REMARKS ON THE POINTS OF INTEREST AT THE SKELTON PARK AND LUMPSEY MINES, ON THE OCCASION OF THE VISIT OF THE INSTITUTE, SEPTEMBER 16TH, 1881.

By A. L. STEAVENSON.

At the first or Skelton Park Mine especially noticeable is the system of mechanical drilling of the shot holes, and the haulage by endless rope on the underground main roads—in both cases by compressed air.

The air compressor, which is placed on the surface, has air and steam cylinders, both of 22 inches diameter and 6 feet stroke. The air, usually compressed to 45 or 50 lbs. per square inch, is taken down the shaft 60 fathoms, and 450 yards in-bye, in 9-inch pipes and distributed, by smaller ones, to three districts, in each of which there is a drilling machine to every eight or nine working places.

The total cubic capacity of the receiver and pipes is at present 2,041 feet, and the displacement of the air cylinder 31·2 cubic feet per revolution.

As the use of compressed air has never hitherto gone much beyond the mere description of machinery in the Transactions, it may be well to look into the practical and theoretical considerations which are incident to its use.

Notwithstanding that the engineers on the Continent have for many years recognised the great loss of useful effect which follows compression without adequate cooling appliances in the shape of jets of water spray, such as are here applied in the cylinder, few English compressors will be found having anything better than the ordinary water bath ; so serious is this that at 75 lbs. effective pressure the excess of work to be developed amounts to 25 per cent., and even at the more usual pressure of 45 lbs. per square inch it equals very nearly 20 per cent. To remedy this, all that is required is to inject into the cylinder about 1 gallon of water per 100 cubic feet of air compressed. The temperature due to this pressure is about 350 degrees Fahrenheit, but by the spray it is maintained steadily at not more than 80 degrees.

Still, when these matters are carefully attended to, compressed air, if used without expansion, leads to a great loss of power. The work given out soon reaches a limit which cannot be exceeded, whatever may be the pressure of the air or the energy expended.

The great error made in using high pressure where it can possibly be avoided, was clearly shown some time ago by Mons. Trasenter, of Liége. He puts it this way :—

"The maximum of work given out (increasing the compression indefinitely and without taking into consideration the elevation of temperature due to this compression) cannot exceed the energy given out by the volume of air acted on by the piston of the blowing cylinder, working with an effective pressure of one atmosphere. This law is easily demonstrated—

Let p = the pressure of the atmosphere—10,333 kilograms per square mètre.

P = do. do. compressed air.

V and v = their corresponding volumes.

Then $P = n\,p$, or $V = n\,v$.

The work which this air is able to give out theoretically is

$$(P - p)\,v = P\,v - p\,v$$

and, as $P\,v = p\,V$, it follows that

$$P\,v - p\,v = p\,(V - v) = p\,V\,(1 - \tfrac{1}{n}).$$

Therefore, a cubic mètre of air compressed to no matter what pressure can only give out a power equal to

$$p \times 1 \text{ or } 10{,}333 \text{ kilogrammètres}$$

when $\frac{1}{n} = O$, or when n is infinite, whilst the same cube compressed only to two atmospheres gives out

$$T = 10{,}333\ (1 = \tfrac{1}{2}) = 10{,}333 \times \tfrac{1}{2} \text{ kilogrammètres.}$$

The quantity of power which a cubic metre of air compressed to a million atmospheres is capable of yielding, without taking the rise of temperature into consideration, can never become double that which the same quantity of air compressed to two atmospheres is capable of yielding.

Air compressed to four atmospheres will give out a power proportional to $(1 - \frac{1}{4})$ or $\frac{3}{4}$, whereas to obtain a power equal to 1, a compression infinitely great is necessary.

In another form the work given out may be expressed by the following logarithmic formula—

$$T = p\,V \text{ log. } nap,\ n\ —$$

that is to say that it increases as the powers of n.

The following formula then expresses the ratio of the work done to the power expended—

$$E - \frac{p\,V\,(1 - \frac{1}{n})}{p\,V\,2{\cdot}303 \text{ log. } n} = \frac{1 - \frac{1}{n}}{2{\cdot}303 \text{ log. } n}$$

by writing n^x instead of n we obtain

$$E = \frac{1 - \frac{1}{n^x}}{2{\cdot}303\ x \text{ log. } n}$$

The power expended increases as the powers of n while the work done can never attain unity, but may be represented by an asymtotic curve, or hyperbola.

By giving to x values ranging from 1 to 6, and to n the value 2, it will be found that—

$E = 0{\cdot}72$	for 2	atmospheres	when	$x = 1$
0·54	„ 4	„	„	$x = 2$
0·42	„ 8	„	„	$x = 3$
0·34	„ 16	„	„	$x = 4$
0·28	„ 32	„	„	$x = 5$
0·23	„ 64	„	„	$x = 6$

As a matter of engineering interest it may be mentioned that at present, in order to conduct the air from the compressor down the shaft to the hauling engine and drills in three different districts, there are—

1,101 yards of	... ...	9 inch pipes.
640 „	... ...	6 „
700 „	... ...	2 „
670 „	... ...	$1\frac{1}{4}$ „

And to test the amount of leakage, when the pressure is raised to 55 lbs., it falls back

1 atmosphere in	... ...	50 minutes.
2 „ „	... ...	2 hours 6 „
3 „ „	... ...	3 „ 35 „
$3\frac{3}{4}$ or total pressure	... ...	6 „

This seems a great loss, but with such a large number of small pipes and having above 1,000 joints, such a drawback to the system seems inevitable, and can be only met by frequent tests and strict attention to details.

MECHANICAL DRILLING.

The ordinary mode in Cleveland is by hand drilling, holes varying from 3 to 5 feet in depth, triangular in form, and $1\frac{1}{2}$ inches on each side. A good man can drill 6 feet per hour, but not continuously throughout his shift.

From statistics the writer got when preparing some evidence, he found that 29 hand-drilled holes were equal to 94 feet in length, that they were charged with 684 ounces of powder, which occupied 33 feet, the stemming filling up the remainder—roughly, the powder equals $\frac{1}{3}$ of the length of the hole, which is equal to $20\frac{3}{4}$ ounces of powder per foot or 7·27 ounces per foot drilled.

Then, as other statistics show, each ton of ironstone requires 6 ounces of powder, $\frac{684}{6} = 114$ tons of stone; 94 feet of hole $= 114$ tons or 1·21 tons per foot drilled.

A miner averages $5\frac{1}{2}$ tons of stone per day, which gives 4·55 feet drilled per man per day; this latter amount of 6 ounces per ton of ironstone is the average of the district, but in this mine it is nearly 8 ounces, making 6 feet of drilling per day per man, the remainder of his work consisting in breaking up the stone and filling it into wagons.

With a view of ascertaining whether any saving could be effected in the amount of labour required by such a large amount of drilling, Messrs. Bell Brothers, after having experimented upon a variety of other drills, eventually adopted those now in use, in the year 1876, which are the invention and patent of Mr. W. Walker, of Saltburn-by-the-Sea. They were designed solely for the Cleveland ironstone, and were the first kind of mechanical drills practically and successfully proved to achieve the object sought. They were first used at Staughon Mines, where Mr. Walker worked them himself: Messrs. Bell Brothers commencing to use them afterwards. Messrs. Pease, and Messrs. Bolckow, Vaughan, and Co. afterwards introduced, and have since continued the use of, the percussive machines.

Mr. Walker has recently made some modification in his machines, and has some of the altered designs working at the Boosbeck Mines, where he is getting over 80 tons per shift from one machine. The stone is very hard at this place, and requires as much powder as at the Park, or neighbouring mines.

In Plate XIII., which shows the altered form of the machine, *x x* is a strong bogy, which has a hollow upright *a* attached, of a height suitable to the seam; on each side of this upright is a slot *y y*. Closely fitting this upright are two circular tables *z z*, provided with feathers fitting in the slots or grooves *y y*; these tables are attached to two bars *w*, Fig. 2, provided with two bosses *t t*, in which work the two screws *v v*, sō that when the screws are caused to turn round they move the tables *z z* up or down as may be required; the motion is given to the screws by means of bevelled gearing and the handle *c*, which can be applied to either screw by affixing it either to the spindle *r* or *s*.

Above the tables *z z* are two wrought iron frames *b b*, which also embrace the upright *a*, so that they can be moved round in any direction, and are secured to *z z* by means of the bolts and hooks *m m*; to these frames arms *q q* are attached by the bolts *o o*, and to these again the two drilling machines, by means of the screws *p p* and the clamps *h h*. By these arrangements it will be seen that the drilling machines can be moved up or down, or in any other direction that may be required.

The drilling machine is a very simple and pretty contrivance. It consists of a casting in which are the two air cylinders $5\frac{1}{2}$ inches diameter and $2\frac{1}{2}$ inches stroke at *a b*, which however are not shown, being hidden by the frame; the air is carried to them by the cock *m*. These cylinders work a crank axle *n*, which is geared by means of a pinion into a wheel *f* which drives a sleeve *d*, provided with feathers working in grooves cut in the screwed spindle *i*, in the ratio of 1·75 to 1. The axle is also geared on the other side by means of a pinion and wheel *e* in a ratio of 2·4 to 1; this wheel *e* is attached to a nut which works over the screw *i*, which has four threads to one inch; this nut is kept in its place by the bearing *c*, and either remains stationary or not as the clutch *k* may happen to be disconnected or in gear. When disconnected the nut is stationary, and the drill advances 1 foot for every $4 \times 12 \times 1{\cdot}75 = 84$ revolutions of the engine. When, however, the wheel *e* is in gear, the nut advances in the same direction, and checks the advance of the drill at the rate of $\frac{84}{2{\cdot}4} = 35 \times \frac{1}{4} = 8{\cdot}75$ inches; the difference, 3·25 inches, been the actual advance. When the drill enters the rock, this clutch is put in gear, and is taken out when the drill is withdrawn. The drill *g* is fixed to the driving screw *i* by means of a universal joint, so that it may alter its direction with any difference that may arise in the nature of the rock to impede its progress, *a′ b′* are the exhaust holes, *l* is a wheel which serves as a starting gear, and *k′* is a counterbalance weight.

A machine of this description is now being made for Messrs. Bell Brothers; whilst others are also to be applied by Messrs. Palmer & Co., at the Port Mulgrave and Grinkle Mines.

With a pressure of 40 lbs., holes are drilled at the rate of 2 feet per minute 2 inches in diameter, which allow the powder to get well to the bottom of the hole and they act as efficiently as the triangular holes made by the miners.

Each drill is in charge of one skilled miner who has with him an assistant, and in a shift of 8 hours they put in about 20 holes, averaging from 4 to 5 feet in depth. After they leave the place they are followed by a skilled miner who charges and fires the shots; labourers then break up and fill the ironstone, so that two skilled men do the work usually requiring nine.

Seven or eight working places are set apart for each machine; at the present time three are at work, and as they each work two shifts per day, the total production somewhat exceeds 300 tons.

The tons per hole were found over a long period to average 2·98 and the cost for powder 2·03d. The drill consists of a twisted augur-shaped tool, made from an oval bar of steel specially manufactured for the purpose, the result being such that it is intended to increase the use of them.

At the mines of the other owners previously mentioned, they have adopted drills with a percussion action, such as the Burleigh and Ingersoll, but the nature of the ironstone is such that unless water at a high pressure is injected into the hole it quickly forms a pasty mass which chokes it and stops the operation, so that they have the double trouble and expense of conveying water as well as air throughout the workings.

HAULAGE BY ENDLESS ROPE.

The system of endless rope working has been described in the well-known report on "Underground Haulage" (Volume XVII.)

Its great value consists in the slow continuous movement, in the almost total absence of friction, in the movement of the rope, and in the advantages obtained from any part of the road having a gradient in favour of the load instead of great lengths of the rope being dragged at high speeds varying from 10 to 20 miles per hour over rollers, the whole length and weight is carried by the wagons. Its advantage had been well tested by the writer at Pagebank Colliery, where the rope is carried on the top of the tubs; but in this district the wagons are so heavily loaded that the stone projects 15 inches above them, and it was therefore necessary to design an attachment underneath. This has been very successfully done by means of an arrangement shown in Plates XIV. and XV.

The cylinder of the engine which drives the rope, is only 12 inches diameter by 18 inches stroke, and is connected by bevel gearing to an upright shaft, which carries a 6-foot clip sheave, and this, with an indicated power of 7 horses, is sufficient on a level road to bring out 750 tons per day a distance of 800 yards. Each wagon carries about 35 cwts., and its resistance is about 40 pounds per ton.

The writer acknowledges that compressed air does not afford a high, useful effect; but, in mines, steam engines and boilers are the indirect cause of much greater expense, often coupled with danger.

Plate XIV. shows the self-acting attaching apparatus, which consists of a bent lever *a*, working between a split rail *x;* this lever is keyed on a socket sliding on the shaft *b*, which it turns by means of feathers, on which are also keyed two other levers *c* and *d;* the lever *c* has a roller which lifts the rope when *a* is depressed by the tub running over it when the lever *d* with its roller *e* rubbing against the bevelled upright *l* draws the shaft *b* and the lever *c* with the rope towards the hook *k* into which it falls after the wagon has passed.

When it is decided not to attach the tubs to the ropes the lever *a* can be withdrawn from between the split rail by the handle *g*. In order that the hook *k* may be always in the position to receive the rope a piece of angle iron *h*, working on a pivot *y* and kept in position by a weight and pulley *o w*, is placed in a slanting position between the rails; this catches the hook in whatever position it may be in when the tub comes up and turns it round till it is in the position shown at Fig. 3.

The detaching apparatus, Plate XV., is much more simple, and consists of the lever *a* working between split rails and actuated by the passing tub. This turns the shaft *d*, raises the lever *b*, and lifts the rope out of the hook *k*. During the time a slight divergence made in the line of rail causes the hook to move aside from the rope which then drops when released by the lever *b*.

LUMPSEY SHAFTS.

The number of shafts sunk in the northern districts has been of late years so very small that it was chiefly to give the younger members of this Institution an opportunity of visiting sinking pits that the invitation was offered.

The strata of the district is of course much milder in its character than in the coal-field. Mr. John Marley, in his Paper, Vol. V., page 165, on the "Cleveland Ironstone," gives all the necessary geological description of it; but it is in the porous soft nature of the strata that the great difficulty in sinking pits consists, as so little suitable rock for making crib beds is met with.

The sinking of two 15 feet pits commenced on the 26th April, 1880, and the ironstone, at a depth of 94 fathoms, was reached 3rd November, 1881.

During this time feeders of water, amounting to 1,700 gallons per minute, were passed through, and nearly 60 fathoms of tubbing put in.

As it was always intended to tub off the water, a temporary pumping engine only was erected, consisting of two 24 inch cylinders by 4 feet stroke, geared 3 to 1, with 45 pounds steam pressure.

The pumps, one 20 inch set and one 18 inch set, both worked in the bottom.

1.—At	6 fathoms	3 feet ...	The walling and ring crib ...	Figs. 1 and 2, Plate XVI.
2.— „	16 „	2 „ ...	Single crib, 20″ × 6″, laid but failed to hold the water, 400 gallons per minute	„ 3 „ 4, „
3.— „	27 „	3 „ ...	Single crib, 20″ × 6″, held the water.	„ 3 „ 4, „
4.— „	34 „	3 „ ...	„ „ „ „ proved bad...	„ 3 „ 4, „
5.— „	37 „	0 „ ...	4th double crib laid, this stopped 200 gallons	„ 5 „
6.— „	51 „	5 „ ...	5th double crib laid, 22″ × 6″ and 20″ × 6″	„ 5 „
7.— „	55 „	0 „ ...	6th double crib laid, 22″ × 6″ and 22″ × 6″ ...	5 „ 2 „

Below this the alum shale or upper lias and the jet rock, being of a soft impervious nature, contained no water, but in the lower part much inflammable gas.

The cribbing is shown in detail in Plate XVI. The ring crib, Fig. 1, is about 4 feet $7\frac{1}{8}$ inches across the inner arc, and has a ring or gutter *a* to collect any water that may run down the walls of the shaft; it is $1\frac{1}{2}$ inches thick all over. Figs. 3 and 4 show the three single cribs, Fig. 4 being a section through A B, Fig. 3; these cribs are also $1\frac{1}{2}$ inches thick. The three bottom double cribs are shown in Fig. 5, the top one being 22 inches wide, and the bottom one 20 inches, the plan being the same for all, as shown in Fig. 3. Both the single and the double cribs have escape valves *c*, Figs. 3 and 5, to release the air as it escapes from the back of the tubbing; where the double cribbing is used, the top crib has simply a hole cast in it to allow the projecting part of the bottom to pass through. The tubbing is shown in Plate XVII., Figs. 1 and 2. The tubbing of the first twenty fathoms was made $\frac{3}{4}$ inch thick; the second twenty, $\frac{7}{8}$ inch thick, and the last twenty, 1 inch thick. Every segment of tubbing has a hole x in its centre, fitted with a wooden plug, which can be bored out when it is desired to tap the tubbing.

When a suitable place is found to lay the various cribs, the diameter of the shaft is widened out and the bed carefully levelled all round; the segments are then placed in position on the stone; between each segment a piece of $\frac{1}{2}$ inch deal sheeting is placed, and behind, pieces of deal are carefully packed. As soon as the whole is laid it is wedged tight by driving in wooden wedges both behind and in the joint. The tubbing is wedged in, in a similar manner. Fig. 2, Plate XX., shows how the tubbing is finished off at the bottom where it rests upon the last double crib. The last row but one of tubbing *a* is widened out at its bottom flange, the last row *b* has both top and bottom flanges as wide as the bottom flange of *a*, and in suitable places has pockets cast in it to carry the ends of the wrought girders *a*, Fig. 1, which support the cistern and the whole weight of the pumps which are placed within them. This row of tubbing again rests on the double cribs *c d*.

Dynamite, on account of its efficiency under water, was almost entirely used; in the pumping shaft 2,029 shots were fired and a great number of shifts were worked by sinkers, including all work at the tubbing and pumps.

The mine, when fully opened, is intended to produce 1,500 tons in 8 hours.

The winding engines, built by John Fowler and Co., will consist of a pair of 42 inch cylinders with 6 feet stroke, with a conical drum increasing from 17 feet to 21 feet.

Number of coils on the spiral, 10.

	Tons.	Cwts.
Weight of cage and chains	3	0
Two empty tubs	1	4
Two tubs of ironstone	3	8
Rope from pullies	1	0
Gross load	8	12

Time in drawing, 30 secs.; time in changing, 25 secs. Distance of drum to centre of pit shaft, 115 feet;—and the whole placed upon a concrete pillar, composed of 12 parts of freestone to 1 of cement.

It will be observed that one or two of the cribs failed to hold the water. This was not so much from the character of the stone as from the shaft having been sunk on a fault.

Plate XVIII. shows the general arrangement of the sinking machinery at the surface; *a* is the main jack engine-house used for raising the men, stone, rubbish, &c.; *b* is the pumping engine-house. The engine has two cylinders 24 inches diameter by 4 feet stroke, it is geared 3 to 1, and is worked with steam at 45 lbs. pressure. *c* is the crab engine-house—this engine has two 14 inch cylinders with 2 feet stroke, and they work the crab by means of a screw and worm wheel.

Plate XIX. shows the mode of hanging the sets by means of ground blocks, and tackle *a b*, and Plate XX. shows the mode in which the pumps and cisterns are supported by the tubbing.

The strata passed through is given in the following table :—

LUMPSEY STRATA ACCOUNT.

	Fs.	Ft.	In.		Fs.	Ft.	In.
Soil		4	0				
Gravel	1	5	0	...	2	3	0
Soft yellow friable freestone	1	0	0	...	3	3	0
Yellow freestone	3	0	1	...	6	3	1
Soft blue metal	3	5	0	...	10	2	1
Grey freestone, with a little water ...		5	6	...	11	1	7
Soft blue metal		5	0	...	12	0	7
Small band of coal			6	...	12	1	1
Soft blue metal, with a little water ...	3	1	3	...	15	2	4
Grey freestone, water on the increase ...	3	3	5	...	18	5	9
Dark brown freestone, with water ...		5	8	...	19	5	5
Soft grey shale	1	1	9	...	21	1	2
Freestone, with a little water	3	2	9	...	24	3	11
Soft metal	2	0	6	...	26	4	5
Grey post		3	0	...	27	1	5
Grey shale		1	0	...	27	2	5
Grey shale		4	0	...	28	0	5

	Fs.	Ft.	In.		Fs.	Ft.	In.
Strong grey post, with water		2	0	...	28	2	5
Dark grey shale		4	0	...	29	0	5
Grey post, with shale partings		5	1	...	29	5	6
Soft dark shale, with jet veins	1	1	11	...	31	1	5
Grey post, with water from it	1	3	6	...	32	4	11
Soft blue metal		5	6	...	33	4	5
Grey post, or bastard ironstone		1	3	...	33	5	8
Dark metal		2	0	...	34	1	8
Dark shale		1	0	...	34	2	8
Grey metal	1	3	7	...	36	0	3
Mild grey post, with water		1	8	...	36	1	11
Dark grey metal do.		3	4	...	36	5	3
Mild grey post, shale partings, water, 320 gallons per minute	1	4	6½	...	38	3	9½
*Hard strong grey post, with partings and water	2	0	0	...	40	3	9½
†Grey post	1	3	5½	...	42	1	3
Fine-grained white freestone	2	3	9	...	44	5	0
Grey post, with partings	1	0	6	...	45	5	6
Dark grey metal, with soft grey partings	3	4	5	...	49	3	11
Grey metal, with post girdle, very much convulsed	1	2	0	...	50	5	11
Dark seggar		2	0	...	51	1	11
Dark grey metal	2	5	6	...	54	1	5
Bastard limestone			6	...	54	1	11
Alum shale	8	0	10	...	62	2	9
Shale or dogger rock	14	5	3	...	77	2	0
Jet shale, with dogger balls	6	0	6	...	83	2	6
Strong grey shale		1	8	...	83	4	2
Jet shale, with cement balls	4	2	10	...	88	1	0
Dark grey shale	4	1	6	...	92	2	6
Grey shale, stronger and lighter coloured		2	0	...	92	4	6
Grey shale, darker coloured		5	10	...	93	4	4
Dogger		2	0	...	94	0	4
Ironstone (Main Seam)	1	3	6	...	95	3	10
Black hard		5	6	...	96	3	4
Peelen band...		1	2	...	96	4	6
Dark grey shale	1	0	0	...	97	4	6
Ironstone (Bottom Seam)...		3	0	...	98	1	6
Dark grey shale	2	2	6	...	100	4	0
Gannister			6	...	100	4	6
Strong grey shale		3	6	...	101	2	0

* 360—1,000 gallons per minute.

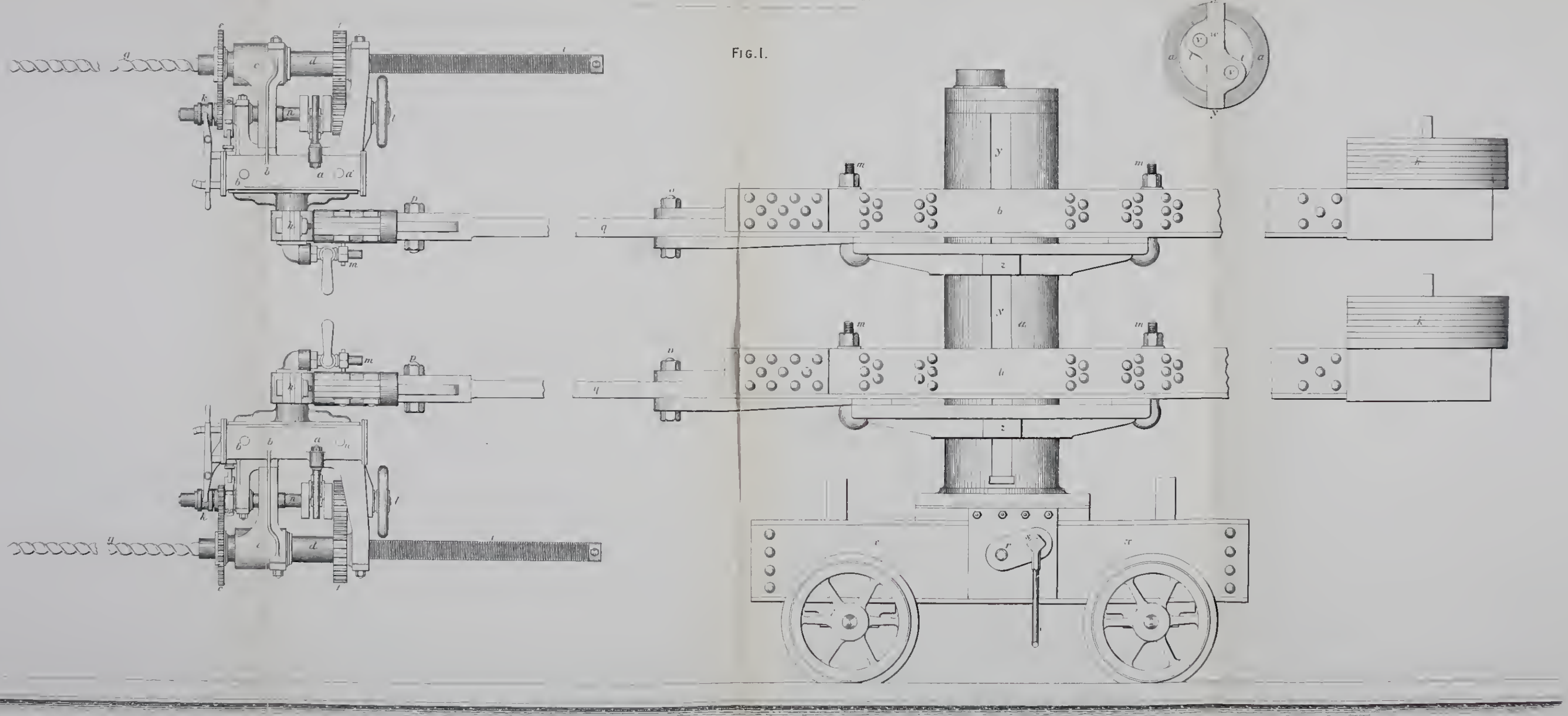
† 1,000—1,500 gallons per minute.

To illustrate Mr. A. L. Steavenson's paper On the Machinery at the Skelton Park and Lumpsey Mines.

Walker's Drilling Machine.

Fig. 1.

Fig. 2.



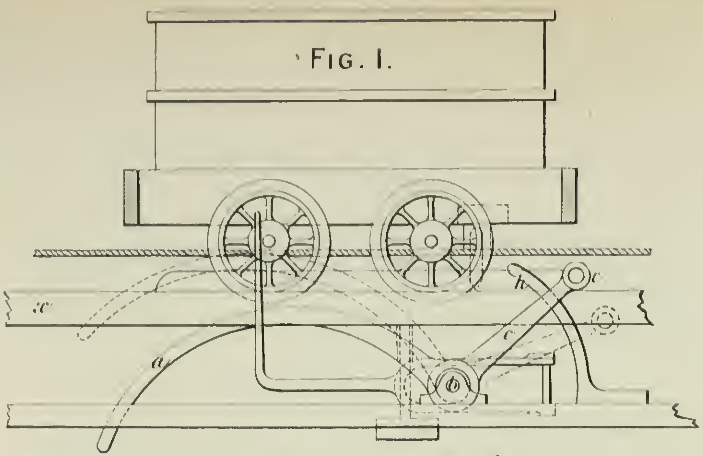


FIG. 1.

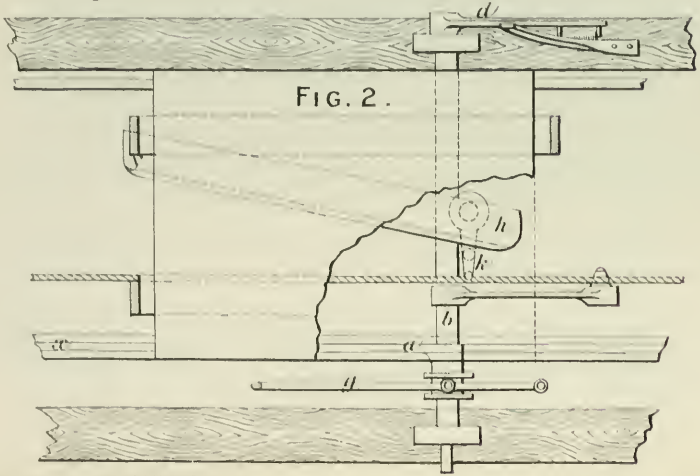


FIG. 2.

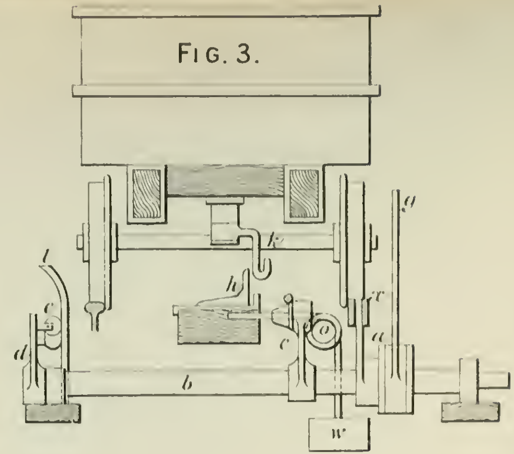


FIG. 3.

ENDLESS ROPE HAULAGE

ATTACHING ARRANGEMENT.

Scale ½ inch 1 foot.

To illustrate Mr. A. L. Steavenson's paper "On the Machinery at the Skelton Park and Lumpsey Mines"

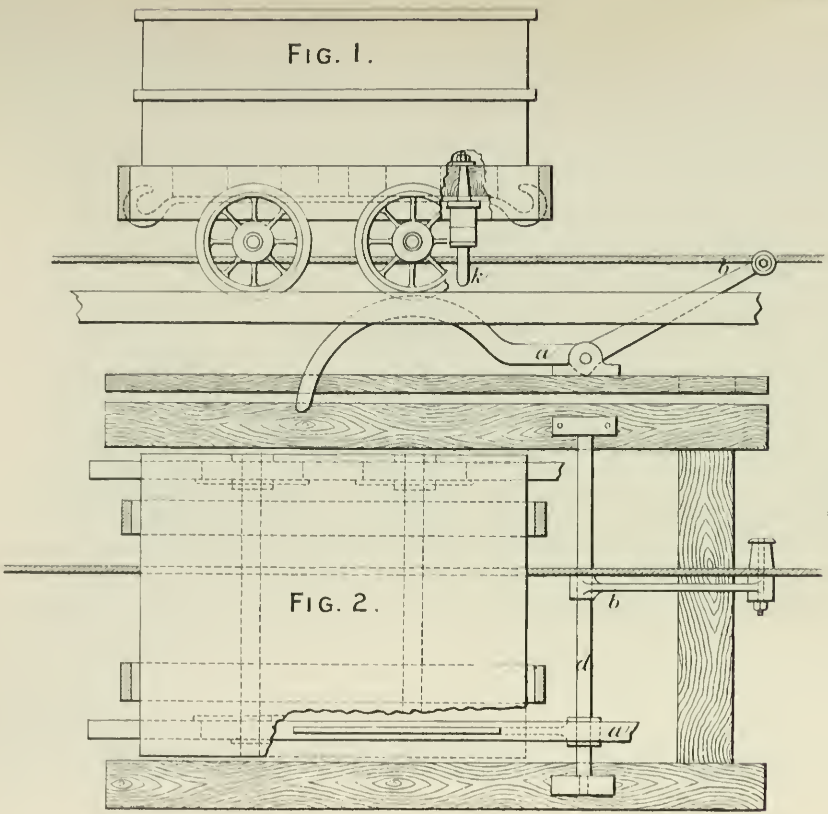


FIG. 1.

FIG. 2.

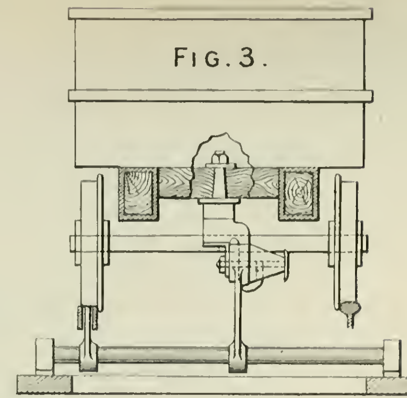


FIG. 3.

ENDLESS ROPE HAULAGE _ DETACHING HOOK.

Scale ½ inch = 1 foot.

To illustrate Mr A. L. Steavenson's paper "On the Machinery at the Skelton Park and Lumpsey Mines."

FIG. 1.

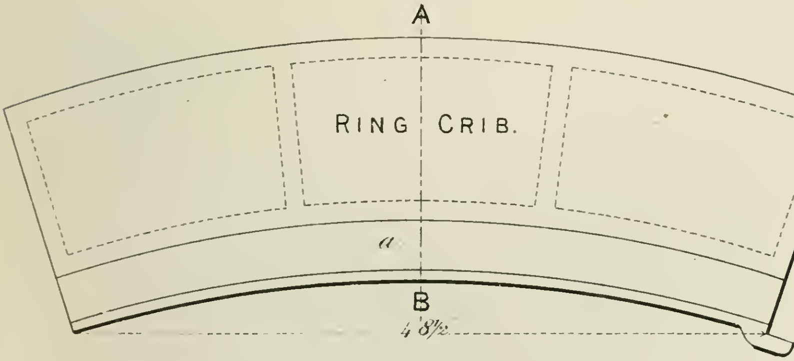
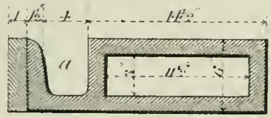


FIG. 2.



SECTION THRO' A.B.

SINGLE CRIB.

FIG. 3.

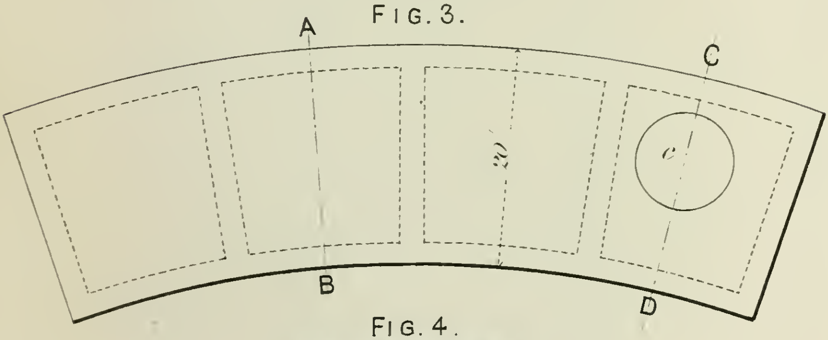
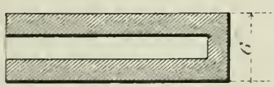
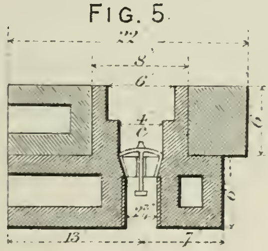


FIG. 4.



DOUBLE CRIB.

FIG. 5.



SECTION THRO' C.D.

To illustrate Mr. A. L. Steavenson's paper "On the Machinery at the Skelton Park and Lumpsey Mines."

TUBBING.

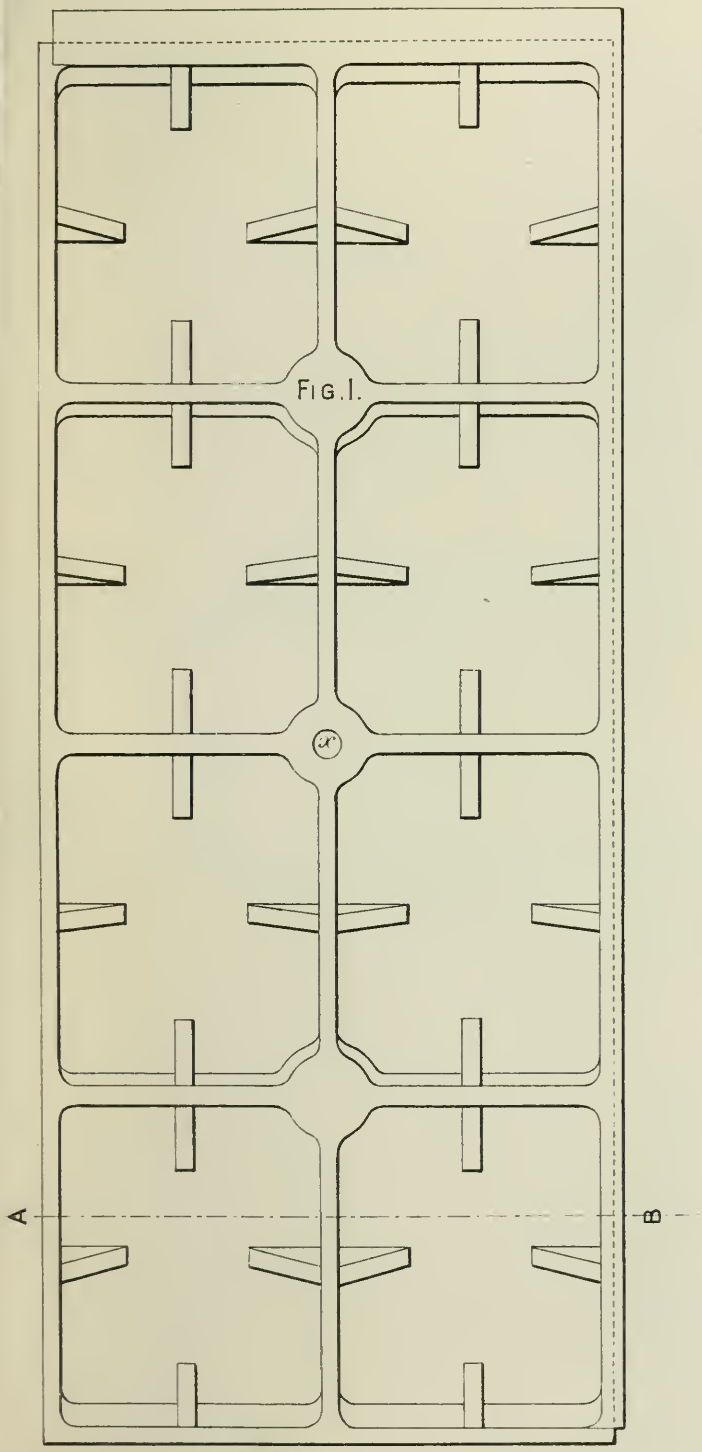
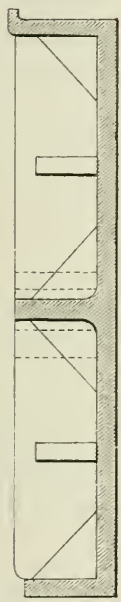


FIG. 1.

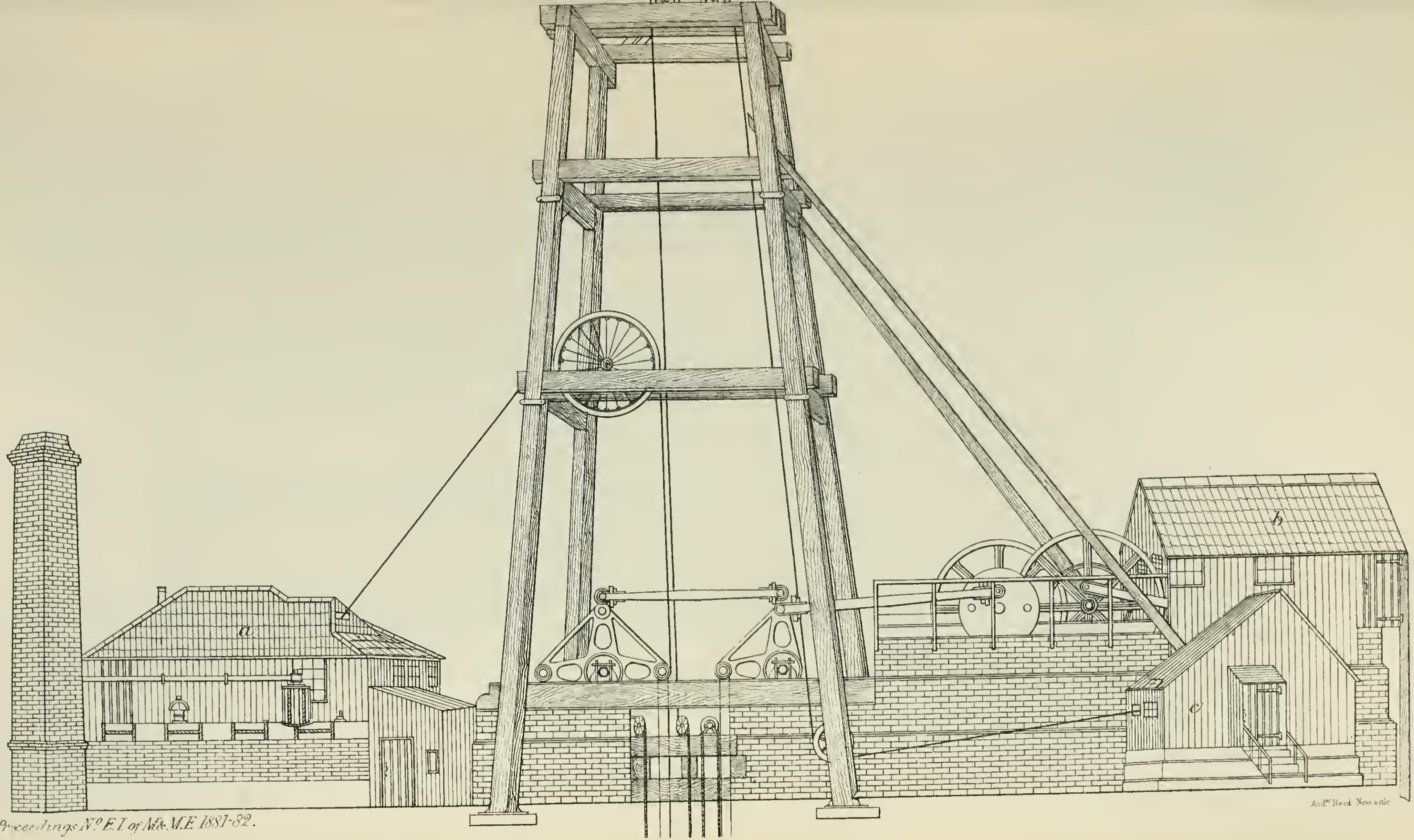
FIG. 2.



SECTION THRO' A. B.

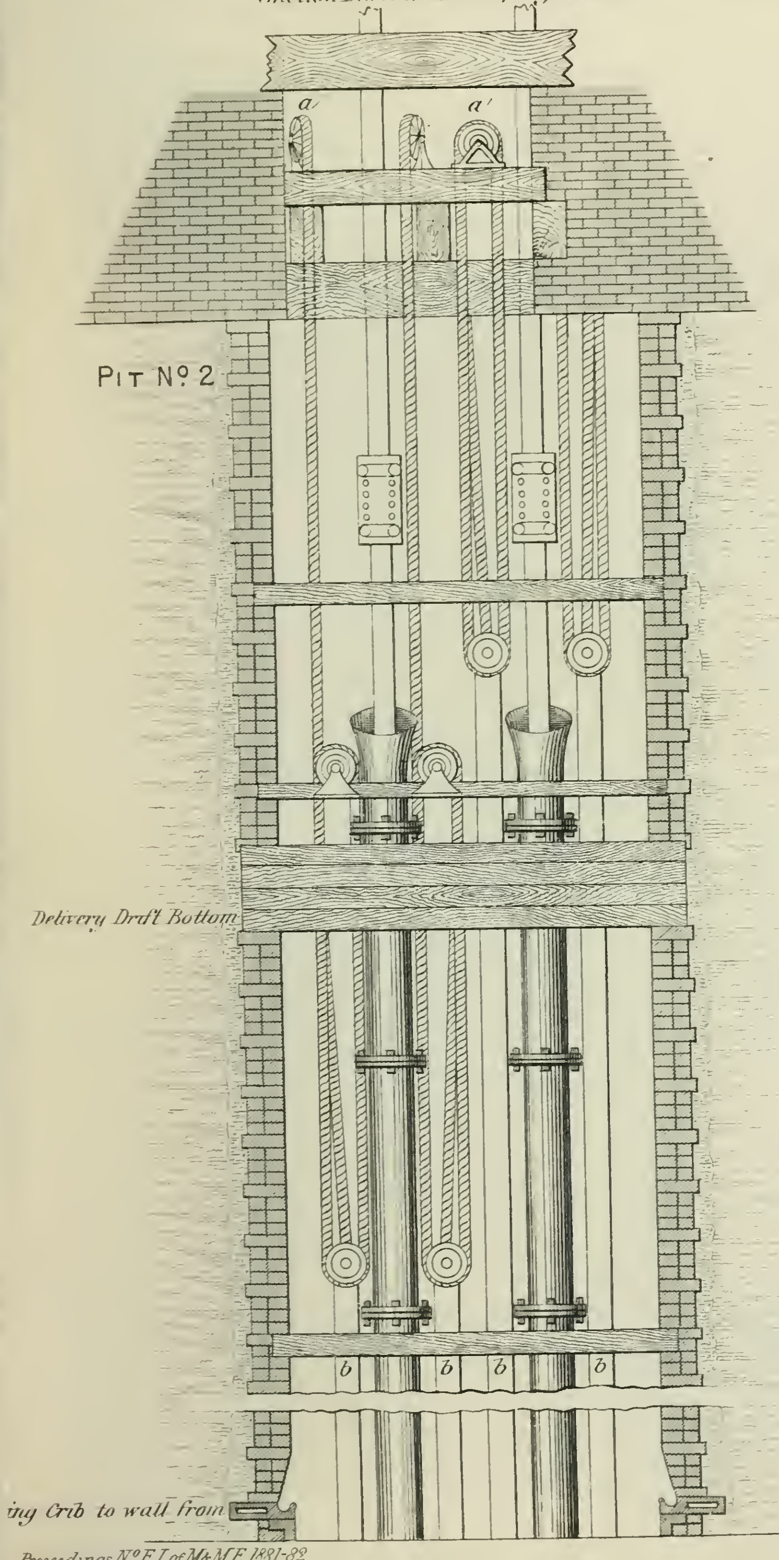
Scale 1½ inches to the foot.

Andw Reid Newcastle



Proceedings No. E.I. of N.&.M.E. 1881-82.

To illustrate Mr. A. L. Steavenson's paper "On the Machinery at the Skelton Park and Lumpsey Mines."



Andw. Reid, Newcastle

To illustrate Mr. A. L. Steavenson's paper "On the Machinery at the Skelton Park and Lumpsey Mines."

PIT No. 2.

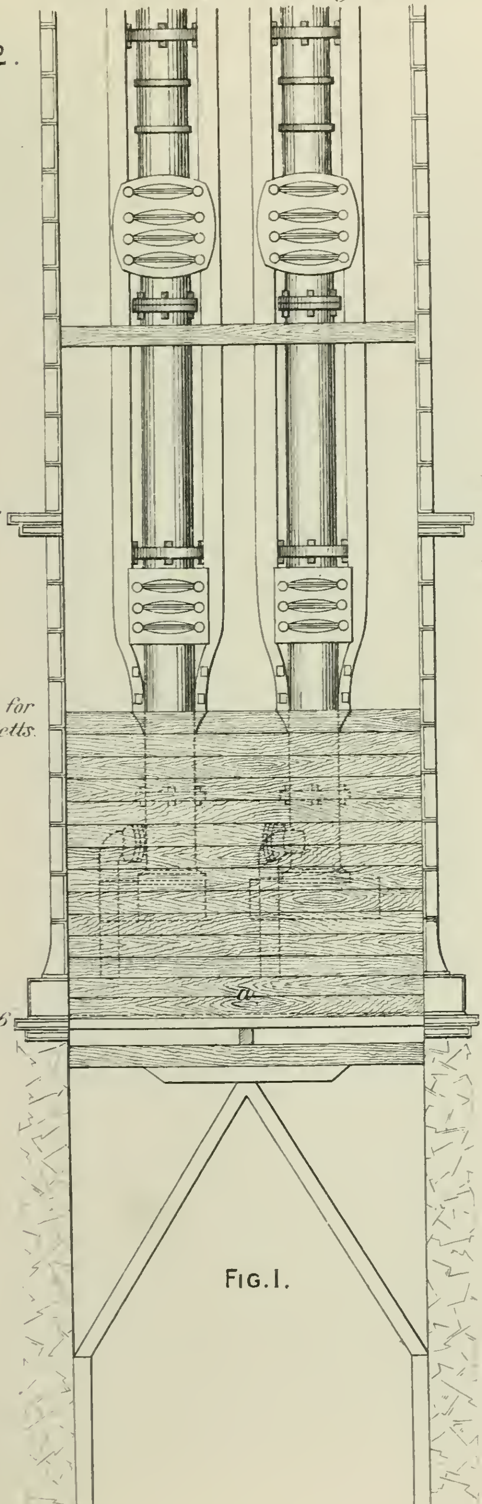


FIG. 1.

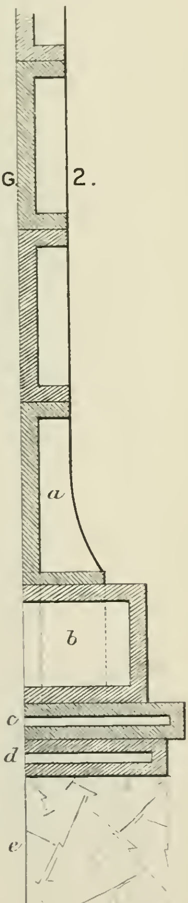


FIG. 2.

Andw Reid Newcastle

The PRESIDENT was sure that every gentleman who, like himself, enjoyed the delightful visit to Cleveland, which was arranged by Mr. Steavenson, would be very glad to hear these interesting particulars of what they saw on that day. He proposed a vote of thanks to Mr. Steavenson for his paper.

Mr. E. F. BOYD seconded the motion, which was unanimously agreed to.

The PRESIDENT said Mr. J. W. Swan, who was announced to exhibit and describe his portable electric mining lamp, was unable to attend on account of illness, which they all regretted; but his assistant, Mr. Payne, was present, and would explain the lamp in the Chemical Lecture Room of the College of Physical Science.

Mr. J. BUXTON PAYNE read the following paper, written by Mr. J. W. Swan:—