type of wheel. Each of those classes of wheels have their useful spheres, and to point out which I am afraid would take up too much of your valuable time.

One of the important features of a turbine water wheel is the curves or forms of the buckets, and in the construction of which it must be confessed that the American inventor's plan can only be called that of the "cut and try" method, while the curves of wheels constructed in Europe have been mainly perfected by careful study and mathematical reasoning, the result of which is that the guides and buckets are of the best shape in the type of wheels they build there.

In the case of an American engineer, should he look to the works of Rankin, Weisbach, Bresse and others, for suggestions that would help him in the construction of a wheel, he would look in vain. In the construction of turbine wheels the bucket shapes have depended entirely upon the whims and notions of the inventor. He makes his wheel after his idea, has it tested against some old timer; changes are perhaps made first in one part and then in another, and so on until the wheel is brought to a stage of perfection satisfactory to the engineer or inventor. From results that have been obtained from all wheels of all shapes of buckets, that shape in which the bucket at its upper part recedes from the water, gradually curving downward, and then receding backward in a direction at almost right angles to that of the bucket's upper form, has given the best results, and wheels with the double bucket device do not attain the same proficiency. In a vertical section of a bucket of this kind, the line of the bucket facing the water or termed the receiving side would be somewhat parabolic in shape, the buckets would be so placed upon the hub or cone of the wheel as to be almost tangent to that body. The discharging point of the bucket or lower part, and in which the reaction of the water mainly takes place, is so made that the water in discharging from the bucket will be delivered in greatest volume from the outer radii of the wheel. The back of the bucket at its top part requires the placing of what is termed a "Y"; this prevents any water from being lodged there and carried round by the wheel, which would be simply load carried for no purpose, although such might not be much. The idea of forming the bucket with a downward curve is that the friction of the water passing downward against the buckets is helpful, together with that against the cone upon which the buckets are placed, in easing the weight off the step upon which the wheel is carried; wheels constructed after this fashion are not troubled much with steps that burn out, a source of great annoyance to the user of such wheels as this occurs in. Buckets in which the upper part presents a vertical plane to that of the inflow have often proved to be injurious to the wheel, because of the fact that the friction of the water acts upon the bucket in a contra direction to that in a bucket where the top part is curved in a direction to the motion of the water.

Wheels with buckets constructed upon the former lines have made the best tests of any kind yet made. We have the "Victor," "Hercules," etc., which have developed in sizes of wheels of from 15" to 48" diameter, from 82 to 89 per cent of useful effect, and when it is considered that many wheels do not develop more than 60 per cent. of that of the power due the head under which they work, wheels of this build must find favor with water-wheel users who do not consider the first cost the essential feature in wheels.

Turbine buckets have been and are made of sheet iron, steel plate, of brass and of bronze, but experience has shown that wheels in which they are of one homogeneous casting are the best that have yet been produced. Wheels in which the buckets, together with the band, are made separately from the cone or hub, either of cast or wrought iron, are decidedly the worst kind. Wheels built in this way often have the buckets sheer off, whereas in wheels of one casting this never takes place, providing the wheel is properly proportioned.

Care should be taken in purchasing a wheel to see that the discharging orifices of the buckets are all of one area; wheels in which these orifices are not of a uniform area produce effects not at all to be desired when imparting motion to a dynamo; irregularity of speed, and not being easily controlled by a governor, are points to be considered by the purchaser.

The distribution of the water as well as the direction and velocity of flow must be taken into account, and this leads me to another important part in the construction of turbine wheels, namely, the method of regulating reaction turbines. There are various methods of doing so; we have wheels placed in scroll cases, in which the water is applied to the wheel through a single long chute which extends in a continual narrowing radius around the wheel. Such constructions are subject to serious defects. Owing to the manner of the application of the water the step is almost in all cases worn to one side; this defect is caused by the pressure of water being greatest at the first point of contact and growing less as it passes around the wheel. Wheels with cases of this style generally have adjustable steps to permit of this being centered, a feature which is not necessary in wheels in which the water is applied to all points in equal volume. The method of regulating the water at part gate is faulty, similar to that of throttling a steam engine. By means of a large gate the water is admitted or shut off from the wheel. This gate being placed at the outer end of chute or case, the water when admitted at part gate, immediately upon passing the gate in this style of regulator, has a great expansion and breaking up of the water, and in which the diminution of pressure and velocity is much greater than would occur from a corresponding loss of head, and perhaps their only redeemable feature is their first cost. Another method of regulation is by means of what is known as fly-trap or hinged gates, which consists in attaching the guide vanes to pivots, so that by changing their inclination with respect to the wheel, the area of the guide passages can be varied at will.

One of the objections to gates of this kind is, that in all positions of the guides but one, the water enters the wheel with impact, the result of which causes a corresponding loss of energy.

In the construction of this gate many parts are required; the tendency is to wear and become leaky. The rods and other devices used to operate the gate sometimes bend and wear until they fail to open the gate but partially. The Leffel, the Success, the Angell, of Providence, R.I., etc., illustrate this style of gate.

Some wheels are regulated by means of a cylinder gate, a round hoop or band, like the rim of a pulley, which is raised or lowered, either outside or inside of the stationary chutes that direct the water on to the wheel when the gate is out of the way. The advan-