wheel round would be the same as that of the water lying in the bucket BD. The same may be said of every bucket ; and the effective pressure of the whole ring of water A *f* HKFI, in its natural situation, is the same with the pillar of water *a h ha* hung on at F. And the effect of any portion BF of this ring is the same with that of the corresponding portion *b* F *f b of* the vertical pillar. We do not take into account the small difference which arises from the depth Bβ or F *f,* because we may suppose the circle described through the centres of gravity of the buckets. And in the further prosecution of this subject, we shall take similar liberties, with the view of simplifying the subject, and sav­ing time to the reader.

But such a state of the wheel is impossible. The bucket at the very top of the wheel may be completely filled with water ; but when it comes into the oblique position BD, a part of the water must run over the outer edge ∂, and the bucket will only retain the quantity ZBD 3 ; and if the buckets are formed by partitions directed to the axis of the wheel, the whole water must be run out by the time that they descend to the level of the axis. To prevent this, many contrivances have been adopted. The wheel has been surrounded with a hoop or sweep, consisting of a cir­cular board, which comes almost into contact with the rim of the wheel, and terminates at H, where the water is al­lowed to run off. But unless the work is executed with uncommon accuracy, the wheel made exactly round, and the sweep exactly fitting it, a great quantity of water escapes between them ; and there is a very sensible obstruction to the motion of such a wheel, from something like friction between the water and the sweep. Frost also effectually stops the motion of such a wheel. Sweeps have therefore been generally laid aside, although there are situations where they might be used with good effect.

Mill-wrights have turned their whole attention to the giving a form to the buckets which shall enable them to retain the water along a great portion of the circumference of the wheel. It would be endless to describe all these contrivances ; and we shall therefore content ourselves with one or two of the most approved. The intelligent reader will readily see that many of the circumstances which con­cur in producing the ultimate effect (such as the facility with which the water is received into the buckets, the place which it is to occupy during the progress of the bucket from the top to the bottom of the wheel, the readiness with which they are evacuated, or the chance that the water has of be­ing dragged beyond the bottom of the wheel by its adhe­sion, &c. &c.) are such as do not admit of precise calcula­tion on reasoning about their merits ; and that this or that form can seldom be evidently demonstrated to be the very best possible. But, at the same time, he will see the gene­ral reasons of preference, and his attention will be directed to circumstances which must be attended to in order to have a good bucketed wheel.

Fig. 6 is the outline of a wheel having forty buckets. The ring of board contained between the con­centric circles QDS and PAR, making the ends of the buckets, is called the Shrouding, in the lan­guage of the art, and QP is called the *depth of shrouding.* The inner circle PAR is called the sole of the wheel, and usually consists of boards nailed to strong wooden rings of compass-timber of consi­derable scantling, firmly united with the arms or radii. The par­titions which determine the form of the buckets consist of three dif­ferent planes or boards AB, BC,

CD, which are variously named by different artists. We have heard them named the start or shoulder, the arm, and the wrest (probably for wrist, on account of a resemblance of the whole line to the human arm) ; B is also called the elbow. Fig. 7 represents a small portion of the same bucketing on a larger scale, that the proportions of the parts may be more dis­tinctly seen. AG, the sole of one bucket, is made about 1/5th more than the depth GH of the shrouding. The start AB is ½ of AI. The plane BC is so inclined to AB that it would pass through H ; but it is made to ter­minate in C, in such a manner that FC is 5/6ths of GH or AI Then CD is so placed that HD is about 1/5th of IH.

By this construction, it follows that the area FABC is very nearly equal to DABC ; so that the water which will fill the space FABC will all be contained in the bucket when it shall come into such a position that AD is a hori­zontal line ; and the line AB will then make an angle of nearly 35° with the vertical, or the bucket will be 35° from the perpendicular. If the bucket descend so much lower that one half of the water runs out, the line AB will make an angle of 25°, or 24° nearly, with the vertical. There­fore the wheel, filled to the degree now mentioned, will *begin* to lose water at about 1/8th of the diameter from the bottom, and *half of the water will be discharged* from the lowest bucket, about 1/24th of the diameter farther down. These situations of the discharging bucket are marked at T and V in fig. 6. Had a greater proportion of the buckets been filled with water when they were under the spout, the discharge would have begun at a greater height from the bottom, and we should lose a greater portion of the whole fall of water. The loss by the present construction is less than 1/10th (supposing the water to be delivered into the wheel at the very top), and may be estimated at about 1/12th ; for the loss is the versed sine of the angle which the radius of the bucket makes with the vertical. The versed sine of 35° is nearly ]th of the radius (being 0∙18085), or 1/10th of the diameter. It is evident that if only ½ of this water were supplied to each bucket as it passes the spout, it would have been retained for 10° more of a revolution, and the loss of fall would have been only about 1/18th.

These observations serve to show, in general, that an advantage is gained by having the buckets so capacious that the quantity of water which each can receive as it passes the spout may not nearly fill it. This may be accomplished by making them of a sufficient length, that is, by making the wheel sufficiently broad between the two shroudings. Economy is the only objection to this practice, and it is generally very ill placed. When the work to be performed by the wheel is great, the addition of power gained by a greater breadth will soon compensate for the additional ex­pense.

The third plane CD is not very frequent, and mill-wrights generally content themselves with continuing the board all the way from the elbow B to the outer edge of the wheel at H ; and AB is generally no more than one third of the depth AI. But CD is a very evident improvement, caus­ing the wheel to retain a very sensible addition to the water. Some indeed make this addition more considerable, by bringing BC more outward, so as to meet the rim of the wheel at H, for instance, and making HD coincide with the rim. But this makes the entry of the water somewhat more difficult during the very short time that the opening of the bucket passes the spout. To facilitate this as much as possible, the water should get a direction from the spout, such as will send it into the buckets in the most perfect manner. This may be obtained by delivering water through an aperture that is divided by thin plates of board or metal,