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PUMPING ENGINES AT THE LEADHILLS MINES

W.S. Harvey

A common feature of both mines and ships is that the ingress of even a small quantity of water can lead to disaster. Pumping this out has therefore an importance which transcends the getting of the ore or the completion of the voyage – if the water is not removed all else becomes impossible.

In hilly country such ore can be mined by drifts along the veins and any water then drains away freely, but many of the mines being worked at Leadhills, Lanarkshire, in the eighteenth century were below the valley floor and drainage problems were becoming acute. The area is one of high moorlands with high rainfall and deep winter snow. The country rock, an Ordivician greywacke, is greatly folded with lines of crushed rock, or rock otherwise changed by intense shearing. Such faults not only allowed the surface water to enter the mines, but reduced the amount of storage in the surface peats which would have kept the burns flowing during the occasional summer drought. Lines written in 1758 about a mine at neighbouring Wanlockhead could well have applied to the whole area.

The workings must always be very precarious and uncertain for in winter the great rains and snows so swell the feeders that the pumps cannot manage, and in summer the day water is so scanty it is not sufficient to turn the wheels.[1]

The need for pumping machinery encouraged engineering talent. Wheels and beams demanded not only skill in fashioning and fitting the parts, but a knowledge of design and materials which would stand up to years of constant usage. The construction of cast iron pumps assisted the transition from wooden devices to steam engines and their engine houses were the academies for many great engineers. Water pressure engines taught hydro-dynamics and demonstrated the explosive forces inherent in a moving column of liquid. Such problems and such opportunities faced the engine builders at the Leadhills mines.

Part 1. The Historical Record.

Manual Power

Men have drained mines with hand pumps since the earliest times. The notion of human beings constantly toiling with pumps has an emotive content. But it seems to have been a method limited more by the demands it made on labour and wages, than by the inefficiency of their efforts.

Reports show hand pumps were frequently used at Leadhills in the eighteenth century; in particular as a way of enabling veins to be worked in dry weather.[2] Even in the century that followed twenty four men were working hand pumps at Wanlockhead,[3] AND the practice probably continued until first compressed air and then electricity provided a better form of portable power. Two kinds of hand pumps were used – ‘kirns’ and ‘swapes’. Both were lift pumps, the kirn was developed from the farm

churn and could move a greater amount of water than the swape. However the swape was worked by a hand lever, so it probably could raise water from a greater depth. Such pumps were used in series to obtain the total lift needed. A letter among the Boulton and Watt MSS in Birmingham, and referring to a visit to the Susanna mine at Leadhills by Watt himself, sets out the amount of water which could be raised.

> (It was) found by the medium of many trials that the pumpers could give 32 strokes a minute but were obliged so frequently to stop and draw their breath ….. the (average) strokes were 16 a minute. The length of their stroke was reckoned 9 inches and the diameter of the pumps is 5 inches. According to my computation they therefore raise near 12 hogsheads an hour.[4]

[5]

This was equivalent to an output per pumper of about 648 gallons per hour. Unfortunately the reference does not mention the height raised but calculation suggests it was about fifteen feet.[5]

Another time honoured method of raising water was to wind it up in kibbles. There seems little doubt that this was done at Leadhills but I have found no specific references.

Wind and Water Wheels

Windmills were used to pump a number of Scottish collieries in the mid eighteenth century,[6] and in 1767 Anthony Tissington had a 'wind engine' on one of his mines at Leadhills. It had canvas sails which drove a crank with three 'fangs'. These worked 'horizontal slides directed by regulators to the spears that goes down the engine shaft.'[7]

The windmill was not a success and it was water power which provided a major source of pumping power into the present century.

By the early eighteenth century there were a number of beam and crank pumps – bob engines – on the Leadhills mines. Water to turn their wheels came from the adjacent valley the Shortiecleuch. Its streams drained the high hills to the South and provided the only consistant source of water. There was little to be had from the stream flowing through Leadhills, the Glengonnar Water, and even today most of the water that flows through the village is poured into the stream from one of the old leats.

In 1731 a lease to part of the NW mining ground was taken by The Governor & Company for Working the Mines in Scotland, commonly known as the Scots Mines Company although they were based in London. Their activities prospered under the able management of James Stirling, and in 1739 they took over a pumping engine at Meadowhead. It was on the mine of that name and at the edge of the village. The mine had been worked by Richard Lowthian who, with a relative, held some of the earliest Leadhills leases from the landowner, the Earl of Hopetoun. The Lowthians seem to have been both active and enterprising and all too little is known about their

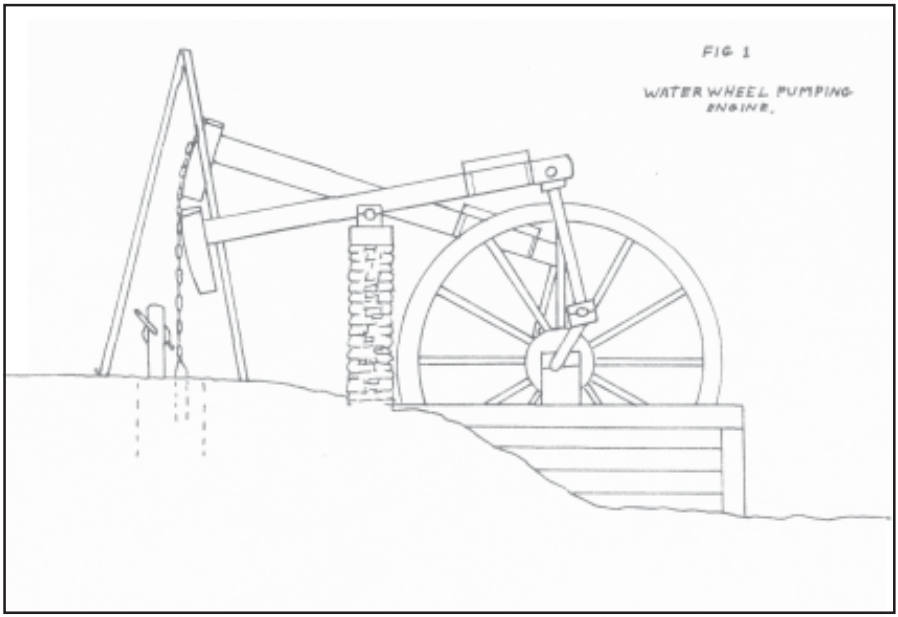
operations at Leadhills. The leat to Meadowhead from the Shortiecleuch followed the 1350ft contour across Glengonnar, and worked an engine on Brown's vein as well. After turning these wheels the water was taken farther down the valley to drive the bellows in the smelt mills.[8]

The Meadowhead engine worked to about 1770, but that on Brown's vein was said to have been 'laid aside' around 1748.[9] The wheel from it may have been used for an engine the Scots Mines Company built on the Mill Vein in 1763, for an entry in one of their Mine Journals notes that parts had been taken from 'one of the old engines'.[10]

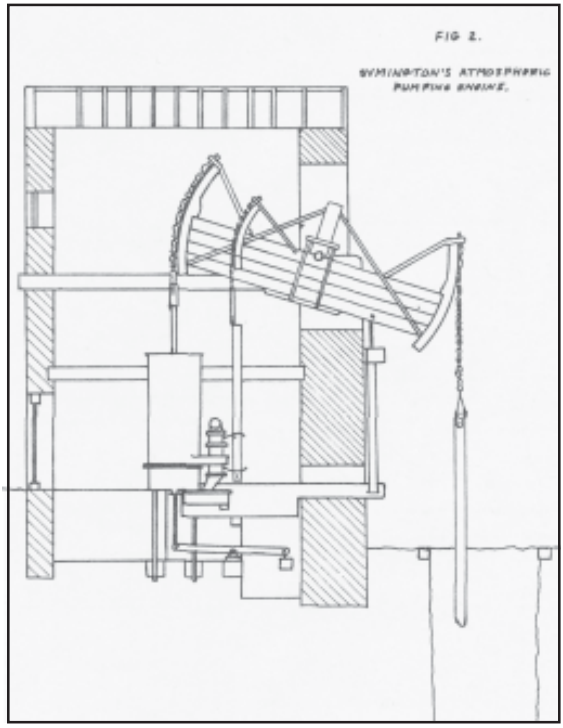
It is likely that most of the early waterwheels were on the mines to the south east of Leadhills, for these were nearest the Shortiecleuch. A map of the mining ground dated 1760 shows a leat entitled 'Mr. Lowthian's Water Course' that circled the top of Mine Hill and terminated at another engine on Brown's Vein.[11] Its site corresponds to the ruined Wheelpit which can be seen in front of the houses near the old railway station. In the late nineteenth century this pit housed a wheel which pumped Wilson's Mine.

However, Lowthian's engine seems to have been underground, for there is a reference to an engine 'underground on Brown's Vein near the timber house',[12] and the map shows the timber house as nearby.

The first reference to a slide works was to one associated with Tissington's windmill, and the arrangement included a 30 ft waterwheel.[13] It pumped a mine on the Brow Vein. The particular shaft is not mentioned, but it was near 'Rashy Grain', a shallow gully on Mine Hill to the South of the Brown's vein engine. Tissington's machine



seems to have been regarded with disapproval. In a letter to the Earl of Hopetoun it was described as being 'too complicated', and it was considered that the 'friction of the cogs and sliders' would make excessive demands on the precious water.[14] In fact it worked well and needed 'only one half the amount of water anybody would have imagined.'[15]



Two other wheels near Mine Hill were at 'Broad Floors' and 'Back Raik' but there is only a passing reference to them.[16] The Broad Floor shaft was behind what is now Woodlands Hall and Back Raik was probably nearby. Both were on the Raik Vein.

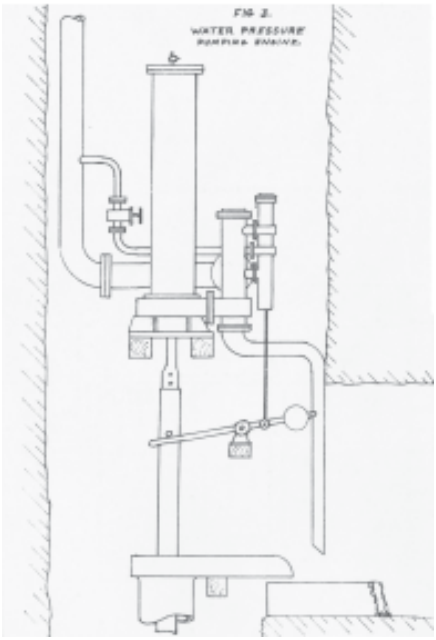
[6]

Over the years the leats were extended around Leadhills, their increasing length probably owing more to agreements about the use of the water, than the expertise of the mine surveyors. In 1768, Alexander Sherrif built a wheel to pump his mine on Wool Law. He was factor to the Earl of Hopetoun and, with a partner Guthrie, took the lease of some mines the Earl himself had previously managed. The water from Sherrif's wheel was carried two kilometres along the Shortiecleuch, through the Thieves Slack Hass by the present road to Elvanfoot, and along the steep slopes of Wool Law to the mine by Big Wool Gill.[17] The leat had been made by the Scots Mines Company who brought it around the present golf course and added its water to the leat to the distant Meadowhead engine. By 1768 they had made a new leat through the more convenient Manor Hass, so they arranged a bargain whereby Sherrif got the water at Thieves Slack Hass, and they got the use of one of the Earl of Hopetoun's smelt mills.[18]

The Scots Mines Company's need for greater smelting capacity arose from their finding rich ore below level in the Susanna Vein. Working it also needed a pump and they erected one underground circa 1770. The Meadowhead engine was no longer in use by that time so its leat was taken farther along the valley to the new wheel in Susanna. Another engine was added some years later, the water flowing over each in turn. John Rennie examined the Susanna wheels in 1791 and recorded their performance in his notebook.[19]

Diameter.	30 ft	24 ft
Width.	18 ins.	14 ins.
Speed.	5¾ RPM	4½ RPM
Pumps.	2 x 71" x 5 ft.	2 x 71" x 5 ft.
Head pumped	41½ f.	31 f.

The only illustration which has come to light of any of the Leadhills bob engines is in a painting by Paul Sandby made sometime between 1746 and 1751. The original is now in the USA, but a photograph of it can be seen in the 1979 Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society.[20] The painting has only the title 'Lord Hopetoun's Lead Mine', so the copy has been closely examined in the hope that the scene would indicate the site of the wheel. Unfortunately, the conclusion that Sandby has painted a hotch potch of mining features is inescapable. The arrangement of the machinery too seems less than accurate, but it could be expected that he based the wheel on the type then in use and had probably examined the Meadowhead engine. The entries in the 'Leadhills Diary' suggest it was on a favourite route around the mines.



Sandby shows the wheel in a shallow pit. It is supported on timber beams and there is a gate across the tailrace. The spokes fit into a massive nave and there are overhung cranks at either end of the shaft. The two beams which work the pump spears have balance boxes and are carried on a stone wall built between the wheel pit and the shaft. The latter has the usual tripod headgear over it, and the water for the wheel is carried along a high leat supported on "A" frames. A representation is shown in fig.l, but with the leat omitted. The whole compares with a drawing of a contemporary bob engine at Wanlockhead, and included in the Transactions mentioned above.[21]

Providing water to power smelt mills and ore crushers, as well as the pumping engines produced a network of leats augmented by gutters and dams. The usage of water was complicated by the fact that, until the 1860s no single company had the whole of the mining ground at Leadhills. The Earl of Hopetoun seems to have been very much aware of the critical role he played in granting water rights, and in 1739 the Secretary to the Scots Mines Company wrote to assure him "It has been and shall always be our endeavour to prevent any dispute (over the water)".[22] But a century later such noble

sentiments had worn thin with constant complaint. In the 1840s the two operators, the Scots Mines Company and the Leadhills Lead and Silver Co. fell out over the right to the Shortiecleuch water and the use of the common drainage levels. Their dispute went to court, action begat counter action and mining was almost brought to a standstill with great hardship in the village. Eventually the Scots [9] Mines Company won the day, but were so weakened by the battle that they had to suspend their operations completely and gave up their lease to the rival contestant.[23]

Steam Engines

The first steam engine to work in the area was one bought from Boulton & Watt for the Margaret Mine at Wanlockhead in 1779.[24] Their introduction at Leadhills perhaps needed the additional impetus of a new lease. In 1782, some of Tessington's partners formed the Leadhills Company. One of its aims was to work deeper on the Brow Vein, but the existing rights of the Scots Mines Company prevented them taking additional water to serve the mine. Instead they looked for a steam engine and approached Boulton & Watt for an engine to pump from 40 fathoms below the adit. It so happened that a suitable engine was available from the White Grit mine in Shropshire, and this was purchased in 1785.[25] Watt advised that the boilers should be obtained in Scotland, and Carron Company of Falkirk made the pumps.[26] It was 1788 before the parts were on site, and Robert Muir, one of the erectors from the Soho works, was sent to Leadhills to take charge of the engine building. It was of 33 ins diameter by 8ft stroke, and worked two columns of 9¾ ins pumps.[27] Muir made a poor job of the erection and eventually the Company engaged 'Mr. Symington to put her to rights'.[28] It may have been William Symington, the engineer and steam boat pioneer, who later built one of his own engines on the Humby mine. Another cylinder was fitted in 1804, so in spite of its deficiencies the engine worked into the nineteenth century.[29]

The Scots Mines Company turned to steam power in 1792. They had found a rich belly of ore in the Humby vein some years before, but the decision to use a steam

engine to pump the new workings was delayed by the vacillation of the manager, Archibald Stirling. The engine he finally ordered was an 'Improved Atmospheric Engine' to William Symington's patent, see fig.2. It was built by the inventor in 1794, and was designed to pump more than 72 gallons a minute from 30 fathoms below the drainage level. It seems never to have been used to its full effect for the shaft proved so wet that the miners could not work in it, and plans had to be curtailed. The Humby mine was eventually abandoned in 1796.[30]

Water Pressure Engines

By the mid nineteenth century steam power had been given up as a way of pumping the mines at both Leadhills and Wanlockhead. The high cost of transporting coal and the need for expert maintenance were a constant drawback, and the fall in the price of lead which followed the lifting of import controls in 1825 must have been the turning point.

By that time water pressure engines – a piston worked in a cylinder by the pressure of a head of water - were becoming reliable machines which could be placed at adit level to work pumps many fathoms below. See fig.3. Placing the power source deep within the mines meant there was a very high head available, and the engine would work with a relatively small flow of water.

When the Leadhills Silver and Lead Mining Company took over the whole mining ground in 1862 they not only brought capital but a fresh enthusiasm and improvements in pumping were among those tackled. To overcome the seasonal variations in the water supply, a large reservoir was built on the Shortiecleuch, and to overcome the defects of the open leats, the water was carried in fired clay pipes.[31] An account of the mines in 1864 lists the following water-powered machines in use.

Four water pressure engines pumping.
One water pressure engine drawing ore.
Four water wheels drawing ore.
One waterwheel driving the crushing mill.
One waterwheel working the blower at the smelt mill.[32]

The four water pressure engined pumps are also described in Ure's Dictionary.[33]

[10]

Pumping shaft .	Cockburns.	Hopetoun.	Hillside.	Moffats.
Date installed.	1833	1833	1853	1862
Diam. x Stroke .	10" x 6'	15" x 10'	19½" x 10'	24" x 10'
Pressure Head. Ft.	180	150	210	216
Strokes / Min.	5	4	3	2½
Head pumped Fathoms	70	22	27	40

The Twentieth Century

In 1903 the Leadhills Company was re-structured and capital raised to develop new workings in Browe's Vein. By that time the Leadhills and Wanlockhead Light Railway brought cheap coal and steam power was economically viable. In 1910 two Tangye mine pumps were raising 13,000 galls per hour in the Glengonnar mine and were augmented by a waterwheel, sited underground, pumping from the 100 fathom level into Gripps adit. The workings in Brown's Vein were re-opened at Wilson's shaft, and a waterwheel built to pump them.[34] The wheel was in a pump house sited at the now ruined wheelpit by the old railway.

The depression of the 1930s led to drastic cutbacks. The Glengonnar and Wilson mines were closed and operations were concentrated on the old Mill Vein, where a new shaft was sunk in 1924. It was officially known as Borlase, but the miners called it Wembly. Expenditure was kept to a minimum and oral tradition has it that the wheel by Wilson's shaft was taken underground. It may be remembered that, almost two centuries before, parts of an 'old wheel' had been used to build a pump on the same vein.

Part 2. Physical Remains.

Tissington's windmill disappeared two centuries ago and little trace remains of the seven or more waterwheel pumps built before 1800. Only the leats which carried water to them still circle the hillsides, but many have been altered and no longer point to the original engine sites.

Only the site of the Meadowhead engine can be pointed out with any confidence. It was at NS.88451520, and in front of the cottages in Lowther View. The site of the engine nearby on Brown's vein is less certain. It may have been c.NS883152 but the area is grassed over with little to be seen but some vague hollows. Parts from this engine may have been used to build the one on Mill Vein. Its site would have been c. NS.886156, and near the track to the Susanna mine.

The pumping engine at the south eastern end of Brown's Vein was underground, and is likely to have been near the ruined wheelpit that remains at NS.88551425. To the East were the engines at Broad Floors and Back Raik. The former c.NS888147. and in an area of ground now covered with tailings from the dressing plant by the golf course. The engine at Back Raik was in an area of old works, c.NS888144. Both would have been supplied from one of the Shortiecleuch leats but the line to them is not shown on the 1760 plan, the oldest the writer has been able to examine.

Also on Mine Hill was Tissington's engine. Since it was on Brow Vein, and near the gully, the Rashy Sike, it was c.NS883138. But the area has been covered with the spoil from later workings, and the remains not only of Tissington's engine, but also the steam engine and a smelt mill have been obliterated. Tissington used a slide works between his engines and the pumping shaft, and another engine distant from its shaft was that built by Alexander Sherriff by Big Wool Gill. Scant trace remains of the leat that brought water along the slopes of Broad Law to the engine, but it can be seen that this was some 100m down the hillside from the Engine Shaft which is

shown on the 1760 plan as C.888164. The arrangement of this engine is a particular puzzle for the hillside is very steep up the side of the Gill and it is difficult to envisage how the engine and pump were arranged.

To date the Leadhills mines have not seen the sort of exploratory fieldwork that will be needed to provide hard evidence of the sites of the old engines. This is particularly the case with the great houses that once contained the steam engines built to the designs of James Watt and William Symington for not even a stone of their foundations can now be seen. This may [11] seem strange until it is realised that the local rock, greywacke, made poor building stone. Disused wheelpits and engine houses were then broken down so that any usable blocks could be used for other works or for the miners cottages.

The second hand Watt engine built on the Brown vein in 1787 could in fact have been on the shaft Tissington had pumped. There is no certain reference to its whereabouts, but furnace cinders in the area NS884138 may be an indicator. Cinders also point to the site of the engine Symington built on the Humby mine, high on the hillside at NS883159.

Leats had to serve the steam engines as much as the waterwheels, but examination of the mine plans of 1760 and 1851[35] shows many of the open leats have all but disappeared in places. One of the largest was that which reached the Susanna mine c.1770, and known as 'No.3'. It drew water from the Shortiecleuch Burn at 1475 ft OD, and its line can still be followed along the hillsides there and through the fields behind the village where it serves as a footpath. About a century later, a 12 inch fired clay pipe was laid to take water from the reservoir. It follows much the same line, but contoured about 50 ft lower and provided a sort of supply header for pumps and other machinery. It still carries water, but is broken to supply the Glengonnar Burn.

Much more fieldwork is needed before the whole anatomy of the leats and pipes is laid bare. Only this will point to the sites of the water-pressure engines for all were deep in the mines they pumped. The largest was in Moffat's Shaft, NS89201405. It was one of the few water engines not dependant on the Shortiecleuch, for it seems to have been supplied from the small reservoir that can still be seen across the track from the mine. The engine worked with a head of 216 ft and its cylinder was 24 ins diameter. This meant a huge mass of water moved at each stroke, and it is perhaps significant that it is said to have 'worked for months at the rate of 1 stroke every 15 minutes'.[36]

Of the more recent works, ruined buildings remain around the Glengonnar Mine, NS88171382, and Wilson's Mine, NS88551400. The former did not have the pumps at surface, but electricity was generated there to power pumps, and other machinery, underground. The Wilson Mine had a large wheel in the Pump House whose ruined pit can be seen at NS88551425.

A number of ruined buildings still surround the site of the Borlase or Wembley Mine at NS.88551545, but all the pumping machinery seems to have been below ground.

It will be apparent that this account of the pumping engines at Leadhills is of a fragmentary nature. The history of the mines is more complex than published accounts would suggest, for the picture is distorted by the large amount of documentary material relating to the Scots Mines Company. There is a need for research into the history of the other operators, and much opportunity for fieldwork to fill gaps in the written record.

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21. ibid. Page 91 Fig.l.

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