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THE LIGHTMOOR COLLIERY WINDING ENGINE

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HISTORY This little non-condensing beam engine which is now being restored (hopefully to working condition) at the Dean Heritage Museum Soudley, is the sole survivor of a great number of beam engines used for winding and pumping at collieries and iron mines in the Forest of Dean. For many years used for winding carts of dirt to the top of the waste tip at Lightmoor Colliery near Cinderford, it had, until August 1982 rested for some 40 years in the grounds of the National Museum of Wales, Cardiff, having been donated to them in 1940 by the colliery owners, Messrs. Henry Crawshay & Co. Due to the kindness of Dr. Gëraint Jenkins, Keeper of the Dept. of Industry at the Welsh Museum, the engine has now been placed into the care of the new Dean Heritage Museum Trust on an extended loan, and in fact it has come home to its birthplace.

Samuel Hewlett established an Iron Foundry on the same site as the present Museum building at Soudley c. 1821, having previously owned a smaller concern adjacent to his residence at Bradley House, about a mile away. Information provided by the Crawshays stat d that the engine was built by Hewlett at Soudley c. 1805. If so, it would have been built at Bradley, but a recent conversation with a former fitter at the colliery brought forth the information that a sister engine, broken up at Lightmoor in 1934, had the name HEWLETT, AYLEFORD (SOUDLEY) and a date believed to be 1828 cast underneath the bedplate. It has not yet been possible to lift the engine again to check if this one is marked likewise.

Stories concerning the early life of the engine have been handed down by former employees of the Colliery, but unfortunately cannot be authenticated, and it is not known when it arrived at Lightmoor, the shafts having been sunk here during 1830.

Design details suggest that a building date of 1828-30 is more feasible than 1805, the most noticeable features being the use of a short slide valve for steam admission, rather than the long "D" valve used on earlier engines, and also the use of wrought iron for the connecting rod, crank, and other small items instead of cast iron, which was formerly used. The 4 inclined columns supporting the beam bearings were widely used by the better-known engine builders, MURRAY, Fenton & Co., and it may be that Hewlett was influenced by the rigidity of this design when he incorporated it in his own engines.

There appears to have been only one major modification to the engine during its working life, and this is that the "Watt" parallel motion used for keeping the piston rod moving in a straight line has been removed. This motion is formed by a system of links making a parallelogram suspended from the beam, and connected to the piston rod crosshead. The innermost link pin passing through the beam has fractured on one side, and has not been replaced. Instead of this, 2 vertical rods bolted to the cylinder flange and supporting a frame or entablature, have been adapted for use as slide bars. The entablature, in addition to providing strengthening between the cylinder and the beam-bearing bracket, also carried 2 bearings as part of the parallel motion, but these have now gone. The piston crosshead has been extended to carry brass slippser sliding on the rods. These items have never been on display at Cardiff although all parts exist. This also applies to the eccentric strap and rod, together with its associated levers and links to the valve spindle.

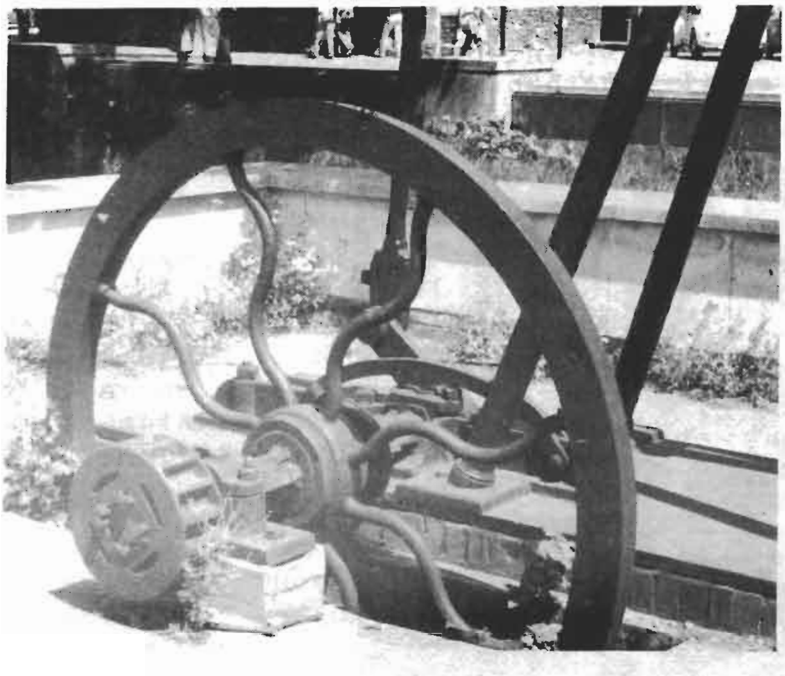
DETAILS OF THE ENGINE

Bedplate The bedplate is a simple but flimsy casting, 12 ft. 4 ins. long x 3 ft. 8 ins. wide, but only $1\frac{1}{2}$ ins. thick. Four rectangular pockets 1 in. deep are provided on the upper surface and locate inclined cast-iron columns of 4 in. maximum diameter. These are bolted to a casting which also incorporates the beam bearings, and the whole forming a pyramidal shape constitutes a very stiff unit and helps to obviate the necessity for a strong bedplate casting.

A weakening in the latter caused by the provision of a rather large hole, 3 ft. 6 ins. x 1 ft. 1 in., for crank clearance, is counteracted by a heavy cast-iron stiffening bracket bolted alongside with $1\frac{1}{4}$ in. bolts with square nuts. This casting also forms the housing for the inner crankshaft bearing brasses which have an octagonal external profile. This bracket is in turn further stiffened by means of a curved wrought-iron link forked at the ends, and bolted to ribs either side of the bearing, thus preventing any flexing of the assembly caused by vertical thrusts on the crank.

Crankshaft The crankshaft is formed from 4 in. square wrought-iron, and has two $3\frac{3}{4}$ in. diameter journals for the main bearings, the outer of which being a pedestal of orthodox type bolted directly to the foundation. A further journal of the same diameter carries a single slip eccentric sheave provided for the reversing gear and is to be described later. The crank is a forging, and is keyed to an extension of the inner journal. Both the Flywheel and a shrouded gear pinion with 16 teeth have square bores, and are 'dogged' on to the crankshaft by means of wedges driven from either side into the gap between bore and shaft. This was a typical practice of the period, and enabled the wheels to be trued up with great accuracy both radially and laterally, overcoming a lack of machining. The pinion is all that remains of the drive to the winding drum.

Flywheel The Flywheel is a compound construction in which the cast-iron hub and rim are cast round the eight wrought-iron spokes. These are probably splayed at the ends to give a rigid fixing. The spokes are $1\frac{3}{4}$ in. in diameter and have a rather unusual double curve, giving a very attractive appearance to the wheel, and may well be unique. Wrought-iron rings are shrunk on to the bosses on either side of the hub, and prevent the latter cracking when the truing wedges are driven in. The wheel is 7 ft. in diameter with rim 5 in. deep by $3\frac{1}{2}$ in. wide. The hub is 1 ft. 2 in. diameter x 8 in. wide.

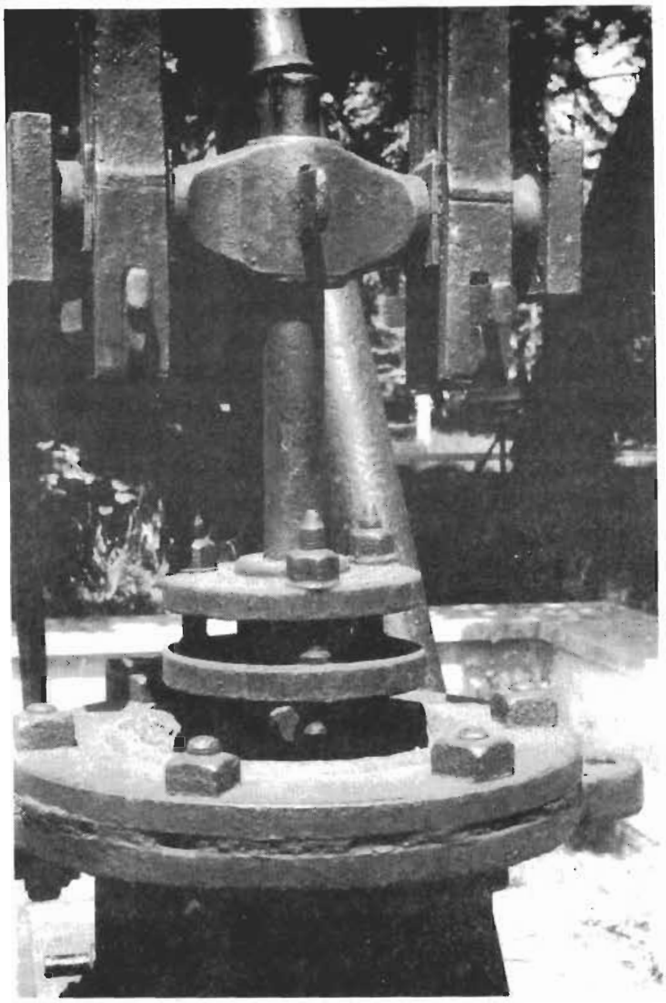


Flywheel end, showing "dogged on" flywheel, eccentric sheave just behind stiffening bracket, incorporating inboard bearing, with wrought-iron stiffening link over. Outboard bearing pedestal of "dogged on" pinion for winding drum drive. Pockets for main frame pillar location also shown.

Cylinder, steam chest, valve spindle, crosshead or guide bracket. Bearings for shaft carrying levers for operating valve spindle.

Cylinder & Valve Gear The cylinder is of cast-iron and has a bore diameter of 10 in. and a stroke of 2 ft. 8 in., thickness of the cylinder wall is only 1 in. Steam is admitted by a simple slide valve, attached to its spindle by means of a buckle, and contained within a short steam chest mounted on the casting forming the steam and exhaust passage-ways. This casting is bolted on to flanges at each end of the cylinder, the lower one being part of the combined bottom cover and mounting flange.

The rectangular steam ports are $3\frac{1}{2}$ in. long, steam inlet being $1\frac{1}{4}$ in. wide, exhaust 2 in., with $1\frac{3}{4}$ in. bars in between. The cast-iron valve has an overall length of $7\frac{1}{2}$ in., an exhaust cavity 5 in. long, and a travel of 3 in.



Cylinder cover, stuffing box and piston crosshead, showing extensions for brass slippers. NOTE the 3 stuffing box adjusting studs which are tapered through the cover flange, and held in position by cotters underneath.

Valve spindle and piston rod stuffing boxes are both packed with graphited hemp. At the time of writing the piston has not been withdrawn to know what packing is used here. None of the joint faces has been machined, relying on quite thick packings to keep them steam-tight, and on closer examination this may apply to the cylinder bore as well. All assembly is with Whitworth threaded bolts having square heads and nuts, passing through square holes cored into the castings.

The single slip eccentric is of cast iron, made in two halves held together with slotted pins and cotters, and is free partially to revolve on its crankshaft journal. Stop pins are attached to both itself and the crankshaft to control its position in relation to the crankpin and providing either forward or reverse motion.

In practice, the engine had to be started in the required direction by moving the valve by hand, the engineman having noticed the position of the crank, and from this knowing to which end of the cylinder to admit steam. The hand lever is an extension of one of three cranks on a short shaft mounted in pedestal bearings on the bedplate, the other two cranks being connected to the valve spindle by links.

The eccentric rod has a slotted "gab" and which is held clear of its pin on the vertical hand lever whilst the engine was started. Once it was revolving in the required direction, the "gab" was dropped on to its pin, and from then on the valve movement was automatic.

<u>The Beam & Connecting Rod</u> The Beam has pin centres of 8 ft., which are equidistant about the centre line, but being only 2¼ in. wide over the outer flange, it is of rather light construction. It has however been reinforced with a wrought-iron strap 2¼ in. wide x 1¼ in. thick, either shrunk or hammered on round the outside. Whether this was provided when the engine was built (possibly to keep down the weight of iron which could be poured in a small foundry) or whether, in fact, it is a repair, has yet to be established. The depth of the beam casting is 11 in. at the centre, tapering to 7 in. at the ends.

The centre pivot shart is octagonal in section, 3 in. across flats at the centre, tapering to 2¼ in. at the ends, which are then turned to 2 in. diameter for the bearings. Here again the beam casting is wedged on to its shaft, and the centre bosses have wrought-iron rings shrunk on either side to resist the wedging forces. Two additional bosses cast on the beam show that this, or sister engines, could have been adapted to use the exhaust steam condensing principle, and rods from these pivot points would have driven pumps for the condensing gear, but this particular engine was not so fitted. The beam pivot bearings are formed as part of a single casting, in turn bolted to a further casting to which the inclined pillars are attached. Stiffening ribs on the inner forces also provide a fixing for the entablature previously mentioned.

The connecting rod has not yet been fully examined, but appears to be a wrought-iron forging, or possibly a combination of two forgings, forge welded just below the upper fork. Bearing brasses are held in place by means of wrought-iron straps and cotters.

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(THE FOLLOWING NOTES ARE FROM PERSONAL MEMORY, BACKED UP BY INFORMATION FROM FORMER EMPLOYEES AT THE COLLIERY.)

The drive from the crankshaft pinion to the winding drum was via a spur gear of about 5 ft. in diameter. The winding drum, of about the same diameter, was free to revolve on the same shaft, but was locked by means of a sliding dog clutch operated by a hand lever. Braking was provided by a simple foot operated block brake working on a track alongside the drum. A further foot brake operated on the engine flywheel.

In operation, an average of 4 full carts were wound to the top of the tip and the engine brake applied and locked. Empty carts were attached to the rope, and lowered by gravity, controlled by the winding drum brake only, the dog clutch having been disengaged. Signalling between engineman and the men at the top of the tip was by means of a 'knocker line', a wire running from top to bottom of the tip, and which operated a gong in the winding engine house.

Reports state that on extremely busy days, known as 'Dirt Days' or 'Bacca Days', when it was necessary to clear a large quantity of dirt from the pit, as many as 300 carts could be moved in a single shift using 2 men, one on the engine, and one operating the clutch and drum brake. The Colliery closed in 1940 and the engine was moved to Cardiff shortly afterwards.

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