placed in the proper position, as we have represented in fig. 6. The form of bucket last mentioned, having the wrest concentric with the rim, is unfavourable to the ready admission of the water ; whereas an oblique wrest conducts the water which has missed one bucket into the next below.

The mechanical consideration of this subject also shows us that a deep shrouding, in order to make a capacious bucket, is not a good method : it does not make the buckets retain their water any longer, and it diminishes the effec­tive fall of water ; for the water received at the top of the wheel immediately falls to the bottom of the bucket, and thus shortens the fictitious pillar of water, which we showed to be the measure of the effective or useful pressure on the wheel : and this concurs with our former reasons for recom­mending as great a breadth of the wheel, and length of buckets, as economical considerations will permit.

A bucket-wheel was some time ago executed by Mr Robert Burns, at the cotton-mills of Houston, of a construction en­tirely new, but founded on a good principle, which is suscep­tible of great extension. It is re­presented in fig. 8. The bucket consists of a start AB, an arm BC, and a wrest CD, con­centric with the rim. But the bucket is also divided by a partition LM, concentric with the sole and rim, and so placed as to make the inner and outer portions of nearly equal ca­pacity. It is evident, without any further reasoning about it, that this partition will enable the bucket to retain its water much longer. When they are filled one third, they retain the whole water at 18° from the bottom, and they retain one half at 11°. They do not admit the water quite so freely as buckets of the common construction ; but by means of thc contrivance mentioned a little ago for the spout (also the invention of Mr Bums, and furnished with a rack-work, which raised or depressed it as the supply of water varied, so as at all times to employ the whole fall of the water), it is found that a slow moving wheel allows one half of the water to get into the inner buckets, especially if the partition do not altogether reach the radius drawn through the lip D of the outer bucket.

This is a very great improvement of the bucket-wheel ; and when the wheel is made of a liberal breadth, so that the water may be very shallow in the buckets, it seems to carry the performance as far as it can go. Mr Burns made the first trial on a wheel of twenty-four feet diameter ; and its performance is manifestly superior to that of the wheel which it replaced, and which was a very good one. It has also another valuable property : when the supply of water is very scanty, a proper adjustment of the apparatus in the spout will direct almost the whole of the water into the outer buckets, which, by placing it at a greater distance from the axis, makes a very sensible addition to its me­chanical energy.

We said that this principle is susceptible of considerable extension ; and it is evident that two partitions will increase the effect, and that it will increase with the number of partitions ; so that when the practice now begun, of making water-wheels of iron, shall become general, and therefore very thin partitions are used, their number may be greatly increased without any inconvenience, and it is obvious that this series of partitions must greatly contribute to the stiff­ness and general firmness of the whole wheel.

There frequently occurs a difficulty in the making of bucket-wheels, when the half-taught mill-wright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account lor, and spills all about, even when the buckets are not moving away from the spout. This arises from the air, which must find its way out to admit the water, but is ob­structed by the entering water, and occasions a great splut­tering at the entry. This may be entirely prevented by making the spout considerably narrower than the wheel, which will leave room at the two ends of the buckets for the escape of the air. This obstruction is vastly greater than one would imagine, for the water drags along with it a great quantity of air, as is evident in the *water-blast* described by many authors.

There is another and very serious obstruction to the mo­tion of an overshot or bucketed wheel. When it moves in back-water, it is not only resisted by the water when it moves more slowly than the wheel, which is very frequently the case, but it lifts a great deal in the rising buckets. In some particular states of back-water, the descending bucket fills itself completely with water, and in other cases it con­tains a very considerable quantity, and air of common den­sity ; while in some rarer cases it contains less water, with air in a condensed state. In the first case the rising bucket must come up filled with water,' which it cannot drop till its mouth get out of the water. In the second case, part of the water goes out before this, but the air rarefies, and therefore there is still some water dragged or lifted up by the wheel, by suction, as it is usually called. In the last case there is no such back-load on the rising side of the wheel, but (which is as detrimental to its performance) the descending side is employed in condensing air ; and al­though this air aids the ascent of the rising side, it does not aid it so much as it impedes the descending side, being (by the form of thc bucket) nearer to the vertical line drawn through the axis.

All this may be completely prevented by a few holes made in the start of each bucket. Air being at least 800 times rarer than water, will escape through a hole almost thirty times faster with the same pressure. Very moderate holes will therefore suffice for this purpose ; and the small quantity of water which these holes discharge during the descent of the buckets, produces a loss which is altogether insignificant. The water which runs out of one runs into another, so that there is only the loss of one bucket. We have seen a wheel of only fourteen feet diameter working in nearly three feet of back-water. It laboured prodigiously, and brought up a great load of water, which fell from it in abrupt dashes, rendering the motion very hobbling. When three holes of an inch diameter were made in each bucket (twelve feet long), the wheel laboured no more, there was no more plunging of water from its rising side, and its power on the machinery was increased more than one fourth.

These practical observations may contain information that is new even to several experienced mill-wrights. To persons less informed they cannot fail of being useful. We now proceed to consider the action of water thus lying in the buckets of a wheel, and to ascertain its energy as it may be modified by different circumstances of fall, velocity, &c.

With respect to variations in the fall, there can be little room for discussion. Since the active pressure is measured by the pillar of water reaching from the horizontal plane where it is delivered on the wheel, to the horizontal plane where it is spilled by the wheel, it is evident that it must be proportional to this pillar, and therefore we must deliver it as high and retain it as long as possible.

This maxim obliges us, in the first place, to use a wheel whose diameter is equal to the whole fall. We shall not gain any thing by employing a larger wheel ; for although we should gain by using only that part of the circumference where the weight will act more perpendicularly to the ra­dius, we shall lose more by the necessity of discharging the water at a greater height from the bottom : for we must suppose the buckets of both the wheels equally well con­structed ; in which case, the heights above the bottom where