(c) *Low specific speed turbine*: Specific speed of these turbines are 8 to 30 with single nozzle and up to 50 with multi nozzles. So these are called low specific speed turbines. Pelton turbine is the example of low specific speed turbine.

5. **According to the inventor's Name:** According to the inventor's Name, turbines may be classified as:

(a) Pelton turbine (b) Francis turbine (c) Kaplan turbine.

(a) *Pelton turbine:* It is named in honour of Allen Pelton (1829 – 1908) of California (USA), is an impulse type of turbine used for high head and low discharge.

(b) *Francis turbine*: It is named in honour of James Bichens Francis (1815 – 1892) who was born in England and later went to USA, is a reaction type of turbine for medium head and medium discharge.

(c) *Kaplan turbine*: It is named in honour of Victor Kaplan (1876 – 1934) of Bruenn (Germany) is a reaction type of turbine for low head and large discharge.

6. **According to the position of the main shaft:** According to the position of the main shaft, turbines may be classified as:

(a) Horizontal shaft turbines (b) Vertical shaft turbines

(a) *Horizontal shaft turbine*: Pelton turbines usually have horizontal shaft.

(b) *Vertical shaft turbine*: Turbines except Pelton turbine all are vertical shaft turbines.

5.4 PELTON TURBINE

A pelton turbine is shown in Fig. 2. Pelton turbine is a tangential flow impulse turbine. The water strikes the bucket along the tangent of the runner. The energy available at the intel of the turbine is only kinetic energy.

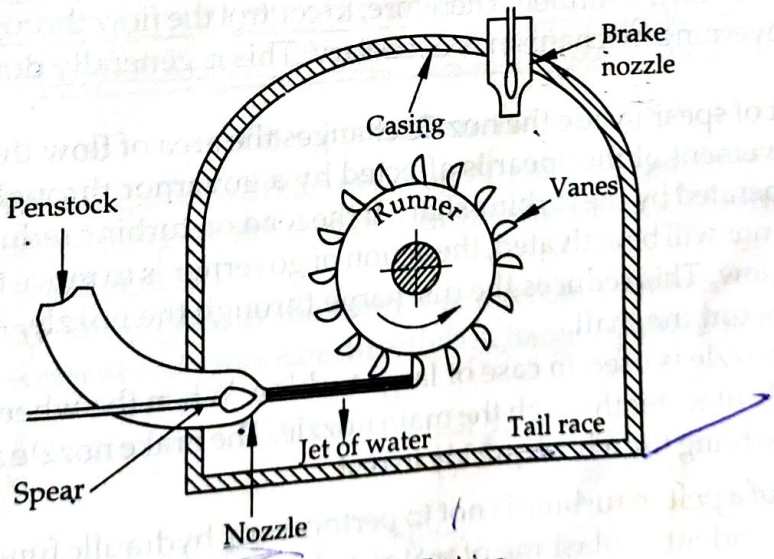

Fig. 2 Pelton Turbine

Water from the reservoir is brought to the turbine through penstocks, at the end of which a nozzle is fitted. The nozzle converts whole of the available head into the kinetic head in the form of a high velocity jet. The jet strikes the buckets mounted on the rim of a wheel called *runner*. The force of jet causes the runner to rotate and mechanical power is produced. In the end, the water goes to the tail race.

Number of nozzles depends upon specific speed. However, maximum number of nozzles can be up to 6.

Components of a pelton turbine

(1) *Runner with Bucket*: The runner of a pelton turbine consists of a number of double cupped buckets

fixed to the periphery of the wheel. Each bucket has a sharp edge at the centre called the splitter. The jet strikes each bucket at this splitter and is divided into two sides, thus avoiding any unbalanced thrust on the shaft. It is shown in Fig. 3.

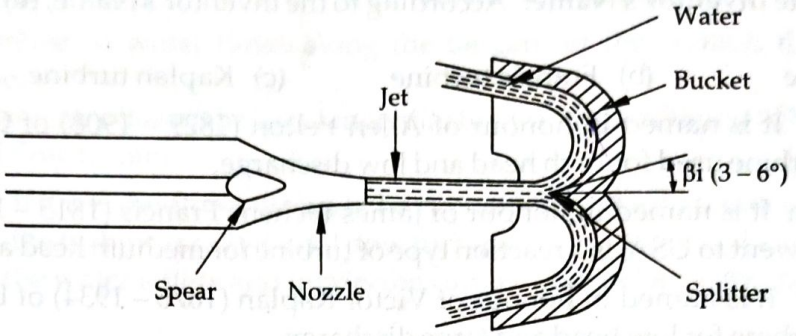

Fig. 3 Bucket

To get full reaction of the jet, it has to be turned through 180° by the bucket. But then, the jet may strike the incoming bucket retarding the speed of the runner. Therefore, the angle through which the jet is turned is kept between 160° to 170°. Average value is taken as 165°.

The bottom portion of the buckets is usually cut which also facilitates the jet to pass through the succeeding bucket.

Material for bucket is cast Iron for low head plant and cast steel, stainless steel and bronze for medium and high heads. The buckets are either cast integral with the wheel or bolted to the rim.

Bolted arrangement is preferred as the damaged bucket can be easily replaced.

(2) *Nozzle with guide mechanism:* The function of the nozzle of a pelton wheel is to convert the available pressure energy into high velocity energy in the form of jet. The quantity of water required is proportional to the load on the turbine. Therefore, to control the flow through the nozzle, some sort of a regulating or a governing mechanism is necessary. This is generally done by using a spear inside the nozzle.

The movement of spear inside the nozzle changes the area of flow through it, thus varying the discharge. The movement of the spear is affected by a governor through a servomechanism. The governor itself is operated by the turbine shaft. If the load on turbine reduces and the runner tries to speed up, the governor will be activated, the action of governor is to move the spear into the nozzle to reduce the area of flow. This reduces the discharge through the nozzle. Reverse will happen if the load increases on the turbine shaft.

A small brake nozzle is used in case of large turbine. When the wheel is to be stopped, besides cutting off the supply of water through the main nozzle. The brake nozzle also directs the water on to the back of buckets to bring the wheel quickly to rest.

(3) *Casing*: Casing of a pelton turbine is not to perform any hydraulic function. However, a casing is necessary to avoid accidents, splashing of water, to lead the water to the tail race and to support the housing for the bearing and the nozzle.

5.5 REACTION TURBINE

Reaction turbine is a pressure turbine *i.e.* the water enters the wheel under pressure after passing through the guide vanes. At the outlet of turbine, the pressure is atmospheric or below atmospheric if the discharge is taken through a draft tube into the tail race. Owing to this difference of pressure, the water flows through the vanes of the turbine towards the outlet. The difference of pressure between guide vanes and runner called reaction pressure is responsible for the motion of the runner. Therefore, such a turbine is called reaction turbine.

A reaction turbine operates under pressure and has more pressure at the inlet than at the outlet.