THE AMAZING ECO-FRIENDLY RAM PUMP

Invented in the late 18th century, the green credentials of a fuel-free pump are helping sustain a 21st century revival in its use.

By **Roger Dettmer**

A sense of history: revival of the ram pump

FOR A REAL sense of history, nothing beats the immediacy of a primary source. I'm sitting in the MD's office of the West Country engineering company Green & Carter Ltd simply mesmerised by a patent document of 1820. It's the name on the patent that's such a jolt to the system: Françoise Montgolfier, son of Joseph Montgolfier (famous as the inventor of the hot air balloon). Not that the patent has anything to do with the 70m-tall Chinese lantern employed by Joseph to send the first man skyward in 1783. It's for something completely different: an improved version of his ram pump, invented around 1797. Outside the confines of a patent office, the ram pump is the closest you'll ever get to a perpetual motion machine, capable of raising water to a height of 100m for years on end, fuelled solely by the power of a flowing water source.

Today, hot air balloons are the basis of a major leisure industry, but, in a world of increasing water scarcity and rising energy costs, the ram pump shows every sign of having greater long-term practical benefits.

Company history

Engineering companies tend to come and go – the technology changes and the market moves on. Green & Carter are very much the exception to this rule. The MD's office – buried in the basement of a Gothic revival rectory at Ashbrittle in Somerset– has the air of an antiquarian bookshop, stacked out with records and correspondence going back to 1774. "The company's been around forever," Charles Doble, the MD, explains. Pride of place among this remarkable commercial archive is the Montgolfier patent. It's the seminal document that laid the foundation for the company's ram pump business and continuing commercial success.

In the year the patent was granted to Françoise Montgolfier, Josiah Easton, a noted West Country surveyor, bought the worldwide manufacturing and marketing rights. Throughout the 19th century, Easton and his descendants developed the technology and the business, eventually supplying ram pumps to many of England's great landed estates. In 1929, the Easton ram pump business was acquired by Green & Carter, rival ram pump manufacturers, and in 1976 the business was bought by Doble.

The Heligan connection

Among the landed estates served by the Easton business was Heligan Manor, near St Austell, Cornwall, where a system of three ram pumps was installed for the owner, John Tremayne, in the early 1880s. In the years following the First World War, the once famous gardens of Heligan fell into a state of ruinous neglect. Eventually, overgrown and derelict, they were re-discovered in 1990 by Tim Smit, a Dutch-born businessman, and John Willis, >

HOW IT WORKS

RAM PUMP EFFICIENCY

The basic object is to deliver water from a supply tank to a header tank at a higher elevation. Assume the energy efficiency of the pump is 100 per cent, then, by equating the potential energy lost in the supply tank to the potential energy gained in the header tank, it's easy to show that best possible ratio of water-lost-to-water-gained is inversely proportional to the ratio of the two heights.

At Heligan, the header tank is 50m above the pump and the supply tank is 8m above the pump, implying that at least 6.25 gallons must be lost from the supply tank to deliver one gallon to the header tank. This ratio, equivalent to 16 per cent, defines the so-called volumetric efficiency of the installation.

Inevitably, the energy efficiency of any ram pump is less than 100 per cent, and a figure of 60 per cent is typical. At Heligan it takes nine gallons to raise one gallon, implying an energy efficiency for the pump of just under 70 per cent.

Heligan's beating heart: a reclamation success story

< a Tremayne descendant. Throughout the 1990s the gardens were gradually restored, and today, 'The Lost Gardens of Heligan' are one of Cornwall's greatest tourist attractions. The story of how Heligan's ram pumps were, literally, unearthed with the serendipitous help of Doble is one of the highlights of the Heligan reclamation story.

The back story

It's December 1991 and Doble is in the St Austell area on company business. With the work of the day completed he calls at the Tremayne's house to check on the 1880 installation. The initial response is not encouraging. The house has been sold and divided into flats, but eventually he's directed to the gardens where, emerging from a jungle of brambles, he meets Tim Smit. That very day the Heligan restoration team has finally located a mysterious rectangular structure marked 'Ram' on the local OS map. It turned out to be a curious three-walled structure, with no apparent purpose.

Doble, primed by a prior check on the company archives, is immediately able to explain. "Eighteen feet down, you will find a doorway into a little room, and there you will find three ram pumps: two-inch, and three-inch and a five-inch. They are capable of pumping nine and a half gallons of water a minute, over a distance of a mile and a half, using only the water power provided by the stream that feeds them."

In 1992, with the help of Green & Carter and supported by a grant from the Countryside Commission, the business of restoring the ram pumps was begun. A mountain of stinking mud was cleared from the access stairwell and the ram chamber, waterways and supply reservoirs were cleared, new pipework installed, and the pumps removed and refurbished using original components from the Green & Carter parts store. The pumps were finally restored to full working order in 1994.

The visit

Access problems mean that the Heligan ram chamber is not open to the general public, but a few weeks prior to my trip to Ashbrittle, I'd had the good fortune of a guided tour in the company of Jim, Heligan's estate manager.

We made our way down into a valley to the west of the gardens, and, after a fair bit of hacking back of vegetation, arrived at the steps down to the ram chamber – they're narrow, covered with moss and running with water. Gingerly I made my way down to the chamber entrance. Inside, the three ram pumps sit side by side in the gloom.

Jim turns the stopcock that connects the three-inch pump to the supply tank and water begins to flow out of the pump's impulse valve. Suddenly, as the flow rate increases, the valve closes. The flowing water stops, and a resounding thump fills the chamber.

Water is virtually incompressible and a column of flowing water behaves very much

The pump's supply tank is connected to the three-inch pump by the stopcock, which controls the water flow

The moss-covered steps down to the ram pump in the Heligan Gardens

The self-acting ram pump: green technology then and, increasingly, now

WEBLINK

For more information, visit the Green & Carter Ltd website at www.greenandcarter.com

BEFORE MONTGOLFIER

JOHN WHITEHURST

Montgolfier's discovery of the self-acting ram pump was preceded by a manually-operated pump invented by the English clockmaker John Whitehurst. In a letter to the Royal Society, written in 1775, Whitehurst describes a machine installed at the brew house of Oulton Hall in Cheshire in 1772. As described in Whitehust's letter, the pumping action was initiated by closing a tap in the Hall's kitchen. The ensuing hydraulic shock then opened a valve, supplying water to a tank on an upper floor. Whitehurst's pump featured an air reservoir formed from lead sheets, and, as he recounts, the pressure was such that it "burst the vessel a few months after it was constructed, though apparently very firm, being made of sheet lead, about nine or ten pounds weight to a square foot". The height of the upper tank is not clear in Whitehurst's letter – but would not seem to have been especially high, possibly 4-5ft above the pressure vessel.

Montgolfier seems to have developed his own ram pump design independently of Whitehurst. But, even if an element of 'borrowing' was involved, Montgolfier's introduction of the impulse valve, avoiding the need to employ a small boy to open and close the tap, was crucial in transforming the ram pump into a practical device. Montgolfier was also responsible for coining the ram pump's name – inspired by the thump, thump of head-butting rams.

like a very stiff steel spring. Closing the impulse valve generates a compression pulse, producing the characteristic thump sound of the water hammer effect – you can get the same sound in old central-heating pipes.

It's this pressure pulse that's key to the ram pump's action. It drives the water up the rising main to the header tank and compresses the air in the pump's pressure vessel. As the force of the pressure pulse dies away, the air in the pressure vessel helps maintain the flow of water to the header tank. Simultaneously, a separate component of the pulse travels back up the drive pipe to the supply tank, where it's reflected back down the pipe, this time as a low pressure pulse. This returning pulse opens the impulse valve again, restarting the pump cycle.

Soon the chamber is filled with the regular thump, thump of the pump. Eighteen-feet underground this Victorian contraption made of gunmetal and cast-iron sounds just like a beating heart.

As electricity became widely available in rural areas the ram pump business went into a definite decline. When Doble acquired Green & Carter in 1976, the turnover was just £1,500 a year.

Growing demand in pumping

Today, the company's business is growing at 40 per cent annually; selling more pumps, over 1,000 a year, than it was 100 years ago. This remarkable turnaround is being driven by the greater demand for pumping in farming, as EU clean water directives encourage the fencing-off of streams and rivers, and the pump's inherent eco-friendly credentials. Internationally, there's a growing business from NGOs, with Green & Carter supplying pumps to locations as distant as the Falkland Islands and Tristan da Cunha in the south Atlantic Ocean. "Wind and solar are unreliable," says Doble, "and a ram pump will feed an entire estate, not just the fields alongside a stream – so it wins hands down. It's green technology par excellence."

> 'Eighteen feet down, you will find a doorway into a little room, and there you will find three ram pumps: two-inch, and three-inch and a five-inch'
> Charles Doble, Green & Carter Ltd

AT present, Heligan isn't party to the ram pump revival. Although the pumps were restored to working order in 1994, a number of practical issues – notably ownership of the pumps and the header tank not lying within Heligan – have prevented them being put to routine use. However, all this could be about to change.

One of the reasons Heligan is such a special place lies in its capacity to evoke the tragedy of the First World War. The carefully restored kitchen garden, along with the great greenhouses, conservatories and extraordinary pineapple pit – fuelled by monumental quantities of horse manure, are reminders of another age, all swept away in the carnage of the trenches.

Don't come here to sleep or slumber

One of the most poignant finds uncovered during the early days of the garden's restoration was the worker's privy. Written on the wall was the message: "Don't come here to sleep or slumber", and underneath the names of the long-dead garden workers who'd sat there. The message was dated August 1914. Now, as part of Heligan's plans to commemorate the start of the First World War, the staff are actively planning to put the pumps to regular use.

If all goes well, the buried heart of Heligan will once again be serving a major part of the estate's water needs – as it once did, unfailingly, for over 80 years. *