floats parallel to their face, or at any angle reverse to the motion of the wheel, is lost.

This rebounding action becomes less as the columns of water projected upon the wheel are increased in number and diminished in size.

To meet the conditions of rotation in the wheel, and to facilitate the escape of the water without dragging, after it has expended its force upon the vanes, the reversed curves of the turbine arrangement become necessary. Keeping these general principles in view, the apprentice will be able to understand in general the construction of impact wheels.

The modern turbine has been the subject of the most careful investigation by able engineers, and there is no lack of mathematical data to be referred to and studied after the general principles are understood. It is a subject of great complicity, if followed to detail, and, perhaps, less useful to a mechanical engineer, who does not intend to confine his practice to water wheels, than other subjects that may be studied with more advantage. The subject of water wheels may be called an exhausted one, that can promise but little return for labour spent upon it with a view to improvements; the efforts of the ablest hydraulic engineers have not added much to the percentage of useful effect realised by turbine wheels during fifteen years past, and their present performance is quite equal to anything that can be hoped for in future.

This matter is alluded to for the reason that in choosing any particular branch for a special study, an apprentice should select such as are least perfect, and present the best chance for improvement, instead of such things as there is every reason to believe have reached a reasonable state of perfection, and are in future to remain substantially the same. The last statement of course applies only to a few branches in the engineering arts, and perhaps more fully to water wheels than to any other

Reaction wheels are used only to a limited extent, and will soon, no doubt, become extinct as a class of water wheels. In speaking of them, I will select what is known as Barker's mill for an example, because of the familiarity with which it is known, although its construction is greatly at variance with modern reaction wheels. A query as to the principle of action in a Barker wheel, while it may be very clear in a scientific sense, still remains a puzzle to the minds of many who are well versed in mechanics, some contending that the power is directly from pressure, others that it is from the dynamical effect due to reaction. It is one of the problems so difficult to determine by ordinary standards, that it serves for endless debate between those who hold to different views; and, considering the advantage that is derived from such controversies, perhaps, the most useful manner of disposing of the problem here is to state the two sides as clearly as possible, and leave the reader to determine for himself which he thinks right and which wrong.

Presuming the vertical shaft and the horizontal arms of a Barker wheel to be filled with water under a head of 16 ft., there would be a pressure of about 7 lb. upon each inch of surface within the cross arm exerting an equal force in every direction By opening an orifice at the sides of these arms equal to 1 in of area, the pressure would at that point be relieved by the escape of the water, and the internal pressure be unbalanced to that extent. In other words, opposite this orifice, and on the other sides of the arm, there would be a force of 7 lb. that was not balanced, and would act as a propelling force in turning the wheel.

This is one theory of the principle upon which the Barker wheel acts, that has been laid down in "Vodges' Mensuration," and perhaps elsewhere, as an explanation. The opposing theory is that, direct action and reaction being equal, ponderable matter discharged tangentally from the periphery of a wheel must create a reactive force equal to the direct force with which the weight is thrown off To state it more plainly, the spouting water that issues from the arm of a Barker wheel must react in the opposite course in proportion to its weight.

The two propositions may be consistent with each other and even identical, but there still remains an apparent difference. The latter seems a plausible theory, and perhaps a correct one; but there are two facts in connection with the operation of reaction water wheels that seem to controvert the latter and favour the first theory, namely, that reaction wheels seldom utilise more than 40 per cent. of useful effect from the water, and that their speed may *exceed the initial velocity of the water.* With this the subject is left as one for argument and investigation on the part of those who choose to consider it.

Pressure wheels, like gravity wheels, would, upon theoretical inference, be expected to give a high per cent. of power, the water resting with the whole of its weight against the vanes or abutments, and without chance of escape except by turning the wheel, would seem to meet the true conditions of realising the whole force; and so it would, if such wheels had not to contend with certain mechanical difficulties that render them impracticable in most cases.

A pressure wheel, like a steam engine, must include running contact between water-tight surfaces, and, like a rotary steam engine, running contact between water-tight joints that move at degrees of speed that vary in the same joint, and when it is considered that the most careful workmanship has never produced rotary engines that would surmount these difficulties in working steam, it can hardly be expected they may be overcome in using water, that is liable to be filled with grit and sediment, and lacks the peculiar lubricating property of steam.

A rotary steam engine is in effect the same as a pressure water wheel, and the apprentice in studying the first will fully understand the principles of both by supposing steam to be substituted by water.

(To be continued.)

CIDER AND CIDER-VINEGAR.

To procure either cider or cider vinegar of the best quality, care and skill are required in the manufacture. Some too economical persons, thinking, that nothing should be wasted, are now engaged in gathering all the wormy and defective apples that fall from the trees, and consigning them to the cider-press. As new cider this questionable liquid is sold to the unsuspecting consumer for fifty cents a gallon. It however bears no comparison with cider that is carefully made from sound apples, and can not be made to produce a well-flavoured vinegar It would be better economy to feed all such apples to the pigs, for the first requisite for good cider or vinegar is sound fruit. All bruised, wormy, or defective apples must be discarded, if perfection is desired in the product. The next consideration is the mill and press, and the method of using them. In districts where timber is plentiful, and the necessary mechanical skill can be had, an improvement upon the old-fashioned mill and press is probably the best machine that can be procured. It is made wholly of wood, and no iron comes into contact with the crushed fruit. The timber should be sugar-maple or birch. These are free from the tannic acid, which renders oak objectionable, and stand wear and tear sufficiently well. The crushers are made of solid blocks, carefully seasoned under cover, so that they are free from cracks. They should be about 18 inches in diameter, and about two feet long. They should be turned perfectly cylindrical in a lathe, and deep, broad grooves cut lengthwise in them, so that the teeth of each, which are left projecting, fit accurately into the grooves of the opposite one. Four inches wide and three deep is a proper size for the grooves. This work should be done by a millwright, or a carpenter used to doing mill-work, as it is a somewhat difficult job. Upon the perfection of the rollers or crushers, the yield of cider greatly depends, as the apples must be reduced to a pulp, before all the juice can be pressed from them. The rollers are furnished with axles, also accurately turned, and are fitted into a frame, which is shown in fig. 1. This frame consits of a strong bottom of plank, four inches thick, preferably of maple, closely jointed and matched together. This is raised about 20 inches from the ground, upon a stout frame, and is pinned fast to heavy posts, set a few inches in the ground, so as to be immoveable. A raised border is placed around the bottom planks. A cross-frame is built across the centre of the bottom, into which the axles of the rollers are fitted, and to which they are secured by short blocks, pinned or bolted to the frame-work. The lower axles of the rollers fit into holes made in the bottom planks. The axle of one roller is lengthened, and attached to a horizontal arm, to which the horse may be hitched. A hopper is built at the rear of the crushers, to receive the apples, and feed them to the crushers. Fig. 1 sufficiently explains all other details. The press is shown in fig. 2. It is an improvement upon the old-fashioned heavy press, which is made from the trunk of a large tree, and frequently requires the trunk of another large tree as a support for it,