

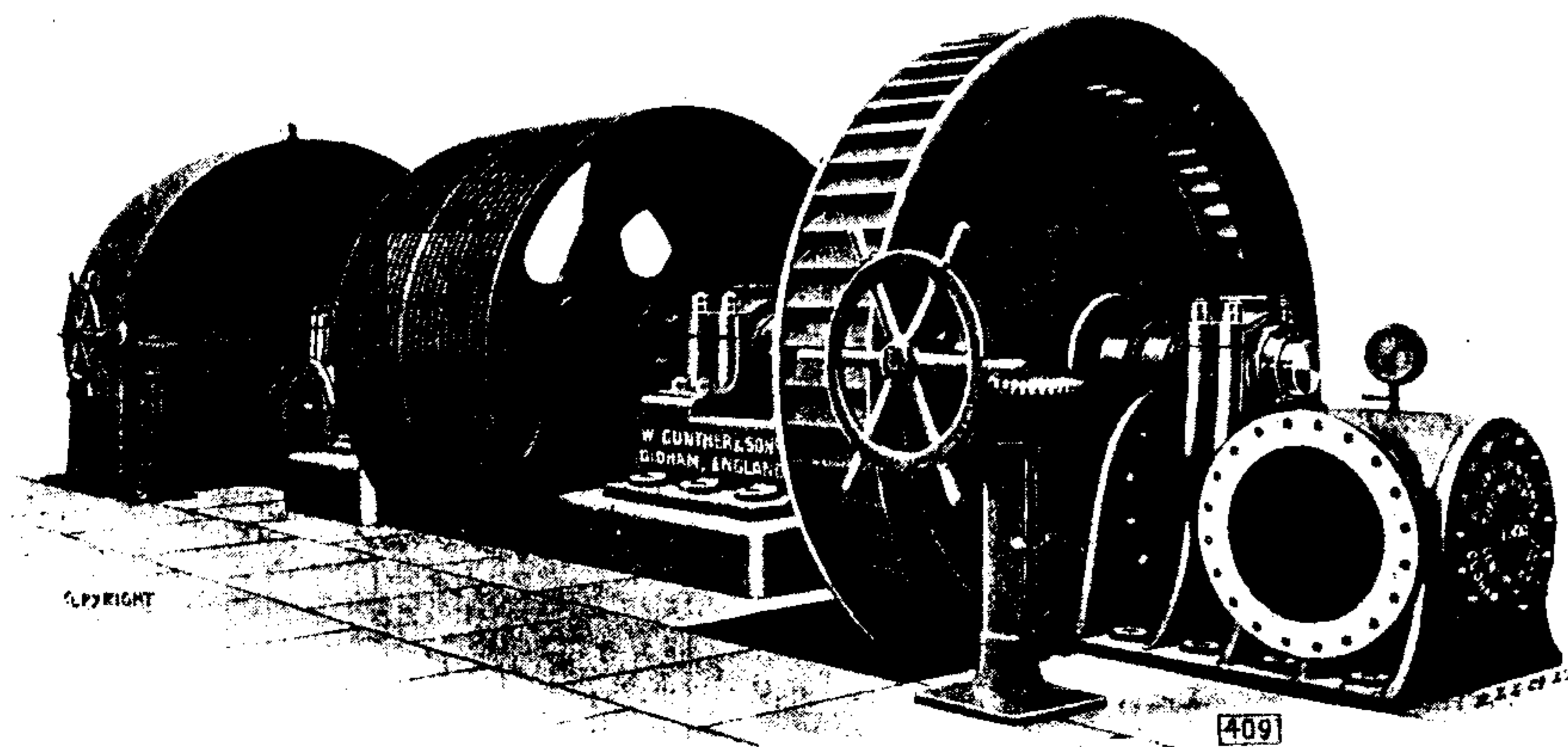
## Miscellaneous Designs

From about 1840 to 1890 many manufacturers went into the water turbine market with varying degrees of success. The Americans concentrated mainly on 'Francis' type turbines which were sold under a number of trade names. Sometimes it was the name of the manufacturers, as in the case of Leffel (the firm of James Leffel is still building water turbines) but in an effort to persuade small mill and factory owners that theirs was the most powerful turbine, trade names such as *Samson*, *Hercules*, *Little Giant*, *Achilles* and *Victor* were used. A number of British engineering merchants sold 'American' turbines which they imported or had made to American designs.

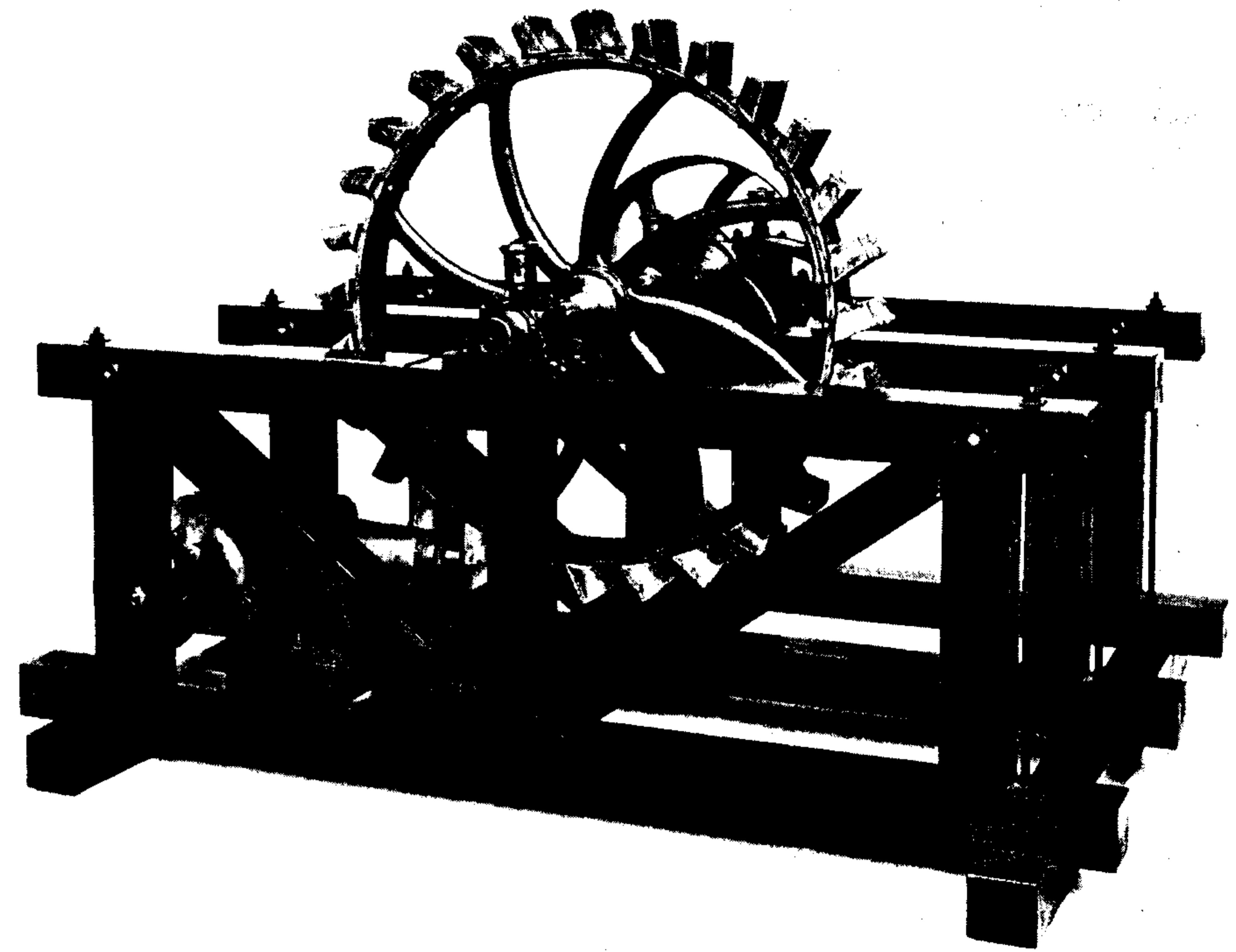
From Europe came the Girard outward flow impulse turbine, and the Jonval axial flow reaction turbine. Both were manufactured by Messrs W Günther & Sons of Oldham who manufactured water turbines from 1881 until 1933. Figure 13 is the reproduction of a catalogue illustration of a Günther Girard turbine of 1899. Neither of these designs had come to stay. The Girard turbine was replaced by the Pelton wheel or Turgo Impulse turbine, and the Jonval by the Francis turbine.

## The Pelton Wheel and the Turgo Impulse Turbine

The Pelton wheel started as a prime mover almost as crude as the Horizontal mill referred to in the Introduction. The gold miners in California in 1850 required power to operate their stamps and other machinery. There was some water power available in the mountain creeks from small



13 500 HP Girard outward flow turbine, 1899.



14 Pitman water motor with Pelton type buckets.

streams with a relatively high head. They evolved what was called the 'hurdy-gurdy' wheel, a pulley with flat plates riveted or bolted to the rim. The stream was tapped fifty or more metres higher up, and the water piped to a nozzle from which a jet discharged, hit the plates and turned the wheel.

The hurdy-gurdy was most inefficient, and Lester A Pelton (1829-1908) carried out experiments to improve it. In 1880 he patented a double 'bucket' to replace the flat plates. The jet struck the 'splitter edge' in the centre of the bucket and was smoothly turned through nearly 180°. The Pitman water motor shown in figure 14 had buckets of this type.

Later, Abner Doble of San Francisco patented the 'ellipsoidal' bucket, giving a much better shape. He appreciated that part of the back of the bucket must be cut away so that successive buckets would not strike and deflect the jet as the runner rotated. He also invented the 'spear' or 'needle' nozzle which can be seen in figures 15 and 16. This controlled the flow of water to the runner in such a way that the jet remained 'solid' even when nearly closed thus keeping up the efficiency of the turbine at low loads.

Although the model of a Pelton Wheel, figure 15, was made in 1913