Museum Guide No. 4.02

(SJ 695027)

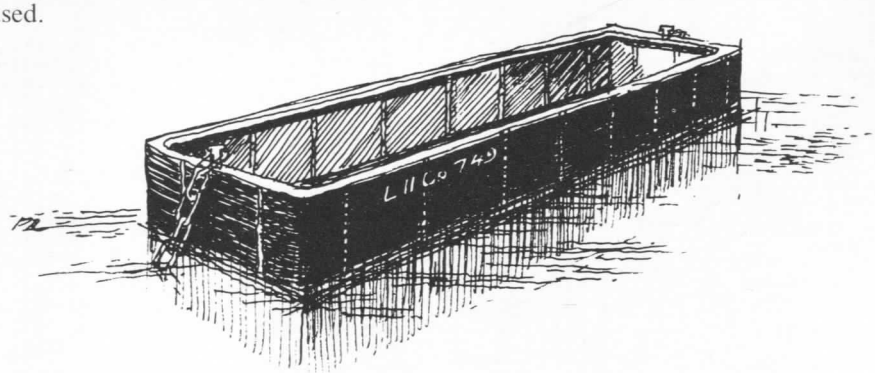
The Hay Inclined Plane

How tub boats were raised and lowered between the Shropshire Canal and Coalport Basin

Ironbridge Gorge Museum Trust

The Hay Inclined Plane

The Hay inclined plane at Coalport is the most spectacular surviving monument of the network of tub-boat canals which provided local transport for the ironworks of the Shropshire coalfield at the time when the area was the busiest iron-producing district in the world. The high, broken ground of the coalfield, with its strata of treacherous clays and its shallow mine workings, was a most unpromising terrain for canal building. Thomas Telford thought that the success of the tub-boat canal system showed that artificial waterways could be built anywhere. The system was effective largely because of its six inclined planes, by which boats could be raised and lowered between different levels without the costly loss of water which would have occurred if conventional locks had been used.

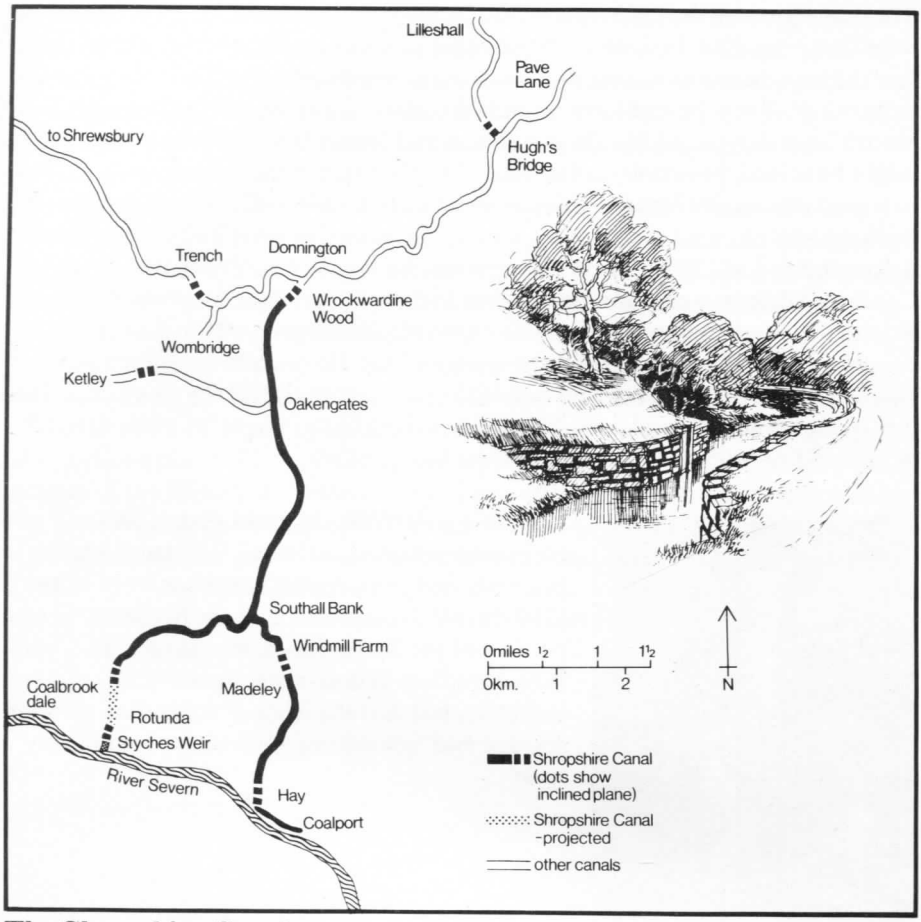


The first canal in the coalfield ran from Donnington Wood to Pave Lane and Lilleshall (see map opposite) and was built in the late 1760s. There was only one major change of level, at Hugh's Bridge, where a tunnel and shaft system was used. The boats used on the Donnington Wood Canal were box-shaped and about 20 ft. long.

The Ketley Incline

Twenty years later the ironmaster William Reynolds built two short canals. One ran from Wombridge to a junction with the Donnington Wood Canal. The other, which went from Oakengates to the Ketley ironworks demanded an abrupt change of level to carry boats down to the valley of the Ketley Brook. This was achieved by means of an inclined plane, the principles of which were doubtless copied from the railway inclines in the district. The boats were removed from the water and carried up or down to the next level on wheeled cradles, running on two parallel sets of rails. The descending load of heavier weight drew up the lighter ascending load, the two being linked by ropes and pulleys to a common winding drum on which there was a brake wheel. At the top were two lock chambers, emptied and filled by a steam engine, in which boats were removed from and placed upon the cradles. This was the first inclined plane to be successfully employed on any canal in Britain, but since it was entirely self-acting only very light loads could be drawn upwards.

Cover illustration: The Hay inclined plane in 1977



The Shropshire Canal

In May 1788 the Ketley Canal was nearing completion, and an Act of Parliament was obtained for a new public waterway to be called the Shropshire Canal, the object of which was to link the mines and ironworks of the Oakengates area with the River Severn.

The plans for the canal envisaged five inclined planes. One was to be at Wrockwardine Wood at the northern end, lifting boats 120 ft from junctions with the Donnington Wood and Wombridge canals. The summit section of the canal then ran for some four miles to Southall Bank on the borders of Dawley and Madeley parishes where it split into two branches. One ran westwards towards Coalbrookdale, where it was intended to descend by two inclined planes, one near the New Pool and the other at the Rotunda, to Styches Weir where the stream running down Coalbrookdale enters the Severn. This line was not completed beyond Brierly Hill above Coalbrookdale and the two inclined planes were not built. (A link between the canal at Brierly Hill and the Severn was established by building a railway along the intended course of the canal). The other, eastern line, descended 126 ft by an inclined plane at Windmill Farm not far from the junction and then passed through Madeley before abruptly descending the side of the Severn Gorge near the Hay Farm, to join a lower canal which ran for about three quarters of a mile through what were then riverside meadows to the Madeley parish boundary near to the present Coalport Bridge.

The exact form of the inclines was not decided upon when plans for the canal were first proposed. In June 1788 the canal proprietors launched a competition for 'the best means of raising and lowering heavy weights from one navigation to another'. They did not have unlimited confidence in the competition, for a month later they asked Matthew Boulton and James Watt how the problem might be solved. However, in October 1788 the prize in the contest was awarded to a plan devised by Henry Williams and James Loudon. The latter was already working for the canal company as a surveyor, although he left its employment before the end of 1789. Henry Williams was an engine erector for the Coalbrookdale partners and before that had been one of the first builders of Boulton & Watt engines. He became superintendent surveyor for the canal company in 1794 and later built the stretch of the Holyhead Road through Oakengates. In 1818 he became one of the partners in the Ketley ironworks. He was buried in the churchyard of St. Mary's, Red Lake, where his grave can still be seen (SJ 683105).

The scheme of Williams and Loudon was eventually adopted, although William Reynolds evidently had some hesitation about it. In May 1789 he told James Watt that the northern portion of the Shropshire Canal above the Wrockwardine Wood incline was nearly complete, but that the form of the incline was not decided and 'something must be fixed upon very soon'.

William Reynolds, 1758–1803. Painted by Wilson of Birmingham. Ironbridge Gorge Museum Trust.

Williams' and Loudon's scheme was a modification of the Ketley incline, but instead of the locks at the top, they recommended reverse slopes, running into two parallel docks. The water in the top canal ran up to the sill where the main and reverse slopes met, and the rails on which the cradles ran continued down the reverse slope into the docks. As at Ketley, the rails at the foot of the main slope simply ran into the water of the lower canal.

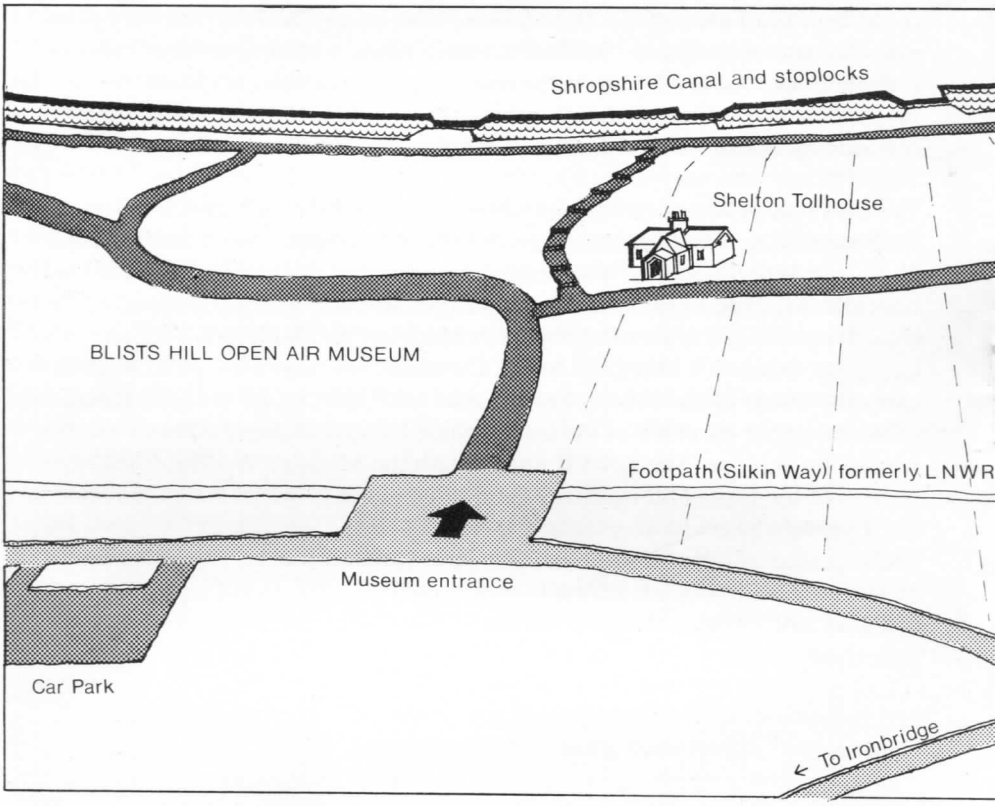
The canal at the foot of the Hay incline was complete by the summer of 1792 when boats were being hauled up and down the slope by teams of men and horses. In December 1792 the installation of the engine at the Hay was authorised, and full operation probably commenced soon afterwards. The canal-river interchange at the foot of the incline was successful and by 1794 the village growing up around it was called 'Coalport'.

The Hay incline was equivalent to twenty-seven locks and was worked by only four men. It could pass a pair of five-ton tub-boats in four minutes whereas it would have taken up to three hours to raise a vessel up twenty-seven locks. The system was effective because it was simple, and well within the limitations of the technology of the period. In 1800 chains replaced the hemp ropes. In May 1801 four tub-boats were destroyed when a chain broke and a boat and cradle hurtled

to the bottom. Later, wire ropes replaced the chains. The first rails were plate rails ('L' section), replaced in the nineteenth century by conventional types of railway track, bullhead rails on the main slope and bridge rails in the docks. The first engine at the Hay, of the type designed by Adam Heslop, was probably replaced by one of another kind sometime during the nineteenth century.

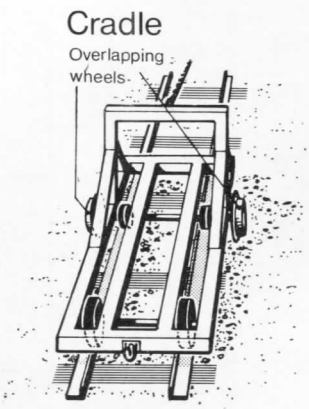
The Hay incline was very busy for about sixty years. By 1855 much of the Shropshire Canal had been damaged by mining subsidence and the Windmill Farm and Wrockwardine Wood inclines were incapable of carrying fully loaded boats. In 1857 the London & North Western Railway took over the canal, closed it north of the Tweedale basin in Madeley, and built a railway to Coalport, much of it along the bed of the canal. A bridge was constructed to carry the tracks of the Hay incline over the line. The closure of the northern part of the canal cut off much of the traffic which had previously passed down the Hay inclined plane. The LNWR agreed with the Madeley Wood Company, owners of the Blists Hill ironworks and most of the collieries which sent coal to the Tweedale basin, to keep open the incline and the wharves at Coalport, but traffic gradually dwindled away and the last recorded use of the incline was in 1894. In 1905 the LNWR formally proposed to close it, and after a legal dispute, did so in 1907. The rails were removed in 1910, and vegetation quickly spread over the trackbed.

The foot of the Hay inclined plane, c. 1950. *Salop County Library.*

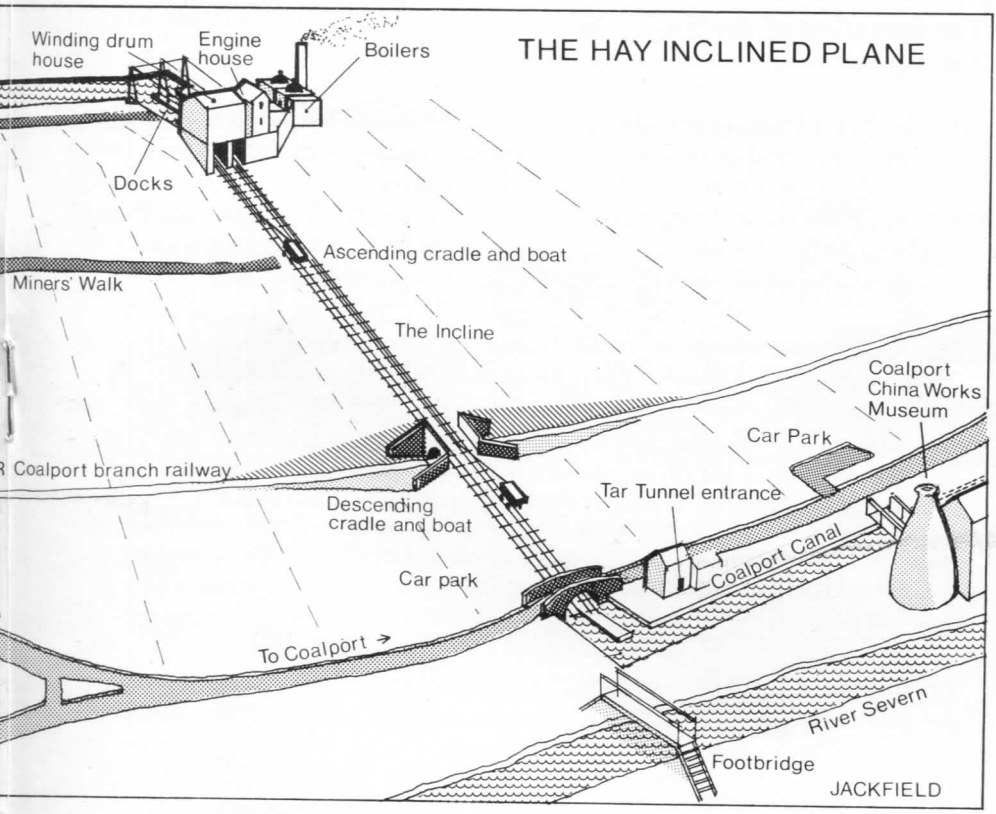


The best view of the inclined plane can be obtained from the footbridge which links Coalport with Jackfield, from which the full vertical rise of 207 ft can be appreciated. At the north end of the bridge is the bottom basin of the incline. There was no complex machinery at this point; the cradle carrying the boat ran down into the water, and the boat was floated off by a man with a pole. From the foot of the incline the Shropshire Canal continued through the Coalport china works to terminate at the Madeley parish boundary near Coalport Bridge.

It is possible to gain access to the rest of the incline only by entering the Blists Hill Open Air Museum. From the museum entrance the incline may be approached either along the canal towpath, accessible by way of a flight of steps opposite the entrance, and at the northern end of the museum near the steam winding engine, or along the Miners' Walk past the Shelton tollhouse.



Cradle. The overlapping wheels at the upper end which ran on iron-lined ledges in the sides of the docks were fitted to keep the boat in an approximately horizontal position on the reverse slope.



The most obvious features of the docks at the top of the incline are the massive stone walls which supported the winding machinery. On the reverse slope in each dock it is possible to see the bridge rails which carried the cradles, and the ledges surfaced with cast-iron slabs on which ran the overlapping wheels of the cradles. At the ends of the docks are grooves for stop-planks which could be inserted to allow water to be drained for maintenance purposes. Alongside the docks are the remains of the engine mountings and of the settings for two haystack boilers which provided the engine with steam. Visitors may explore the whole of the incline right down to the fence under the road bridge above the bottom basin. The chief feature of interest on the lower portion is the brick bridge which carried the tracks of the incline across the LNWR branch railway from Wellington to Coalport which was opened in 1861. The line was closed in 1960, and the Silkin Way footpath now runs along its trackbed.

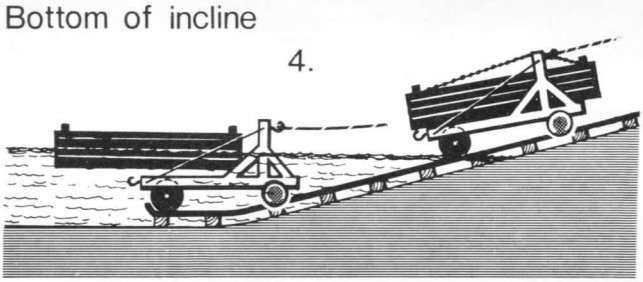
The operation of the Hay incline

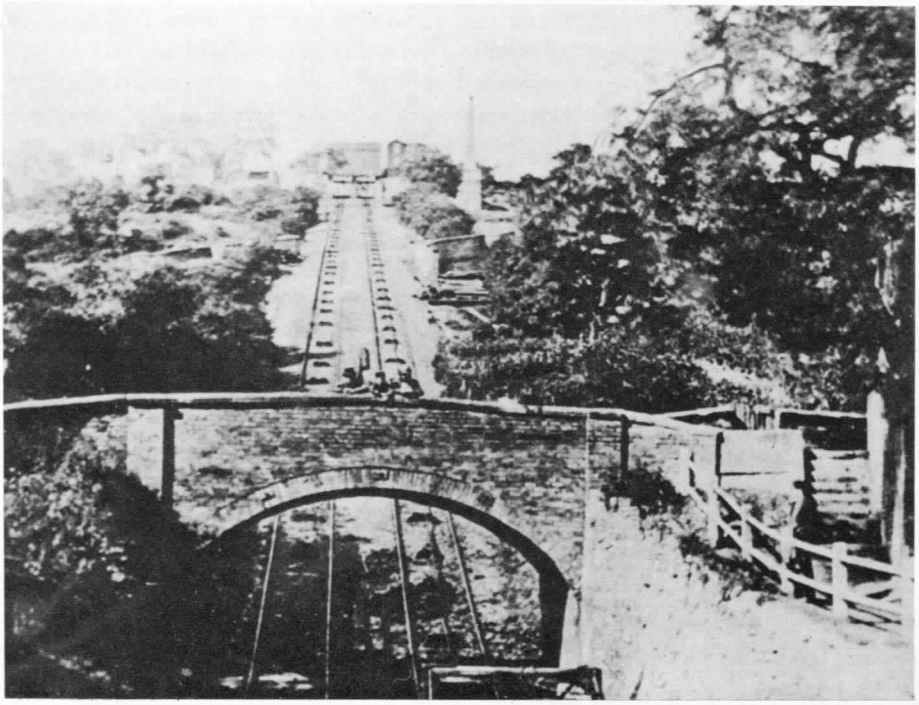
The sequence of operations was as follows:

(1) The boats both at the top and bottom of the incline were steered on to the submerged cradles and attached to them by means of chains.

(2) The cradle at the upper end was lifted up the reverse slope by a rope from the smaller of the two winding drums, which was rotated by the steam engine. Once over the sill it stopped and the rope was detached.

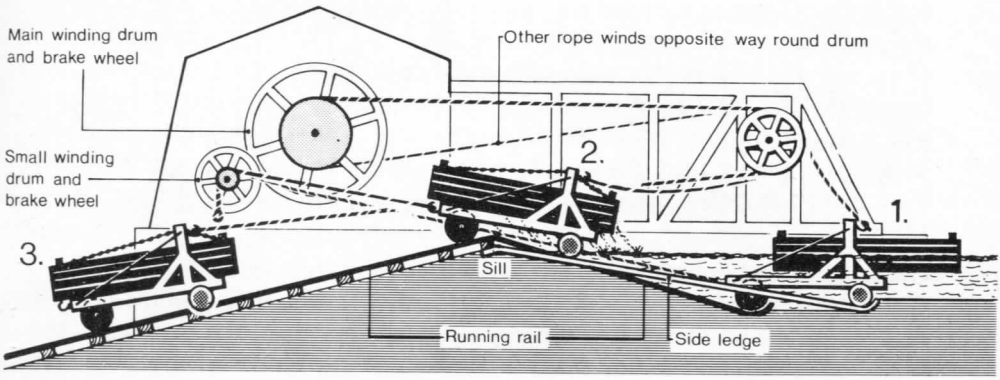
(3) The descending boat and cradle were allowed to go down the main slope of the incline, controlled by a rope from the rear of the cradle running over a large pulley at the upper end of the docks on to the main winding drum, the rotation of which was controlled by a brake wheel. As the rope unwound from one side of the drum, so the rope on the other side was wound up, causing the boat and cradle at the bottom of the incline to rise.





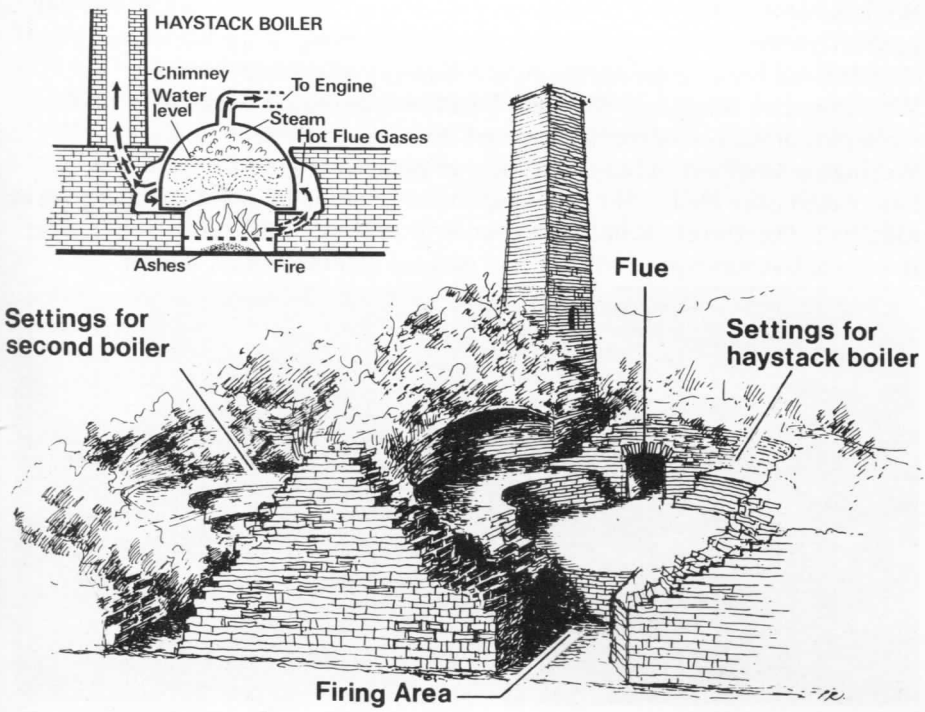
The Hay inclined plane in the late nineteenth century.

How it worked - Top of incline



(4) The ascending boat and cradle stopped at the top of the main slope for the rope from the small winding drum to be attached in order to control entry to the water in the docks. At the same time the descending load entered the lower canal.

When there was a substantial upward traffic, the steam engine was used to turn the main winding drum, but if empty boats were ascending the incline was self-acting.



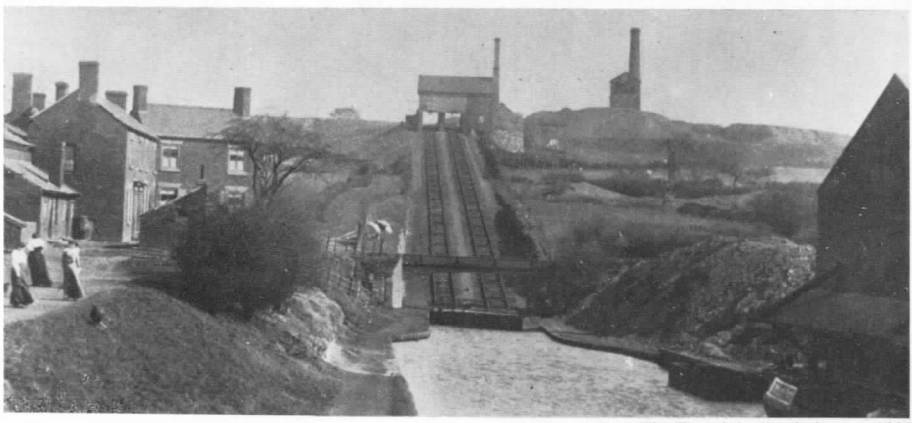
At the end of the eighteenth century many visitors, British and foreign, artists, writers and ordinary tourists as well as engineers and industrialists, came to the Ironbridge Gorge to see what was one of the most spectacular as well as one of the most important ironworking areas in the world. The Hay inclined plane, along with the Iron Bridge, the Coalbrookdale ironworks, the Lincoln Hill limeworks, the Tar Tunnel and the Coalport chinaworks, was one of the sights which was on the itinerary of almost every visitor. The best surviving measured drawings of the inclined plane are by a Frenchman, Jean Dutens, who published them in a book called "Memoirs sur les Travaux Publiques d'Angleterre" in 1819.

Clearance and conservation

When the Ironbridge Gorge Museum Trust was established in 1968 the slope of the Hay incline was covered in dense, jungle-like undergrowth. Clearance of the docks at the summit was one of the first tasks undertaken by voluntary workers for the Museum. In 1969 the undergrowth was removed by a detachment of the Territorial Army Royal Engineers, who also, in subsequent years, re-graded the slope. The rails were laid by volunteer working parties in the early months of 1975. The docks have been uncovered by various working groups during the past nine years, and have been restored by the Museum's craftsmen. The basin at the foot of the incline was first excavated in 1974, and the bottom canal fully restored as far as the Coalport china works in 1976. While the Museum Trust aims to carry further the process of conservation of the incline, and in particular to excavate and make good the remains of the boiler and engine houses, it is not intended to make any attempt to restore the inclined plane to working order.

The other Shropshire inclined planes.

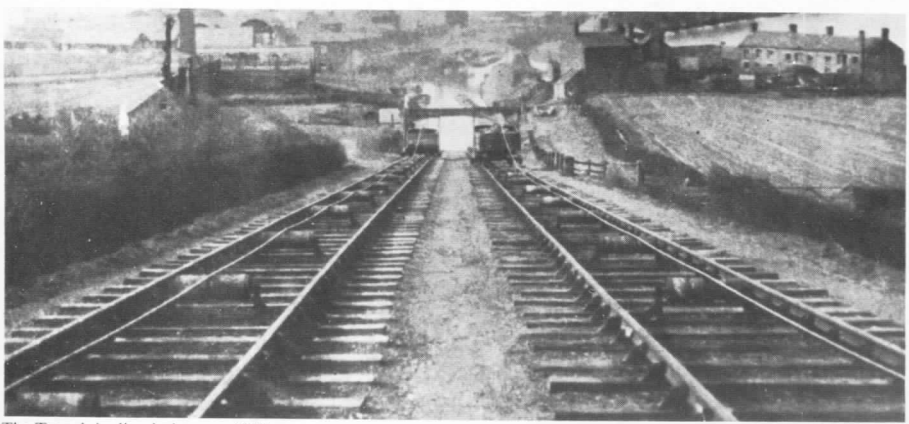
The average working life of the six inclined planes on the canals of east Shropshire was nearly eighty years, a sign of the soundness of the Loudon and Williams design. The first to cease operation was that at Ketley which was not used after about 1816, probably because the ownership of the Ketley ironworks changed, not because the incline itself was in any way inadequate. The Wrockwardine Wood and Windmill Farm inclines ceased work about 1858 when part of the bed of the Shropshire Canal was converted into the Wellington-Coalport railway. The inclined plane at Hugh's Bridge was no longer used after about 1880 following the contraction of limestone quarrying at Lilleshall. The Trench incline ceased work in 1921 after 127 years of operation. It was the last survivor of all the canal inclined planes in Great Britain.



The Trench inclined plane, c. 1900

There are now few remains of the canal inclined planes in Shropshire apart from that at the Hay. At Windmill Farm (SJ 699058) the remains of the earthworks have in recent years been destroyed by the road works of Telford Development Corporation's Brookside housing estate. At Ketley (SJ 678107) the whole slope of the incline has been covered by housing developments during the past decade. The site is commemorated by a road called 'The Incline' adjacent to Ketley Hall. At Wrockwardine Wood (SJ 701121) the slope of the incline remains as a rough track alongside Wrockwardine Wood Methodist Church, although it will soon be bisected by a new road. The foot of the incline was destroyed in a housing development about 1960. The docks and embankment of the Trench incline (SJ 690122) were destroyed in 1968 to fill the basin at the bottom, and houses now cover much of the site. At Hugh's Bridge (SJ 740151) the embankment of the incline is well preserved, and it is also possible to see some traces of the docks.

Inclined planes of various sorts were used on several canals in other parts of Britain. Some, like those at Morwellham (1817–73) on the Tavistock Canal in Devon, or Combe Hay (1801–05) on the Somerset Coal Canal carried only containers which were lifted on and off boats at the top and bottom of the slope. On some, like the six on the Bude Canal (1823/5–91) and Weare Giffard (1827–71) on the Torrington, special boats were employed, fitted with wheels. On Thornfalcon (1841–68), Wrantage (1841–68) and Ilminster (1842–68) inclines on the Chard Canal boats were lifted up and down in caissons filled with water. The Chard Common incline (1842–68) on the same canal, and those at Pont-Henry and Capel Ifan (1838–67) on the Kidwelly & Llanelly Canal in south-west Wales, all employed cradles, and had their machinery operated by water power, while that at Millhill (1819–32) on the Tavistock Canal had horse-powered winding apparatus. The inclined plane which most closely resembled those of east Shropshire, with boats carried on cradles which were wound up and down by a steam engine, was that at Wellisford (1838–67) on the Grand Western Canal in Devon. Most of these inclines were on remote canals which were not linked to the connected waterway system of the industrial Midlands, on which inclined planes were never regarded with much favour. The only one of consequence on a traditional narrow boat canal was that at Foxton on the Grand Union, up which boats were lifted sideways in caissons, which was operated for only about ten years at the beginning of the twentieth century. Nowhere else in Britain were inclined planes employed so successfully on canals as in Shropshire.



The Trench inclined plane, c. 1900

Inclined planes in other European countries

Vertical lifts of many different designs were tried out on British canals during the Industrial Revolution period, though few were in any way successful, but at the end of the nineteenth century several lifts of this kind which have given many years of good service were built, among them those at Anderton in Cheshire, Fontinettes in northern France, La Louvière in Belgium and Henrichenburg in West Germany.

With the expansion of European waterways since the World War I the inclined plane has come back into favour. There are several in Eastern Europe, including one on the Yenisey navigation at Krasnoyarsk, the town where that river is crossed by the Trans-Siberian Railway. At St. Louis-Arzviller on the Canal du Marne au Rhin, 58 kilometres from Strasbourg in eastern France is an inclined plane completed in 1969, which replaces seventeen locks on the old line of the canal. At Ronquières in Belgium on the Canal from Charleroi to Brussels is the most impressive canal inclined plane in Western Europe (pictured above), which was also built in the 1960s. Boats are lifted in caissons 68 metres (221 ft) in a horizontal distance of 1,432 metres (5,654 ft). The Ronquières incline can carry barges of up to 1,350 tons, a far cry from the five and six-ton tub-boats which were lifted up and down at the Hay, and an indication that the principle first successfully used in this part of England in the Industrial Revolution of the late eighteenth century is still of importance in the modern European economy.

Published by the Ironbridge Gorge Museum Trust 1978
Text by Barrie Trinder
Designed by Robin Wade Design Associates/Robert Cook
Illustrations by Pat Read and Peter Stoddart
Filmset by Rembrandt Filmsetting Ltd, Watford
Printed by Printex Press Limited, Telford, Salop.