STEAM TURBINES, FROM THE USERS' POINT OF VIEW.*

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There is such an abundance of literature on the subject of the steam turbine giving descriptions of types and systems, that only a passing reference will be made to this point. Briefly, the present situation of the steam turbine industry is a battle for supremacy between the Impulse and Reaction types, and while the partisans of each type claim all sorts of wonderful advantages which the other does not possess, yet the following statements are put forward as representing the point of view of a user who has studied the problem from all sides. (1) All turbines must fulfil a certain law of combination of blade speed and a number of running rows. (2) Steam expanding between boiler pressure and condenser must generate a certain velocity, and this velocity must be imparted to the revolving mass in small increments as in the Parsons machine, entailing many rows of blades, or in larger increments, as in the Zoelly of Curtis machines, or in one increment as in the Laval. (3) The fewer the rows of running blades the higher must be the speed at which the blades run, and consequently the higher the speed of the steam impinging on the blades. (4) The Impulse type turbine runs at a much higher speed at blading than the Reaction type, and necessitates particular attention being given to the design of the wheels and blades, owing to the greater stresses that prevail. (5) The Impulse type turbine lends itself to a more mechanical-looking construction than the Reaction type. (6) The Reaction type, as illustrated by the best Parsons type, is more economical than the Impulse type. (7) For speeds of 3,000 revolutions per minute and below 1,000 kw. the Impulse type is better than the Reaction. (8) For speeds of 1,500 revolutions per minute and up to 3,000 kw. the Reaction type has, up to the present, proved most satisfactory. (9) For speeds of 1,000 and 750 revolutions per minute, and up to the largest sizes likely to be used, there is absolutely no evidence that the Impulse type can compete in reliability or economy with the Parsons type.

In making the above statements regarding reliability and economy, isolated cases have not been considered, only an opinion expressed on a general survey; and a very important point which must be considered, both for and against the two types, is that the Reaction type has been longest in the field, the uses to which it has been put are of wider application, and the horse-power in use must very greatly exceed that of the Impulse type; whether the Impulse type will come through the many vicissitudes that are supposed to beset all turbines is a matter which has yet to be proved.

A review of the progress of the last two years, the writer thinks, shows that while trouble with the Reaction type has shown a marked diminution—due to the defects of the earlier designs having had time to come to light, thus showing the necessity of more mechanical construction, and notably of stiffer shafts—the Impulse type has not made the headway many people looked for, and may still be said to have its infantile complaints ahead.

Turbine Outputs and Speeds.

Too little attention is given nowadays to selecting an efficient combination of power and speed, although the latter is such an important point from every point of view. Take two instances:—(1) 750 kw. on 50 cycle; (2) 1,500 kw. on 40 cycle. In case 1 the periodicity being 50, only two speeds can be considered, viz.; 3,000 revolutions per minute with a two-pole machine, or 1,500 revolutions per minute with a four-pole machine. Many engineers have selected the slower speed in putting down their installations, but there is no arguments in reason which can be given against the higher speed of 3,000 revolutions per minute, as the high-speed set will be (1) more economical by about 10 per cent.; (2) take up less floor space; (3) be about 15 per cent. cheaper in first cost.

The same remarks apply to case 2, where of the two speeds of 2,400 revolutions per minute and 1,200 revolutions per minute, it is an uncommercial proceeding to put in the slow-speed set. A very good rule to follow, and one which should be insisted on is:—Choose the size of your unit to suit the highest speed that the periodicity will allow, and here the assistance to be obtained from external fan cooling of the generator should not be overlooked, because the higher the speed at which the set is run, the greater the benefits which will be obtained from a turbine installation.

At Sunderland we have a 1,500-revolutions per minute, Willans-Dick-Kerr combination installed to carry a load of 2,000 kw. continuously, and 2,500 kw. for two hours, and the economies effected by this plant, have been most pronounced, as is very practically exemplified by the fact that with the present normal works day load, amounting to about 2,300 kw. on the turbine, two boilers will easily steam the turbine, but upon changing over to three modern high-speed reciprocating engines, of about 700 kw. capacity each, it is impossible to hold the steam without substantial assistance from a third boiler, and we always hold additional boilers banked against the contingency of a failure of the turbine plant.

For direct-current turbo sets, the merits of the tandem machine must not be lost sight of. For a given size of unit the advantages accruing from tandem machines are many. For instance: (1) by putting in tandem generators, the speed of the set can be increased by about 75 per cent. with all the attendant advantages, as already pointed out. (2) The electrical portion being divided into two, there is only 50 per cent of the machine out of commission should troubles of any sort arise.

Turbines v. Reciprocating Engines.

It is often a subject of some concern to an engineer to decide at what size of unit it becomes advisable to adopt turbines in preference to reciprocating engines; a general statement which has been made very frequently is that above 750 kw. as a unit use turbines, below 750 kw. use engines. It is, however, impossible to draw any definite line of demarcation, as so much depends upon the available conditions and the requirements. For instance, the temperature and quantity of circulating water affects the situation very seriously, and must be taken into consideration as regards both capital and running costs, before any decision can be arrived at. Every case calls for a detailed investigation, which it will repay to make thoroughly. There is, however, not the slightest doubt that with the higher speeds at which it is now possible to run turbo-generators, the proposition of turbines versus engines, will soon disappear, and it will be a case of turbines only; in fact, it is even now difficult to prove a case for the reciprocating engine under any ordinary conditions.

The Brush Company, who have made a specialty of small turbo-generator sets, give the following typical figures for a 300 kw. plant:—

Steam consumption in lbs. of steam per kw.-hour with steam at 160 lbs. per square inch:—

	Dry steam.	With 100 degrees superheat.
Reciprocating engine, 26-in. vacuum..	24	29½
Turbines, 28-in. vacuum	22	19¾

The capital cost of the two plants complete with condensers is practically the same.

Granting that capital and steam costs are equal upon so small a unit, and taking into consideration the undeniable advantages the turbine has in cost of oil and general upkeep, it does indeed appear that the reciprocating plant has only a small field left, except upon sites where the facilities for obtaining cooling water are exceptionally bad.

The selection of conditions for turbine installation can be summed up in few words:—

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