CAUDWELL'S MILL TRUST LTD.

Turbines

There have been three turbines at Caudwell's Mill, after the first one replaced a waterwheel in 1887. This first one was a 40 inch (approximately 1 metre) diameter "Trent" turbine made by C.L. Hett of Brigg which drove the flour mill until 1914 when it was replaced by a more powerful machine. Little more is known about the "Trent' although Caudwell & Co. were pleased with it's performance and sent a testimonial to Hett.

Around January1898 Caudwell’s asked for quotes to replace the provender waterwheel with a turbine. John Hetherington of Ancotes Works, Manchester offered a Special Duplex Turbine producing 30 to 35 IHP on 8 to 9 feet fall. Unfortunately the price and further information is missing. However Gilbert Gilkes & Co. Ltd. (who had purchased the patterns from C.L.Hett) offered a "Trent" turbine of 35 h.p. on a fall of 9½ feet at 85 r.p.m. The turbine was quoted at £124 and extra length of shafting and regulator gear added £13.12.0. Delivery to Rowsley station was an additional £4.10.0.

Finally Caudwell’s purchased a second turbine which was a 33 inch (84 cm.) "Little Giant". This was a Canadian made machine, supplied by S. Howes of London in 1898, which, producing 50 hp (37 KW), drove the provender machinery and is still in use today.

The third was the "Francis" twin turbine of 76 hp (57 KW) installed in 1914 to drive the flour mill, when the German firm of Amme, Giesecke & Konegen modernised the mill.

The "Little Giant" Turbine

A c.1904 catalogue from J.C. Wilson & Co. of Glenora, Ontario advises that their foreign office is The S. Howes Co. of 64 Mark Lane, London and that upwards of 1900 "Little Giant" turbines are now in use. The catalogue shows that a wide range of "Little Giant" turbines were available covering diameters from 14 to 38 inches which on a head of 11 feet (as at Caudwell's Mill) could produce power outputs from 8.4 to 87.7 hp. On the larger sizes there were two types available, a normal and a deep bucket and for the 33 inch "wheel" (as Wilson's referred to it) supplied to Caudwell's Mill, these produced 54.2 and 65 hp respectively with 11 feet head and a shaft speed of 96 revolutions per minute. (Note: the 33 inch wheel would produce 9.2 H.P. on a head of 3 feet and 830 H.P. on a head of 60 feet.)

The "Little Giant" has a vertical shaft onto which are attached the two rotors, one at the top of the body and one underneath. These have a series of cup shaped outlets for the water which cause the rotation of the shaft. Water is fed into the body of the turbine via a vertical sluice which can be used to control the power output. A restriction on the output power is caused by the body of the turbine being submerged in the tail race, which slows down the water flow through the machine.

Due to the upper and lower rotors the thrust of the water is evenly distributed and so the thrust bearing at the base of the shaft has only to withstand the weight of the shaft and the bevel gear in the mill. This bearing is formed of a block of lignum vitae, a hard wearing wood, and runs under water, thus preventing overheating. The upper bearing is also lignum vitae and is adjustable to centre the wheel in the case, to prevent friction caused by the wheel rubbing against the case.

Access to the turbine is via a hole in the floor of the mill, having a set of steps leading to a walkway above the turbine. It is possible to then stand on top of the turbine casing for maintenance of the vertical shaft and the sluice control rods. It may be noticed that the timber of the sluice control has been replaced recently.

If floating debris should enter the turbine, having passed through the trash grid, it is very difficult to remove as the body of the turbine is under water, except in times of drought (or when the tail race is dammed and the water pumped out).

Although the "Little Giant" driving the provender mill (and recently the electric generator) is difficult to see, being almost completely submerged, a smaller turbine (16 inch diameter) of a similar type can be seen on the bridge over the head race. This was given to Caudwell's Mill Trust Ltd. by the Castle Museum at York, who had found it being used as ballast in a sunken barge.

The "Francis" Turbine

This is a much larger machine than the "Little Giant", being about 8 feet (2.5 metres) long, 6 feet (1.8 metres) high and 3 feet (1 metre) diameter. Again there are two rotors on a shaft but this time the shaft is horizontal, avoiding the need for bevel gears. In this case the water enters the turbine at either end, flowing towards the centre of the turbine, where it exits by means of the draft tube into the tail race.

Each runner (rotating blades) is designed to turn the water from radial inward flow to axial flow whilst passing through the blade passages. This is achieved by making the blades a "J" shape with the top of the "J" coming from the closed end of the runner. As the velocity of the water is greatly reduced when passing through the runners the exit area of the runner is larger than the inlet area. In order to assist the flow of water out of the turbine a draft tube is fitted from the centre of the underside of the turbine down to the tail race. This is a tapered tube with the larger end at the water level and thus converts some of the remaining velocity head when leaving the runner into pressure head which adds to the total power produced by the turbine.

Control vanes are fitted on the water inlets, which can be opened & closed by handwheels on the roller floor to regulate the power output. These operate like the segments of a Venetian blind, being pivoted towards the centre (on an axis parallel with the turbine axis), then rotated by moving a metal ring which surrounds the end of the turbine and has a link from each vane fitted to it. This allows all the vanes to be turned simultaneously in one direction or the other so that the water passage between them may be varied in width or completely closed.

As water enters from either end and passes to the middle, there is only a limited amount of sideways thrust on the shaft, most of this being caused by altering the control vanes a different amount on either end.

The main horizontal axis of the turbine is set about 7 feet (2 metres) below water level (and about 3 feet above floor level) with the outlet of the draft tube being 4 feet (1 metre) below the shaft to produce a 11 foot (3 metre) head.

Access to the turbine is again through a hole in the floor above it, and then down a vertical ladder into the turbine chamber. In this case by closing the main sluice it is possible to drain the chamber and thus obtain access to all the turbine except the outlet of the draft tube. A manhole on the turbine casing allows the interior to be inspected and debris removed.

As the turbine runs submerged with a horizontal axial shaft, there has to be means of getting the drive from the turbine chamber into the mill. This is done by a watertight gland fitted to the wall between the turbine chamber and the drive shaft below the roller floor. This is one of the main problems of this type of twin horizontal turbine as the gland has a tendency to leak, which can (and has) result in the drive shaft space being flooded to a depth of 5 feet.