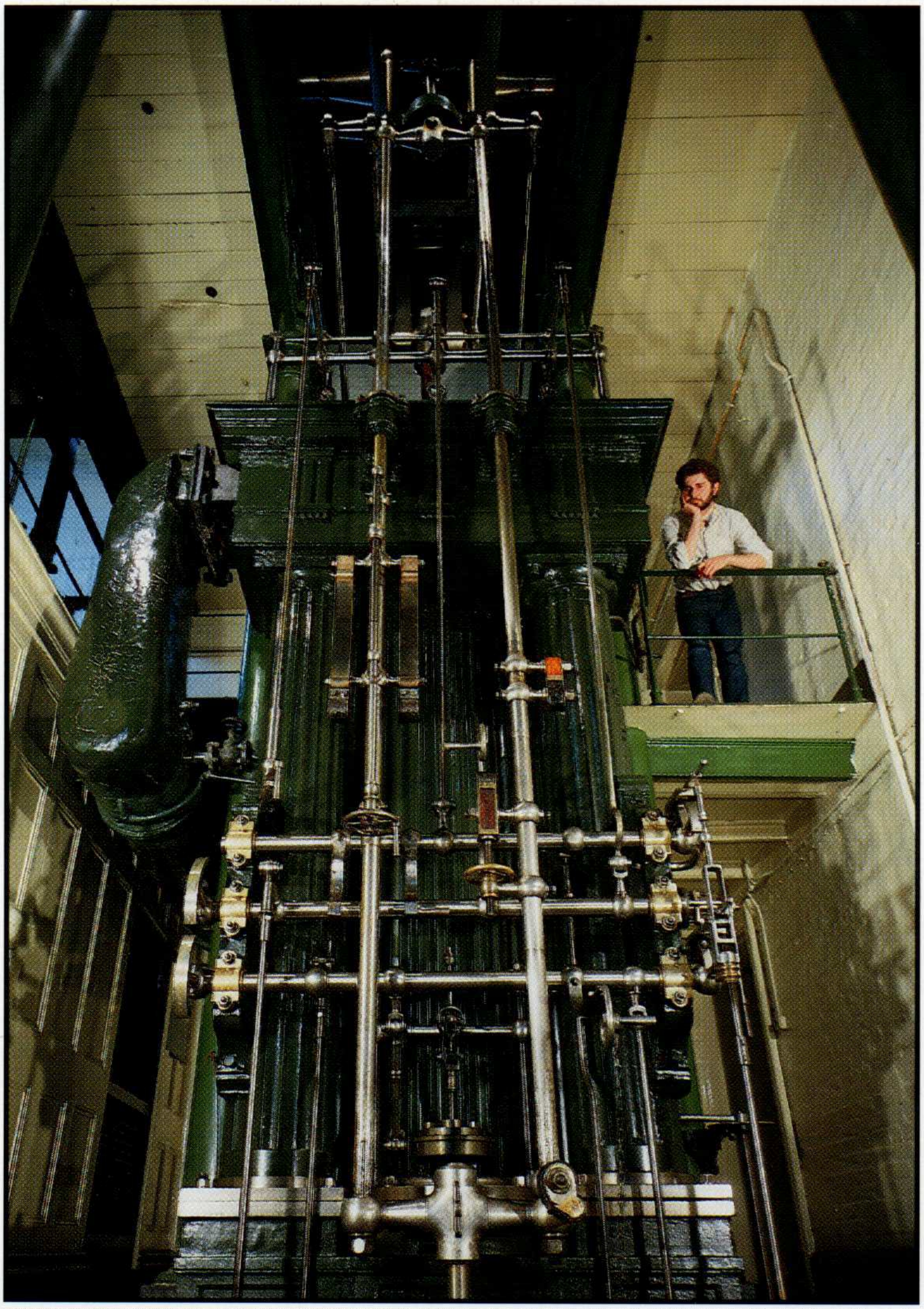
KEW BRIDGE BEAM ENGINES



HISTORIC MECHANICAL ENGINEERING LANDMARK
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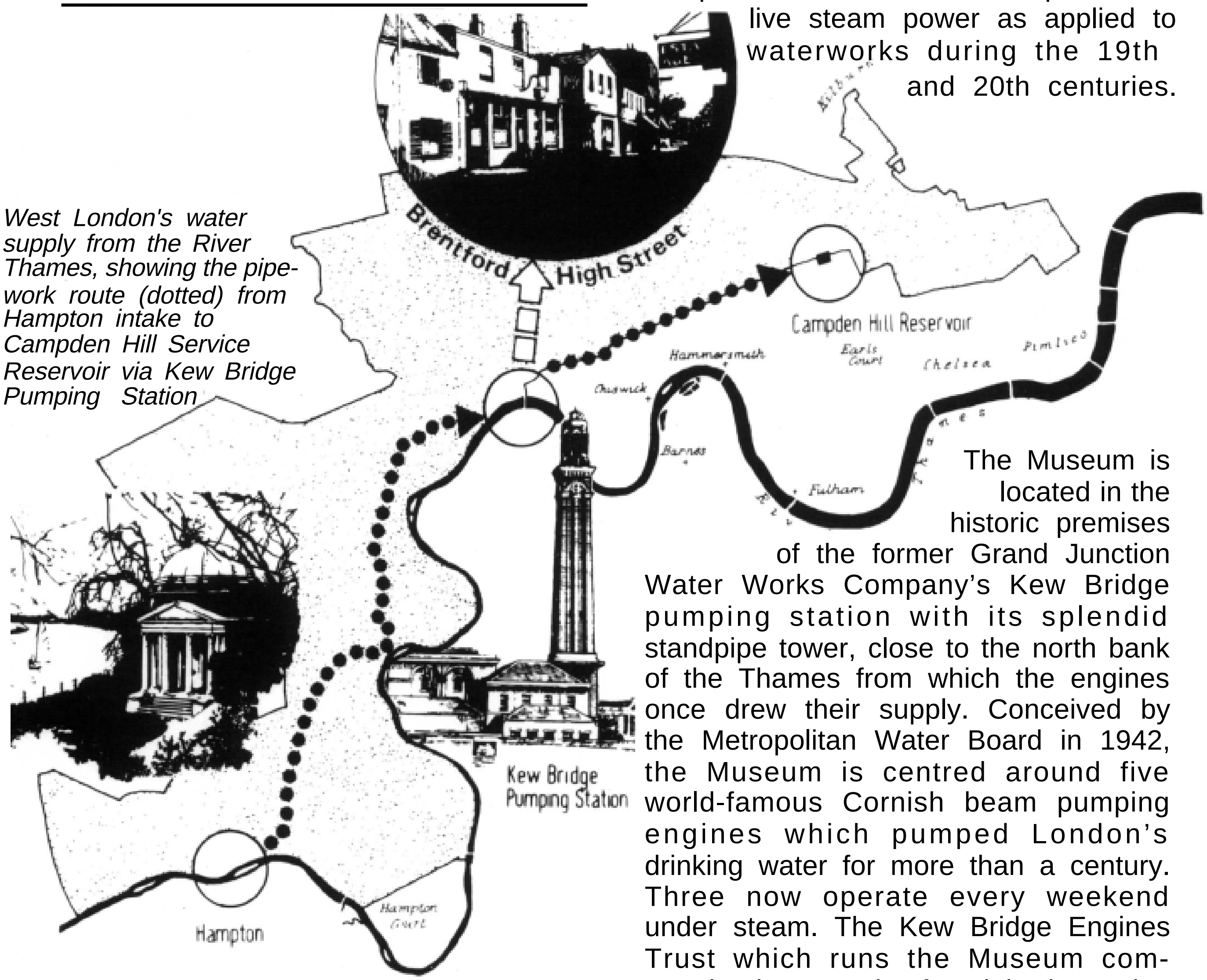
CONTENTS

WHAT YOU WILL SEE

"Until you have seen and heard one of these huge engines at work it is impossible to appreciate their majesty fully. As the great beam rocks to and fro in its trunnions high overhead, the down plunge of the piston rod and the polished geometry of the Watt linkage, in the poetry of their mechanical motion, seem the most perfect expression of power. Take steam away and their breath of life is gone, bright metal tarnishes and the engine house goes cold and dead."

L T C Rolt

There are few sights more inspiring than a large steam engine in a cathedral-like enginehouse, majestically yet quietly going about its work. What you will see at Kew Bridge is a developing Museum of Water – Man's most basic need – a unique museum with an emphasis on live steam power as applied to waterworks during the 19th and 20th centuries.



West London's water supply from the River Thames, showing the pipe-work route (dotted) from Hampton intake to Campden Hill Service Reservoir via Kew Bridge Pumping Station

The Museum is located in the historic premises of the former Grand Junction Water Works Company's Kew Bridge pumping station with its splendid standpipe tower, close to the north bank of the Thames from which the engines once drew their supply. Conceived by the Metropolitan Water Board in 1942, the Museum is centred around five world-famous Cornish beam pumping engines which pumped London's drinking water for more than a century. Three now operate every weekend under steam. The Kew Bridge Engines Trust which runs the Museum commends the Board's foresight in saving these unique engines and the site.

Other large steam, diesel and electric pumping engines are being added to the collection as time and money permit. Six steam engines are now running, including the three Cornish engines. In addition, the display includes a variety of smaller stationary steam and internal combustion engines, together with a fascinating collection of relics connected with London's water supply, some dating back to early times.

Steam traction engines, steam boats and their engines and other historic steam engine types are restored and you may find one in steam. A 19th century Forge and a Machine Shop, both vital in the process of restoring old machinery, are also open to view.

The oldest engine at Kew Bridge is the Boulton & Watt 'West Cornish' engine dating from 1820. Despite its age, this beautifully-finished engine literally sparkles with life, its huge beam rocking to and fro six times a minute and its pump shifting 130 gallons (590 litres) on each stroke.

In an adjoining room is a unique steam engine yet to be restored. It is a 70 inch diameter cylinder 'Bull' Cornish engine, built in Cornwall in 1856. At ground level it stands hidden behind its panelling next to the recently restored Maudslay engine of 1838 (see page 10).

The main Steam Hall – formerly a boilerhouse – is being used to house additional engines of different designs and periods. It contains two rotative beam engines of contrasting design and dating from the 1860s. In the same room is a much more modern example of steam pumping power, a 1910 Hathorn Davey triple expansion engine from Newmarket waterworks, which strongly resembles a ship's engine. All these engines were transported, re-erected and restored to steam by our own engineers and volunteers. These will shortly be joined by a 1910 James Simpson compound horizontal pumping engine from Waddon Pumping Station in South London. Small steam engines, models and displays illustrating the history of London's drinking water supply and items of machinery undergoing restoration complete the main hall.

Our pride and joy, however, is the Grand Junction 90-inch Cornish beam engine, named after the diameter of its huge cylinder inside which a BBC-TV camera crew recorded a party for Blue Peter to celebrate the engine's return to work in 1976. Made in Cornwall in 1845, it is now the biggest beam engine working anywhere. Every Saturday and Sunday, it lives again to the delight of thousands. In an adjacent house is the still larger 100-inch engine, built in 1869-71. One day, given enough public support, it too will pump water again...

OUR FUTURE PLANS...

As we go to press, our landlord – Thames Water Authority – is releasing more of the historic part of the site to us. We have just taken over the old Carpenters Shop (the building you first entered) which was originally a boiler-house; the low level buildings to the east of the site; the former Diesel house and, all the low level buildings on the western side of the site.

Our plans are: 1. In the 'Carpenters Shop', to create a History of London's water supply from early beginnings through the 'New River', the early 19th century epidemics to the present day. Exhibits will emphasise domestic appliances such as closets, baths and basins and the problems and methods of waste disposal.

2. In the low level buildings to the west, we plan to install in the present Electric Pump House other examples of electric pumps, switch gear and controls. And next door, to open a new Tea Room adjacent to the Steam Hall.

3. In the Diesel House, to retain one of four Allen diesel engine sets, a Mirrlees diesel set, a Ruston & Hornsby set together with a gas fired Tangye set from Bewdley plus its gas producer. Visitors will be able to see this work in progress.

4. A 2 ft. gauge steam railway to run around the museum site, representing a typical industrial railway.

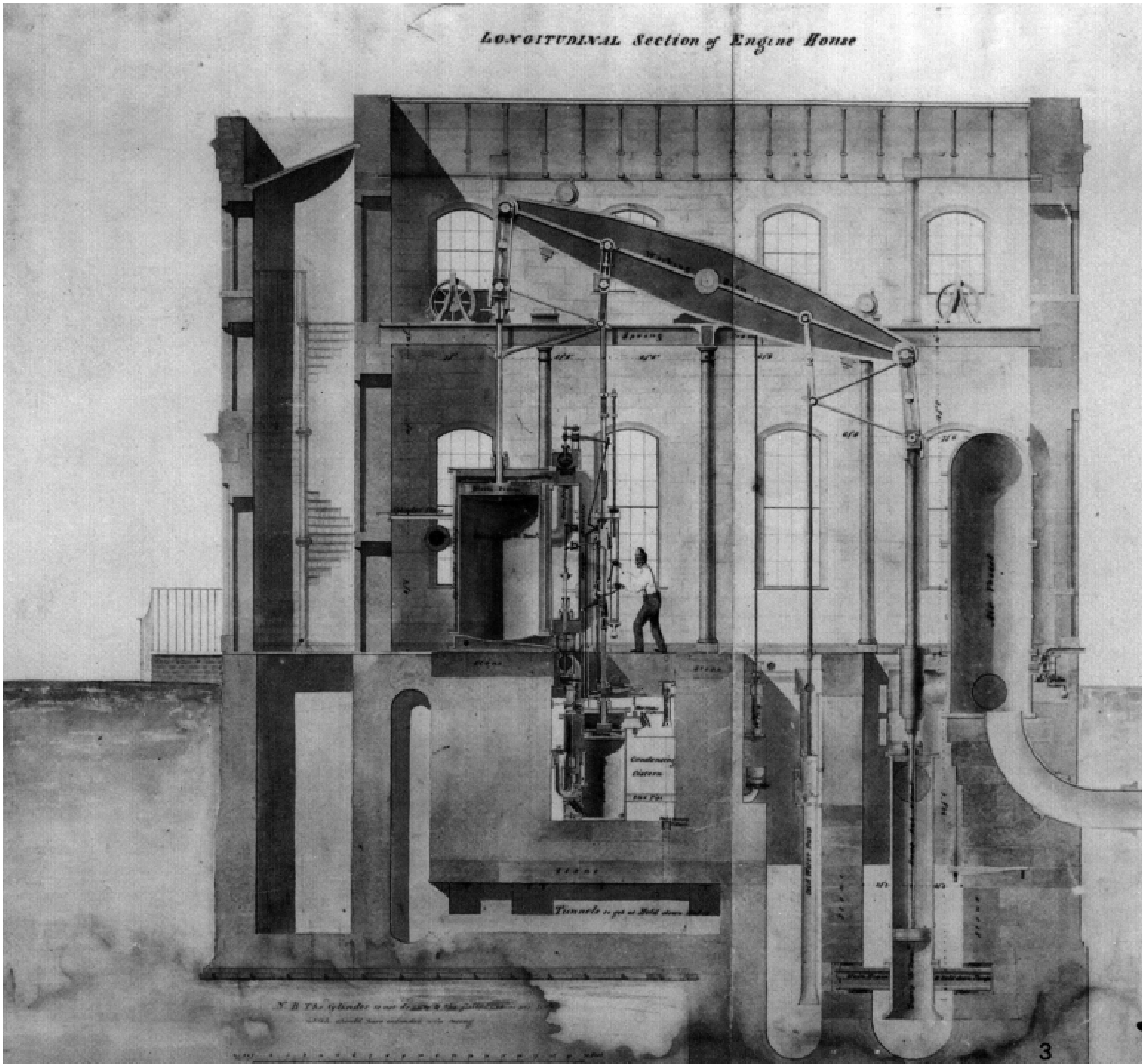
5. To erect a large water wheel driven pumping set between the two engine houses.

THE STORY OF A LONDON WATERWORKS

The story of Kew Bridge Pumping Station is the story of a water company's struggle to keep pace with the demand for water by a rapidly spreading metropolis. The station was laid down in 1837 to the design of William Anderson: the third attempt on the part of the Grand Junction Waterworks Company to establish a pollution-free source from which to supply a large area embracing Paddington, Kensington, and later Ealing.

The first station was built in 1811 near what is now Paddington railway station and the source was the Grand Junction Canal, from which the company took its name. In 1820 the company built a new station at Chelsea where a pair of Boulton & Watt beam engines pumped water from the Thames to the reservoirs at Paddington. This source too, proved to be polluted so the station was closed and the two engines transferred to Kew Bridge between 1838 and 1842. One fortunately survives today and was the first engine that was set to work by the Kew Bridge Engines Trust at the start of the museum project in 1975.

Kew's earliest beam engine – the 1820 Boulton & Watt – was originally installed at Chelsea Pumping Station pictured below. One of a pair, it was transferred to Kew in 1840.



The first engine to start pumping at Kew Bridge was, however, a new engine, built by the Lambeth firm of Maudslay, Sons & Field and set to work in 1838. It, too, was a beam engine and still survives today, albeit somewhat altered from its original condition. In 1845 the Grand Junction Water Works Company commissioned a new reservoir at the top of Campden Hill, whereupon the Paddington reservoir was closed and the three Kew Bridge engines began pumping to the new reservoir.

Even at Kew Bridge, however, pollution was a problem and filter beds had to be built (filtration was compulsory by 1856). Two 40-inch diameter cylinder 'grasshopper' Cornish beam engines were built by Sandys, Carne & Vivian at Copperhouse Foundry, Hayle, to pump raw water into them. These unusual engines were installed alongside the Maudslay engine in 1845. This move was part of a major plan to update and augment the pumping capacity at Kew Bridge and was the brainchild of a young engineer, Thomas Wicksteed. He was an ardent proponent of the Cornish type of beam engine, which was performing with unprecedented efficiency and reliability in the task of draining Cornwall's deep tin and copper mines. (The term Cornish Engine is described in the next chapter.)

In 1846 the biggest waterworks engine in the world was put to work in a new engine house; a 90-inch Cornish beam engine also built by Copperhouse Foundry. (Cornish engines were commonly named after the cylinder bore in inches.) When first installed its plunger was 33 inches (838mm) in diameter but this was later altered by Harvey&Company of Hayle to one of 38 inches (965mm). Along with Wicksteed's improvements, the old Watt-type 'wagon-top' boilers were replaced by Cornish boilers capable of producing the much higher steam pressure 40lb per sq in (2.8kg per sq cm) to operate the new engine efficiently. Finally the two Boulton & Watt engines of 1820 and the Maudslay engine had their valves and valve gear altered to take advantage of the higher steam pressure.

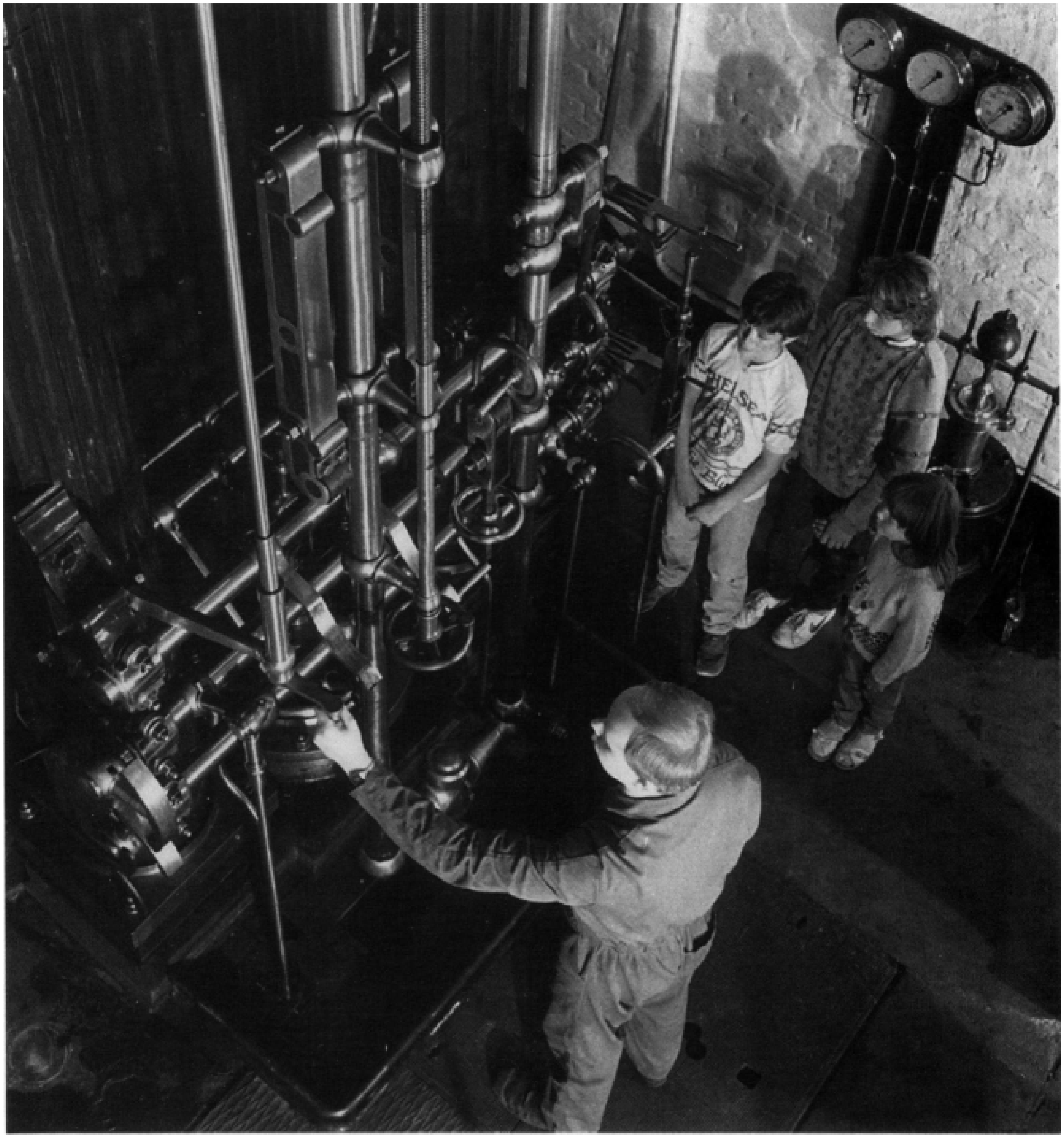
Alas for the Grand Junction Water Works Company's faith in the Thames at Kew Bridge. Outbreaks of cholera in London forced legislation in 1852 compelling all companies using the Thames as their source to remove either their pumping stations or their intakes to tap the purer water in the non-tidal Thames above Teddington Weir. The company chose to lay a main to Kew Bridge from a new intake at Hampton which came into operation in 1855. This made the grasshopper filter engines redundant so they were disposed of and a 70-inch cylinder inverted 'Bull' Cornish engine built by Harvey & Company put in their place.

The station was soon hard put to it to meet the demand. The breakage of the beam of one of the Boulton & Watt engines in December 1862, which put the engine out of action for two months, highlighted the problem. Acting on the advice of Harvey's William Husband, the GJWWCo's engineer, Joseph Quick, instituted a programme of adding strengthening trusses to the beams of all the engines. These may still be seen.

In 1867 the present standpipe tower was built, following frost damage to the original exposed standpipes, and two years later an even larger Cornish beam engine was ordered from Harvey & Co, the famous 100-inch engine. It was first put to work in 1871 and with its pumping capacity of 10 million gallons (45 million litres) a day, came close to doubling the capacity of the station overnight.

By some quirk of fate, the new engine had no strengthening truss on the beam and in May 1879 a deep crack in one half was spotted and the engine stopped, narrowly averting a catastrophe. The beam was skillfully patched and trussed and the engine then ran almost continuously without trouble for the next 65 years, an astonishing tribute to the designers and builders of these great machines.

By this time the Maudslay engine was pumping against a greater head than the other engines to a reservoir on Hanger Hill, Ealing, with one of the Boulton & Watt engines acting as a reserve. In 1888 the Maudslay, too, suffered a broken beam and the offending piece was



A trained volunteer driver prepares to start the 90 inch, the world's largest working Cornish beam engine.

replaced by one much heavier, giving the beam a curious lopsided appearance today. At about this time the area served by the station was reduced, affording much-needed relief.

Also about this time, the original engine house was extended and a Worthington duplex non-rotative horizontal pumping engine was installed at Kew Bridge but this has not survived. In 1903, the eight companies including the Grand Junction which served London were merged to form the Metropolitan Water Board. During World War I the workshop area suffered a direct hit by a Zeppelin bomb. The buildings were re-built and today include the forge and workshops.

In 1934, the Metropolitan Water Board installed Allen Gwynne diesel-driven centrifugal pumps to act as standby pumps to the beam engines pending their eventual replacement. One of these diesel pumps and the 'temporary' building which housed them survive today. The electric pumps, which were brought into service from 1941 were in operation together with the diesels until the summer of 1985 although the diesels were only really used in later years to help meet extra demand for water during the daytime.

The last engine to work regularly was the 100-inch engine in 1944, but as a means of ensuring survival of the splendid Cornish collection this engine and the Bull were left coupled to the mains, being officially on standby. The 100 was indeed run on occasions before invited guests, the last time being in 1958. By this time the chimney stack had become unsafe so it was demolished and the 14 Lancashire and Cornish boilers were sold for scrap.

Apart from one of the Boulton & Watt engines which was scrapped in 1946 to make room for small exhibits the Board wished to preserve, the Cornish engine collection remained complete, their brightwork coated with shellac and condensation kept at bay by central heating. This situation lasted until the epoch-making agreement between the Kew Bridge Engines Trust and the Board (now part of Thames Water Authority) concluded in 1975, which signalled the start of the present museum operation.

The long term aim remains the same –to restore all the engines on site which includes the ‘Bull’ engine and the 100-inch Cornish engine.

Standpipe tower

The most prominent feature of Kew Bridge Pumping Station is its fine Victorian standpipe tower (see cover picture) – it is not a chimney stack. Its purpose is to house two systems of vertical pipes rising to heights of 175 and 235ft (53.4 and 72.7m) respectively through which water from the Cornish engines was pumped before passing into the mains. The purpose of the standpipes was to act as a ‘buffer state' between water under the pulsating pressure of the engines and the constant pressure required in the mains. They also served to protect the engines against possible damage due to sudden loss of load in the event of, say, a burst water main.

The tower was built in 1867 to replace an earlier open lattice structure. It is no longer in use but is maintained by the Museum as a listed building.

THE CORNISH ENGINE EXPLAINED

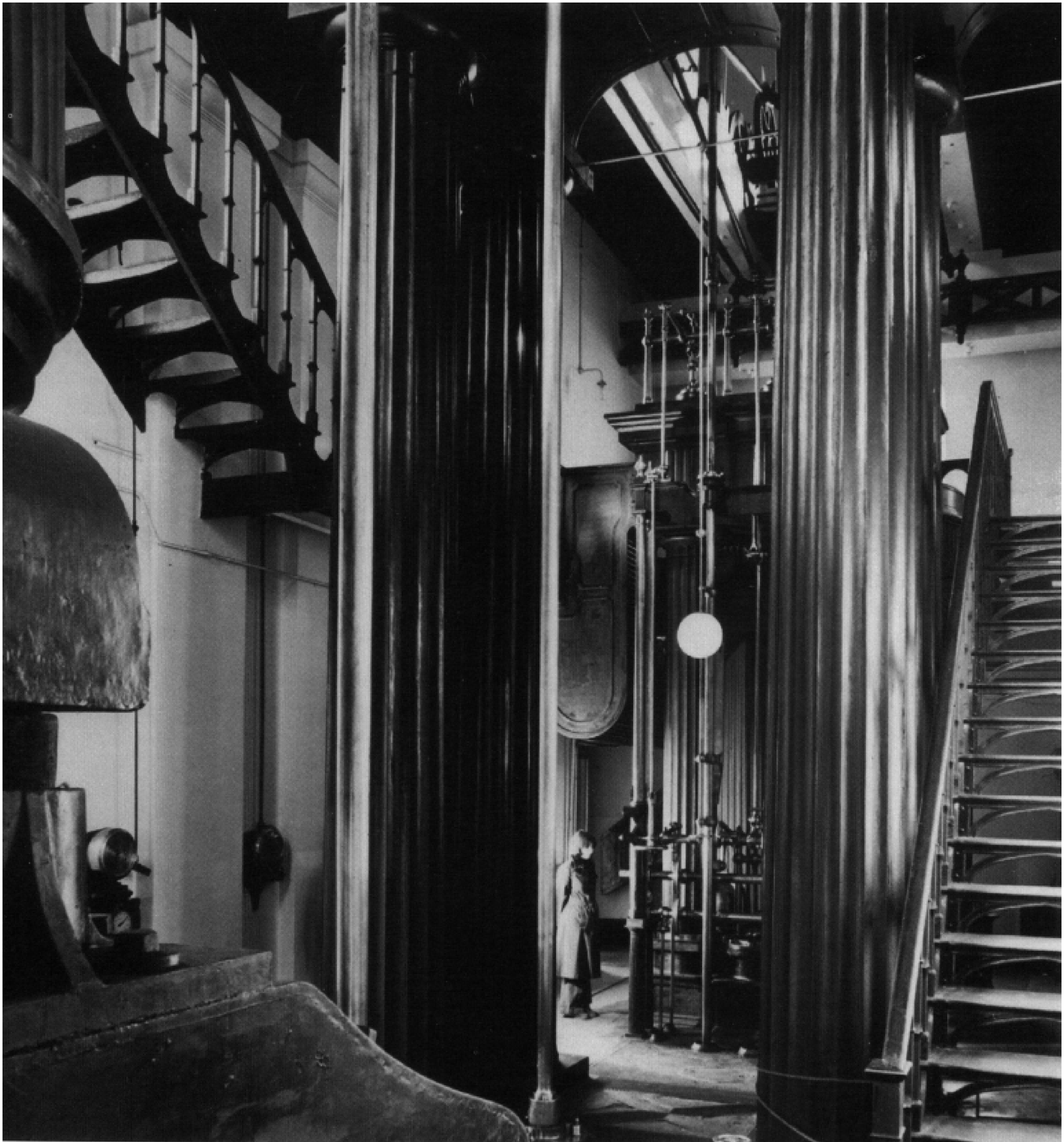
To the more technically minded, the great significance of the Kew Bridge museum is the collection of large Cornish beam pumping engines. Not only do the five engines represent one quarter of the world’s population of this rare type, but Kew Bridge is the only place where large examples may be seen working under steam in their full splendour.

Because of the way the pumping station grew to serve an expanding urban area, as described previously, they were built at different times in the period 1820-71 and are each different to one another.

The survival of the collection is the more remarkable when it is considered that the majority of the two thousand or so built were scrapped long before the turn of the century. The Cornish engine was developed in an age before railways, when steam engines of any kind were few and far between. Yet despite the clumsiness of their huge parts, these engines have a grace and beauty all of their own; and-in terms of efficiency and reliability for pumping water they were unsurpassed for more than half a century.

The term 'Cornish' arises from the part played by Cornish engineers in the development of these engines from the earlier pumping engines of James Watt – men like Richard Trevithick, Arthur Woolf and Jonathan Hornblower. Indeed the Cornish engine represents the zenith of perfection in the evolution of the single-cylinder beam engine which began at Dudley in 1712 in the form of Thomas Newcomen’s first atmospheric engine.

The immediately obvious feature of a Cornish engine is its lack of rotating parts. Thus despite the mass set in motion at each stroke (80 ton(ne)s in the case of the 90-inch engine) there is no stored energy source as a fly wheel to help carry the engine through successive strokes. Piston movement is controlled, not by being tethered to a



The Cornish engine manufacturers supplied a complete package which included Kew's elegant columns and stairways.

crank but by the opening and closing sequence of the various valves, which ensures that at the end of each up and down stroke, the engine pauses in a state of balance.

The action of a Cornish engine may be likened to an old village pump with the hand lever replaced by the beam. A plunger pump and weight box hang from one end of the beam while a piston, working in an upright cylinder, is attached to the other. Live steam is used to depress the piston and so raise the plunger and weight box rapidly. On the return stroke, which is made more slowly, the plunger descends under gravity and in so doing displaces a certain volume of water into the main. (A more detailed explanation of the working of a Cornish engine is contained in a separate leaflet obtainable from our shop.)

One important side effect of the Cornish engine's intermittent action is that each up and down stroke is a separate power entity. So its high efficiency – an 80-inch engine in Cornwall attained 11% overall in 1835, a staggering figure for the time – is virtually unaffected by the pumping rate. Maintaining efficiency over a wide range of load factors is a problem with prime movers even today.

The spur to the development of the non-rotative Cornish beam engine in its final form was the massive inflow of water encountered in the deep Cornish tin and copper mines. Allied incentives were the demand for these metals during the industrial revolution, and the high cost of carting coal all the way to Cornwall from the pits. Prior to 1800 James Watt had made great improvements to the atmospheric engine. He had invented the separate condenser, introduced live steam above the piston, changed the beam from timber to cast iron and begun to use a steam jacket. As the 18th century gave way to the 19th, engine details steadily improved along with better manufacturing techniques. As an example, after Wilkinson's invention of the boring bar in 1775 it became possible to produce accurate cylinder bores.

After 1800 Watt turned more attention to rotative engines and their much wider market, leaving the Cornish engineers free to tackle the problem of more efficient mine drainage. This they did to such purpose that by the 1830s engines were shifting four to five times the quantity of water per ton of coal burnt compared with the best Watt engines. Even more remarkable, Cornish engines continued to be built without further change until the present century. Examples were still working commercially in 1960 after lives of 70-80 years. Has any other sophisticated machine so withstood the test of time with no changes in design?

The principal Cornish development was Richard Trevithick's Cornish boiler, which made possible much higher steam pressures than the 2-3lbs per sq in (0.14-0.2kg per sq cm) which was the maximum Watt's boilers would stand. Higher steam pressures, up to 60lb per sq in (4.2kg per sq cm), enabled Cornish engines to work expansively, that is the steam valve could be shut early in the stroke instead of filling the whole cylinder with steam at close to boiler pressure – the real secret of their economy. Other Cornish improvements were to the heat insulation, the condenser and the pumps (or pitwork) in the shaft; and the invention of the 'double-beat' valve.

Alongside the Cornish mines, great engineering firms grew and flourished. Their craftsmen erected engines not only in Cornwall but in many other places in Britain and overseas. Most Cornish pumping engines spent their lives in the mines, sometimes moving several times to different sites as mining fortunes changed. But some of the finest examples of all were built for water-works, like those at Kew Bridge. Three of our engines were built in Cornwall while the two older engines were built in Birmingham and in London. They are the only surviving examples of close on 100 Cornish engines which were employed in London's water supply at one time. By comparison, upwards of 1,500 were employed in the Cornish mines, though not simutaneously and some were exported to mining theatres overseas – Mexico, Australia and South Africa!

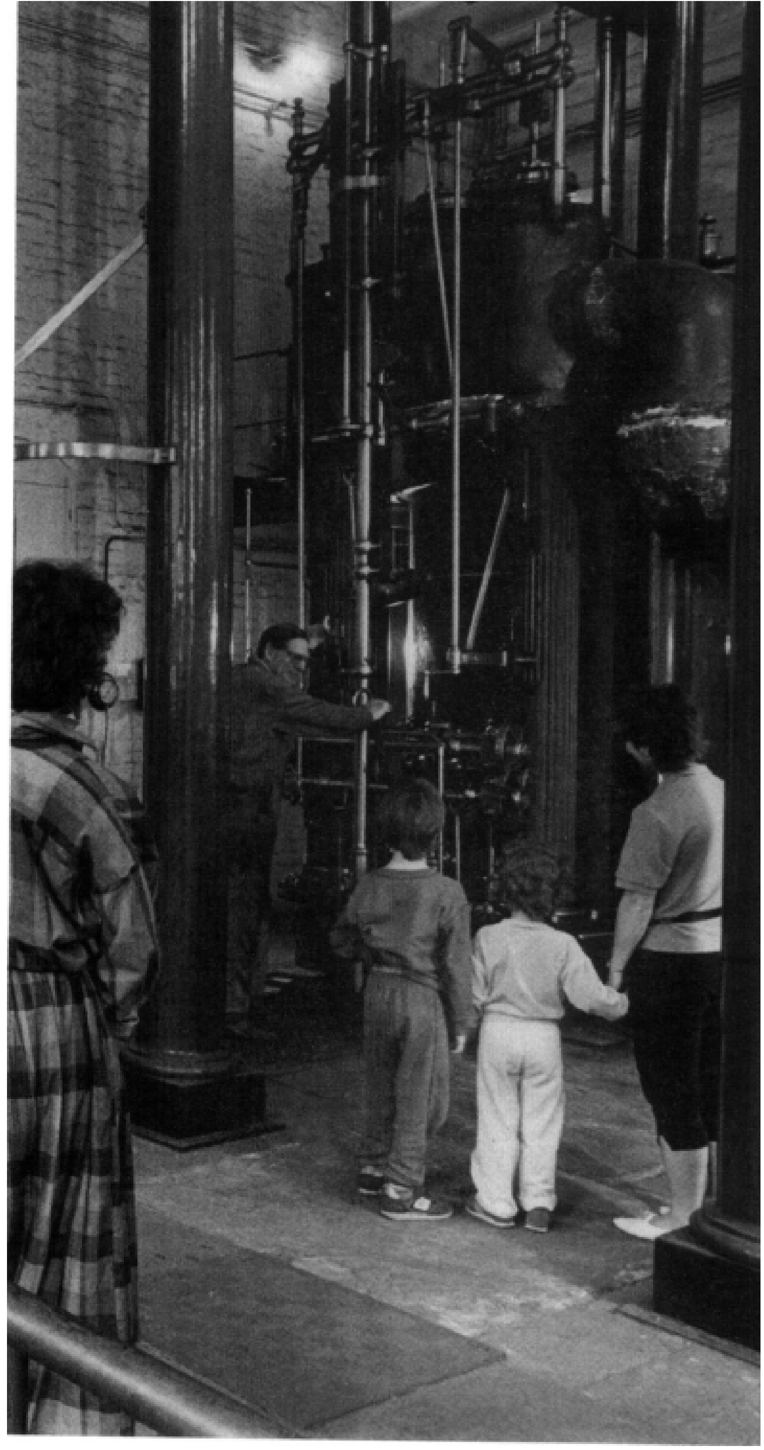
The Boulton & Watt 'West Cornish' Engine

This is the oldest of our Cornish beam engines. It stands on the right (east) side of the entrance lobby of the original (west) enginehouse built in 1838. It was the first engine put back to work at the start of the museum project in 1975. The ground floor is the driver's, or working, floor and a stone staircase leading off the lobby gives access to two higher levels from which all three engines in this house may be studied.

The West Cornish engine was built by Boulton & Watt of Soho Foundry, Birmingham, in 1820, the year after the death of James Watt, the famous inventor. It was erected at Chelsea as the North Engine and put to work there in November 1820. The move to Kew Bridge was carried out by Hunter & English in 1839-40 and took 11 months. For a few years it pumped into the Grand Junction Water Works Company's Paddington reservoir and was known as the Paddington Engine even after the reservoir closed.

It was joined in the same room by the Chelsea South engine after a short interval. This was a sister engine whose iron framing and massive granite bedstone (which probably came from Chelsea with it) can still be seen alongside the present engine. The second engine became known as the East Cornish engine and was scrapped in 1946. Traces of a brick arch in the north wall show where a temporary opening was left by the builders so that parts of both engines could be brought in and erected under cover.

Both engines had a cylinder diameter of 64 inches and stroke of 8ft. The present engine is thought to have had new piston rings fitted to match ovality in the bore. The plunger pump, which is not original, is 24 inches (710mm) diameter and shifts 130 gallons (590 litres) of water at each stroke. For many years the engine pumped to the Ealing or 'country' district against a head of 235ft (72m). Today it is pumping through a bypass system designed by the Trust's chief engineer, Ron Plaster.



Kew's oldest working beam engine and the first to be restored to steam by the Trust in 1975 is the 1820 Boulton & Watt.

Worthy of note are the pumpwork and sump which on this engine are left uncovered; the sump was originally filled direct from the Thames via a now-disused culvert. Other points to note are the polished rods, levers and trips of the valve gear which the driver is always willing to explain; the illuminated cistern under his feet which contains cooling water for the condenser; and brass plates and other relics dotted around the room from steam pumping engines which used to serve the London Area.

From the upper floors may be observed the highly polished cylinder 'false' cover, with brass oilers, provided mainly for decoration and to conserve heat; the three valves in the valve chest or top nozzle'; the 15 tonine) cast iron beam with the stiffening truss added as a safety measure in 1863 after a breakage on the sister engine; and Watt's elegant parallel motion fitted to each end which constrains the piston and pump rods to move in a straight line.

The valves and valve gear are not original. They were altered by Samuel Homersham in 1848 as part of improvements instituted by Thomas Wicksteed to enable the engine to utilise steam, at a much higher pressure than hitherto, under the Cornish system. After the alterations the driver could select the cut-off position – that is the point in the stroke at which the steam valve shuts – much earlier by means of the brass handwheel on the moving 'plug rod'. In practice, the engine is regulated on the governor: the cut-off is rarely touched.

Technical particulars

Cylinder bore and stroke:	64 inches by 8ft (1.52 by 2.4m)
Pump diameter and stroke:	24 inches by 8ft (610mm by 2.4m)
Pump delivery per stroke:	130 gallons (590 litres)
Steam pressure:	40lb per sq in (2.8kg per sq cm)

The Maudslay Engine

Across the lobby, the engine nearest the door in the West engine room is the Maudslay engine, restored to work in 1985 and more extensively rebuilt during its life than the West Cornish engine. Indeed little of the original remains. Built by the Lambeth firm of Maudslay Sons & Field, this engine went to work in August 1838, the first at Kew Bridge to do so, but in a somewhat incomplete state by all accounts because it was needed so urgently to relieve the Chelsea Station.

It shared with the West Cornish engined the duty of pumping to Paddington. On trial in December 1838 it delivered per hour an average of 601 ton(ne)s of water for an average consumption of 4¾cwt (250kg) of Wylam Moor coal, working at a speed of 13 strokes a minute.

Conversion of the engine to work on the Cornish system was also carried out by Homersham. The twin plug rods to operate the valve gear, the three valve-operating shafts or 'arbors' brought together within easy reach of the driver and the decorative cast-iron cladding to the valve nozzles are typical Cornish features. The main pump of the engine is hidden from view in the panelled iron tank by the windows.

Upstairs can be seen evidence of a cracked beam the engine suffered in 1888. One half of the beam on the east side was replaced, the casting being made much thicker as a precaution against further accident, so today the two sides of the beam are of quite different design.

Whilst on the top floor, note the construction of the roof; it is built almost entirely of wrought iron strips, ingeniously wedged together. No wood whatsoever is used in its construction; an important fire precaution. Look out of the west windows behind the Bull engine and you will see one of the old filter beds, now housing a new all electric pumping station, commissioned by the Thames Water Authority in 1985.

The original intention was to install four similar beam engines in the West enginehouse, that is two each side of the central lobby, but in fact only the framing of the fourth was erected, in the space beside the Maudslay engine. In 1845, the two 40-inch by 10ft stroke 'grasshopper' Cornish filter engines built by Sandys, Carne &Vivian were put in the space as described earlier. Drawings of these interesting engines exist and their mounting plates may yet be seen in the floor.

Technical particulars

Cylinder bore and stroke:	65 inches by 8ft (1.52 by 2.4m)
Pump diameter and stroke:	24 inches by 8ft (610mm by 2.4m)
Pump delivery per stroke:	130 gallons (690 litres)
Steam pressure:	40lb per sq in (2.8kg per sq cm)

The 'Bull' Engine

With the ever-increasing demand on the station, the Grand Junction Company decided to make the maximum use of the space freed by removal of the grasshoppers by installing a 70-inch cylinder, 10ft stroke inverted Cornish Bull engine. As can be seen, the cast iron framing had to be cut about to fit a cylinder of this size in the building.

Today the Bull engine is the largest survivor of its type and the only one in a complete state. The name is derived from the Cornish inventor, Edward Bull, who was a friend of Richard Trevithick and whose first engines had the cylinder inverted over the mine shaft. Kew Bridge's example was built by Harvey & Company of Hayle in 1856-7 yet curiously it was not put to work until March 1859. It appears to have spent all its working life pumping to the Company's Campden Hill reservoiir near Notting Hill Gate where three more Bull engines were installed, one with a 90-inch cylinder, for pressurising the mains at that elevation.

In a Bull engine, instead of the piston driving the pump via an overhead rocking beam and connecting linkage, it does so directly, the piston and pump rod being one. The cylinder and valve gear are mounted at first floor level and the pump and ancillaries are concealed in the panelled compartment beneath. This arrangement takes less than half the space of a beam engine of comparable size and capacity and requires a far simpler building. Nevertheless these engines were often unpopular with enginemen as they ran less smoothly and were more difficult to regulate. Also attending to the piston and piston rod packing, working overhead and perched above the well, was far more difficult than with the cylinder the normal way up.

Below ground floor level can be seen the wrought-iron half beam used in a Bull engine to work the plug rod, air and feed pumps. The valve gear, apart from being upside-down, is unusual even for a Bull engine in having the speed control, or 'cataract' arranged to trip the equilibrium valve instead of the steam and exhaust valves.

Kew Bridge's Bull engine was probably used mainly as standby to the 90- and 100-inch engines as its valve gear shows little sign of wear by comparison with the other engines. To examine the valve gear means going up the stairs to the middle floor; at top floor level only the decorative false top to the cylinder may be seen.

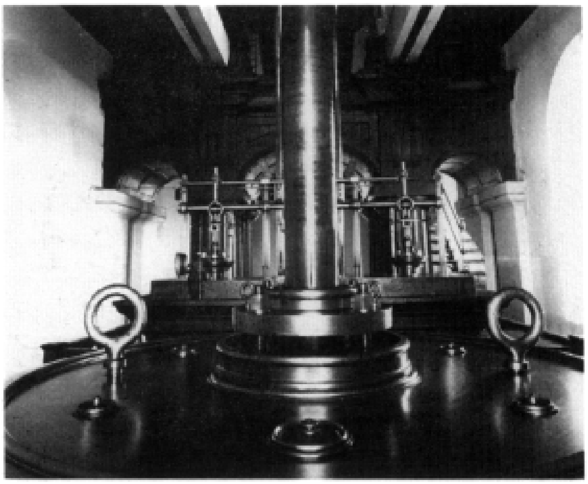
Technical particulars

Cylinder bore and stroke:	70 inches by 10ft (1.78 by 3.05m)
Pump plunger diameter and stroke:	28 ins by 10ft (711mm by 3.05m)
Pump delivery per stroke:	236 gallons (1073 litres)
Steam pressure:	40lb per sq in (2.8kg per sq cm)

Believed to be the sole surviving 'Bull' engine in situ in the country, Kew's example has yet to be restored.

Grand Junction 90-inch Engine

This superb machine represents the very zenith in craftsmanship and engineering skill which was so evident in the work of the Cornish engine designers and manufacturers in the mid-19th century. It was the second engine put back to work by the Trust, in July 1976 – it is also, because of its size, the most expensive to run!



A typical example of Kew's grandeur is this view from the cylinder top of the 90 inch.

It stands next door to the 100-inch engine which was installed 25 years later. Fewer than 70 engines with a cylinder diameter in excess of 80 inches were built by Cornish firms and only four survive – two at Kew, one in Cornwall (Taylor's 90-inch at East Pool) and one in Holland (the Cruquius 84/144 inch annular compound). Our 90, as it is affectionately- known, was the world's biggest waterworks engine when started in 1846. It was the first engine built in Cornwall specially for waterworks duty; a sister engine at Old Ford Waterworks in East London did not come into service until the following year. These two engines were built by Sandys, Carne &Vivian of Copperhouse Foundry, Havle, to the order of Thomas Wicksteed, and were despatched to London by sea from the -company's private wharf at Hayle which may still be seen.

The 90 is typical of a large Cornish pumping engine as applied to mine drainage in Cornwall and elsewhere in considerable numbers. The chief difference is at the pump end where a single lift plunger surmounted by a weight box takes the place of a long wooden pump rod with plungers attached at intervals reaching down the mine shaft. The weight box is necessary to provide the impetus for the 'outdoor' or pumping stroke – on a deep mine the weight of the pump rod itself was more than sufficient.

When new, the engine had a 33-inch (838mm) plunger but in order to increase its capacity Harvey & Co. of Hayle were contracted to fit new pump-work with a 38-inch (965mm) plunger, which was done in 1863. Thus equipped, the rating of the engine went up from 5.5 to 7.5 million gallons a day (25,000 to 34,100Ml/d) delivered to the Campden Hill reservoir, but this meant working the engine at 9½ strokes per minute which was rather too fast. The rating was later reduced to 6.5mgd (29,550Ml/d). Today's speed is 4-4½ strokes per minute, a good average speed in Cornwall.

Also in 1863 the beam was trussed, more elaborately than on the smaller engines with a forged strap encircling each half of the beam. Despite its seemingly massive parts, the components of the 90 are, in fact, slender compared with engines built later in the century. The beam, for example, weighs 32 ton(ne)s whereas that on Taylor's 90-inch engine in Cornwall, built in 1892 and having a shorter stroke, is no less than 56 ton(ne)s.

Typical of Cornish practice is having the condenser of the 90 'outdoors' or between the entablature and the pump; the hotwell is too close to floor level to permit it to be opened to view and the same applies to the sump which is completely boxed in with iron plates.

The sister engine of Old Ford was scrapped following pollution problems in 1892. Kew Bridge's splendid engine normally only runs in the afternoon on steaming days, but attracts visitors from all over the world.

Technical particulars

Cylinder bore and stroke:	90 inches by 11ft (2.28 by 3.35m)
Pump diameter and stroke:	38 ins by 11ft (965mm by 3.35m)
Pump delivery per stroke:	472 gallons (2146 litres)
Steam pressure:	40lb per sq in (2.8kg per sq cm)

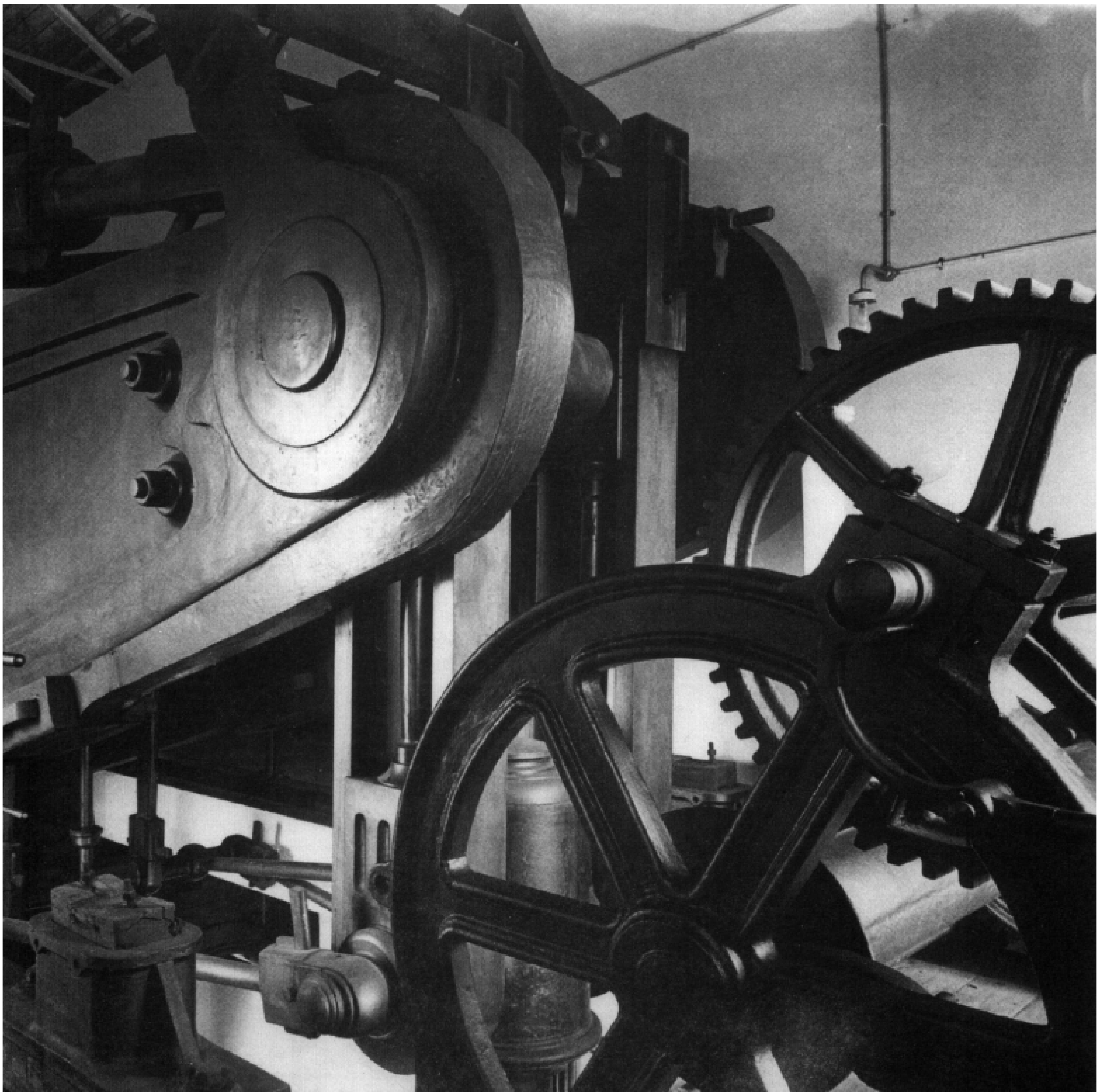
The 100-inch Engine

Six engines of this size were built in Cornwall. Five, including Kew Bridge's, were built by Harvey & Co. of Hayle and one by Perran Foundry. Harvey were the premier Cornish engine builders and for many years they maintained in London an office and a squad of fitters who looked after the Cornish engines in the capital's water supply. At one time, 70 per cent of London's water was pumped by engines of Harvey manufacture.

Kew Bridge's 100 was maintained as a standby for many years after the other engines were shut down in the early 1940s. It enjoyed occasional brief runs for the benefit of engineering societies, the last being in 1958. By then the chimney stack had become unsafe so it was demolished and the 14 coal-fired boilers scrapped.

The engine was built and erected during 1869-71 and comparison with the 25 years older '90' next door shows how massive the parts of later engines were

The giant beam of Kew's 100 inch Cornish engine which is pictured with the crank wheels used for maintenance.



made, out of proportion to the few extra inches of cylinder diameter. The enginehouse of the '100' was cleverly 'siamesed' on to the '90's', existing windows in the east wall of the latter being enlarged to provide access to all three levels. Even the beautiful Copperhouse Foundry staircase had a rounded extension at the bottom added by Harvey & Co., exactly matching the original.

When the '100' was built, Harvey had their own vessels and one was doubtless used to despatch the huge parts from Hayle to London. They would have been transferred to barges in London docks for the last part of their journey up-river to the temporary wharf at Kew Bridge. Here they would have been brought on to the site using bogies pulled by horses and erected through openings left in the enginehouse walls. From the outside it can readily be seen how the architect made provision for this heavy and intricate operation.

Once the 100 was running, it and the 90 together were able to provide the bulk of the station's output. They ran day and night with an interconnection beneath the floor so that they made their strokes alternately – about 8 per minute per engine. It would be nice to record that the 100 was entirely troublefree but this would not be true of its early years. Despite the earlier trussing of the beams of the other engines, this was not done on the 100 until after a near-disaster in May 1879 when one side of the beam was found to have developed a deep crack near the main gudgeon. Thanks to the vigilance of an engineman, the engine was stopped in time and the beam repaired by bolting on a large patch before adding the trusses. This amazing repair can still be seen today; a drawing on the wall of the enginehouse shows visitors how it may be located.

Erection of a Cornish engine was done from the top downwards, and required structural completion of the enginehouse and time for the mortar to have set. A large engine would normally take a year to get to work. The method of erection is described in a technical leaflet obtainable from the shop.

While on the top floor of the 90/100-inch enginehouse, spare a thought for the men who had to oil the bearings in and around the beam by the dim light of gas mantles probably without stopping the engines. People often ask why these engines, in view of their splendid condition, are not still used for commercial operation today. The answer lies partly in the cost and inconvenience of burning coal, but the main factor is the manpower requirement. Imagine the number of men needed to stoke the 14 boilers on three shifts. Add a driver for each engine, a greaser for each pair of engines, also fitting shop, forge and office staff and it would be realised why waterworks use electric pumps today.

Technical particulars

Cylinder bore and stroke:	100 inches by 11ft (2.54 by 3.35m)
Pump diameter and stroke:	46 ins by 11ft (1.07 by 3.35m)
Pump delivery per stroke:	717 gallons (3260 litres)
Steam pressure:	40lb per sq in (2.8kg per sq cm)

The Waddon Engine

The Waddon pumping station of Thames Water Authority (formerly Croydon Water Company) had the distinction of being the last waterworks to have a reciprocating steam engine in commercial operation in this country. The two pumping engines were finally shut down in 1983 and the older one (No. 1) generously presented to the Trust.

Since it is a horizontal engine it will occupy a large amount of floor space in the Main Hall, which illustrates the main drawback of the type. Against this, the engine requires less headroom and its working parts are more readily accessible than in a vertical engine like our Hathorn Davey triple.

No. 1 engine was built by James Simpson & Company of Pimlico in 1910 and set to work a year later. Its younger sister, No. 2, was built after the Worthington-Simpson association and was not set to work until after the end of World War 1.

For many years until their replacement, the Waddon engines only operated during the summer months

April to October when the water demand was highest. It was customary to run turn and turn about, each engine performing several weeks' continuous duty between changeovers. Steam superheated to 440°F was provided by three hand-fired Cornish boilers fitted with economisers, the maximum working pressure being 120 psi.

Burning Welsh dry steam cobbles, the fuel consumption for one engine was about 2 cwt per hour at a running speed of 20 rpm. At this speed the engine would deliver 1.3 million gallons a day (5.9 megalitres a day) against a total head of 190 ft (58 m).

Waddon No. 1 was dismantled and removed to Kew Bridge during 1984 by the Trust's own staff and volunteers. Its re-erection in the Main Hall is due to begin in 1986. It is a surface condensing, cross-compound engine (that is, the cylinders are side by side) and the cylinder sizes are 21 and 42 in bore by 3ft stroke (534 and 1068 by 915 mm). Both cylinders have slide valves with a Meyer expansion valve fitted.

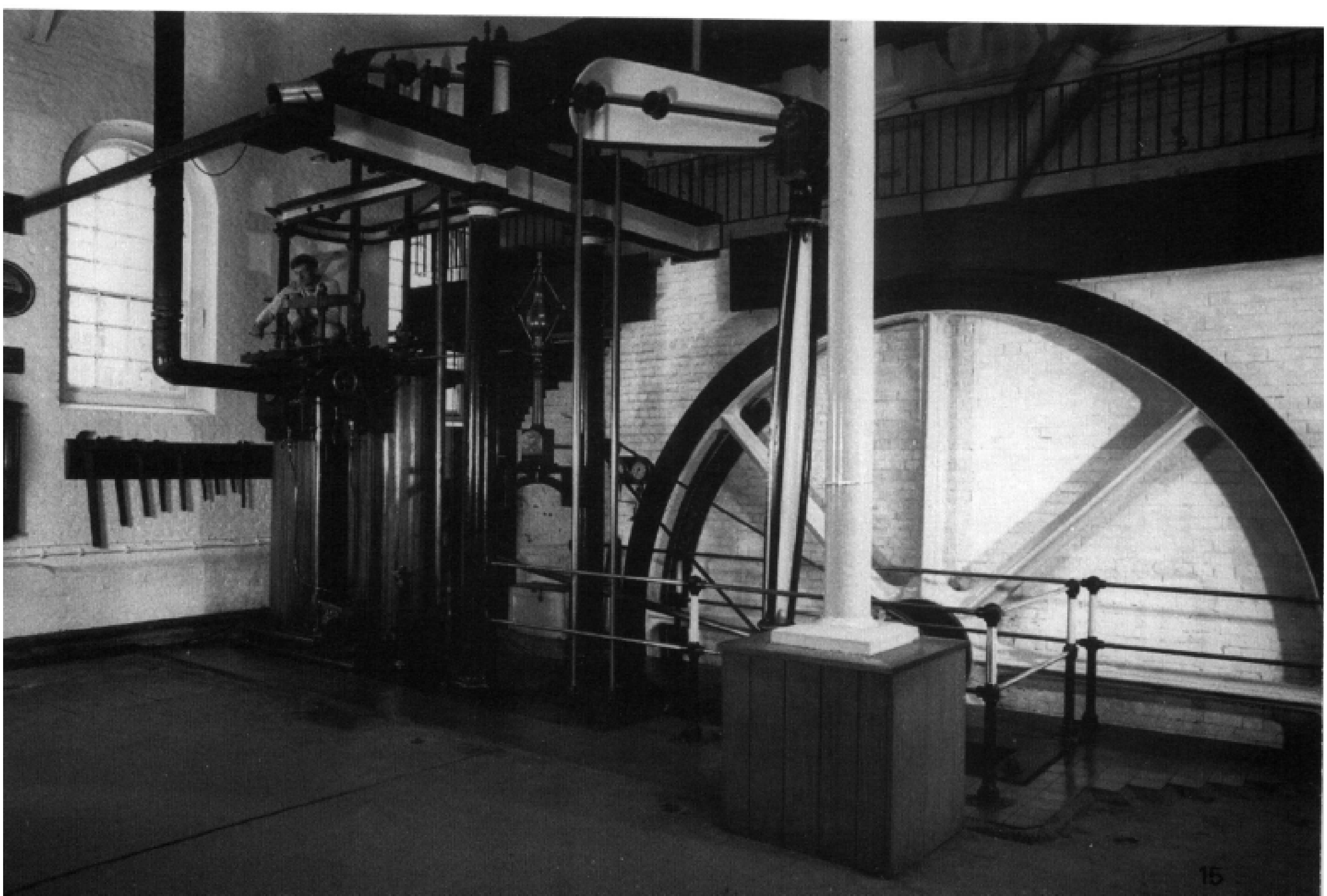
Centrally on the crankshaft is keyed a flywheel with provision for moving the engine off dead centre with a small barring engine. The engine worked well and force pumps. Well pumps consisting of a bucket and plunger were situated below the engine room floor and coupled to a cast double bell crank above, which received its motion from the low-pressure piston tailrod. The force pump was driven direct from the high-pressure piston tailrod.

On trial in 1921 No. 2 engine achieved a water horsepower of 180 and a mechanical efficiency of 91.4 per cent, at a speed of 30 rpm and a working against a 282 ft (92.5 m) head. Lubrication is by conventional oil cups which would have been topped up at intervals by the engineman during long continuous spells of running.

The Easton & Amos Engine

This beam engine, and the red-painted Dancer's End engine opposite, are

A fine example of a rotative beam engine is the Easton & Amos given to the Trust by the Northampton Water Authority.



different to the large Cornish beam engines which formed the permanent installation at Kew Bridge in having one end of the beam connected to a crank to produce rotary motion.

While this introduced extra cost in terms of engine parts and heavy foundations compared with a pumping engine producing a straight up-and-down motion, it made the engine simpler to operate and maintain and was thus much favoured for use in small rural waterworks where the huge capacity of a Cornish engine was not required.

Rotative beam engines were also commonly used for driving mill and factory machinery, usually by means of gearing, but after 1870 their use was practically confined to waterworks. A few were built for pumping duties as recently as the 1920s.

This engine was built in 1863 by Easton & Amos of Southwark, London SE1. It ran for many years at Cliftonville Pumping Station, Northampton, on a site now occupied by a hospital. It drove three-throw well pumps from an extension of the crankshaft which passed out through the wall and which was cut off before the engine came into the Trust's possession. It came here as a "kit of parts" which had lain in store for several years, and was re-erected, restored and put back to work by our own staff and volunteers during 1977-8.

Points to note about the engine include the use of two cylinders compounded in a form developed by Arthur Woolf early in the nineteenth century; the double parallel motion which guides the tops of the piston rods; and the slender flywheel cast in segments and held together by wedges and straps. The centrifugal governor is of the American Porter-Allen type, introduced into Britain the year before the engine was built and more sensitive than the Watt pendulum type which preceded it (see the Dancer's End engine).

The valves are of the slide type with extended ports, driven by a single eccentric and capable of being disengaged for starting.

Technical particulars

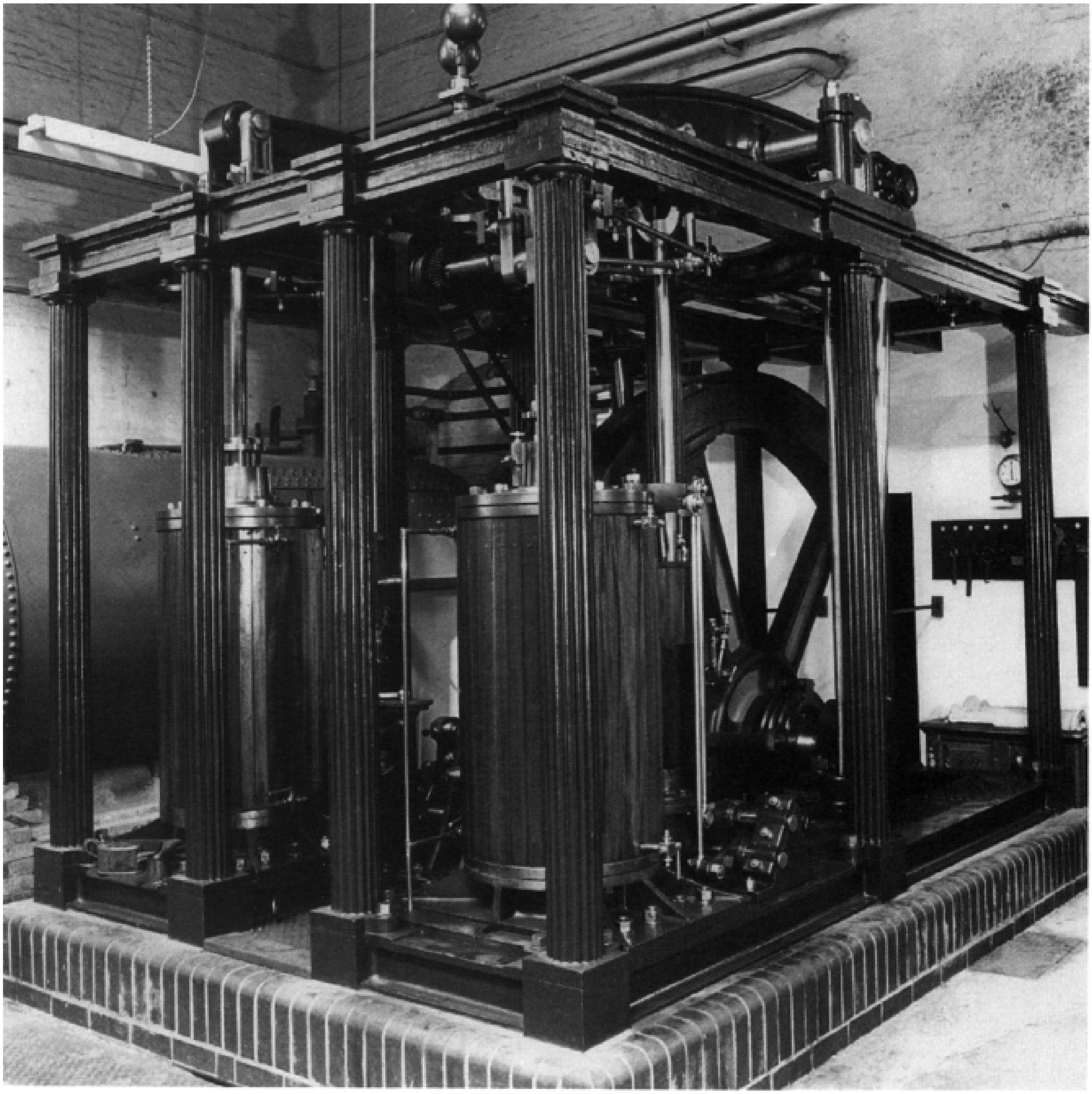
Highpressure cylinder:	17.5 bore by 40in stroke (444mm by 1014mm)
Low pressure cylinder:	30in bore by 60in stroke (763mm by 1524mm)
Flywheel diameter and weight:	18ft (6.5m), approx 10ton(ne)s
Maximum steam pressure	60lb per sq in (4.2kg per sq cm)
Power rating:	60hp (45kW) at 18rpm.

The Dancer's End Engine

This beam engine differs from the Easton & Amos engine opposite in having two high-pressure cylinders each connected to its own beam and crank, the flywheel being common to what are, in effect, twin engines. This arrangement was commonly used around 1850 to drive textile mills in Lancashire and Yorkshire, the engine's builder, James Kay of Bury, having built up his business supplying machinery to the textile industry.

In the normal form, the cranks would be set at 90 degrees to produce an even turning moment, but in this engine they are set at 180 degrees to suit the lift pumps in the well. They were driven direct from the piston tailrods working through a gland in the bottom of each cylinder. Although the engine probably dates from 1867, which is when it was installed on Lord Rothschild's estate at Dancer's End, near Tring, it is possible that it is an older engine converted to work pumps for water supply.

At Dancer's End, the engine was arranged in a building at first floor level, the cylinder end of the engine being directly over the well and supported on a cast iron framework. Water brought up the well was delivered into a cistern from which it was further pumped to an underground reservoir by means of force pumps driven directly from the engine beams. The level at which the engine stood was therefore in between the level in the well and the level in the reservoir, quite a common practice when steam was used for waterworks pumping.



The delightfully compact twin-beamed pumping engine built in Bury, Lancs., by James Kay was installed on Lord Rothschild's estate at Dancer's End, near Tring in 1867.

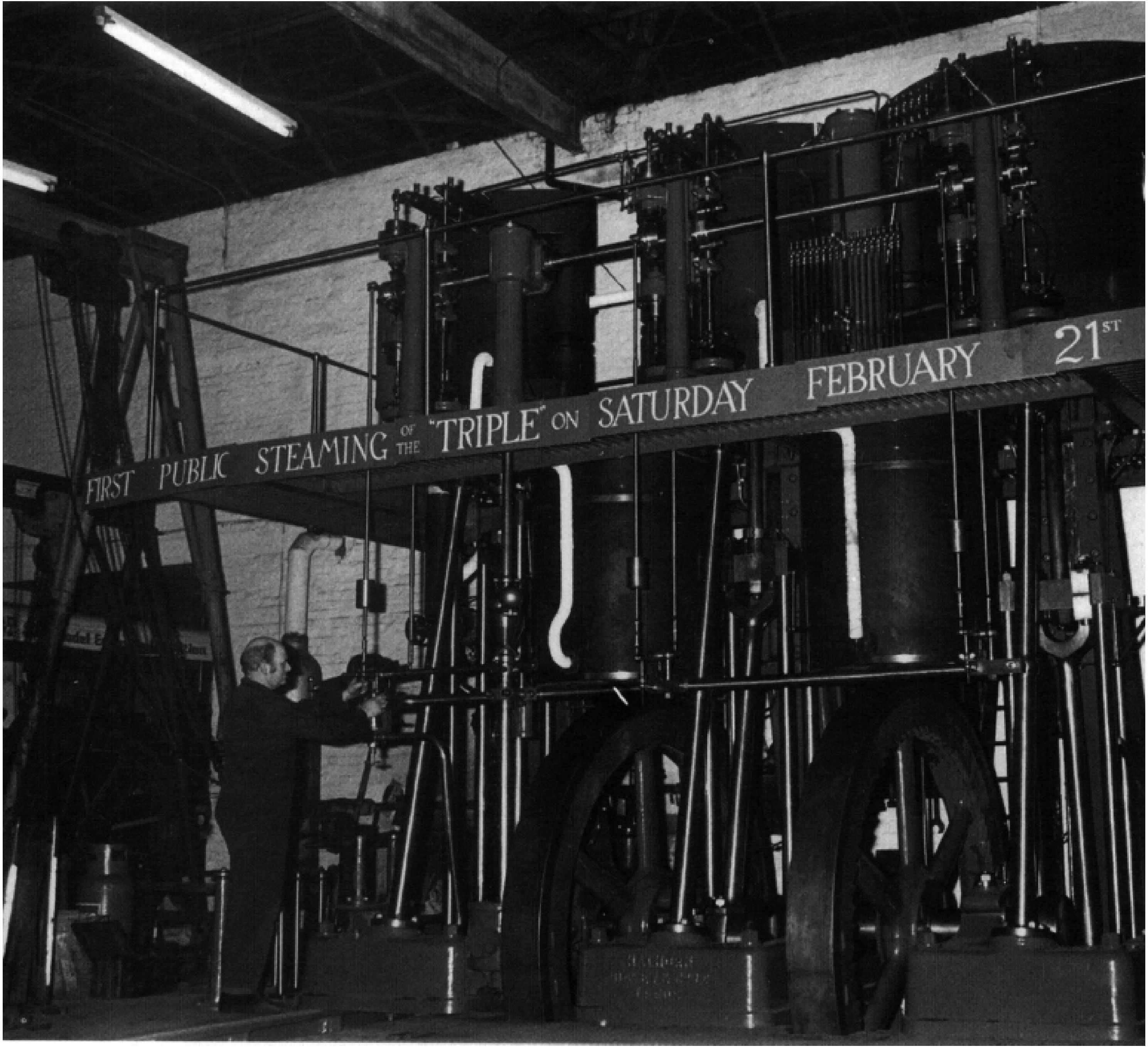
Points to note about the engine are the compact arrangement – textile mill owners begrudged anything more than minimal space for the machinery – the heavy flywheel rim and the splendid example of a Watt pendulum governor on top of the engine.

Steam distribution is by slide valves each driven by an eccentric on the crankshaft with expansion valves worked by separate eccentrics, Overspeed is regulated by the Watt governor. Each half of the engine has its own jet condenser in the conventional position with air and feed pumps worked from the beam.

This engine was donated to the Kew Bridge Engines Trust by Thames Water Authority's Chilterns Division, after the engine had been kept on standby at Dancer's End since the 1930s. It was found to be in excellent order, having been turned over and oiled regularly. It was dismantled, transferred to Kew, re-erected and repainted by the Trust's own staff and volunteers, being first set to work here in March 1979.

Technical particulars

Cylinders (2) bore and stroke:	14 by 30in (356 by762mm)
Flywheel diameter andweight:	11ft (3.35mm), approx 6 ton(ne)s
Steam pressure when in service:	56lb per sq in (3.9kg persq cm)
Power rating:	36hp (27kW) at 36rpm



Buillt by Hathorn Davey of Leeds in 1910, this Triple Expansion engine came to us from the Southfields Pumping Station at Newmarket.

Hathorn Davey Triple Expansion Engine

This imposing engine is of modern design compared with our beam engines and represents the most common type of pumping engine built for waterworks after about 1900. It may be considered a halfway stage in development between the cumbersome machines of the 18th and 19th centuries and the internal combustion engines of today. Indeed, inverting the cylinders and placing them in line directly over the crankshaft anticipated modern internal combustion engine practice.

This layout with single or multi cylinders is said to have derived from Nasmyth's steam hammer of 1855. It became universally adopted for marine screw propulsion from about 1870, due to its compactness. By far the most common form was the 'triple' (three-cylinder triple expansion) where the steam is expanded in three cylinders in succession. The idea of using this type in a waterworks came from the USA in the 1880's and quickly caught on.

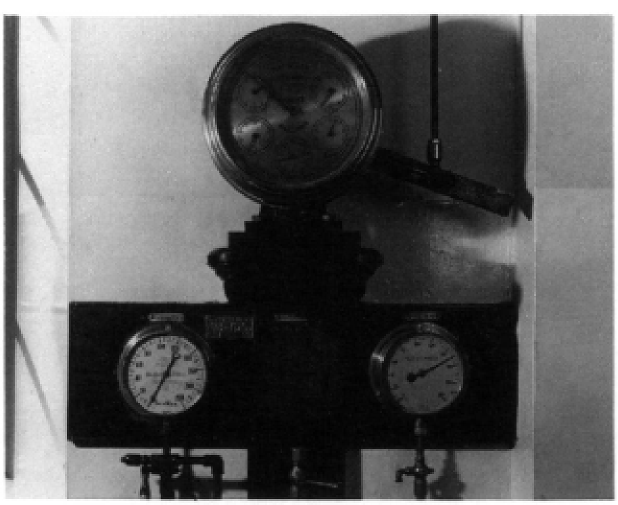
Vertical triples were always impressive engines to watch because of their height and stately running speed. Our engine was built in 1910 by Hathorn Davey of Leeds – one of the world's best-known pumping machinery manufacturers – and erected at Southfields Pumping Station, Newmarket. Though relatively small, it is nonetheless a typical example with its twin flywheels, plunger pumps beneath the floor driven by rods from the crossheads, and Corliss (rotary) valves with governor-controlled cut-off on the high pressure cylinder.

At Newmarket, the engine pumped 1,000 gallons (4.5MI) per minute against a 350ft (110m) head. A surface condenser beneath the floor receives exhaust steam from the low-pressure cylinder. Originally, cooling would have been provided by the simple expedient of passing the pump discharge through the condenser. Today, it is done from the mains. Due to headroom limitations, the pumps are no longer fitted. Because this engine is intended for long spells of running with minimum attention, it has a relatively sophisticated lubrication system.

The engine was donated by the Anglian Water Authority. It was dismantled, transported here, re-erected and restored to its original glory by Kew Bridge staff and volunteers in the period 1978-1981.

Technical particulars

Cylinders (3):	12,20 and 31 in by 2ft 6in stroke (305,508 and 787 by 762mm)
Working pressure:	200lb per sq in (14kg per aq cm)
Pump horsepower:	108hp (80kW) at 39rpm



The Salisbury Engine

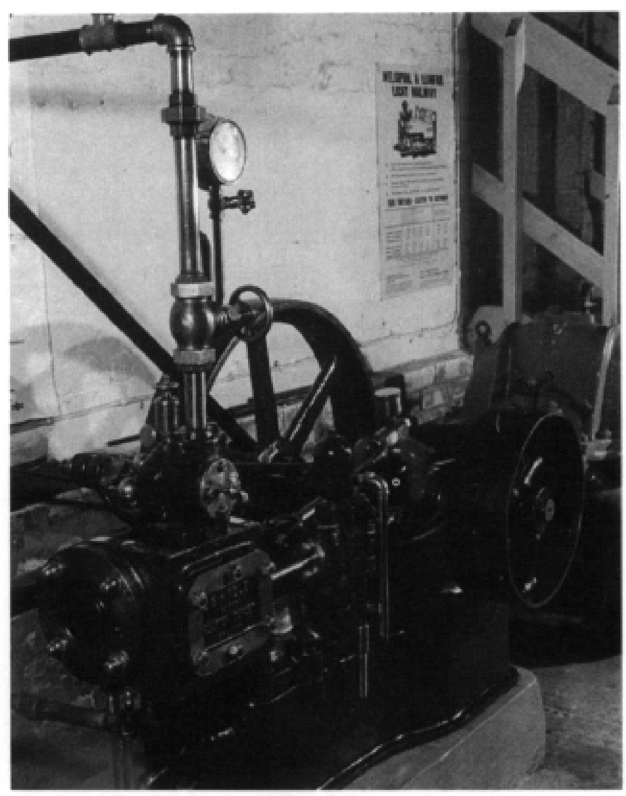
This is a smaller example of a steam pumping engine and is on display under steam when circumstances permit. It is an attractive single cylinder horizontal engine made about 1895 by Benham and Company whose head office was in Wigmore Street, London W1. The firm is still in existence as a manufacturer of bulk catering equipment.

The engine came from Mylees workhouse, Salisbury, where it used to raise water from a well sunk 100ft (30m) into the chalk.

As now set up, it is driving a typical vertical three-throw single acting pump as used in small waterworks and breweries in the last century. But when at Salisbury it drove pumps at the foot of the well by long rods from a geared layshaft at the well head. The engine and the original pump is on display behind the Easton & Amos engine, and were recovered thanks to the Wiltshire County Council.

Technical particulars

Cylinder bore and stroke:	5 5/8 by 10in (143 by 254mm)
Horsepower rating:	18hp (13.5kW) at 100rpm)



Kew's 'Salisbury' engine is a good example of a single cylinder horizontal pumping engine built by Benham & Company in 1895.

Auxiliary engines in the Steam Hall

A number of typical 20th century auxiliary steam engines are kept at Kew Bridge, but because of the frequent moves as development of the Main Exhibition Hall progresses, it is not always practicable to put them on display.

They include a Green's economiser engine, one of many hundreds of single cylinder horizontal engines turned out by E. Green & Sons of Wakefield as part of economiser installations supplied by the firm. The purpose of an economiser was – and is – to recover a proportion of the heat in the gases escaping through the main boiler flue by interposing a grid of cast iron tubes through which feed water was circulated.

To keep the tubes clear of soot, each was fitted with a scraper ring. The rings were slowly racked up and down the tubes by means of chains and pulleys driven by the engine, change of direction being effected by automatic tumbler gear. We have an economiser mechanism at Kew Bridge which is intended to become a working display.

To feed the boiler we employ two vertical non-rotative Weir pumps, built by the well known firm of G. & J. Weir of Glasgow in 1955. These feed pumps were made in thousands and at one time a fair proportion of all the world's steamships would have been fitted with them. The steam and water cylinders are arranged on the same axis with a common piston rod, and the steam valve is operated by a shuttle device which reverses the direction of movement of the piston as it approaches the end of the stroke. Utter simplicity and reliability are more important than efficiency where feeding boilers is concerned.

The horizontal duplex non-rotative Worthington pump which originated in the USA is represented by several examples. The principle of operation is similar to the Weir pump except that there are two steam cylinder and pump assemblies side by side.

A Chandler 'Silent' engine by Bumsted and Chandler of Hednesford is of interest in being single acting and having a totally enclosed crankcase with forced lubrication. With no load reversals on the moving parts, very quiet operation results, despite a running speed as high as 500rpm. Kew Bridge's example used to be directly coupled to a centrifugal pump.

Another enclosed engine, by E, Reader of Norwich, was installed at a waterworks to drive a boiler fan but never used. This type, too, had forced lubrication but being double-acting with a high running speed gave a high power output in relation to size.

Turbine-driven centrifugal pumps are represented by a 2hp (1.5kW) 1000rpm Pulsometer unit made in 1940 and direct-coupled to a single-stage steam turbine by Turney Turbines Ltd, of Harrow; and a larger centrifugal pump, by Mather & Platt of Manchester and capable of delivering 200 gallons (910 litres) per minute at 1460rpm.

Vintage internal combustion engines associated with waterworks pumping are represented by a single-cylinder gas engine built by the National Gas Engine Company about 1900. This engine was formerly coupled by flat belt to a set of vertical three-throw pumps at Ealing Waterworks. The pump set is also on display and is typical of light-duty pumping practice in waterworks, breweries and process plants around the turn of the century – topping up a roof tank, for instance. More modern diesel-driven pumps are either in store or earmarked for preservation by the Trust when circumstances permit.

A model of an early wooden water pipe boring machine – there are examples of real 'elm' pipes on display also.

WATER SUPPLY RELICS

Along with the large Cornish engines, the Trust inherited a number of historical exhibits relating to London's water supply, for which a display area is being prepared.

Oldest of these is a battered-looking piece of 4-inch lead pipe, said to be 700-800 years old, which was used as part of a 'conduit' to convey water to the City of Westminster from springs in Hyde Park.

Other early exhibits include two sections of wooden water main dating from the pre-steam pumping era which began about 1750. One consists of a junction between main and branch pipes and has been sectionalised to show its construction. Hollowed-out elm tree trunks were used for these early pipes which gave rise to the expression 'trunk mains'. A model shows how the boring and jointing of wooden pipes was carried out.

Ironfounding techniques developed to make parts for steam engines began to be used for water mains late in the 18th century. Early examples of cast iron work on display include a 3-inch (76mm) diameter butterfly valve dating from about 1800 and a 5-inch (127mm) diameter plug valve dating from 1822. Another sectionalised exhibit shows how lead was employed to make watertight joints between cast iron pipes.

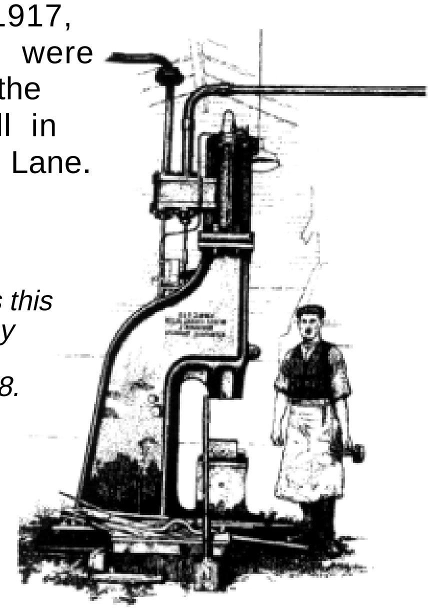
Early instruments are represented by a water meter capable of indicating flows of up to 6 million gallons (27 million litres) a day; and a Watt pendulum counter made of brass for recording the number of strokes made by a beam engine. Mounted in a sealed, glass-fronted case and clamped to the beam, the counter was introduced by Messrs Boulton & Watt to assess payments due on their engines, which depended on the fuel consumed in relation to work done.

A length of stone pipe is also displayed. Wooden pipes could not cope with large demand, or with the increased pumping pressures that came in with steam engines. They also became impregnated with the flavour of town gas which they imparted to the water. Stone pipes were an attempt at a replacement.

One of the directors of the GUWW was also a director of the Stone Pipe Company which had a factory in the Cotswolds, and whose site has been the subject of a recent archaeological dig. Unfortunately, stone pipes were a failure due to joint leakage. After Thomas Simpson invented the spigot and socket joint for cast iron mains, these replaced the stone pipes.

Forge and machine shop

The row of buildings in which these are situated, is believed to date from the start of the station in 1838. At some later date, probably after the Zeppelin bombing in 1917, the buildings were taken back to the boundary wall in Green Dragon Lane.



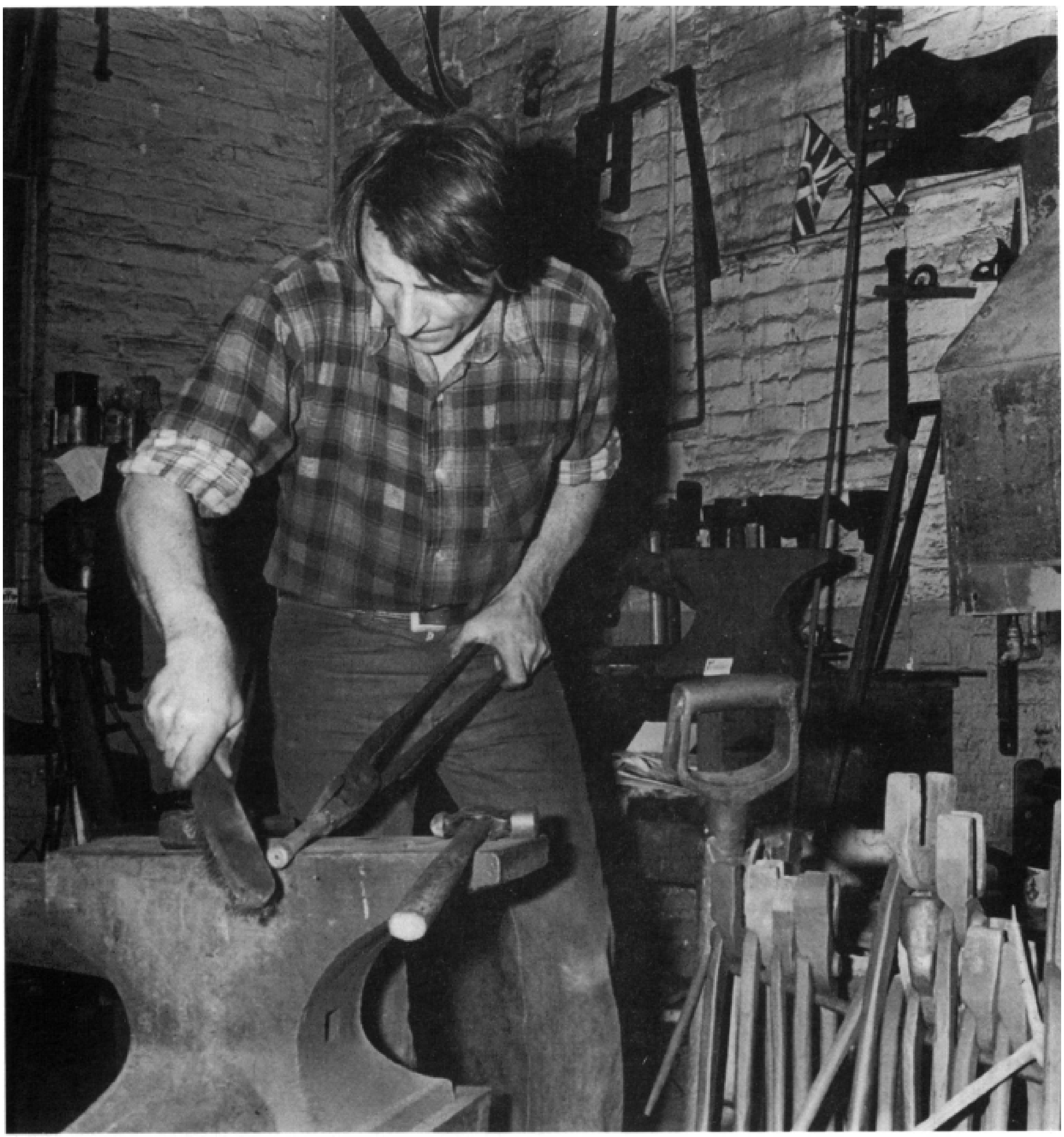
In Kew's forge is this restored Massey steam hammer dating from 1898.

The Forge is in regular operation by a professional blacksmith who undertakes ironwork restoration, welding and steel fabrication work for the Trust and for outside customers. It contains a Massey 5cwt (0.25 tonne) steam hammer dating from 1898 and believed to have come secondhand from Battersea pumping station (where there were also Cornish engines at one time). There are also two hearths, a bending plate and a full set of typical blacksmith's tools as demanded by his craft during the 19th century. At one time shoeing of horses would have been undertaken in addition to work of a heavier nature, since the station had its own horses and carts for the conveyance of coal and other materials. The stables used to occupy the area where the east toilets are now situated.

The Machine Shop was probably re-equipped when making good the bomb damage. It is all driven by belt from overhead lineshafting and pulleys in traditional manner. During the Museum's formative period the machine shop was in daily use but more modern equipment is now used, on another part of the site.

The basic equipment consists of a centre lathe of unknown make and date, two drilling machines and a screwing machine dating from about 1900, and a mechanical hacksaw. To these the Trust has added a Butler travelling head shaper of 1911, a 1920 planing machine and a 1943 Colchester lathe which is the most used of all the equipment. The oldest machine tool on the site is a 100-year old Broadbent lathe with a 25ft (7.6m) bed which is accommodated near the boiler house.

Nick Vestey, a professional blacksmith at work in Kew's forge.



STEAM TRACTION ENGINES

Steam enjoyed a brief reign for heavy road haulage during the 1890s and the first part of the present century, and a number of waterworks switched from horses to steam for hauling coal and other materials. They also used steam for roadmaking and temporary pumping duties. The preserved road engines based at Kew Bridge may be regarded as typical examples of the types water companies employed.

However the Trust cannot guarantee that the engines are always on display. They are privately owned and are sometimes away during the traction engine rally season attending events in London and the Home Counties, often travelling under their own steam. Also, due to increasing pressure on covered space at the Museum, it is not always practical to have the road engines on display even when they are ‘at home’, particularly during the winter when they have to be protected against frost and corrosion.

ELECTRIC PUMPHOUSE

This building, which adjoins the Maudslay and Bull engine house on the west side, was built to house a horizontal non-rotative triple expansion duplex pumping engine which began work in 1886. The engine was eventually scrapped to make room for the present electrically driven centrifugal pumps which were installed during the early 1940’s.

Since these were retired in mid 1985, we plan to exhibit one engine and its attendant switch gear.

BOILER PLANT

The main boiler supplying steam to our engines is of the Lancashire type and dates from 1927. It was presented by the Reading Area Health Authority and fitted for gas-firing; the working pressure is 40lb per sq in (2.8kg per sq cm). Back-up was later provided by a portable loco-motive-type boiler built by Marshall of Gainsborough in 1938, number 78 of an order by the Metropolitan Water Board for boilers for emergency use should any of the Board’s boilers be damaged by air attack in World War II. It was donated to the Museum by the Thames Water Authority.

STEAM INFORMATION

An increasingly important facet of the Kew Bridge Engines activity is providing all kinds of information relating to the steam engine in the widest sense. More and more enquiries are being received from historians, researchers, TV and film companies and from people visiting Britain who want to know where engines may be seen or records consulted.

Among the full time staff and volunteers at Kew Bridge are people with specialist knowledge on such matters as the technicalities of engine restoration, the handling and care of steam machinery, the running of a live steam museum, the history of the Cornish engine and of steam pumping machinery the history of London’s water supply, and the whereabouts of all kinds of steam preservation projects.

Connections are maintained with organisations such as the Science Museum, the Newcomen Society, the Trevithick Society, the Crofton Society, the Thames Water Authority, the Cornwall County Record Office and other bodies whose interests are in some way related to the Trust’s.

The Museum can also arrange illustrated lectures on the Kew Bridge project and related subjects for the benefit of kindred societies and educational establishments. Special steamings of the engines at Kew Bridge can be arranged on weekdays, subject to circumstances, for schools, colleges, and TV, film and advertising companies. All enquiries to the Kew Bridge Engines Trust, address overleaf.

THE KEW BRIDGE ENGINES TRUST

The Trust's first tasks before opening the Museum in November 1975 were to install a Lancashire boiler fitted for gas firing, together with steam and feed piping, restore the West Cornish engine to working order and provide facilities for the public.

A registered charity, our objective is to bring back to life the beam engines at Kew, bring in other engine types which used to pump water, and create a portrayal of the dramatic history of London's water supply and use.

We welcome 25,000 people a year to public steamings: their entry fees and shop and tea room purchases together with grants, donations and our membership largely pay the fuel bill, the wages, operating costs and the overheads. Any gap is filled by doing restoration work on traction engines or steam boats and other steam machinery. It takes 20 volunteers to run the site at weekends and thousands of other hours to do the restoration work, publicise us, run the membership and administer our affairs.

Membership and other enquiries to Tony Cundick, general manager, Kew Bridge Engines Trust, address below.

No steam restoration task is too big or too small for Kew's full time staff and volunteers who are pictured erecting the 'Triple' in the Museum's steam hall.

We appeal for your support - We need it!

1. Become a member; (each receives a copy of Kew News, our periodical).
2. Help run the site, or our administration.
3. Give money.
4. Or at least, tell everyone about us.

Yours sincerely,
Nicholas Reynolds
Secretary

Enquiries:

Kew Bridge Engines Trust
Green Dragon Lane
Brentford, Middlesex TW8 0EN
Phone: 0181 568 4757

The forge has its own phone:
0181 568 7432

ASME International

Keith B. Thayer, PE, President
Harry Armen, PE, Senior Vice President, Public Affairs
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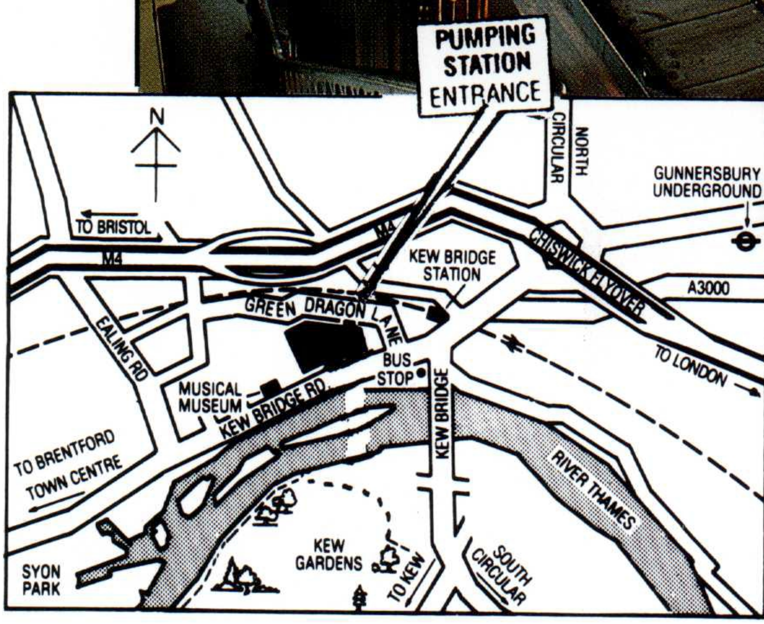
ASME ID: H194

Author: Kenneth Brown



HOW TO FIND KEW BRIDGE PUMPING STATION

Buses: 27,65,237,267 (also 7 on Sundays)

Trains: British Rail from Waterloo to Kew Bridge every half hour in both directions. (Hourly on Sundays).

Tube: Gunnersbury (District Line and BR North London Link –20 minutes walk or bus)
South Ealing (thence by 65 bus).

Tea Room – Sales Shop – Free Car Park

KEW BRIDGE STEAM MUSEUM

H194