that if the velocity of the wheel is one third of that of the stream, and if seventy-two degrees of the circumference are immersed in the stream, the wheel should have thirty-six floats. Each will dip one fifth of the radius. The velocity being still supposed the same, there should be more or fewer floats according as the arch is less or greater than seventy- two degrees.

Such is the theory, and such are the circumstances which it leaves undetermined. The accumulation of the water on a float-board, and the force with which it may still strike another, are too intricate to be assigned with any tolerable precision : for such reasons we must acknowledge that the theory of undershot wheels is still very imperfect, and that recourse must be had to experience for their improvement. We therefore strongly recommend the perusal of Mr Smea­ton’s experiments on undershot wheels, contained in the same dissertation with those which we have quoted on over­shot wheels. We have only to observe, that to an ordinary reader the experiments will appear too much in favour of undershot wheels. His aim is partly to establish a theory, which will state the relation between their performance and the velocity of the stream, and partly to state the relation between the power expended and the work done. The velocity in his experiments is always considerably below that which a body would acquire by falling from the surface of the head of water ; or it is the velocity acquired by a shorter fall. Therefore if we estimate the power expended by the quantity of water multiplied by this diminished fall, we shall make it too small, and the difference in some cases is very great ; yet, even with these concessions, it appears that the utmost performance of an undershot wheel does not surpass the raising one third of the expended water to the place from which it came. It is therefore far inferior to an overshot wheel expending the same power ; and Μ. Belidor has led engineers into very mistaken maxims of construction, by saying that overshot wheels should be given up, even in the case of great falls, and that we should always bring on the water from a sluice in the very bottom of the dam, and bring it to the wheel with as great a velocity as possible. Mr Smeaton also says, that the maximum takes place when the velocity of the wheel is two fifths of that of the stream, instead of two sixths according to the theory ; and this agrees with the experiments of Bossut. But he measured the velocity by means of the quantity of water which ran past. This must give a velocity somewhat too small, as will appear by attending to Du Buat’s observations on the superficial, the mean, and the bottom velocities.

The rest of his observations are most judicious, and well adapted to the instruction of practitioners. We have only to add to them the observations of De Parcieux and Bossut, who have evinced, by very good experiments, that there is a very sensible advantage gained by inclining the float-boards to the radius of the wheel about twenty degrees, so that the lowest float-board shall not be perpendicular, but have its point turned up the stream about twenty degrees. This inclination causes the water to heap up along the float-board, and act by its weight. The floats should therefore be made much broader than the vein of water interrupted by them is deep.

Some engineers, observing the great superiority of over­shot wheels above undershot wheels driven by the same expense of power, have proposed to bring the water home to the bottom of the wheel on an even bottom, and to make the float-board no deeper than the aperture of the sluice, which would permit the water to run out. The wheel is to be fitted with a close sole and sides, exactly fitted to the end of this trough, so that if the wheel is at rest, the water may be dammed up by the sole and float-board. It will therefore press forward the float-board with the whole force of the head of water. But this cannot answer; for if we suppose no float-boards, the water will flow out at the bot­

tom, propelled in the manner those persons suppose ; and it will be supplied from behind, the water coming *slowly* from all parts of the trough to the hole below the wheel. But now add the floats, and suppose the wheel in motion with the velocity that is expected. The other floats must drag into motion all the water which lies between them, giving to the greatest part of it a motion vastly greater than it would have taken in consequence of the pressure of the water behind it ; and the water out of the reach of the floats will remain still, which it would not have done independent­ly of the float-boards above it, because it would have contri­buted to the expense of the hole. The motion therefore which the wheel will acquire by this construction must be so different from what is expected, that we can hardly say what it will be.

We are therefore persuaded that the best way of deliver­ing the water on an undershot wheel in a close mill-course is, to let it slide down a very smooth channel, without touching the wheel till near the bottom, where the wheel should be exactly fitted to the course ; or to make the floats exceedingly broader than the depth of the vein of water which glides down the course, and allow it to be partly in­tercepted by the first floats, and heap up along them, acting by its weight after its impulse has been expended. If the bottom of the course be an arch of a circle described with a radius much greater than that of the wheel, the water which slides down will be thus gradually intercepted by the floats.

Attempts have been made to construct water-wheels which receive the impulse obliquely, like the sails of a com­mon wind-mill. This would, in many situations, be a very great acquisition. A very slow but deep river could in this manner be made to drive our mills ; and although much power is lost by the obliquity of the impulse, the remainder may be very great. It is to be regretted that these at­tempts have not been more zealously prosecuted ; for we have no doubt of their success in a very serviceable degree. Engineers have been deterred, because when such wheels are plunged in an open stream, their lateral motion is too much impeded by the motion of the stream. We have however seen one which was very powerful. It was a long cylindrical frame, having a plate standing out from it about a foot broad, and surrounding it with a very oblique spiral like a cork-screw. This was plunged about one fourth of its diameter (which was about twelve feet), having its axis in the direction of the stream. By the work which it was performing, it seemed more powerful than a common wheel which occupied the same *breadth* of the river. Its length was not less than twenty feet : it might have been twice as much, which would have doubled its power, without occu­pying more of the water-way. Perhaps such a spiral, con­tinued to the very axis, and moving in a hollow canal wholly filled by the stream, might be a very advantageous way of employing a deep and slow stream.

But mills with oblique floats are most useful for employ­ing small streams, which can be delivered from a spout with a great velocity. Bossut has considered these with due attention, and ascertained the best modes of construction. There are two which have nearly equal performances.

1. The vanes being placed like those of a wind-mill, round the rim of a horizontal or vertical wheel, and being made much broader than the vein of water which is to strike them, let the spout be so directed that the vein may strike them perpendicularly. By this measure it will be spread about on the vane in a thin sheet, and exert a pressure nearly equal to twice the weight of a column whose base is the orifice of the spout, and whose height is the fall producing the velocity. Mills of this kin<l are much in use in the south of Europe. The wheel is horizontal, and the vertical axis carries the mill­stone; so that the mill is of the utmost simplicity: and