tenoned strongly into at strong post, 14 by 14 inches, 12 or 14 feet long, standing near the cog-wheel, on a sill in the bottom of the cog-pit; the top is tenoned into the husk-plank; these are called the tomkin posts. The other head-blocks appear at 20 and 28. In these large head-blocks there are small ones let in, that are 2 feet long, and 6 inches square, with a stone in each for the gudgeons to run on. That one in the spur 19 is made to slide, to put the wallower in and out of gear, by a lever screwed to its side.

Lay the centre of the little shaft level with the big one, so as to put the wallower to gear $\frac{2}{3}$ the thickness of the rounds deep, into the cog-wheel; put the shaft into its place, hang the wallower, and gauge the rounds to equal distance where the cogs take. Hang the cog-wheel,

put in the cogs, make the trundle as directed for the wallower. (See fig. 4, Plate XVII.)

ARTICLE 140.

DIRECTIONS FOR PUTTING IN THE BALANCE-RYNE.

Lay it in the eye of the stone, and fix it truly in the centre; to do which, make a sweep by putting a long pin through the end, to reach into, and fit, the pivot hole in the balance-ryne; by repeated trials on the opposite side, fix it in the centre; then make a particular mark on the sweep, and others to suit it on the stone, scribe round the horns, and with picks and chisels sink the mortises to their proper depth, trying, by the particular marks made for the purpose, by the sweep, if it be in the centre. Put in the spindle with the foot upwards, and the driver on its place, while one holds it plumb. Set the driver over two of the horns, if it has four, but between them if it has but two. When the neck is exactly in the centre of the stone, scribe round the horns of the driver, and let it into the stone, nearly to the balance, if it has four horns. Put the top of the spindle in the pivot-hole, to try whether the mortises let it down freely on both sides.

Make a tram, to set the spindle square by, as follows: take a piece of board, cut a notch in one side, at one end, and hang it on the top of the spindle, by a little peg in the shoulder of the notch, to go into the hole in the foot, to keep it on; let the other end reach down to the edge of the stone; take another piece, circle out one end to fit the spindle neck, and make the other end fast to the lower end of the hanging piece near the stone, so as to play round level with the face of the stone, resting on the centre-hole in the foot, and against the neck; put a bit of quill through the end of the level piece, that will touch the edge of the stone as it plays round. Make little wedges, and drive them in behind the horns of the driver, to keep both ends, at once, close to the sides of the mortises they bear against when at work, keeping the pivot or cock-head in its hole in the balance; try the tram gen-

tly round, and mark where the quill touches the stone first, and dress off the bearing sides of the mortises for the driver, until it will touch equally all round, giving the driver liberty to move endwise, and sidewise, so that the stone may rock an inch either way. The ryne and driver must be sunk $\frac{3}{4}$ths of an inch below the face of the stone. Then hang the trundle firmly and truly on the spindle; put it in its place, to gear in the little cog-wheel.

ARTICLE 141.

TO BRIDGE THE SPINDLE.

Make a little tram of a piece of lath, 3 inches wide at one end, and 1 inch at the other, make a mortise in the wide end, and put it on the cock-head, and a piece of quill in the small end, to play round the face of the stone: then, while one turns the trundle, another observes where the quill touches first, and alters the keys of the bridge-tree, driving the spindle-foot toward the part the quill touches, until it does so equally all round. Case the stone neatly round, within 2 inches of the face.

ARTICLE 142.

OF THE CRANE AND LIGHTER STAFF.

Make a crane, with a screw and bale, for taking up and putting down the stone. (See it represented in Plate XI., fig. 2 and 3.) Set the post out of the way as much as possible, let it be 9 by 6 inches in the middle, the arm 9 by 6, the brace 6 by 4; make a hole plumb over the spindle, for the screw; put an iron washer on the arm under the female screw, nail it fast; the length of the screw in the worm part should exceed half the diameter of the stone, and it should reach 10 inches below it; the bale must touch only at the ends to give the stone liberty to turn, the pins to be 7 inches long, $1\frac{1}{8}$ thick, the bale to be $2\frac{1}{2}$ inches wide in the middle, and $1\frac{3}{4}$ inches wide at the end; the whole should be made of the best

iron, for if either of them break, the danger would be great: the holes in the stone should be nearest to the upper side of it. Raise the runner by the crane, screw, and bale, turn it and lay it down, with the horns of the driving ryne in their right places, as marked, it being down, as it appears in Plate XXI., fig. 9. Make the lighter staff CC, to raise and lower the stone in grinding, about 6 feet long, $3\frac{1}{2}$ by $2\frac{1}{2}$ inches at the large end, and 2 inches square at the small end, with a knob on the upper side. Make a mortise through the but-end, for the bray-iron to pass through, which goes into a mortise 4 inches deep, in the end of the bray at b, and is fastened with a pin; it may be 2 inches wide and half an inch thick, made plain, with 1 hole at the lower, and 5 or 6 at the upper end; it should be set in a staggering position. This lighter is fixed in front of the meal-beam, at such a height as to be handy to raise and lower at pleasure; a weight of 4lbs. is hung to the end of it by a strap, which laps two or three times round, and the other end is fastened to the post below, that keeps it in its place. Play the lighter up and down, and observe whether the stone rises and falls flat on the bed-stone; if it do, draw a little water, and let the stone move gently round; then see that all things be right, and draw a little more water, let the stone run at a moderate rate, and grind the faces a few minutes.

ARTICLE 143.

DIRECTIONS FOR MAKING A HOOP FOR THE MILL-STONE.

Take a white pine or poplar board, 8 inches longer than will go round the stone, and 2 inches wider than the top of the stone is high, dress it smooth, and gauge it one inch thick, run a gauge mark $\frac{1}{6}$th of an inch from the outside, divide the length into 52 parts, and saw as many saw-gates square across the inside to the gauge-line. Take a board of equal width, 1 foot long, nail one-half of it on the outside at one end of the hoop, lay it in water a day or two to soak, or frequently sprinkle the out-

side with hot water, during an hour or two. Bend it round so that the ends meet, and nail the other end to the short board, put sticks across inside, in various directions, to press out the parts that bend least, and make it truly round. Make a cover for the hoop, (such as is represented in Plate XIX., fig. 23;) 8 square inside, and 1 inch outside the hoop. It consists of 8 pieces lapped one over another, the black lines showing the joints, as they appear when made, the dotted lines the under parts of the laps. Describe it on the floor, and make a pattern to make all the rest by; dress all the laps, fit and nail them together by the circle on the floor, and then nail it on the hoop; put the hoop over the stone and scribe it to fit the floor.

ARTICLE 144.

OF GRINDING SAND TO FACE THE STONES.

Lay boards over the hoop to keep the dust from flying, and take a bushel or two of dry, clean, sharp sand, teem it gently into the eye, while the stone moves at a moderate rate, continuing to grind for an hour or two; then take up the stones, sweep them clean, and pick the smoothest, hardest places, and lay the stone down again, and grind more sand as before, turning off the back, (if it be a burr,) taking great care that the chisel do not catch; take up the stone again, and make a red staff, equal, in length, to the diameter of the stone, and 3 by $2\frac{1}{2}$ inches; paint it with red paint and water, and rub it over the face of the stone in all directions, the red will be left on the highest and hardest parts, which must be picked down, making the bed-stone perfectly plain, and the runner a little concave, about $\frac{1}{6}$th of an inch at the eye, and lessening gradually to about 8 inches from the skirt. If they be close, and have much face, they need not touch, or flour, so far as if they be open, and have but little face; those things are necessarily left to the judgment of the mill-wright and miller.

ARTICLE 145.

DIRECTIONS FOR LAYING OUT THE FURROWS IN THE STONES, &c.

If they be five feet in diameter, divide the skirt into 16 equal parts, called quarters; if 6 feet, into 18; if 7 feet, into 20 quarters. Make two strips of board, one an inch, and the other 2 inches wide; stand with your face to the eye, and if the stone turn to the right when at work, lay the strip at one of the quarter divisions, and the other at the left hand side close to the eye, and mark with a flat pointed spike for a master furrow; they are all to be laid out the same way in both stones, for when their faces are together, the furrows should cross each other, like shears in the best position for cutting cloth. Then, having not fewer than 6 good picks, proceed to pick out all the master furrows, making the edge next the skirt and the end next the eye, the deepest, and the feather edge not half so deep as the back.

When all the master furrows are picked out, lay the broad strip next to the feather edges of all the furrows, and mark the head lands of the short furrows, then lay the same strip next the back edges, and mark for the lands, and lay the narrow strip, and mark for the furrows, and so mark out all the lands and furrows, minding not to cross the head lands, but leaving it between the master furrows and the short ones of each quarter. But if they be close country stones, lay out both furrows and lands with the narrow strip.

The neck of the spindle must not be wedged too tight, else it will burn loose; bridge the spindle again; put a collar round the spindle neck, but under it put a piece of an old stocking, with tallow rolled up in it, about a finger thick; tack it closely round the neck; put a piece of stiff leather about 6 inches diameter on the cock-head under the driver, to turn with the spindle and drive off the grain, &c., from the neck; grease the neck with tallow every time the stone is up.

Lay the stone down and turn off the back smooth, and

grind more sand. Stop the mill, raise the stone a little, and balance it truly with a weight laid on the lightest side. Take lead equal to this weight, melt it, and run it into a hole made in the same place in the plaster; this hole should be largest at bottom to keep it in; fill the hole with the plaster, take up the runner again, try the staff over the stones, and if in good face, give them a nice dressing, and lay them down to grind wheat.

ARTICLE 146.

DIRECTIONS FOR MAKING A HOPPER, SHOE, AND FEEDER.

The dimensions of the hopper of a common mill is 4 feet at the top, and 2 feet deep, the hole in the bottom 3 inches square, with a sliding gate in the bottom of the front to lessen it at pleasure: the shoe 10 inches long, and 5 wide in the bottom, of good sound oak. The side 7 or 8 inches deep at the hinder end, 3 inches at the foremost end, 6 longer than the bottom of the fore end, slanting more than the hopper behind, so that it may have liberty to hang down 3 or 4 inches at the fore end, which is hung by a strap called the feeding-string, passing over the fore end of the hopper-frame, and lapping round a pin in front of the meal-beam, which pin will turn by the hand, and which is called the feeding-screw.

The feeder is a piece of wood turned in a lathe, about 20 inches long, 3 inches diameter in the middle, against the shoe, tapered off to 1½ inches at the top; the lower end is banded, and a forked iron driven in it, that spans over the ryne, fitting into notches made on each side, to receive it, directly above the spindle, with which it turns, the upper end running in a hole in a piece across the hopper-frame. In the large part, next the shoe, 6 iron knockers are set, 7 inches long, half an inch diameter, with a tang at each end, turned square to drive into the wood, these knock against and shake the shoe, and thereby shake in the grain regularly.

You may now put the grain into the hopper, draw wa-

ter on the mill, and regulate the feed by turning the feed screw, until the stream falling into the eye of the stone, be proportioned to the size thereof, or the power of the mill. Here ends the mill-wright's work, with respect to grinding, and the miller takes the charge thereof.

ARTICLE 147.

OF BOLTING CHESTS AND REELS.

Bolting chests and reels are of different lengths, according to the use for which they are intended. Common country chests (a top view of one of which is shown in Plate XIX., fig. 9,) are usually about 10 feet long, 3 feet wide, and 7 feet 4 inches high, with a post in each corner; the bottom 2 feet from the floor, with a board 18 inches wide, set slanting in the back side, to cast the meal forward in the chest, that it may be easily taken up; the door is of the whole length of the chest, and two feet wide, the bottom board below the door sixteen inches wide.

The shaft of the reel is equal in length with the chest, 4 inches diameter, 6 square, two bands on each end, $3\frac{1}{4}$ and $3\frac{3}{4}$ inches diameter; gudgeons 13 inches long, $\frac{7}{8}$ of an inch diameter, 8 inches in the shaft, rounded at the neck $2\frac{1}{2}$ inches, with a tenon for a socket, or handle; there are six ribs $1\frac{1}{2}$ inch deep, $1\frac{1}{8}$ inch thick, $\frac{1}{2}$ an inch at the tail, and $1\frac{1}{2}$ inch at the head, shorter than the shaft, to leave room for the meal to be spouted in at the head, and the bran to fall out at the tail; there are four sets of arms, that is, 12 of them, $1\frac{1}{2}$ inches wide, and $\frac{5}{8}$ thick. The diameter of the reel from out to out of the ribs, is one-third part of the double width of the cloth. A round wheel, made of inch boards, in diameter equal to the outside of the ribs, and $4\frac{1}{2}$ inches wide, measuring from the outside towards the centre, (which is taken out,) is to be framed to the head of the reel, to keep the meal from falling out at the head, unbolted. Put a hoop $4\frac{1}{4}$ inches wide, and $\frac{1}{4}$ thick, round the tail,

to fasten the cloth to. The cloth is sewed, two widths of it together, to reach round the reel, putting a strip of strong linen, 7 inches wide at the head, and 5 inches at the tail of the cloth, by which to fasten it to the reel. Paste on each rib a strip of linen, soft paper, or chamois leather (which is the best) 1½ inches wide, to keep the cloth from fretting. Then put the cloth on the reel tight, sew or nail it to the tail, and stretch it lengthwise as hard as it will bear, nailing it to the head.—Six yards of cloth cover a ten feet reel.

Bolting reels for merchant mills are generally longer than for country work, and every part should be stronger in proportion. They are best when made to suit the wide cloths. The socket gudgeons at the head should be much stronger, they being apt to wear out, and troublesome to repair.

The bolting-hopper is made to pass through the floor above the chest, is 12 inches square at the upper, and 10 inches at the lower end; the foremost side 5 inches, and the back side 7 inches from the top of the chest.

The shoe 2 feet long at the bottom of the side pieces, slanting to suit the hopper at the hinder end, set 4 inches higher at the hinder than the fore end, the bottom 17 inches long, and 10 inches wide. There should be a bow of iron riveted to the fore end, to rest on the top of the knocking wheel, which is fixed on the socket gudgeon at the head of the chest, and is 10 inches diameter, 2 inches thick, with 6 half rounds, cut out of its circumference, forming knockers to strike against the bow, and lift the shoe ¾ of an inch every stroke, to shake in the meal.

ARTICLE 148.

OF SETTING BOLTS TO GO BY WATER.

The bolting reels are set to go by water as follows:—

Make a bridge 6 by 4 inches, and 4 inches longer than the distance of the tomkin post, described Art. 139; set it between them, on rests fastened into them 10 inches below the cogs of the cog-wheel, and the centre of it half the diameter of the spur-wheel in front of them; on this

bridge is set the step gudgeon of an upright shaft, with a spur-wheel of 16 or 18 cogs to gear into the cog-wheel. Fix a head-block to the joists of the 3d floor for the upper end of this shaft; put the wheel 28, (Pl. XIX.) on it; hang another head-block to the joists of the 2d floor, near the corner of the mill at 6, for the step of the short upright shaft that is to be fixed there, to turn the reels 1 and 9. Hang another head-block to the joists of the 3d floor, for the upper end of the said short upright, and fix also head-blocks for the short shaft at the head of the reels, so that the centres of all these shafts will meet. Then fix a hanging post in the corner 5, for the gudgeon of the long horizontal shaft 27—5 to run in. After the head-blocks are all fixed, then measure the length of each shaft, and make them as follows; namely:—

The upright shaft 5½ inches for common mills, but if for merchant-work, with Evans' elevators, &c., added, make it larger, say 6 or 7 inches; the horizontal shaft 27—5, and all the others 5 inches diameter. Put a socket-gudgeon in the middle of the long shafts, to keep them steady; make them 8, or 16, square, except at the end where the wheels are hung, where they must be 4 square. Band their ends, put in the gudgeons, and put them in their proper places in the head-blocks, to mark where the wheels are to be put on them.

ARTICLE 149.

OF MAKING BOLTING WHEELS.

Make the spur wheel for the first upright, with a 4½ inch plank; the pitch of the cogs, the same as the cog-wheel, into which it is to work; put two bands ¾ of an inch wide, one on each side of the cogs, and a rivet between each cog, to keep the wheel from splitting.

To proportion the cogs in the wheels, to give the bolts the right motion, the common way is—

Hang the spur-wheel, and set the stones to grind with a proper motion, and count the revolutions of the upright shaft in a minute; compare its revolutions with the revolutions that a bolt should have, which is about 36 revo-

lutions in a minute. If the upright go $\frac{1}{8}$ more, put $\frac{1}{8}$ less in the first driving-wheel than in the leader, suppose 15 in the driver, then 18 in the leadere but if their difference be more, (say one-half,) there must be a difference in the next two wheels; observing that if the motion of the upright shaft he greater than that of the bolt should be, the driving-wheel must be proportionably less than the leader; but if it be slower, then the driver must be greater in proportion. The common size of bolting wheels is from 14 to 20 cogs; if less than 14, the head-blocks will be too near the shafts.

Common bolting wheels should be made of plank, at least 3 inches thick, well seasoned, and they are best when as wide as the diameter of the wheel, and banded with bands nearly as wide as the thickness of the wheel; the bands may be made of rolled iron, about $\frac{1}{8}$ of an inch thick. Some make the wheels of 2 inch plank, crossed, and no bands; but this proves no saving, as they are apt to go to pieces in a few years. (For hooping wheels, see Art. 136, and for finding the diameter of the pitch circle, see Art. 126.) The wheels, if banded, are generally two inches more in diameter than the pitch circle; but if not, they should be larger. The pitch or distances of the cogs are different; if to turn 1 or 2 bolts, $2\frac{1}{2}$ inches; but if more $2\frac{3}{4}$; if they are to do much heavy work, they should not be less than 3 inches. Their cogs, in thickness, are half the pitch; the shank must drive tightly in an inch auger hole.

When the mortises are made for the shafts in the head, and notches for the keys to hang them, drive the cogs in and pin their shanks at the back side, and cut them off half an inch from the wheel.

Hang the wheels on the shafts so that they will gear a proper depth, about $\frac{2}{3}$ the thickness of the cogs; dress all the cogs toeequal distances by a gauge; then put the shafts in their places, the wheels gearing properly, and the head-blocks all secure; set them in motion by water. Bolting reels should turn so as to drop the meal on the back side of the chest, as it will then hold more, and will not cast out the meal when the door is opened.

ARTICLE 150.

OF ROLLING-SCREENS.

These are circular sieves moved by water, and are particularly useful in cleaning wheat for merchant-work. They are of different constructions.

1st. Those of one coat of wire with a screw in them.

2dly. Those of two coats, the inner one nailed to six ribs, the outer one having a screw between it and the inner one.

3dly. Those of a single coat, and no screw.

The first kind answers well in some, but not in all cases, because they must turn a certain number of times before the wheat can get out, and the grain has not so good an opportunity of separating; there being nothing to change its position, it floats a considerable distance with the same grains uppermost.

The double kinds are better, because they may be shorter, and take up less room; but they are more difficult to keep clean.

The 3d kind has this advantage; we can keep the grain in them a longer or shorter time, at pleasure, by raising or lowering the tail end, and it is also tossed about more; but they must be longer. They are generally 9 or 10 feet long, 2 feet 4 inches diameter, if to clean for two or three pairs of stones; but if for more, they should be larger accordingly: they will clean for, from one, to six pairs of stones. They are made 6 square, with 6 ribs, which lie flatwise, the outer corners taken off to leave the edges $\frac{1}{4}$ of an inch thick; the inner corners are brought nearly to sharp edges; the wire work is nailed on with 14 ounce tacks.

The screens are generally moved by the same upright shaft that moves the bolts, which has a wheel on its upper end, with two sets of cogs: those that strike downwards, gear into a wheel striking upwards, which turns a laying shaft, having two pulleys on the other end, one of 24 inches diameter, to turn a fan with a quick motion, the other of 8 inches, which conducts a strap to a pulley

24 inches diameter, on the gudgeon of the rolling screen, to reduce its motion to about 15 revolutions in a minute. (See fig. 19, Plate XIX.) This strap gearing may do for mills in a small way, but where they are in perfection for merchant-work, with elevators, &c., and have to clean wheat for 2, 3, or 4 pairs of stones, they should be moved by cogs.

ARTICLE 151.

OF FANS.

The Dutch fan is a machine of great use, for blowing the dust and other light stuff from among the wheat; there are various sorts of them; those that are only for blowing the wheat, as it falls from the rolling-screen, are generally about 15 inches long, and 14 inches wide, in the wings, and have no riddle or screen in them.

To give motion to a fan of this kind, put a pulley 7 inches diameter, on its axle, to receive a band from a pulley on the shaft that moves the screen, which pulley may be of 24 inches diameter, to give a swift motion; when the band is slack it slips a little on the small pulley, and the motion is retarded, but when tight the motion is quicker; by this the blast is regulated.

Some use Dutch fans complete, with riddle and screen under the rolling screen, for merchant-work; and again use the fan alone for country-work.

The wings of those which are the common farmers' wind-mills, or fans, are 18 inches long, and 20 inches wide; but in mills they are set in motion with a pulley instead of a cog-wheel and wallower.

ARTICLE 152.

OF THE SHAKING SIEVE.

Shaking sieves are of considerable use in country mills, to sift Indian meal, separating it, if required, into seve-

ral degrees of fineness; and to take the hulls out of buckwheat meal, which are apt to cut the bolting cloth; also, to take the dust out of the grain, if rubbed before ground; they are sometimes used to clean wheat, or screenings, instead of rolling screens.

If they are for sifting meal, they are 3 feet 6 inches long, 9 inches wide, 3½ inches deep; (see it fig. 16, Plate XVIII.) The wire-work is 3 feet long and 8 inches wide: across the bottom of the tail end is a board 6 inches wide, to the top of which the wire is tacked, and then this board and wire are tacked to the bottom of the frame, leaving an opening at the tail end for the bran to fall into the box 17, the meal falling into the meal-trough 15; the head piece should be strong, to hold the iron bow at 15, through which the lever passes that shakes the sieve, which is effected in the following manner. Take two pieces of hard wood, 15 inches long, and as wide as the spindle, and so thick that when one is put on each side just above the trundle, it will make it 1½ inches thicker than the spindle is wide. The corners of these are taken off to a half round, and they are tied to the spindle with a small, strong cord. These are to strike against the lever that works on a pin near its centre, which is fastened to the sieve, and shakes it as the trundle goes round; (see it represented Plate XVIII.) This lever must always be put to theeside of the spindle, contrary to that of the meal-spout; otherwise, it will draw the meal to the upper end of the sievee there must be a spring fixed to the sieve to draw it forward as often as it is driven back. It must hang on straps and be fixed so as to be easily set to any descent required, by means of a roller in the form of a feeding screw, only longer; round this roller the strap winds.

I have now given directions for making, and putting to work, all the machinery of one of the most complete of the old-fashioned grist-mills, that may do merchant-work in the small way; these are represented by Plates XVIII., XIX., XX., XXI.; but they are far inferior to those with the improvements, which are shown by Plate XXII.