TURBINE WATER WHEELS.

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Turbines when correctly designed and constructed are by far the most efficient motors for the utilization of water power, and on account of their comparatively small size, moderate or high speed, regularity of motion, and the slight amount of gearing required, are superior in every respect to the ordinary water wheels of the overshot, breast, etc., class.

The turbine water wheel was the invention of Fourneyron, of France, in 1827, and was introduced into this continent some time later by Mr. Ellwood Morris, an engineer of Pennsylvania. Since that time there have appeared before the public numerous varieties of turbines, each inventor claiming for his wheel improvements over that of his predecessors.

There are many types of turbines, good, bad and indifferent, so that in the choice of one we should not be guided solely by catalogues representing one particular design. Many turbines give fair or good results when working under the full supply of water, but the majority are nearly useless when working at part gate, at say below half gate, hence on streams subject to fluctuations it becomes a matter of primary importance to select a motor that will give a high efficiency, not only at full gate opening, but also at all stages of gate opening.

A turbine water wheel consists essentially of a ring, to which are attached curved vanes or buckets, arranged uniformly round the circumference, revolving on a shaft to which is keyed the hub or boss of the ring. This is encircled by a case in which are placed the chutes or guides, and by means of which a whirling motion is imparted to the water; over this case is placed the dome, or covering of the wheel which, together with the short suction or draft tube in which is to be found the step upon which the wheel or runner is carried, go to make up the wheel. All turbines are made more or less after this fashion, and yet there are hundreds in which the difference is only slight, and yet the percentage of useful effort developed by them, when under test, has shown from 40 to 90 per cent. of useful effect, and from the fact that most streams in our country are subject to fluctuations in the volume of water, it is necessary that in placing turbine wheels from which we derive our motive power, that we place a turbine capable of developing a high percentage of useful effect whether working at part or full gate.

All turbines so far as the behaviour of the water in them is concerned, belong to one of two systems: 1st. That in which one works with all its parts entirely drowned or full. 2nd. That in which free deviation of the water, and the admission of air to the buckets, are required for the proper working of the wheel.

These systems or classes are known among turbine water wheel builders as reaction wheels in the former, and impulse in the latter. In reaction turbines it is required that there be a continuous flow of water to the buckets of the wheel; and they can be successfully used with a draft or suction tube, which in many cases overcomes obstacles to the successful working of the wheel.

In the case of impulse turbines, the buckets are only partially occupied by the water passing through them; the atmosphere has free access to the remaining space, so that the feed to the wheel always takes place under atmospheric pressure. Usually both reaction and impulse turbines are provided with guides or chutes, from between which the water enters the buckets of the wheel, and by means of which the water is caused to enter in the desired direction.

All modern turbine wheels are constructed after one of three types, or of some combination of these types. They are: 1st. The outward flow wheels. 2nd. Inward flow, or centre discharge wheels. 3rd. Parallel flow wheels.

In the outward flow wheel of which Fourneyron's reaction wheel is the earliest type, the water flows usually through a pipe or conduit, and is diverted from its course in an outward direction by means of fixed guides or from the axis of motion; the form of these guides gives the water a whirling motion upon entering the wheel.

In the inward flow the water flows first in the direction of the axis, usually downward, and is then diverted by fixed guide blades inwardly or towards the axis of motion, the fixed guide blades giving the water a whirling motion as it enters the wheel.

In the parallel flow type the water moves parallel to the axis of motion before and after it passes through the wheel, the fixed guide blades again imparting a whirling motion to the water.

These types of wheels are best illustrated: in the first case, that of outward flow wheels, the Fourneyron wheel may be taken; there have been many modifications made upon this wheel, but they are all of the same, and the same principle applies to all. This type finds its greatest field in France, where it originated, and is not used with a draft tube.

In the second case, that of inward flow or centre discharge wheels, the "Rose," the "Francis," "Centre Vent" wheel and others—in this type of wheel the guides or chutes have simply changed places with that of the wheel, the former being placed outside or concentric to the latter. From this type of wheel has developed that of the combined or mixed turbines, in which the previously named systems are combined. It is easy to see how this has taken place, for by a continuation of the guides into that part of the wheel where the water assumes a vertical direction, the radial flow is changed to that of an axial flow, while the water is in the buckets, instead of after it has left them, and it is of this type or combination that the leading American wheels are built, and of which class anything I may say will mostly be directed.

In the third case, that of parallel flow turbines, this type is generally illustrated by that of the "Jouval," so named after the engineer who first introduced them; they are more extensively adopted in Europe than any other type of reaction wheel.

The adoption of the combir . or mixed flow turbine, by American engineers, would appear to be caused by the large volumes of water at their disposal. Economy of water was second to that of first cost of the wheel, and yet their principal aim has been to construct a turbine of the smallest possible diameter, and yet develop the largest amount of horse-power for the amount of water consumed. How far they have succeeded in this is shown by the efficiency course table exhibited. Impulse turbines seem to have been discounted by American engineers, and such is perhaps due to the fact that reaction wheels, when running at their best possible speed, and using the full volume of water for which they were designed, develop a better percentage of useful effect than that by the impulse