NEIMME/ZB/24

ZB-24-P-Title page
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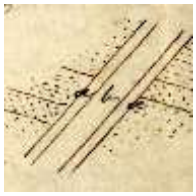
North of England Institute of Mining and Mechanical Engineers [rubber stamp]
MAR 23 1899 [rubber stamp]
A Short Account of the present System of Coal Mining. To which is added An account of Scalegill Collieries, William Pit Machines and Overend Limekilns.
June 1808

ZB-24-p0 intro page
The following **Drawings & Observations** relative To the present System of **Coal Mining,** Part of the Coal Works, Engines, & Lime works In the vicinity of Whitehaven Are most humbly addressed to **The Right Honble. William Lord Lowther** By his Lordship's Most Respectful, and devoted Servant, John B. Longman
Whitehaven, June 24th 1808.

ZB-24-p1
1.
A short account of the present System of **Coal Mining**
The chief of the difficulties that Coal Miners have to contend with, are those irregularities in the Strata called **Dykes, Water,** a want of a proper Current of Atmospheric Air, & an abundance of Noctious [noxious?] Airs or Damps.
Dykes are fractures in the Strata of considerable Length, and Depth, and from 1 foot to 6 feet broad. A Dyke is composed of two Stickings a, a; and a Gut b between the two Stickings, it is filled with contiguous Strata irregularly broke into small pieces; the Stickings are of the same materials but minutely divided and afterwards compressed.



A Dyke disarranges the regularity of the Strata. Any Stratum on one side of the Dyke is lost at the Sticking, and on the same Level on the contrary side another Stratum presents itself which laid considerably above or below the Stratum on that side it was lost. When a Stratum lost on one side of a Dyke is found on [margin note – An Upthro [sic] Dyke] the contrary side above its Level that Dyke is called an Upthro [sic].
[margin note – A downthro' Dyke] On the contrary when any Stratum lost on one side of the Dyke is found on the other below its Level that Dyke is a down thro'.
An Upthro' Dyke may throw either to the rise or dip.
[margin note – Upthro to the Rise] An upthro' to the rise is represented by a **f** (Figure 1st Plate 1st) The Coal is stopped at **g** by the Dyke **f d** and found again at **e** – as **e** is on the

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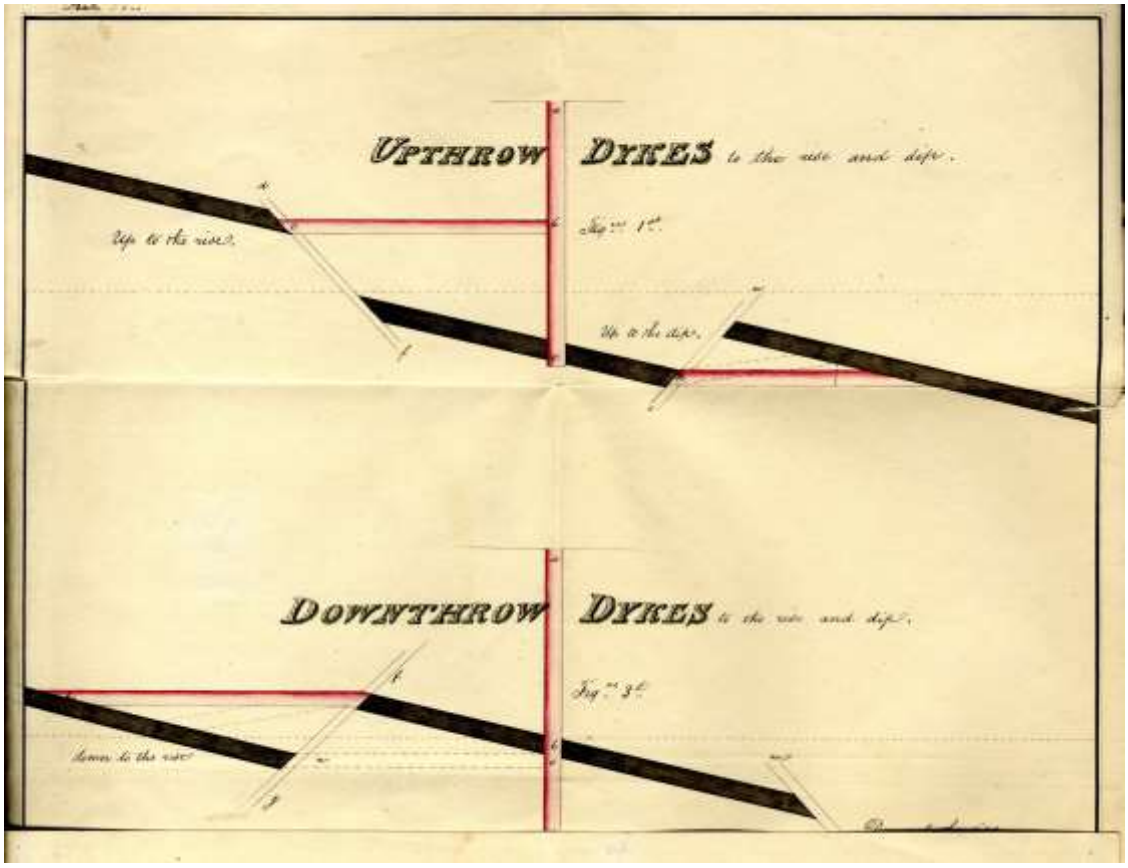
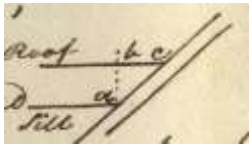
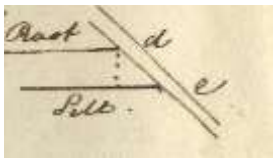


A

ZB-24-p2-3
2
The rise side of the Dyke and higher than **g** the Dyke is an upthro' to the rise.

Upthro' to the dip [marginal note or subheading]
An upthro' to the dip is shewn by **n o** The Coal is lost at **h** and found at **m**, as **m** is to the dip of the Dyke and above **h**
The Dyke throws up to the dip.
Downthro' to the rise [marginal note or subheading]
A Downthro' Dyke may throw either to the rise or dip. A downthro to the rise is shewn by **f, g,** Figre. 3rd. The Coal is lost at **d**, and found again at **e** on the rise side of the Dyke and considerably lower than **d –** the Dyke therefore throws down to the rise.
Downthro' to the dip [[marginal note or subheading]
m – l Figre. 3rd. is a downthro' to the dip, the Coal is depressed from **i** to **k** and as **k** is on the dip side of the dyke, it throws down to the dip.
Hitches are a certain modification of Dykes. When any Stratum is thrown up or down, not so far as its own height; the Dyke is then termed a Hitch.
Whenever a Dyke is met with first at the sill and then runs towards the roof making an angle **a.b.c** with the Perpendicular Line **a, b,** it is an upthro' Dyke and the Coal is certain to be found above head on the other side of the Dyke but when the Dyke is found first at the Roof and then slopes in the direction **d e** towards the Sill the Coal is sure to be found below on the other side of the Dyke





As all dykes present themselves in these two Shapes, Miners know on inspection whether to search for the Coal above or below.

Dykes divide the different Strata of Coal into parts, any part bounded every way by Dykes

3.
Coal fields [marginal note or subheading]
Is called a **Coal Field**
Numerous Coal fields are found in extensive Collieries and their boundary dykes are some of those already described, but which, and to what extent, is very uncertain as is the Shape and extent of the Coal field. These variations in the Dykes and Coal fields give rise to two branches of Mining. The first is Setting over the Dykes from one Coal field to another – and the second, The proper Tryals to be made to ascertain the extent of the New Coal field.

1st. **Setting over Hitches,** or Dykes is a very extensive branch in which much variety occurs. Some general principles may be laid down but so many local circumstances are to be taken into the question that none of them can be strictly adhered to.
Setting over a Dyke that throws up to the rise;-
To win the Coal at **e** Figre. 1st from **g** – A Sloping Drift must be drove parrallel [sic] with the Dyke rising so many Inches in every Yard of Length, according to the situation and extent of the throw. In this case as the Coals have to be brought down the Drift it may rise 6 Inches in a Yard or 1 Yard in 6. This Drift is shewn by Figre. 2nd and 4th Plate 1st…

When the distance of the throw is great, and the distance from **e** to the Shaft **a, b, c** (Figre. 1) not far; a Stone Drift **a, b** is sometimes drove and the Coals are carried on this Drift to the Shaft from **e,** instead of carrying them down the Sloping Drift and from **g** to **c** (Fig. 1st). This saves a distance in their Carriage equal to the Length of the Sloping Drift, and in raising them up the Shaft **a, b, c,** a distance equal to **c b.**

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4.

To set over a Dyke throwing up to the dip.

A Stone Drift **h, i** is drove upon a Level Line directly to the dip 'till it intersects the Coal at **i** – or, as it is sometimes done to save expence, drove rising to the dip towards the Coal in the direction **h, k,** this shortens the Length of the Stone Drift. -

To set over a Dyke throwing to the rise.

A Stone Drift must be drove to the rise as is shewn by **d, h,** Figre. 3rd. Sometimes it is drove dipping to the rise as is shewn by the dotted Lines **d p** by which means it reaches the Coal sooner than the Drift **d h.**

To set over a downthro' Dyke to the dip.

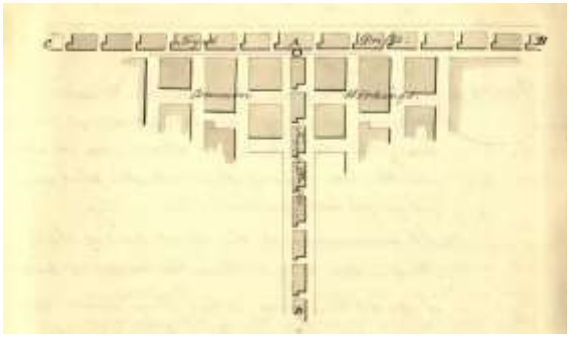
If the throw does not exceed 5 or 6 yds., A Stone Drift must be drove parallel with the Dyke, dipping or Sloping down till it reaches the Coal **k** Figre. 3rd (from the Coal **i**) This drift is the same as that shewn by Figres. 3 and 4, only supposing that it is drove downwards from the high end.

When the throw is a good distance say 10 or 20 Fathoms, The Pit **a, b, c** is sunk down from **b** to **c** and a Stone drift **c, k** drove till it gets the Coal at **k.**

2nd. **Proper Tryals** to be made to ascertain the extent of the New Coal field.

When a Pit is sunk, Three tryal Drifts in Coal are generally set away, Two **A B** & **A C** on the Water Level Line of the Strata, and one **A D** to the rise. By having these Tryal

5.



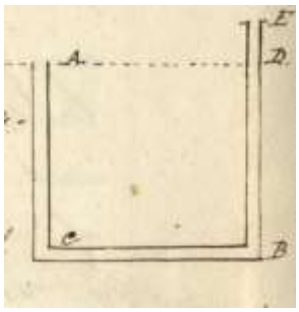
Tryal Drifts at a proper distance before the common workings, time is allowed to set over any Dyke that may be met with and to gain a fresh set of workings in the New field of Coal, or as it is termed to open it out; - These tryal Drifts are then to be set away in the New field in the most suitable directions. Tryal Drifts are necessary in Collieries having any inflammable Air, when there is no need of them otherwise. They give time for the inflammable air to discharge itself before the Common Workings are set forward, They also are necessary in particular situations to Drain the Coal of its Water and to carry it into the Sump &c.

ZB-24-p6-7

6.

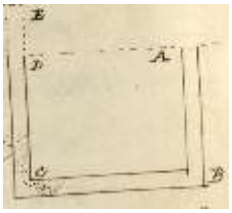
Water in Mines [pencilled note inserted here – 'This when' plus 2 more illegible words] is a very troublesome visitor, making its way down Dykes and from them thro' the beds of the Strata into the Mine also thro' the beds of those Strata that run out to the surface.
It always runs to the lowest part of the Mine where proper room is made to hold it for stated times when it is drawn out either with Engines, Horse Ginns, or other Powers.
Into mines that are above the Levels of any part of the surface adjoining, a Stone Drift is drove on a Level by which all the Water above it is carried out at no expence and if it is found necessary to work below this Level the water that part makes is lifted into it by Steam Engines or other Powers.
Water is found in the greatest quantity immediately below the surface and it diminishes as the Depth increases.

7.
A Want of a **sufficient Current** of Atmospheric Air in Mines must always be avoided, but it is most prejudicial and indeed fatal to the lives of Miners in those Mines where any of the Noctious Airs abound.
Two different methods are used to ventilate Mines according as they are circumstanced. - If they are not extensive nor troubled with Noctious Airs the Atmospheric air is left to circulate naturally round them, the Miners using these precautions, That there be two pit shafts communicating together and that the top of one be higher than the top of the other.
As the temperature of all Mines increases downwards from the Surface the air in them becomes Rarer and rarer to the bottom of the pit

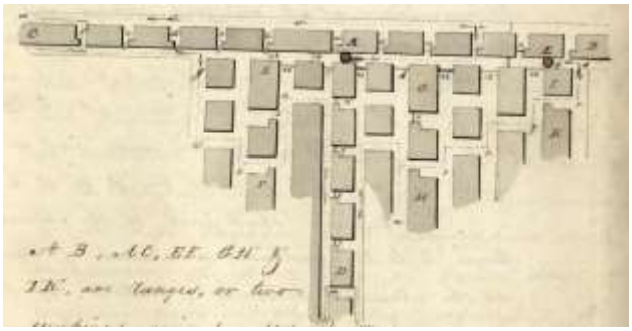


Thus suppose any Pit **A C**, the Air will be rarer at **C** than at **A**, if the Pit communicates with another **B D E,** and if that pit top is continued above the other Pit top any distance **D E** 'till the Air at that part be as rare

ZB-24-p8-9
8.
Rare or somewhat rarer than the Air in the Mine at **B** Then will the Denser air at the surface **A D** descend down the Pit **A C**, get an increase of temperature, become rarer, and ascend up the Pit **B D E,** by which means a current circulates round the Mine, but its constancy is very much hindered by different causes, such as whenever the Air at the Surface suddenly acquires an increase of temperature so as to exceed that of the Mine. This often takes place in Summer and again, the direction and velocity of the wind [?] increase or retard the Current of Air. At the time when there is a stagnation in the Mine from any of the above causes, if there was any Noctious Airs they would accumulate and become prejudicial, either from their Inflammable or Unrespireable [sic] qualities. When they are found in any quantity, Miners adopt a second method of Ventilation. They endeavour to force a proper current round the Mine by artificial means, none of which answer so well as a Large fire placed at the Pit bottom say at **C**. The heat it emits rarefies the Air coming down the Pit **A B** and causes it to ascend up the Pit **C D** with great velocity. When it reaches the Pit top **D** it is warmer and rarer than the surrounding Atmosphere and uses to a considerable



9
considerable [sic] height in it, say to **E.**
If the fire be well attended to, and kept burning constantly with the same degree of heat a constant Current of Air may be depended upon, but it is difficult to carry it round every part of an extensive Mine, and if one part be left without Air there the Noctious Airs collect and catch the Miner by surprise. The following method is adopted to carry the Air round by the foreheads [?] of the Mine -



At **B, A C, E E, G H & I K,** are ranges, or two workings going parallel, between which there are Cross Workings **a, b, c, d** &c, made narrow at one end, These Cross workings are named Thirls. All the Thirls in each range are made up except that one next the foreheads of the Range. Ranges are meant to carry the

ZB-24-p10-11
10.
The air from the part they commence to where <u>they end without letting</u> it pass thro' them. 18, 19, 20, 21, 22 23 are doors across leading workings for the Convenience of bringing Coals thro' that way; Where there is no Coals to bring thro' workings that require stops for the air these Doors are not necessary and fixed stops will do, as at 1, 2, 3, 4, 5, 6, &c to 17. From this arrangement it will be easy to trace the Course of the Atmospheric Air from its entrance at the Pit **A** till it ascends up the Pit **L**. It commences at **A** and goes round in the direction shewn by the Pricked Line and arrows touching the points **a, v, w, f, g, h, i, k, l m, n, o, p, q, r, u, t** But if by accident the Doors 18-19 are left open the air will not go round by **a v w f g** but by **A** 19 18 [illegible symbol] [word erased] leaving that part of the Mine from **C** to **E** without a current of Air or as the Miners term it, neuter. If that part so left neuter makes any Inflammable Air and if the Doors should open a Length of time (say 24 Hours) a great body of it will be collected together. When the Coal Laggers [?haggers?] come to work and do not perceive the Doors open they go directly into the

11.
Inflammable Air without perceiving it. Hence the source of all the accidents by Fire.

The Noctious Airs or Gasses [sic] incident to Mines are Carburretted [sic] Hydrogen Gass [sic], Carbonic Acid Gass & Azatic [?] Gass.

Carburetted Hydrogen Gass, Inflammable Air, or Foul Air, is found in the greatest abundance in Coal Mines, It is the lightest of all airs except pure Hydrogen, Its leading property is inflammability, It can be set on fire by a Candle, an Electric Sparke [sic], or by the Sparkes from a Steel Mill. When collected in a sufficient quantity and set on Fire it produces an explosion, which is owing to the Hydrogen of the Carburetted Hydrogen uniting instantaneously with the Oxyagen [sic] of the Atmospheric Air and forming the dense body of Water. The immense body of those Airs required to make a very small quantity of water and the quickness with which they pass from Airs into Water make a Vaccuum [sic], It is the surrounding Air rushing in every direction into this Vaccuum that is

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12.

Is called the explosion or the blast. At the same time that the Hydrogen and Oxyagen are uniting together The Carbon of the Carburetted Hydrogen and more of the Oxyagen of the Atmospheric Air unite and form Carbonic Acid, the other element of the Atmospheric Air the Azotic Gass being left uncombined.

An explosion knocks down the Doors, Wood Stops, &c, in that part of the Mine within the sphere of its action, so that a current of Atmospheric air is completely excluded. The poor Miner that has escaped the effects of the fire and the explosion, that is, if he is not burned to death [word erased] nor his Limbs all broken, has yet another effort to make to save himself, he runs to that part of the Mine where he supposes the fresh Air is, and endeavours to get from the Noctious Airs generated by the fire – but he very seldom accomplishes his object for he is in the Dark, his hands and face severely burned & perhaps some of his Limbs broken, & his sences [sic] so completely bewildered that he frequently runs to the place where he most wishes to avoid, If he should take a right direction his strength so often fails him that he

13.

he falls down on the Road and if he once falls he never can rise again by himself for the Carbonic Acid Gass or Choak [sic] Damp which is found next the Sill is the most fatal Air to the Miner. If he can keep his head up and his body erect he stands a better chance of escaping suffocation for the atmospheric Air is found in most abundance next the roof of the Mine, sometimes pure but most frequently mechanically mixed with the Azotic Gass in different portions; below them and next the Sill is the Carbonic Acid; & the Water which was made by the union of the Hydrogen and Oxyagen is found in small drops on the Roof, sides and Sill of the Mine, and bedewing the Clothes of the Miners that may have been within the sphere of the fire.

Carburetted Hydrogen Gass is unfit for respiration.

Carbonic Acid Gass, Fixed Air, Choak or Black Damp is frequently found in Mines; in some blowing out of the Roof like the Blast from

ZB-24-p14

From Furnace Bellows. It is the heaviest of all Airs. It is not inflammable but unfit for respiration. When Miners apprehend the presence of the Air they carry their Candles at arms length before them and when they cease to burn they advance no further.

Carbonic Acid Gass is formed when the Carburetted Hydrogen is set on fire by the union of part of the Oxyagen of the Atmospheric air and the Carbon of the Carburetted Hydrogen.

Azotic Gass is never found in Mines but after a fire – it is one of the Elements of the atmospheric Air left uncombined. It is unfit for respiration when pure.

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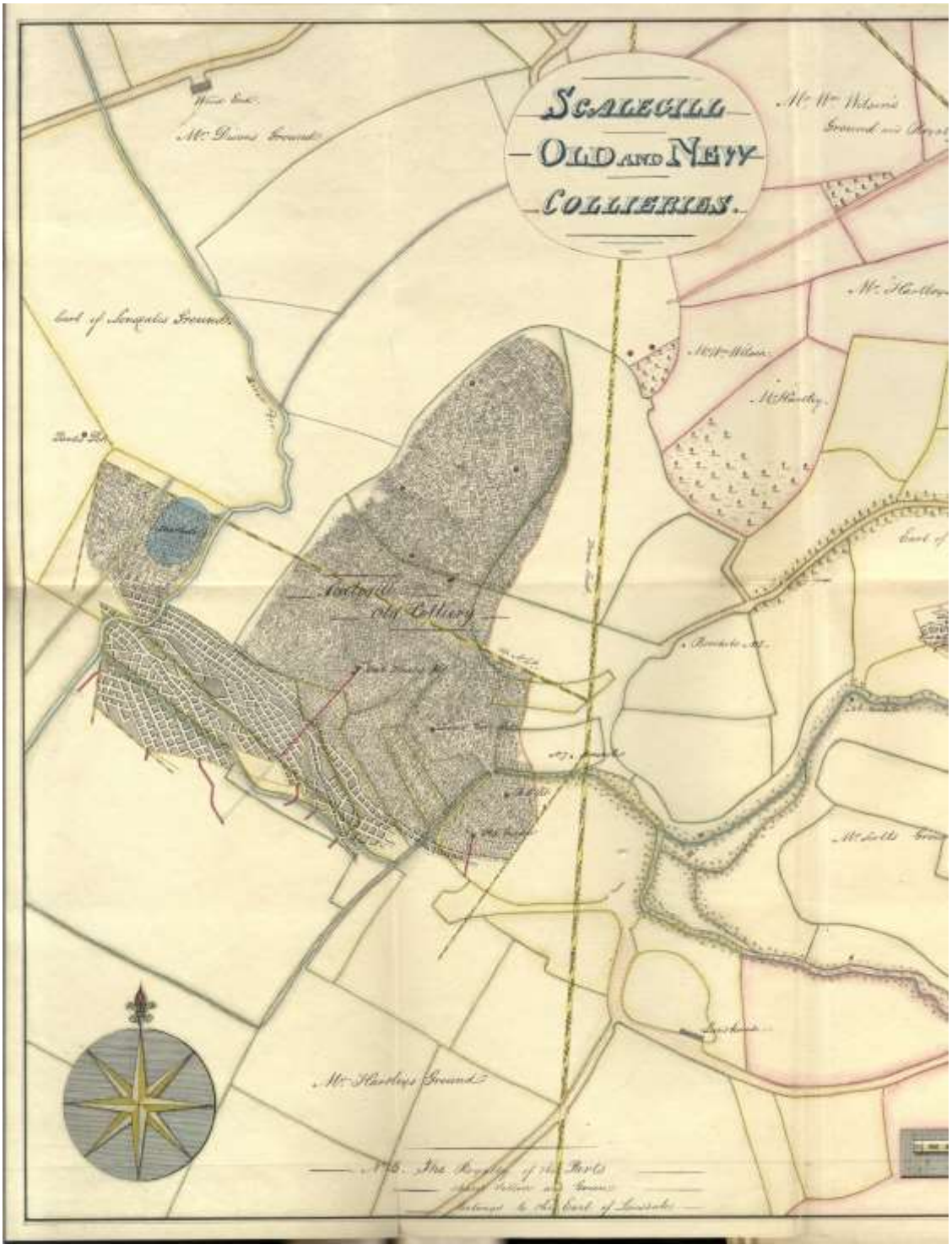
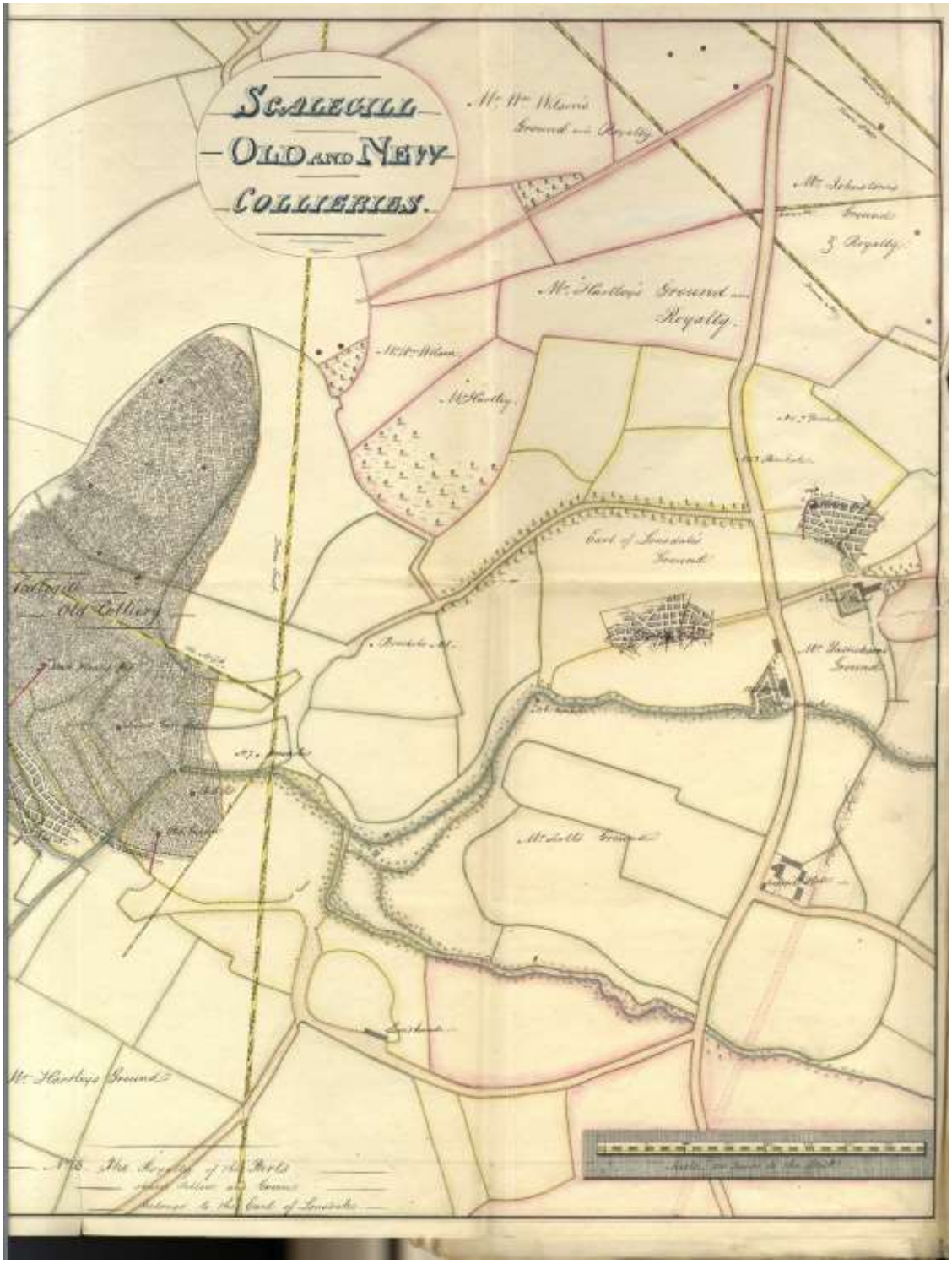
ZB-24-p30 LH.


SCALEGILL
OLD AND NEW
COLLIERIES.
Mr Dixons Ground
Mr Wm Wilsons
Ground
Mr Hardleys Ground

ZB-24-p30 RH


Scaleghill
Old and New
Collieries.
Mr Wm Wilson's Ground and Royalty
Mr Johnstone's Ground
3 Royalty
Mr Hartley's Ground and Royalty
Mr Wm Wilson
Mr Hartley
Mr Bainbridge's Ground
Mr Hartleys Ground

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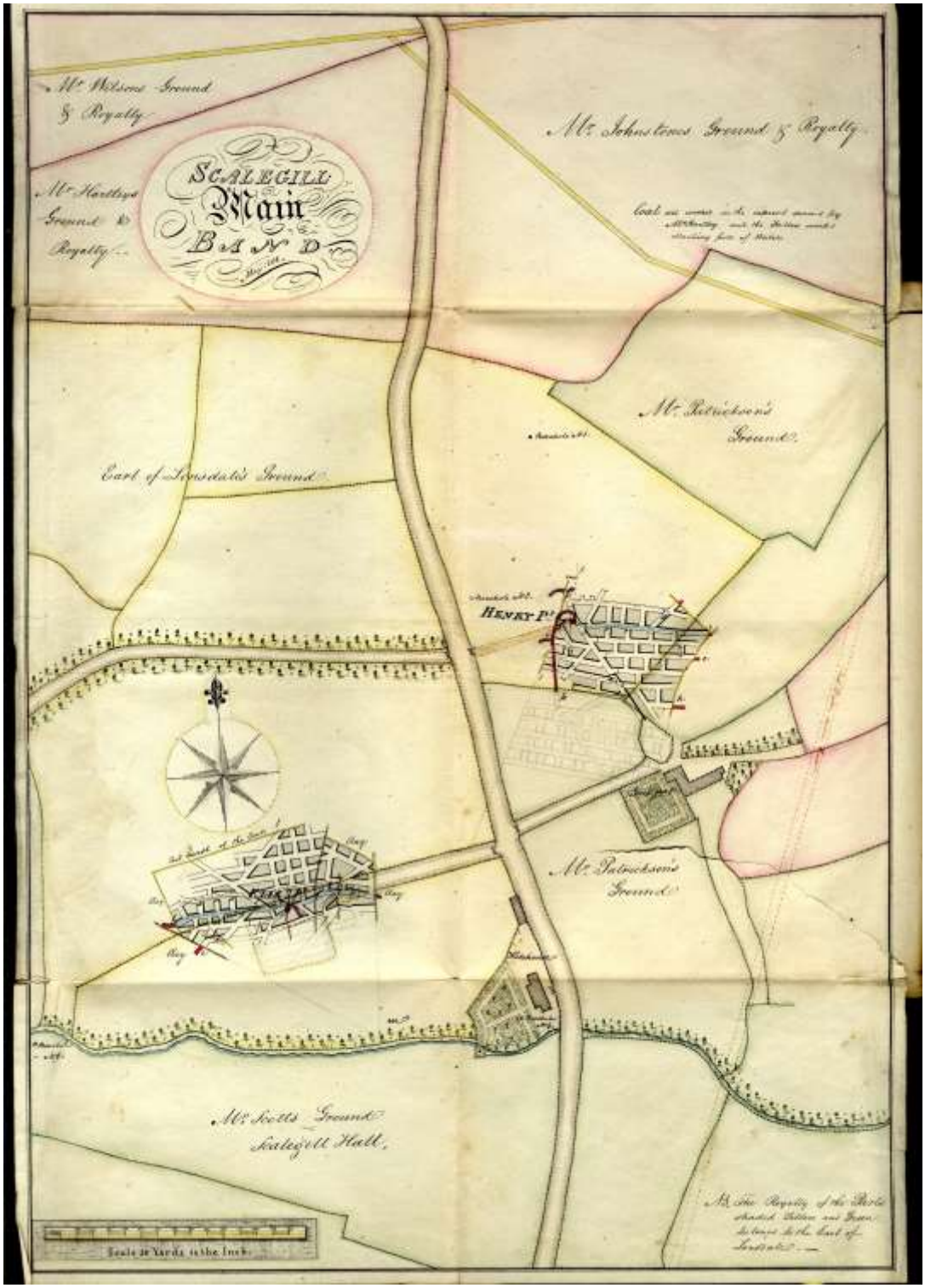

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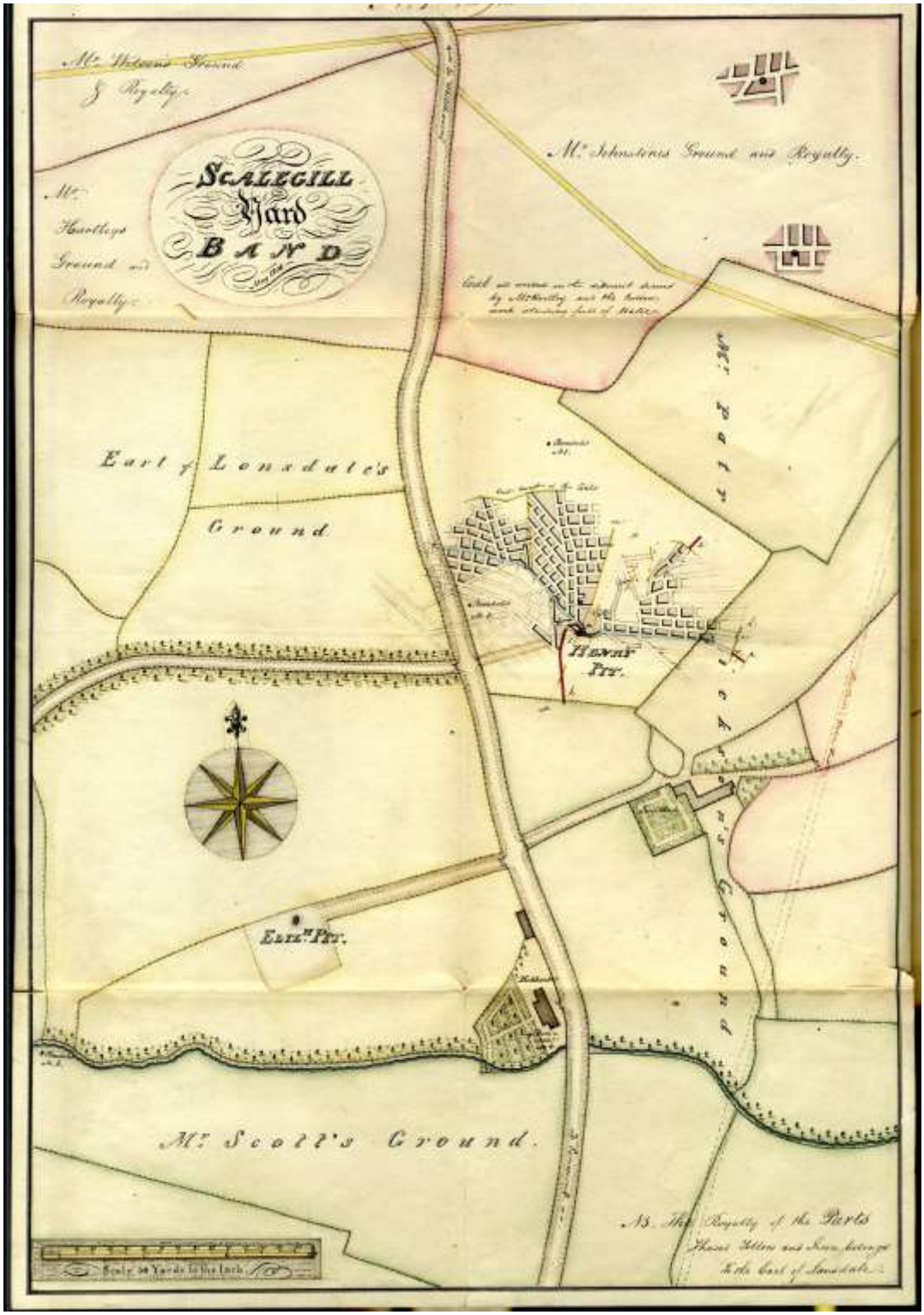

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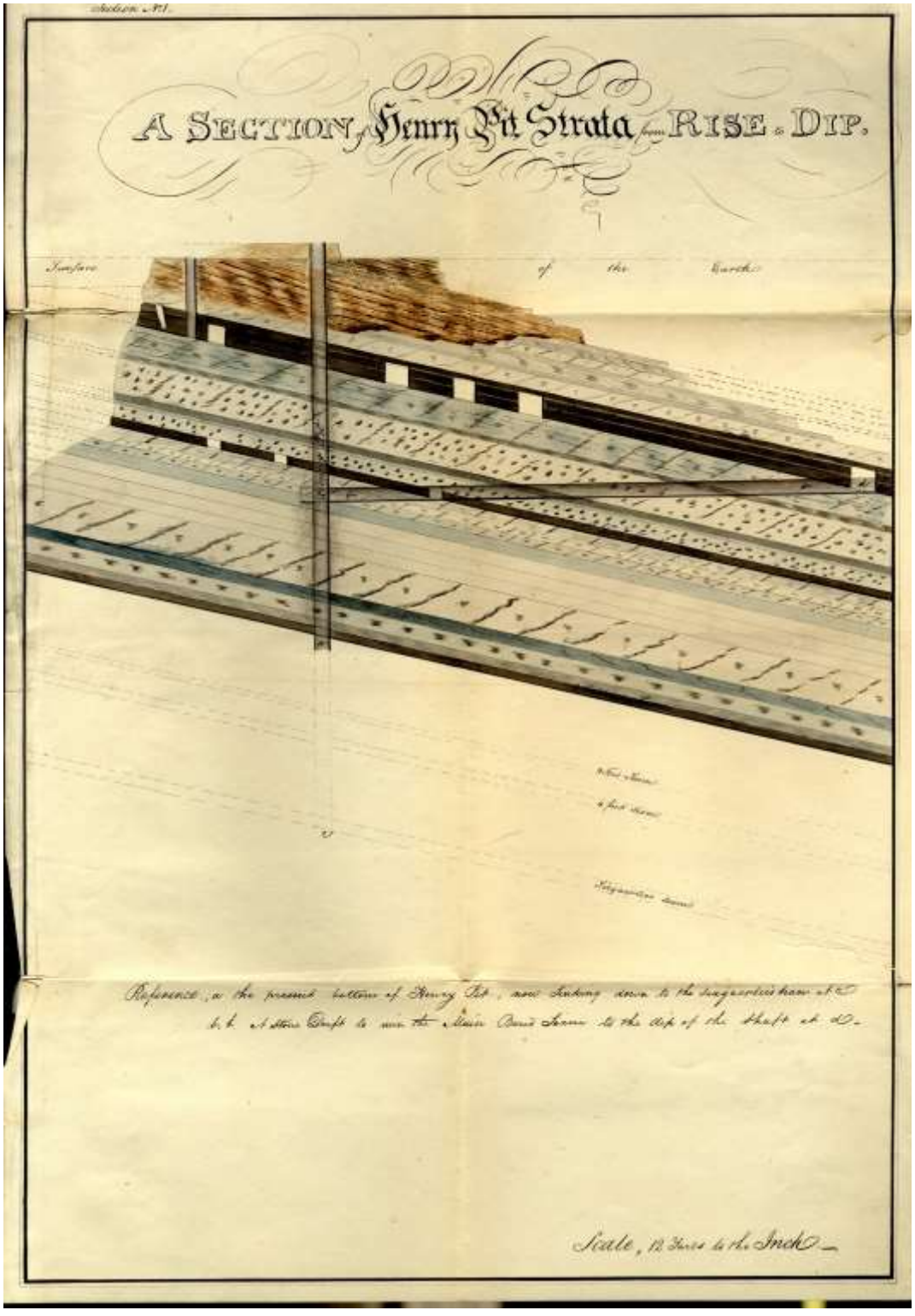

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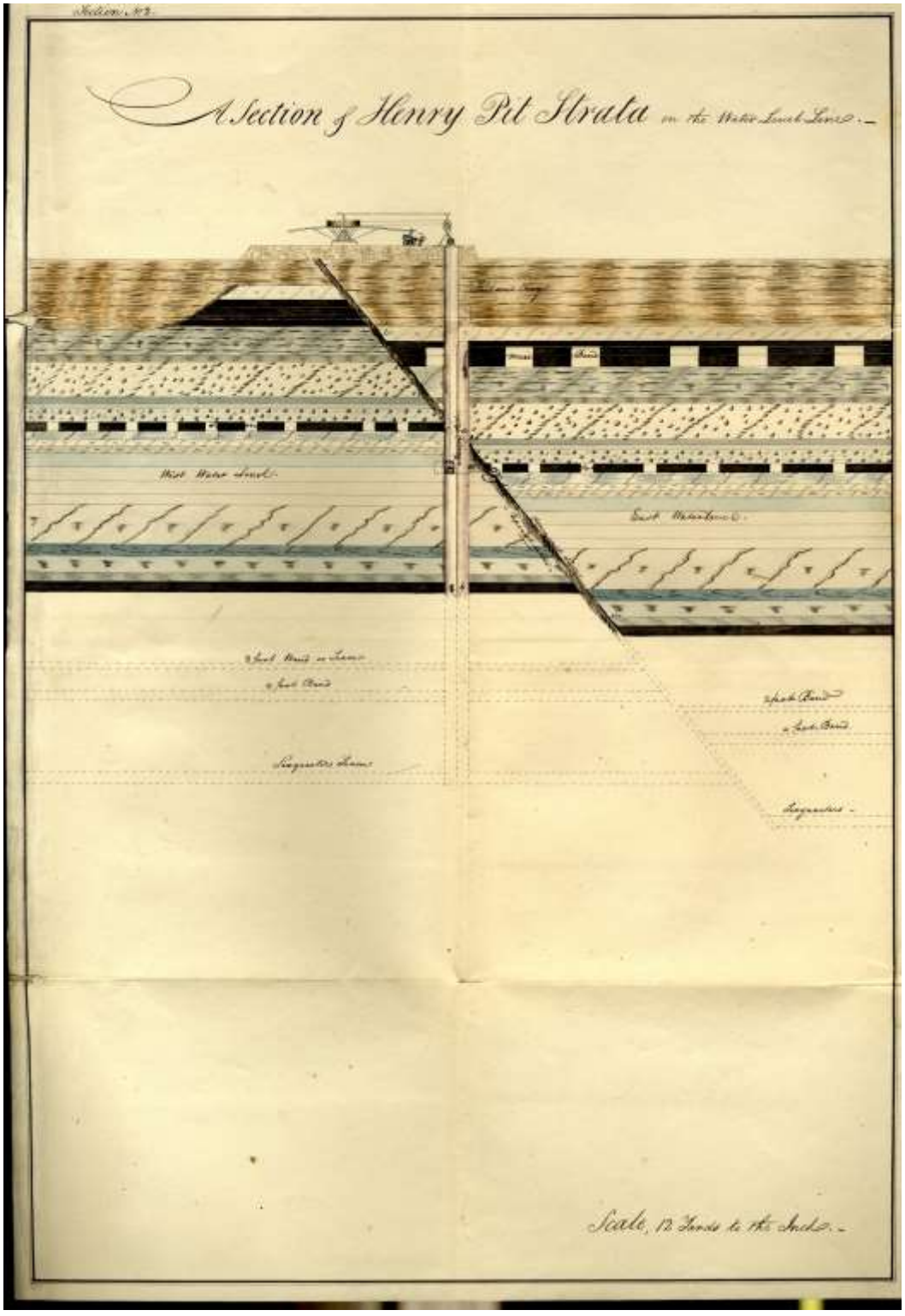

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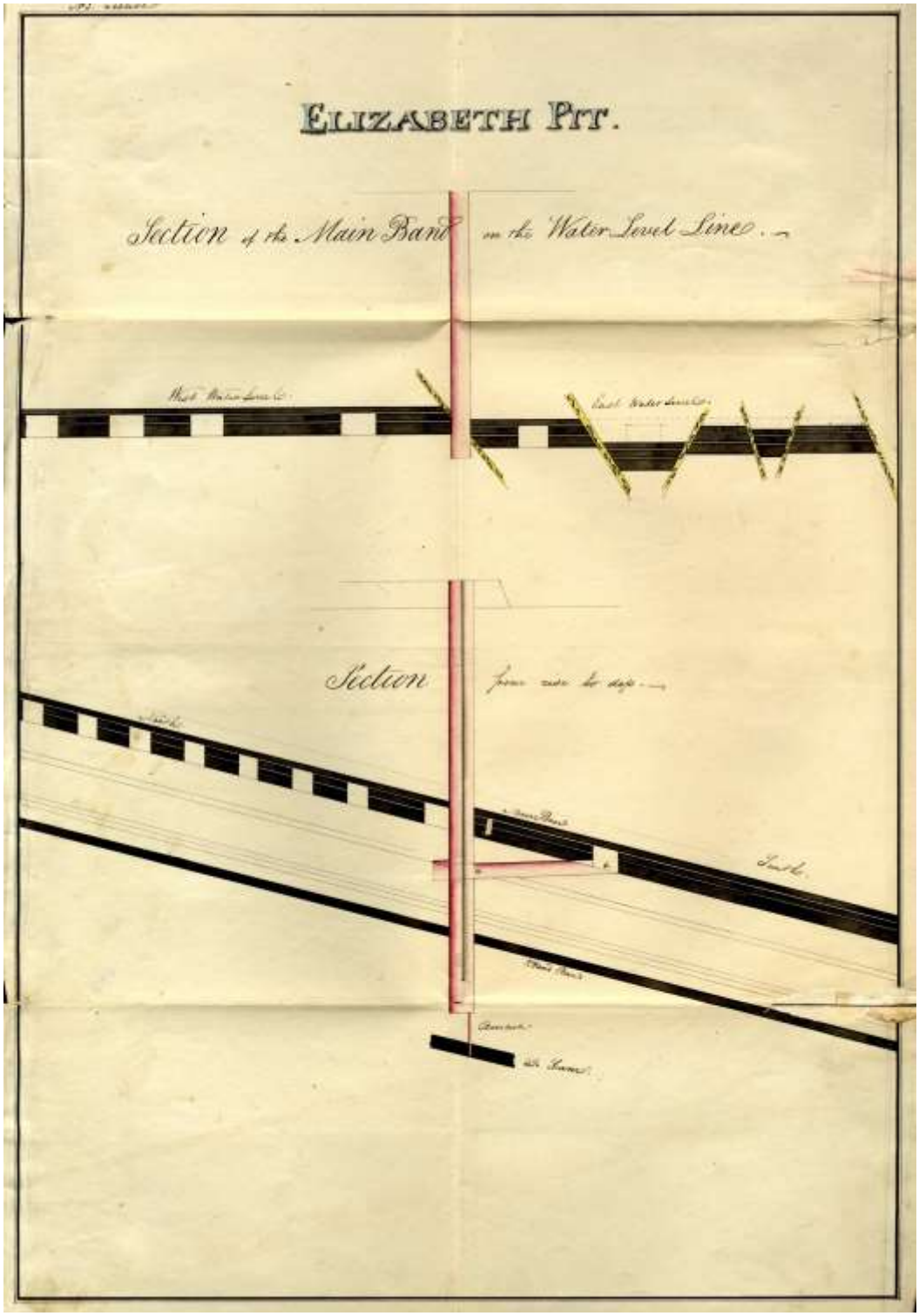

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Scalegill New Colliery
June 30th 1806, Began to search for Coal at Holehouse at the Place marked Borehole No. 1 on the Plans. This hole was bored 34½ fathoms. In that distance 5 Workeable [sic] Seams were found, the

last and largest of which was 4F 11In thick. It is called the Sixquarters Seam of Coal. The rest were from 2 [ft?] 6 [ins?] to 3 6 in thickness
The **Second** Tryal hole was, were [sic – where?] Henry Pit now is, it was bored 8 Fathoms to the Main Seam of Coal 9 feet high.
The **Third** Tryal hole was made at the place marked borehole No. 3 upon the plans~~,~~ it was bored 34 fathoms. Four Seams of Coal each about 1 Yard thick were met with. They all lay below the Main Band.
The **Fourth** tryal hole was bored about 20 fathoms, in hole house Garden, but no Coal was met with in that distance.
The **Fifth** Tryal hole was made where Elizabeth Pit is sunk, it was bored 15¾ Fathoms to the Main Seam 12 feet high.
The **Sixth** Tryal hole was made at No. 6 upon the general Plan was bored 12½ fathoms to a Yard Seam

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42
The **Seventh** Tryal hole was made at No. 7 on the General Plan – a Yard Seam was found at 8 fathoms.
The **Eighth** Tryal hole was made at the place marked No. 8 upon the General Plan. It was bored 31 fathoms but found no workeable Seams.

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The following **General** statement of the **Strata** at **Scalegill New Collry.** is abstracted from the foregoing Borehole Lists.

Local names of the Strata	Thickness of each Stratum				Distance between ea: Coal			
	Fs	Yds	Feet	Ins	Faths	Yds	Feet	Ins
Soil and Clay	-	-	2	-				
Sand	-	-	1	6				
Strong Clay	4	1	-	6				
Grey Stone with Post Girdles	1	-	1	-				
Blue Metal	-	-	-	7				
Soft Blue Metal	-	-	-	5				
Main Band Coal	1	-	2	11				
	7	1	2	11				
Blue and Grey Metal	4	1	1	9				
Black Slaty Metal	-	-	2	1				
Grey Metal	-	-	1	7				
Black and grey metal with Iron Stone Bailes	2	1	-	8				
Grey Metal	-	-	1	6				
Black Metal	-	-	1	6				
Blue Grey Metal	1	-	-	-				
Dark Grey Metal	-	-	-	3				
Coal	-	1	-	5	10	-	-	9
	18	-	-	8				
Grey Metal with Post Girdles	-	1	2	2				
Grey Post	-	1	-	-				
Grey Metal Stone with Metal partings	-	1	1	-				
Grey Post	-	-	2	-				
Grey Metal	1	-	1	5				
Black Stone	-	1	-	4				

Grey Metal Stone	-	1	2	4
Grey Metal with Post Girdles	-	1	-	9
	23	1	1	8

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44
New Scalegill Colliery Strata continued

Local names of the Strata	Thickness of each Stratum				Distance between ea: Coal			
	Fs	Yds	Feet	Ins	Faths	Yds	Feet	Ins
Brot. over	23	1	1	8				
Blue Grey Metal	2	1	2	4				
Blueish Black Metal	1	-	-	-				
Grey Metal with Ironstone	2	-	2	-				
Black Metal	-	1	-	-				
Coal	-	-	2	11	12	1	2	3
	30	1	2	11				
Black Metal	-	-	-	4				
Blue Grey Metal with post Girdles	-	1	-	-				
White Post	-	1	-	5				
Grey Metal with Ironstone Balls	2	1	-	-				
Do.	-	-	2	8				
Do. with Post Girdles	2	1	2	1				
Dark Blue Metal	-	1	-	1				
Coal	-	-	1	1	7	1	-	8
	38	1	-	7				
Grey Metal mixed with Coal	-	-	1	-				
Blue Grey Metal	4	1	1	10				
Black Metal	-	-	-	2				
Coal	-	-	2	6	5	-	2	6
	44	-	-	1				
Grey Sill	-	-	2	-				
Grey Metal	-	1	2	11				
Do. with Post Girdles	-	1	-	10				
Coal with 1Ft 3in of Metal in the middle	-	1	-	11	2	1	-	8
	46	1	-	9				

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Local names of the Strata	Thickness of each Stratum				Distance between ea: Coal			
	Fs	Yds	Feet	Ins	Faths	Yds	Feet	Ins
Brot. Forwd.	46	1	-	9				
Grey Sill	-	-	-	8				
Grey Metal	2	1	2	9				
Dark Grey Metal	-	1	-	-				

Coal with 1Ft 9in. of Metal	-	1	1	7	4		-	2	-
	50	1	2	9					
Blue Metal Stone	-	1	-	8					
White Post	4	1	-	10					
Dark Blue Metal	-	-	-	10					
Blue Metal Stone	-	-	-	8					
Six quarters Coal with 1Ft 2in. of Metal	-	1	1	11	6		-	1	11
	57	-	1	8					

[ZB-24-p-46 – blank page]

ZB-24-p-47

47

Henry Pit was the first Pit sunk at **Scalegill New Colliery**
It is 9 Fathoms to the Main Band -
17 – to the Yard Band on the upcast side of the Dyke running thro the Shaft
20 – to the Yard Band on the downcast side of the Dyke

to the 2nd Yard Band on the Downcast Side of the Dyke

The Seams of Coal in this Pit dip to the South one Yard in four.
The **Main Seam of Coal** is 9 feet high.
All the Coal above **a**, towards **f**, (see Henry Pit Band Plan) is the rise Coal

[ZB-24-p-48-p49 – blank pages]

ZB-24-p-50-51

50

an inferior Coal, and the Sinkers are continuing down to the Sixquarters which is expected to be a good Coal, and a large field.
The air in Henry Pit goes down the Shaft into the low eye of the Yard Band and on the South End-gill [?], **a, d** then to the rise as the arrows, Dotted Lines, and figures 1, 2, 3, 4 shew; from 4 it continues its course over the Dyke 5, and round by the figures 6 and 7 to the back Pit, up it into the Main Band foreheads in the direction of the Arrows and figures 4, 3, 2 and lastly up the Airpit 1 to the Surface. In Summer there is a small fire kept at the bottom of the Airpit 1 to keep a constant current of Air going.

51

Elizabeth Pit is $16^{4}/_{6}$ Fathoms to the Main Band.
It is 12 feet high
a f is the Rise Coal
The Coal to the rise of the East and West End-gills **a e** and **a f** is wrought to the Clay or outburst on every side -
f is a downthro Dyke to the West, it brings the Clay on the Downthro' Side upon a Level with the Main Band.
c is a Downthro' Dyke to the East. It brings the Clay upon a Level with the Main Band.
a, b, c, d are hitches.
- **a** throws down to the East [blank space] feet
- **b** Do. to - -
- **c** Do. to -
- **d**

g are hitches throwing down West about 1 yd. each

a, i is a Drift in Stone set out of the Shaft at 3½ Fathoms below the Main Band, and continued to the dip ‘till it met with the Main Band again as at **b** Section No. 3 – All the Coals to the dip of the Endgills – **e a . a f** are hung on at this place, it is called the Main Band Low eye.
The Dykes **e,** and **f** continued till

ZB-24-p-52
52
till they meet shew the field of Coal yet to work in the Main Bd.
Elizabeth Pit is Sunk 19 Fathoms below the Main Band
At 10 Fathoms the first Yard band was met with
& at 15 A very strong feeder of Inflammable Air coming out from the joints of the freestone Strata.
It was conjectured that a Seam of Coal was not far below a borehole was put down 4 fathoms and a 4½ Seam got.
As the Inflammable Air was so strong the Pit was stopped from being sunk any further to give time for it to exhaust itself partly. The Pit has been stopped about half a Year but there is not much difference in the Strength of the Inflammable Air.

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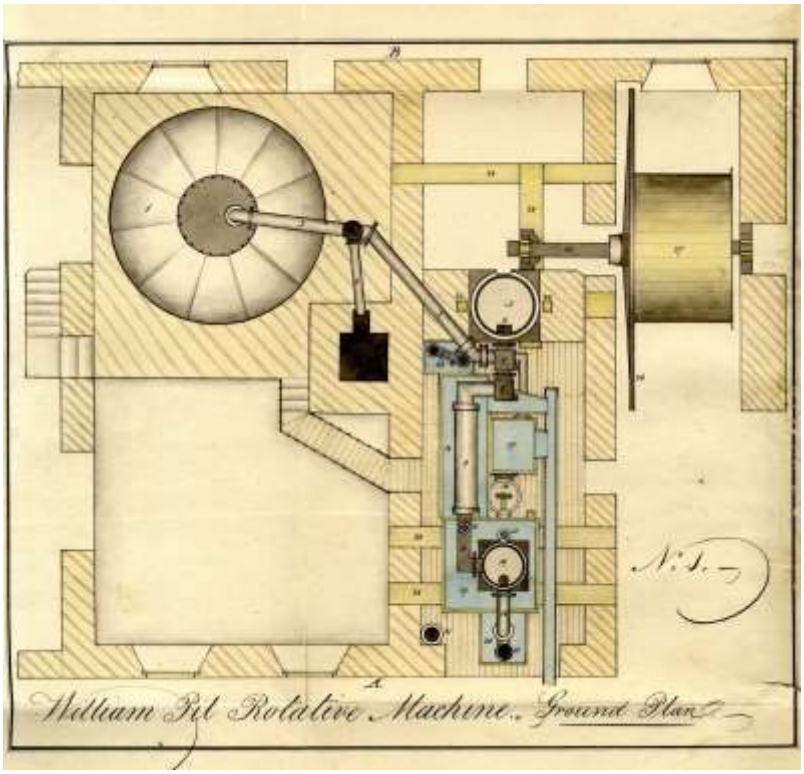
ZB-24-p-64



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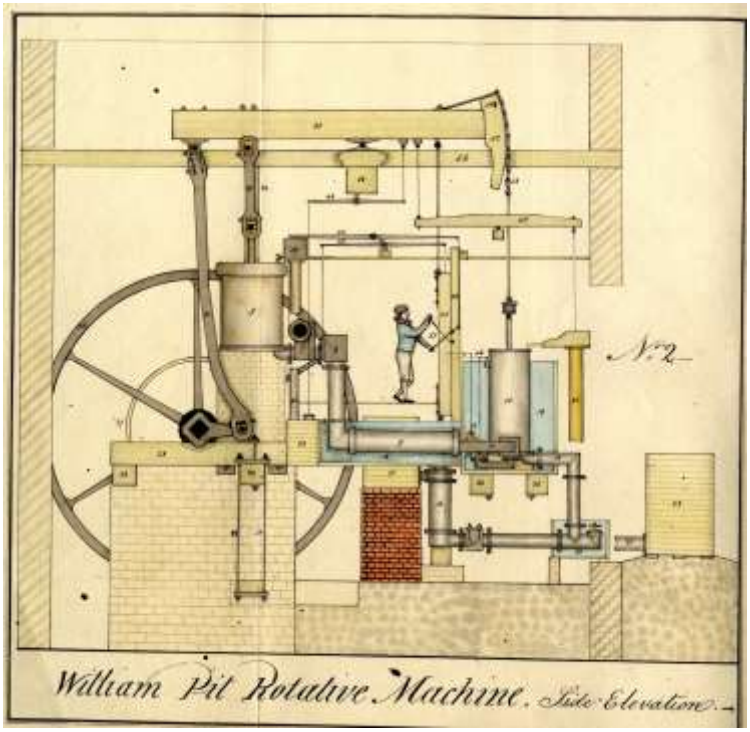
ZB-24-p-66



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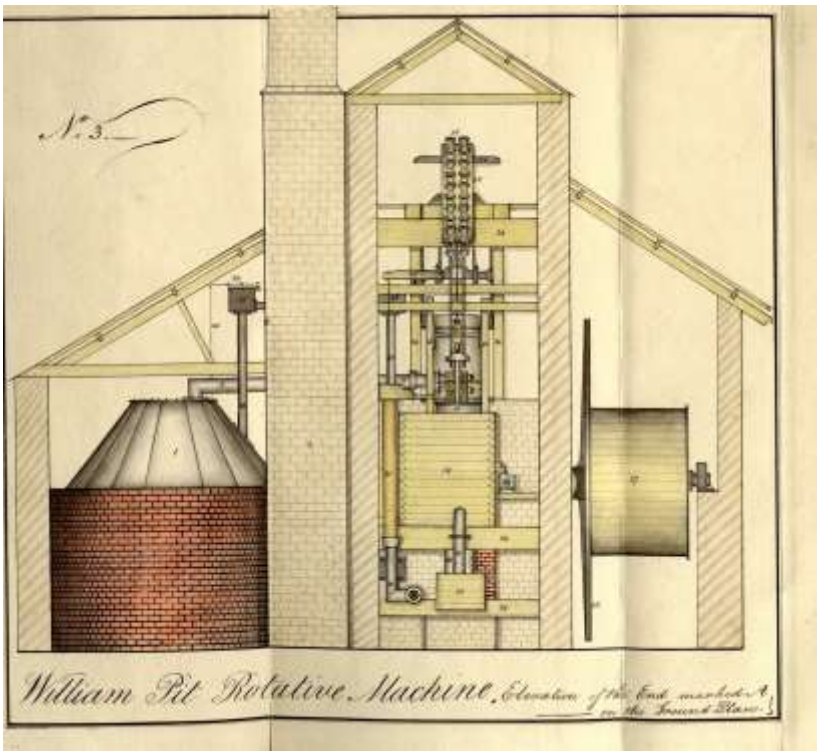
ZB-24-p-68



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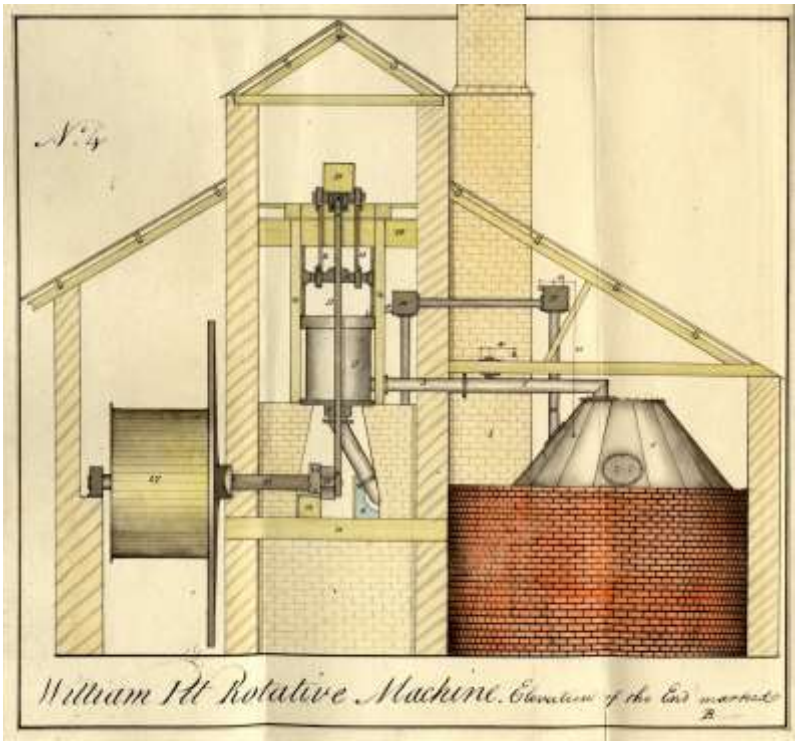
ZB-24-p-70



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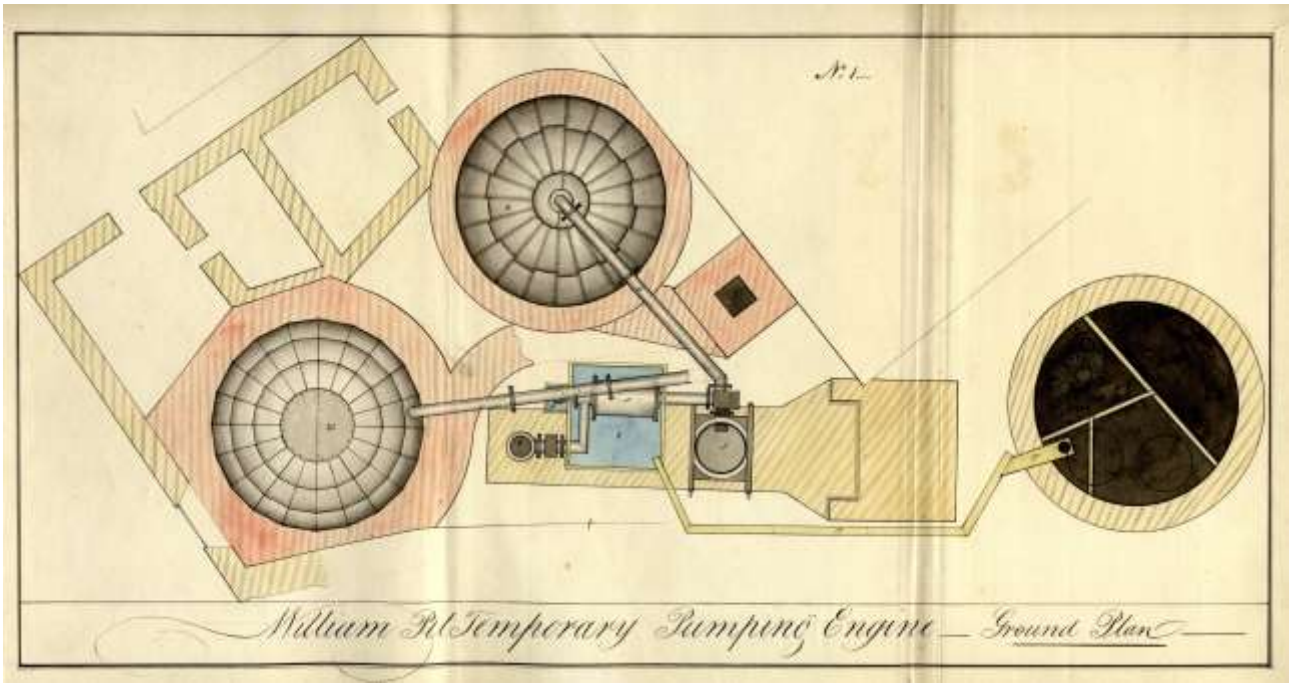
ZB-24-p-72



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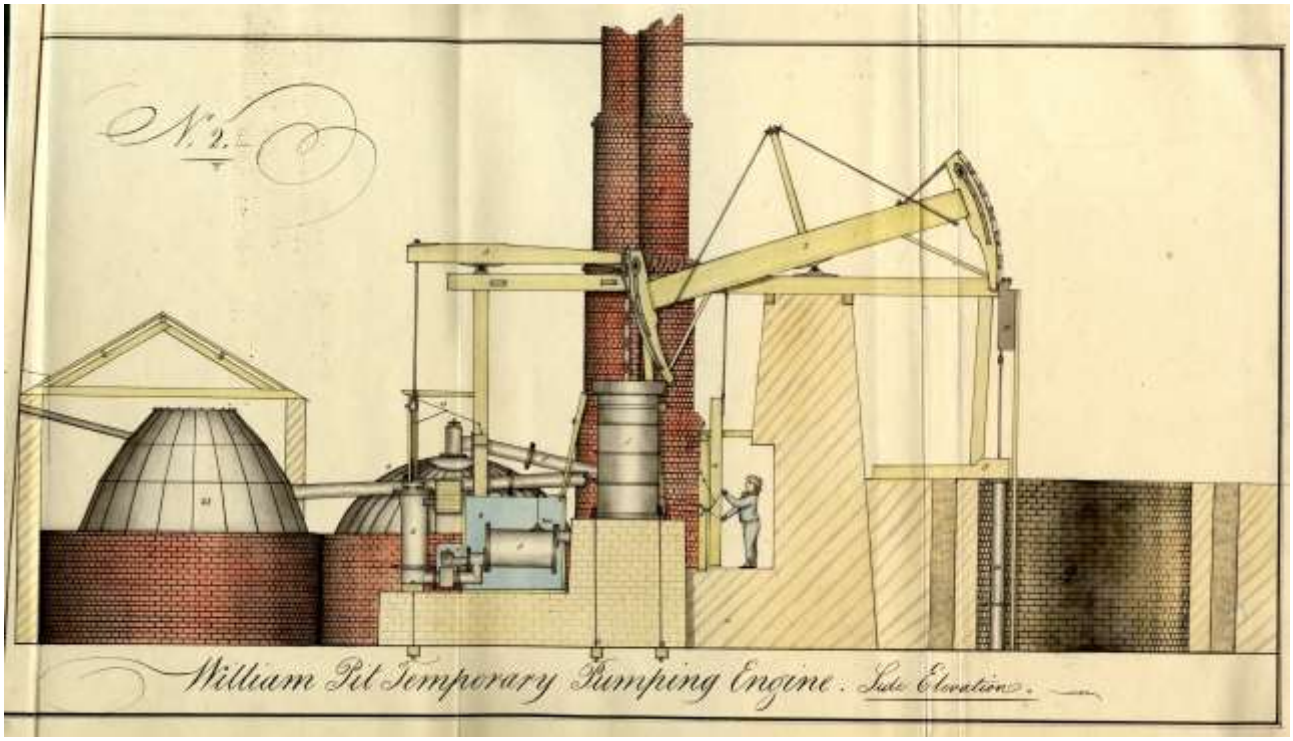
ZB-24-p-74



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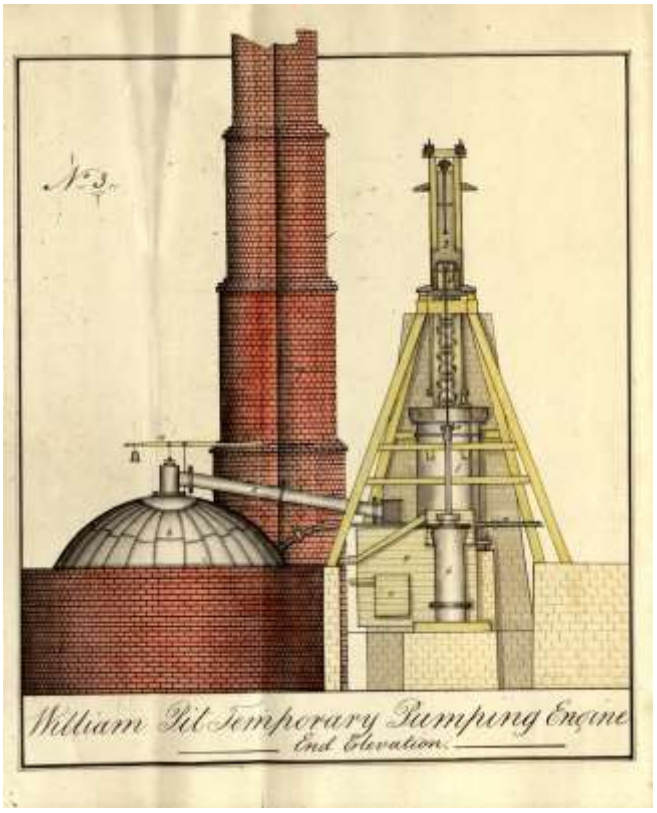

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ZB-24-p-79

79

Steam Engines These Machines [last two words inserted later in pencil] act either by the force of the Temporary Elastic Vapour of Water or Steam, or by the Pressure of the Atmosphere.
Steam Engines having Steam as a first mover are brought to great perfection by Mr. James Watts and other Engineers adopting his principle while those Engines that act by the pressure of the atmosphere, were 'till of late left unimproved, no one thinking them worthy of attention. The following rotative Machine and pumping Engine are the greatest attempts to carry this Principle to any degree of perfection.

When Water is heated to a great degree it passes into an Elastic Vapour or Steam. This Vapour preserves its elasticity as long as it is kept at the temperature that it passed from Water into Vapour, but if it be cooled below that temperature it resumes its former state, of Water. - It is therefore called a Temporary Elastic Vapour.
When it is generated at 212° of Fahrenheits Thermometer it is about 800 [question mark inserted in pencil here] times as rare as Water. Steam then from one Cubic Inch of water will occupy a Space of

ZB-24-p-80-81

80

Of 800 Cubic Inches, (?) [question mark in brackets inserted later] if this was included in a Vessel and a jet of Cold Water introduced into it the steam would instantly be condensed and a partial Vacuum made.
In one of the Atmospheric Engines Steam is made to fill the Cylinder. It is then condensed and a vacuum made under the Piston. The Air then acts by its pressure upon the Piston with a power nearly equal to 15lb upon every square Inch, and forces it down to the bottom of the Cylinder.
In pumping Engines, or others requiring power only at one part of the Stroke One Cylinder is used, but in a complete double powered Atmospheric Engine two Cylinders are used, one at each end of the regulator Beam and the air acts upon their Pistons alternately.
William Pit Rotative Machine is a Double Powered Atmospheric -
1. The boiler is 13 feet Diameter, and 10 feet high.
2 The Chimney, 3 feet square within, 7 feet without, and 62 feet high.
[NB. From this point to the end of P87, numbers struck through thus ~~55~~ are an attempt to render the handwritten hashtags over the originals. Also many crossings out and insertions in these pages.]
3 ~~3~~ The Steam Pipe from the Boiler to the

81

Steam Cylinder.
4 ~~4~~ The Safety Valve and pipe for letting the Overplus Steam from the boiler into the Chimney.
5 The Steam Cylinder 44 Inches Diameter. The stroke of the Piston 3F 8I.
6. The branch pipe between the Cylinder bottom and the Nozzles.
7. The Steam Nozzle connected with the Branch Pipe to the Cylinder at its lower end, and the Steam Pipe ~~3 3~~ at its upper end. There is a Brass Valve fixed in the Nozzle about half way between those Pipes.
8 The Exhausting Nozzle with a Value of the same dimentions [sic] as the others fixed at the lower end.
9 The Condenser, it is 6 feet long and 16 Inches Diameter. It is immersed in a Cistern of Cold Water.
10 The Cold Cylinder 28½ Inches Diameter, The Stroke of the Piston 4F 9I long. This Cylinder is immersed in a Cistern full of Cold Water & there is always a Vacuum under its Piston.

11 The Communication pipe between the

ZB-24-p-82-83
82
Condenser and Cold Cylinder.
12 and 13, The Injection Valves, thro' the first the water jets horizontally into the Condenser **g** and thro' the other perpendicularly into the Cylinder ~~10~~.
14 The Eduction Pipe from the bottom of the Cylinder ~~10~~. It conveys the injected Water and Air to the foot of the Air pump ~~16~~
15 The blow Valve.
16 The Air pump 18 Inches Diamr. having a Stroke of 2F 9I. The Air pump draws the Hot water and Air out of the Condensors [illegible symbol] and maintains a more [last word inserted later] Completer [sic] Vaccuum [sic] than could be done without it.
17 The delivery Cistern of the Airpump. The hot water that the Airpump delivers is collected into this Cistern, and part of it is lifted by the Pump ~~23~~ to supply the Boiler ~~1~~, and the rest is conveyed away by the troughs ~~29~~ -
18 The Cistern the Condensor is immersed in
19 The Great Cistern that holds the Cold Cylinder ~~10 & c~~
20 A Cistern that holds water to cover the blow Valve ~~15~~. -
21 The Cold Water pump 7 Inches Diamr. having a

83
A 2½ feet Stroke. It draws water from the one [word inserted later] Cistern ~~22~~ into the other [word inserted later] Cistern ~~19~~
22 The Cistern communicating with the Reservoir by means of Iron pipes – it is always full of water.
23. A Little Cistern having a pump 4Ins. Diam. and 12 Inches Stroke. It draws water to feed the Boiler. The Cistern has its supply from the delivery Cistern of the Airpump by means of a pipe laying between them.
24, ~~24~~ Two strong pieces of Wood standing upright to which are fixed two Iron guides for preserving the Piston Rod perpendicular.
25 & 26 the Fly Wheel [word inserted later] 20 feet Diameter.
27 the Ropebarrel wedged upon the fly Wheel [word inserted later] shaft ~~25~~. It is 9 feet in Diameter and 6 feet broad.
28 ~~28 &c~~ Strong pieces of Wood wedged in the Walls to support the Work.
29 – The Trough that conveys the hot water back to the Reservoir.

~~Section No. 4~~
30. The Regulator beam, 20 feet long, and 20 by 21 Inches square.-
31 The strong Cast Iron connecting Rod fastened to the Regulator beam at the high end by means of a joint, and at the low end to the Crank.-
32 The Crank 2 [ft?] 9 [ins?] Long. -
33 Parrallel [sic] Links
[no item 34]
35 ~~35~~ The boiler Pump and Cistern

ZB-24-p-84-85
84
36 The Piston Pipe having a Cock at its end to regulate the feed of Water upon the Piston
37, 38 The Boiler feed pipe and Cistern. At the bottom of the Cistern ~~37~~ there is a valve fixed, and worked by a small Iron beam ~~39~~ To the other end of this Iron beam there is a strong Wire ~~40~~ fixed. This Wire goes thro' the boiler top and has a bouy [sic – buoy?] fixed to its lower end. When the Surface of the Water in the boiler is of a proper height the Valve at the bottom of the Cistern ~~37~~ is

shut, but when it is lowered by the evaporation of the Water the bouy floating on its surface is lowered too, it therefore lifts that end of the Beam ~~39~~ to which the valve is hung and by raising the Valve permits the Water out of the Cistern ~~37~~ to descend down into the Boiler until the surface of the Water be so high as again to shut the Valve by raising the bouy.
[No 40]
41 The Iron beam fixed to the Safety Valve that regulates the strength of the Steam.
~~Section No. 2~~
42 The Plug Frame that hangs by a strong Iron Rod to the Regulator Beam ~~30~~. It works the airpump ~~16~~ and the Hand Geer [sic] ~~55~~.
43 Uprights to which guides are fixed to cause the plug frame to work perpendicular.
44 & 45 Two Iron beams connected with the Hand geer ~~55~~

85
To open and shut the Valves in the Nozzles ~~7 & 8~~ -
46 Two beams that open and shut the Injection Valves ~~13 & 12~~
47 The Cold Water Pump Beam
48 The Boiler Pump beam
49 and 50 Two strong Screw Bolts to screw the Beams firmly to the Stone works
51 The Airpump [illegible word] Nozle [sic] wherein is fixed the lower Valve of the Airpump.
52 The Arch head upon the Regulator Beam ~~30~~ Is to keep the Piston Rod of the Cylinder ~~10~~ allways [sic] Perpendicular
53 The Chains that connect the regulator Beam ~~30~~ with the Piston Rod of the Cylinder ~~10~~
54 The Catch Pin. It goes thro' the head of the beam and its ends project out as is shewn by Figre. 3rd. When the Engine makes by accident a longer stroke than usual, it rests upon the beam ~~56~~ before the Piston can touch the bottom of the Cylinder, and by that means prevents its breaking the Cylinder bottom

ZB-24-p-86-87
86
The Boiler being half filled with Water a strong fire is made on underneath it. After the Water is heated to the boiling point, Those particles at the bottom and sides of the boiler begin to evapourate [sic], rise thro' the Water in the State of a Vapour and throw it into a Violent adgitation [sic] in other words, the heat at the bottom and sides of the Vessel removes the particles of the Water to a greater distance and diminishes their Cohesive power. In this State they rise thro' the Water. When a sufficient quantity of Vapour or Steam is collected and the Engine is to be set forward The Steam Valve ~~7~~ and Exhaustion Valve ~~8~~ are opened, the Steam from the Boiler enters and fills the Cylinders ~~5 & 10~~ , the Condensor ~~9~~, and the Eduction Pipe ~~14~~, and expells [sic] the the [sic] air out at the Blow Valve ~~15~~. Then the Valve ~~7~~ is shut and jets of Cold water enter at the other Valves ~~12 and 13~~, and Condence [sic] the the [sic] Steam in the Condensors [sic] and Cylinders. By which means a Vaccuum [sic] is made in the Condensor and under the Piston of one Cylinder ~~10~~, the atmosphere acts by its pressure on that Piston; while at the same time ~~the~~ one Valve ~~8~~ being shut, and the Steam Valve ~~7~~ opened, the Steam on the Underside of the Piston of the other Cylinder ~~5~~, counteracts the pressure of the atmosphere on its upper side, and the power of the first Cylinder 10,

87
~~10~~ causes that end of the regulator Beam ~~30~~ to descend and moves the Crank and ropebarrel one half of a Revolution. The Steam (~~32~~) which was open (27) [highlighted section inserted and crossed out] Valve ~~7~~ is then shut and ~~8~~ the Valve which was shut, [highlighted section inserted and crossed out] opened, the jets of Cold water continuing to flow into the Pipes, the Steam in the Cylinders and Pipes is condensed, so that the air acts by its pressure on both the Cylinders ~~5 and 10~~, but one Cylinder ~~5~~ being double the power of the other Cylinder ~~10~~ overcomes its resistance and raises the Basket by moving the Crank ~~32~~ and Ropebarrel ~~27~~ the other half of the revolution. Again

the Valves are reversed, the atmosphere acts on the underside of the Piston of the Cylinder ~~5~~. - And so the Motion is repeated.
It takes this Engine 20 Strokes, which is 20 Revolutions of the Ropebarrel to raise a Basket (Wt.* 1700Lbs) 95 Fathoms, or the Depth of William Pit.
This the Engine has performed in 40 Seconds, and its common rate of doing it is 45 Seconds or about 12 Feet pr. Second.
*Rope and Basket

ZB-24-p-88-89
88
William Pit Temporary Pumping Engine. This is a Single Atmospheric Engine.
No. 1 – The Cylinder, open top'd [sic – topped?], 44 Inches Diameter with a 7 feet Stroke.
2 – The Regulator Beam.
3 – The Airpump Beam
4 – The Boiler 15 feet Diameter
5 – The Condensor
6 – The Airpump – 18 Inches Diameter and a 3½ feet Stroke
7 – The Engine Chimney 32 feet high
8 – The Condensing Cistern
9 – The blow Valve Cistern
10 ~~10~~ – The pipe from the pond to supply the boiler with Water
11 – The Steam Pipe from the Boiler to the Cylinder
12 – The Blow Valve
13 – The Airpump Parallel Motion
14 – The Plug frame
15 – The [illegible word]
16 – The Top Set Pumps
17 – The Launderbox and troughs
18 ~~18~~ The Deadman and hanks to hold down the Cylinder.
19 – The Lever and Weight for loading the safety Valve.
20 – ~~(see Plan No. 1)~~ The Great Engine Pumps
21 – The Present working Pit
22 – The Second – Do. after the Temporary Pumps are taken out.
23 – A Spare Boiler

89
When this Engine is to be set forward, The Steam and Exhaustion Valves are opened. The Steam from the Boiler fills the Cylinder ~~1~~ (the Piston being at the top of its Stroke) the Condensor ~~5~~, and Airpump ~~6~~, and expells [sic] the Air out at the blow Valve ~~12~~. The Steam Valve is shut the injection Valve opened (~~see Plan No. 2~~) and the Cold Water from the (24) [this number in brackets inserted above the line] Cistern ~~8~~ condences [sic] the Steam; the Air then acts upon the Piston of the Cylinder ~~1~~ , and forces it to the bottom of the Cylinder. This part of the Stroke lifts the Water out at the top of the Pumps ~~16~~ .
The Exhaustion Valve is then shut and the Steam Valve opened, the Steam then enters under the Piston of the Cylinder ~~1~~ and counteracts the Pressure of the Atmosphere, while the Weight of the [illegible word] ~~15~~ and Wood Rods in the Pumps raise the inner end of the Regulator Beam ~~2~~ and depress their own end. Again the Steam Valve is shut and the Exhaustion Valve opened, the Steam from under the Piston of the Cylinder ~~1~~ rushes into the Condensor and is condensed and the Air again forces the Piston to the bottom of the Cylinder lifting more Water out at the top of the Pumps ~~16~~.
The Cylinder being 44 Ins. Diameter, and reckoning the Pressure of the Air at 10lb upon every Square Inch, will lift a Column of Water equal to 6 Ton 15 Cwt. -

SEE NOTE [last phrase entered in pencil later]

[ZB-24-p-90-99 - blank pages]

ZB-24-p-100 LH

ZB-24-p-100 RH

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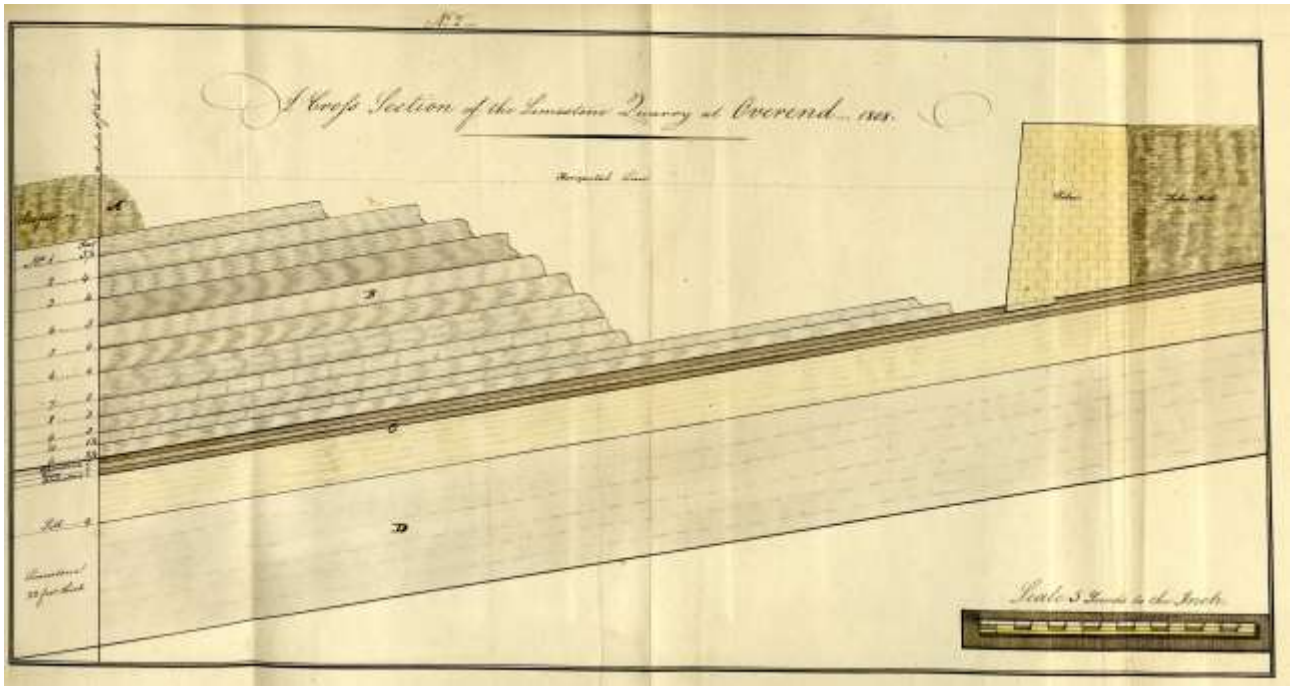
ZB-24-p-102



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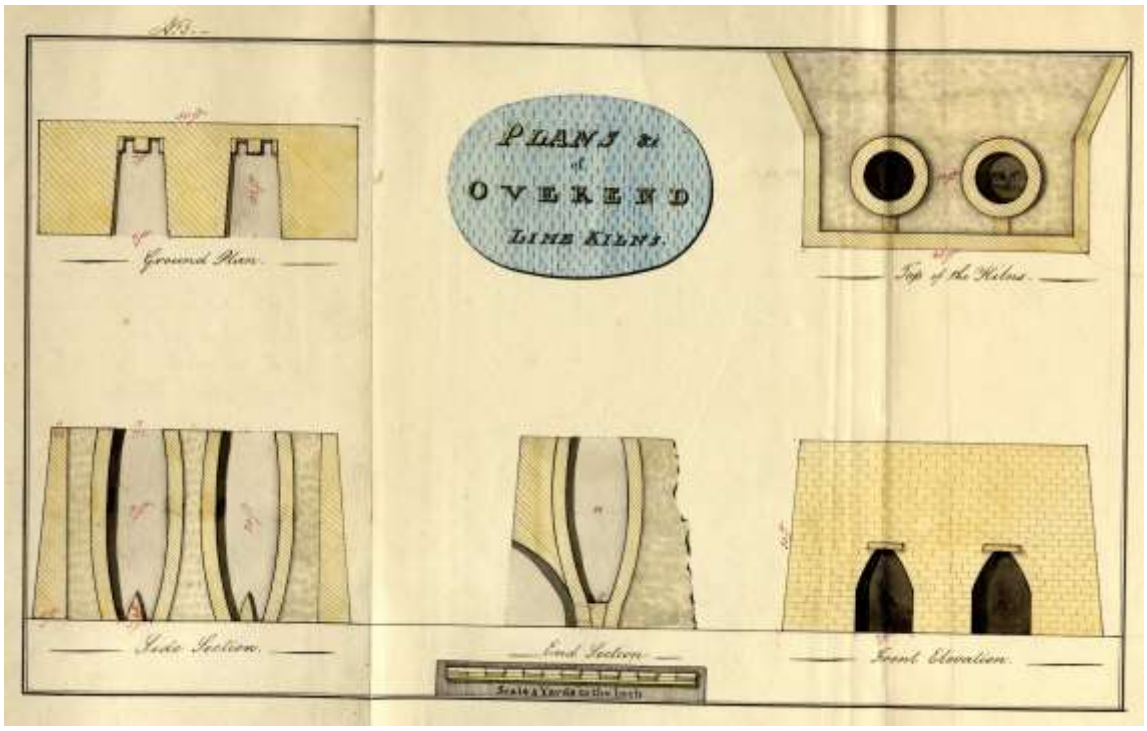
ZB-24-p-104



[ZB 24-p105 to p108 – blank pages]

ZB-24-p-109
109
Overend Limestone Quarry
Reference to the Plan of the Quarry No. 1 -
A The present working Quarry 39½ high [no measurement specified] of Limestone
B The low Quarry now working supposed to be the same as D.
C An old Quarry filled with Water, wrought by Mr. Walker.
D A Quarry worked by Mr. Burn it is supposed to be the outburst of the Lower beds of Limestone 22 feet high which lays under the higher beds of Limestone Whin and Silt. (see plan No. 2 [brackets not closed]
a, b A Water course to drain the quarry of its water
c The Coal bill [?] where the Coals are stored in Winter
No. 1 to 12 are boreholes to ascertain the height of the Mould [?] &c above the Limestone
The depth of No. 1 is 11 feet to the Limestone

2… 15… to a bed of freestone
4… 1 10 to Do.
5… 1 6 to Do.
6… 3… to the Limestone
7… 16… to a bed of Gravel
8… 6 9 to the Limestone
9… 8 Do.
10… 11 Do.
11… 14 to a freestone and bored in at 11½ feet
12… 11½ to the Limestone

ZB-24-p-110-111
110
Reference to the section of the Limestone Quarry – Plan No. 2 -
A – Is the Mould above the Limestone 11 feet thick. It is led in carts off the Limestone during the Winter Season.
B The Limestone beds at present quarrying they are about 39½ feet thick.
D another bed of Limestone having between it & the upper beds 12 feet of Sill, Clay, and Whin.

-This section, is from the Kilns No. 7 & 8 in a line with the Dip of the Quarry which is to the N.Wt. 1 Yard in 4.

111
One Kiln of the dimentions [sic] stated in Plan No. 3 will hold 300 Bushels of Lime exclusive of Coals and when set on fire will burn 8 Days or a fortnight before any Lime can be drawn. In burning the Limestones thrown in on a Monday morning will be drawn out on Wednesday morning. One Kiln burned about 120 Bushels a day. In burning the Lowest Layer of Coals is never below **a** (see the End sections) so that the Lime cools in passing from **a** downwards and will come sufficiently cool if not more than 120 Bushels be drawn in a day. The quick cooling of the Lime is owing to a vast quantity of Air passing thro' it to the fire above. From **a** upwards there is a continuation of Layers of Coals and Stones to the top of the Kiln: and when they are one foot below the Kiln top the Burner keeps adding more of each alternately.
The Weight of a Cumberland Bushel of Limestone is 22 Stones, but when burned a Bushel will weigh only 14 Stones which is a Loss of 36 Stones for every 100. This is owing to the disengagement of the fixed Air or Carbonic acid
Gass [sic]

Gass from the Limestone during the time it passes thro' the fire. But if the burned Lime be left laying upon the Ground in a fortnight it will have acquired the weight it was before passing thro' the fire. This is owing to its absorbing a quantity of Carbonic Acid Gass from the atmosphere. This property of the Lime has been made useful by the German Miners who carried it into their Mines in large quantities to rid them of the fixed Air. - But this method is now superceeded [sic] by better ventillation [sic] of the Mines.