THE

FIRST REPORT

OF A

SOCIETY FOR PREVENTING ACCIDENTS

IN

COAL MINES,

COMPRISING

A LETTER TO SIR RALPH MILBANKE, Bart.,

ON

THE VARIOUS MODES EMPLOYED IN THE VENTILATION OF COLLIERIES,

ILLUSTRATED BY PLANS AND SECTIONS,

BY JOHN BUDDLE.

NEWCASTLE:

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From Joseph Lawson to Mr I. Sharp —

October

FIRST REPORT.

The Committee of the Society in Sunderland for preventing Accidents in Coal Mines, have solicited and received communications from intelligent men, as to the causes of those explosions which so frequently occur, and which have been productive of such extensive and deplorable calamities; and as to the measures which may be best calculated to prevent them. They regret that hitherto no suggestion has pointed out any adequate mode of destroying, or of preventing, the generation of the inflammable gas; or of so completely ventilating the pits, as to secure them from its dreadful effects. They are not, therefore, in possession of sufficient information, fully and exactly to specify all the circumstances which are necessary to be attended to, in promoting the discovery of any general measures of correction for the evils lamented: and they are compelled to add, that they must look to a more extensive support than they have hitherto received, to enable them to hold out such encouragement to scientific and practical men, as may stimulate their attention to the subject: for, notwithstanding the general approbation which their designs have obtained, and the liberal subscription which they have received from the noble and respectable individuals who have countenanced the Society, their funds do not yet empower them to offer a premium, suitable to the object, for the best production that may be procured. They still, however, flatter themselves, that as their proceedings shall be further disclosed, they will obtain a more ample support, which may give effect to their views.

In the mean time, they conceive that the following Paper, voluntarily communicated to the Society by Mr Buddle, a gentleman of great celebrity and intelligence as a viewer of coal-mines, will throw considerable light upon the subject in contemplation; and as it explains the means which are adopted in the collieries under his inspection, they trust that it may suggest some useful hints, and induce other gentlemen to impart any further information to the Committee, which may be likely to concur with their design.

The Committee are in possession of other valuable Papers, containing information and suggestions of which they hope hereafter to avail themselves; but their first object being to lay before men of talents and general science, who may be unacquainted with the details of mining, a clear view of the present state of the subject on which they are anxious for their assistance, they have been unwilling to delay the publication of a Paper so well adapted to this purpose.

Wall's End Colliery, 18th October, 1813.

To Sir RALPH MILBANKE, of Seaham, Bart.

President of the Society for preventing Accidents in Coal Mines, &c. &c.

Sir,

Though the letter, which I have now the honour of addressing to you, is entirely of a professional nature, it is not without great diffidence and hesitation that I have been able to prevail upon myself to lay before this Society my mite of information on the subject for which it has been humanely instituted. But considering that, in matters of such importance to the cause of humanity as that before us, we may modestly wave our common scruples of incompetency to do them the fullest justice, I venture to solicit the Society's attention to essential points, in order to avoid, as much as may be, an unnecessary waste of time.

With this view, I shall attempt to point out, as briefly as possible, what measures have been adopted here, and in other parts of the kingdom, for the prevention of accidents in Collieries by the ignition of inflammable gas; wherein these measures have succeeded, and the desiderata required to preclude the recurrence of such calamities.

The only method we are at present acquainted with, for the prevention of accidents by fire, is, the thorough ventilation of the several passages and workings of the mine—that is, a mechanical application of the atmospheric air to the removal or sweeping away of the inflammable gas, as it is generated in the workings of Collieries, or as it issues from the several fissures which the workings intersect in their progress.

In order that the observations I have to offer may be clearly understood, I have made several Sections of the mechanical Agents employed in the ventilation of Coal Mines; and illustrative Plans to shew the ancient and present mode of conveying the atmospheric air through the workings of Collieries.

FIG. I. is a Section shewing the principle of SIMPLE VENTILATION by a *furnace** under-ground.

a, the *downcast*; b, the *upcast* pit; c, the furnace near the bottom of the upcast pit: the darts shew the direction of the current of air.

The defect of this system is, that in the event of a *blower*, or discharge of inflammable air, occurring to windward of the furnace, as at d, sufficiently copious to mix the circulating current of atmospheric air to the *firing point*, it would inevitably explode at the furnace c.

To guard against such an event, the general practice has been to extinguish the furnace c, and apply (see Fig. II.) a WATER-FALL a, on the downcast pit a, by which a current of air is forced through the workings, and up the pit b. In this case the workings are accessible with candles to windward of the blower d.

But this expedient is objectionable on three accounts:—

1. A stream of water large enough to produce the desired effect, would very often be both difficult to obtain, and inconvenient to be raised again out of the workings of the mine.

2. Coals cannot conveniently be drawn up the pit during the time of its application.

3. Its inefficacy to answer its intended object; for the current of air which it forces through the workings is generally insufficient.

When the water-fall cannot conveniently be employed, I apply the steam ventilator, the hot cylinder, or the air pump.

* All the terms printed in Italics are explained in a glossary at the conclusion.

FIG. III. represents the STEAM VENTILATOR. f, the furnace to heat the boiler, and g, its chimney; a, the boiler which generates the steam; b b b, a box made of deal (as being the most convenient non conductor of heat) to convey the steam into the cast-iron pipe c e, which is suspended in the upcast pit d d, where the discharge of steam at its lower end e, rarifies the ascending air.

It is obvious that the farther the cast-iron pipe c e is carried down the pit the better.

FIG. IV. is a section of the apparatus for ventilating by a HOT CYLINDER.

a a, the cylinder of cast iron, which is fixed in the brick furnace b b, b b, with the chimneys c c c.

d d, the upcast pit, which is closed at the top; and e e, the air tube, with its drift of communication f f. An old cylinder from a steam engine answers the purpose very well.

The cylinder, being completely enveloped in flame, becomes heated, and by rarefaction induces the air of the mine in a regular current up the pit d d, through the drift f f, and discharges it out of the tube e e.

In practice I have found it necessary to lute the outside of the cylinder, or to case it with fire brick to prevent its being cracked by the partial application of the fire in its middle part. Inflammable gases never ignite at hot iron. —— *that is not true I have seen the contrary JC*

Great care must be taken to prevent the flame of the furnace from communicating with the inflammable gas passing along the inside of the cylinder, by making its ends perfectly air tight.

FIG. V. Section of the AIR PUMP. a a a a the body of the pump, which is square; b, its piston; c c, its suction pipe, which communicates by the drift d d, with the upcast pit e. f, a valve or trap door; and g g, the intake valves, and h h, the discharging valves.

This pump may be wrought by a steam engine or other machine, attached to the piston rod k k. It is made of three inch fir plank—the piston is five feet square—the stroke eight feet long; and the suction pipe and valves about one third of the area of the piston.

The piston may work with ease 20 strokes per minute, and will draw 8000 cubic feet, or 778 hogsheads of air in that time. But allowing one fourth less for the inaccuracy of the piston, valves, &c. it will draw 584 hogsheads of air per minute. Its power may be increased at pleasure.

It is worthy of remark, that in the event of the air pump being accidentally stopped, if the valve f be opened, the current of air will continue a considerable time, from the momentum acquired by the action of the pump.

The exhausting pump has always been found preferable to the forcing pump. Under the exhausting system the atmosphere always presses on the downcast shaft: by the contrary method, the current of air often recoils in *pinched air* courses. Indeed, I have heard that, in practice, a current of air, impelled 700 yards through pipes of small diameter, is useless in blast furnaces.

These three modes of ventilation have their advantages and defects. Their success depends altogether upon a judicious application of their several powers to such circumstances and occurrences as they are respectively best calculated to control.

Where the steam ventilator is used, the upcast pit may be kept open, which admits of the coals being drawn up as usual; but both the hot cylinder and air pump require the top of the upcast pit to be closed up, which of course prevents the drawing of coals.

In all cases where two or more downcast pits can be made to communicate with one upcast, I have introduced the double, or COMPOUND VENTILATION (Fig. VI.) with the most complete success.

a a, the upcast pit; d e, two furnaces near its bottom; f, *stopping*, which preve nts any communication of air between the downcast pits b b c c and g, a discharging drift from the furnace d, into the upcast pit a a.

From many years experience, I have found that the furnace d, by its rarefying the air in the drift g, gives so powerful an impulse to the column of air in the upcast pit a a, as to induce a stream of air down the pit c c, sufficient for all the purposes of ventilating the workings between the pits c c and a a, without the use of the furnace e. And, vice versa, the furnace e will effectually ventilate the workings between the pits b b and a a.

One of the furnaces is therefore sufficient to produce a thorough ventilation through all parts of the mine, as well from c to a, as from b to a.

It is necessary to place the furnaces d and e, at such a distance to windward in the drifts m m and c c, as to prevent the flame from either of them reaching the point h, in the upcast pit. When circumstances will permit, an air funnel may be placed upon one of the downcast pits, as at k.

The advantage of this mode of ventilating is evident. Should an overpowering discharge of inflammable gas occur at x, the furnace d should be extinguished, and a corresponding power obtained by lighting the furnace e. If, on the contrary, the discharge issues from n, by extinguishing the furnace e, and lighting the one at d, the ventilation will, in general, be effectual and safe; for though large discharges of inflammable gas are (as they are connected with our views of humanity) events of too frequent occurrence, yet in fact the most dangerous mines are often free from their visitation for months and years: it must therefore be a coincidence of events of rare occurrence, to find blowers of any dangerous magnitude issuing on each side of the upcast pit at the same period. In ten years practice, only one or two cases of the kind have come under my observation.

Wall's End, Percy Main, Hebburn, and Heaton Collieries are all ventilated upon this principle.

Much more difficulty is generally experienced in making new openings, or passages, through old *crept* workings, than in conducting the workings of a colliery in a field of whole coal. This is owing to the uncertainty, and frequently the largeness, of the discharge of inflammable air from the old excavations.

FIG. VII. is a plan of my improved mode of passing through a tract of old crept workings, where the pillars of the Mine have sunk into the floor by the weight of the super-incumbent pressure, and the boards, walls, &c. are completely closed up with the substances of which the floor is composed.

The faint shade shews the old workings, the dark one the new drifts.

In cutting through old workings, only two drifts have hitherto been used, as a b, d c. According to this system, the current of air is passed along one drift as a b, and returns by c d. In this case the inflammable air from the old workings X Y, is discharged into the intake drift a b, as well as into the return drift c d; consequently candles cannot be used in either.

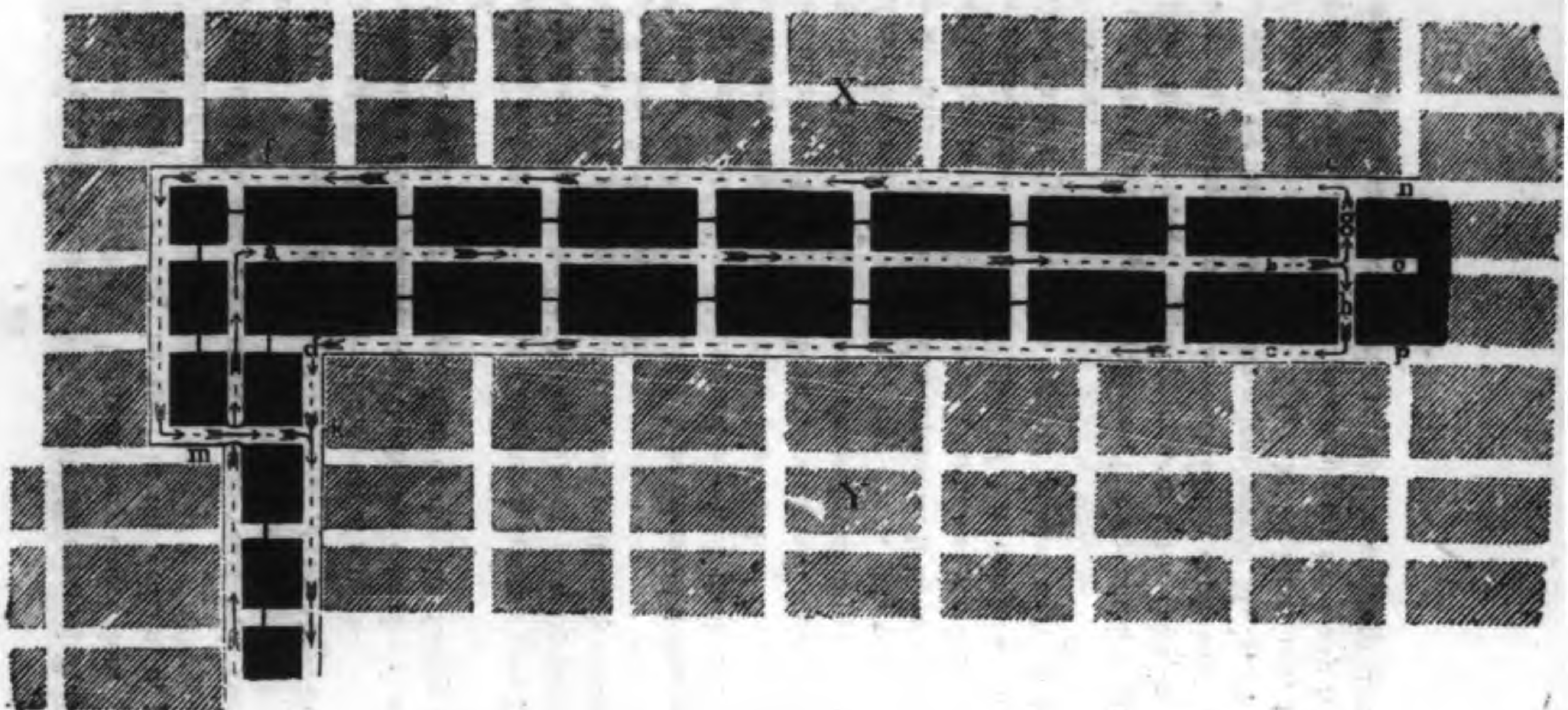
It is to be observed, that one drift, as a b, is always occupied by the rail-way to convey the coals, &c. obtained from the drifts, to the bottom of the pit; the other is merely an air course.

I have succeeded in rendering the drift a b safely accessible with candles, by driving a third drift e f. In this case, we have a centre drift a b for the intake of the air, and two flank drifts c d and e f for its return.

In practice, it is always found that the current of air, passing along the centre drift a b, at the innermost stentings g h, divides itself equally, one half returning up the flank drift c d, and the other up e f, and both uniting again at k, after crossing the entering air over an arch-way of brick, or plank, at m.

It is therefore evident, that under this mode of ventilation, discharges of inflammable gas from the old workings X Y, will be swept off without danger along the flank drifts c d and e f,

FIG. VII.



by the two currents of returning air, while the centre drift a b is rendered securely accessible by lights of every description.

Steel mills must, of course, be used in the drifts n, o, p, beyond the stentings g h.

I have pursued this system for nearly three years with complete success.

FIG. VIII. is a profile, shewing the manner of sweeping away the inflammable gas from a blower in the roof of a mine.

a b represents a cavity, formed by the blower c tearing down the rock above the level of the coal d e, or by the falling of the roof.

In this case a *check* door f, with a *brattice* h erected over it, is placed in the drift g g, by which the current of atmospheric air plays upon the mouth of the blower, and continually dilutes, and sweeps away its foul eructations.

In the many fatal accidents which have occurred within my knowledge, from explosions of inflammable gas, I think I may venture to assert, that not more than one-fourth of the persons they have ultimately killed, have been the victims of their immediate effects. Three-fourths of them almost invariably perish by suffocation; for, after the stoppings, trap-doors, &c. are swept away by the destructive ravages of an explosion, it is, in general, quite impossible to restore the *main* channels of ventilation in time to relieve those whom the blast has left uninjured, who have missed their way, or are too weak or maimed to reach the *adit* of the mine.

The difficulty of relieving the sufferers, in cases of this nature, arises from the *main bearing* stoppings, or *main doors* being blown out, or broken down by the shock of the explosion. As for example, if, by an explosion any where near to M, N, P, or Q, FIG. XII. the main stopping X should be blown out, the current of air would immediately pass along the head-way K K to the upcast pit b, and leave all the rest of the workings unventilated, nor could the ventilation be restored, until the stopping X was replaced.

Before this could be effected, all the people in that district of the workings where the fire happened, would, in all probability, be suffocated, even if they should not have been injured by the immediate effects of the fire.

The same disaster would happen, if either the stoppings T U or the main door W should be blown down. Thus the loss of lives by suffocation must always depend upon the number and situation of doors and stoppings which are blown down by an explosion.

Immediately after an explosion, the first care of the Viewer of a colliery is to collect his *overmen*, *deputies*, *wastemen*, and other assistants, and to ascertain from such as may have escaped from the blast, the exact situation where it occurred, and, if possible, the cause and extent of its ravages.

After descending the pit, he hastens towards the place where he supposes the persons who are missing are most likely to be found; which, in most cases, is in the direct road between the spot where they were working, when the accident happened, and the bottom of the pit.

The success of his first attempt depends entirely upon the extent of the devastation; for should the stopping X, Fig. XII. be blown out; or if the stoppings X, T, U, remain entire, and the door W, be broken down, he will be unable to proceed beyond either of these points, till the stoppings or door be repaired.

Stoppings and doors are generally replaced immediately after an explosion, by half inch deal; and though the overmen, &c. have acquired the greatest dexterity in this sort of operation, yet because they have often to scramble over heaps of ruins shaken from the roof or blown out of different parts of the mine, and always, in a great measure, to work in the dark (on account of the steel mills eliciting a very feeble light in the thick smoke and dust raised by the explosion) their proceedings are necessarily slow, and the persons they are hastening to save are often suffocated before they can possibly reach them.

But a Viewer, who has accurately treasured up in his mind the various circumstances of his collieries, and reflected upon the probable causes and effects of explosions, which, as in the four cases hereafter to be enumerated, in spite of his skill and industry may occur, not only in a measure foresees the extent of the injury they may occasion, but guards against their effects, by supporting the bearing stoppings with *pillaring* of rough walling, as represented by the dotted lines at X, Fig. XII.

I have frequently experienced the most satisfactory results from this practice; but one example is sufficient to shew its advantages.

On the 7th April, 1813, the inflammable gas exploded in the Riga District of the Howdon Pit, Percy Main Colliery, burnt twenty-three persons, and broke down the greater number of the doors and *sheth stoppings* in that division; but the bearing stoppings being all secured by pillaring, withstood the shock, and consequently secured the *main channels* of the ventilation, so that its smaller ramifications only were deranged. Not a life was lost by the choak damp; but if the pillaring had been wanting, not an individual could have been rescued from its suffocating powers.

But though the bearing stoppings can be fortified in such a manner as to resist the shock of all ordinary explosions, yet because great strength cannot be given to the *main doors* of the avenues leading to the working boards, a degree of security to them is still a desideratum. The consideration, however, that art might accomplish an object to which mere strength is inapplicable, has lately led me to the invention of the SWING DOOR.

FIG. IX. a, the swing door fixed on the lower surface of the head frame d, by hinges which allow it to swing freely through the semicircular dotted line e c f. c, its threshold; g, a slight deal prop, barely sufficient to support the door in the position represented in the profile; and b, a recess hewn out of the roof of the drift M N, for the purpose of receiving the door, when propped open. It should be barely of sufficient weight to resist the impulse of the ordinary air course, when closed, and should move so easily, as to allow the least trapper boy to creep through it. The fittest materials, therefore, for its construction, are deals one inch, or one and a half inch thick, and moderately loaden with a weight at its bottom h, so that if the prop g be struck out, the door, after ceasing to vibrate, will hang vertically over its threshold c. Its bottom and sides may be lined with soft leather, to make it fit closer to its cheeks and threshold; and the cheeks should be fixed in recesses, hewn out of the sides of the drift or passage in which it is to be hung, in order to prevent its being torn away by the resistance any projection would give to the progress of an explosion: it may be placed between the two main doors k k, or at l or m, as most convenient.

The use of this door is to preserve the air course in its proper channel, in the event of the main doors being blown away; for it is presumed that a shock which would blow out the doors k k, would also blow out the prop g, and allow the swing door to close the drift, and act as an immediate substitute for the doors k k.

In case of a repetition of concussions, it is also expected that this door will yield to their shock, and after ceasing to vibrate, return to its vertical position, and close the passage sufficiently to keep the current of air in its proper channel, till the main doors k k can be replaced.

Its peculiar advantage is, that it cannot be left open by mistake, as it will always close of itself, except when designedly supported by the prop g.

Though I have not yet experienced the effect of this kind of door, after an explosion, yet I feel so confident of its utility, that I am fitting them up with all convenient speed, in every situation where I think them necessary; and my hope of their utility is still more confirmed by having frequently observed after explosions, that weak sheth doors have been very little injured, while the brick stoppings near to them have been blown out; and this I cannot attribute to any other cause than their yielding to the shock of the explosion.

FIG. X. is a plan which will afford a FULLER ILLUSTRATION of the system of COMPOUND VENTILATION, than that contained under Fig. VI.

a, the pit, which is subdivided by perpendicular *brattices*, or partitions, from top to bottom, into two downcast pits b and c, and one upcast d. e f, the two furnaces near to the bottom of the upcast pit.

The darts shew the direction of the two currents of air, from the bottom of their respective downcast pits, to the bottom of the upcast pit.

The single lines shew the brattices; the double lines, the stoppings; the double shaded lines, the trap-doors; d d, d d, the head-ways; i i, &c. the stentings; k k, the walls; l l, l l, &c. the boards; f f, the furnaces; and g g g three arches, by which the current of air is carried over its former course.

FIG. XI. is a plan of a small tract of the workings of a colliery, to shew the principle of SIMPLE VENTILATION.

The double lines shew the air stoppings; the darts the direction of the current of air; and the double-shaded lines the *trap doors*.

a, the downcast pit; b, the upcast pit; c c, c c, the double winning *head ways* between the pits; A a, the west *mothergate*; B a, the east mothergate from the downcast pit a.

The current of air, after descending the downcast pit a, would pass in the shortest line (which is along the double head-ways c c, c c) to the upcast b, if not prevented by the stoppings d d and f, which, with the *main doors* e e, in the west mothergate A a, the stoppings g g g g g, and the door h, in the holings on the north side of the east mothergate a B, force it along to the south holing i, from whence it is carried round by the extremities of the workings to the upcast shaft, without ever visiting the interior parts of the mine, as at C, D, E, F, which are left completely stagnant. If, therefore, a discharge of inflammable air should occur at F, it would soon spread itself over all the space distinguished by a light shade, force the stagnant air and itself into the course of the atmospheric current at G, and render it nearly impossible for the workmen to prevent its exploding at their lights, as they pass and repass along the *working head-ways* from X to X.

The inadequacy of this system was fully admitted, but no improvement was made until the late ingenious Mr Spedding, of Whitehaven, to whose memory our tribute of gratitude is due, suggested the idea of *coursing the air*: that is, forcing it through every passage of the several workings, or in other words, making an air pipe of every passage of the several workings of a coal mine.

FIG. XII. is a plan of the same workings as Fig. XI. a the downcast, and b the upcast pit.

The current of air, the stoppings, and trap-doors, are represented by darts and lines, as in the former.

This figure shews the IMPROVED SYSTEM OF VENTILATION, by which the current of air sweeps every part of the workings.

By tracing the darts, it will be seen that the current of air from the bottom of the downcast pit a, first passes along the east mothergate a A, and the adjoining south board M B, to which it has free access through the *holings* or *walls* 1, 2, 3, 4; it then passes through the holing 5, called the *air wall*, into the boards C D, having free communication between them by the holings 6, 7, 8, 9.

After passing up the board C D, it enters the head-ways EE, in going along which it ventilates the boards F G, by being forced into them by the brattices x x, x x.

Where the current of air sweeps the boards by two and two, as above described, it is called *double coursing;* but where it is thrown down one board and up another, as it is from H to H, it is called *single coursing.*

The remaining part of the ventilation back to the east mothergate A, is in double courses. The current of air is at last discharged out of the first board (L) north of the east mothergate A a, into the head-ways K K, along which it is forced by the *board end stoppings* s, s, s, s, and the *stenting stoppings* r, r, r, r, r, to the bottom of the upcast pit b.

Under this system, if the stoppings, &c. be all in order, and the passages kept sufficiently open for the current of air to circulate freely, there can be no partial stagnations in the workings—no accumulations of inflammable gas. For in the event of a blower commencing at any place, as at M, N, P, Q, its stream is immediately carried off by the circulating current of atmospheric air, and so diluted that it cannot explode, unless indeed, the discharge should be so copious as to mix the current with inflammable gas to the firing point. The air course, or circulating current of air, is at the firing point when it is so highly mixed with hydrogen gas, as to fire at the flame of a candle.

The presence of inflammable gas, from the slightest mixture, through all its gradations to the firing point, is readily discovered by an experienced collier; and he judges very correctly of the degree of inflammability and danger which threaten the safety of the mine, by observing attentively the appearance of the spire upon the top of his candle.

The common pit candles vary in size, but those generally used are forty-five to the pound; the wick is of cotton, and the candle made of ox or sheep tallow: but clean ox tallow is best.

The mode of trying the candle, as it is called, to ascertain the mixture of inflammable gas, is as follows:

In the first place, the candle, called by the colliers the low, is trimmed, that is, the liquid fat is wiped off, the wick snuffed short, and carefully cleansed of red embers, so that the flame may burn as purely as possible.

The candle being thus prepared, is is holden between the fingers and thumb of the one hand, and the palm of the other hand is placed between the eye of the observer and the flame, so that nothing but the spire of the flame can be seen, as it gradually towers over the upper margin of the hand. The observation is generally commenced near the floor of the mine, and the light and hand are gently raised upwards, till the true state of the circulating current be ascertained.

The first indication of the presence of inflammable air, is a slight tinge of blue, or a bluish grey colour, shooting up from the top of the spire of the candle, and terminating in a fine extended point. Thi: spire increases in size, and receives a deeper tinge of blue as it rises through an increased proportion of inflammable gas, till it reaches the firing point; but the experienced collier knows accurately enough all the gradations of shew (as it is called) upon the candle, and is very rarely fired upon, excepting in cases of sudden discharges of inflammable gas.

The shew upon the top of the candle varies very much, according to the length of run, or distance, which the current of air has passed through, before it is mixed with the inflammable gas. The shorter the run of the current of air, before it is mixed with the inflammable gas, the less will be the shew upon the candle when at the firing point, and vice versa.

The same size of spire which would indicate danger in a current which had passed only one mile, might be perfectly harmless in a current that had run five or six miles. Consequently the length of run of the current of air is to be taken into consideration, as well as the appearance of the top of the candle.

The air course too, for a short distance beyond a small discharge of fire-damp, may be highly inflammable, but by passing a few yards farther, it becomes so diluted as to be perfectly secure.

The distance, therefore, within which a blower can be safely approached with candles, is regulated entirely by the magnitude of the discharge and power of the current of air. Long experience and attentive observation are consequently necessary to obtain a thorough practical knowledge of this art.

The workings of a colliery are very often inaccessible with candles near the downcast pit, called the first of the air, while they may be safely entered with any description of lights near the upcast pit, called the last of the air. This arises from the inflammable gas, as it is carried from the place of its discharge, being gradually diluted by the atmospheric current. Hence the advantage of sufficient extent of pit room, to obtain length of run to dilute the inflammable air.

It is from the want of pit room that the explosions in newly opened collieries are generally the most violent.

The run of the air, or the distance which the current of air passes through between the downcast and the upcast pits, varies much according to circumstances. I have known it exceed thirty miles.

After the current of atmospheric air is so highly mixed with inflammable air, as not to be accessible with lighted candles, steel mills may be employed with safety.

Although the inflammable air has frequently fired at the sparks of the steel mills, it only happens, from all the facts which I have been able to collect, when the mills are played near the place where the hydrogen gas is discharged; and this, by due attention, may be easily avoided.

I never, indeed, witnessed an explosion from the sparks of flint; but from my own observations on their appearance in dangerous states of the air, as well as from the observations of several intelligent men, I believe, that, in most cases, the change of the appearance of the sparks, if attentively observed, gives sufficient notice of the threatening danger.

When elicited in atmospheric air, they are of a bright appearance, rather inclining to a reddish hue, and as they fly from the wheel, seem sharp and pointed. In a current of air, mixed with inflammable gas above the firing point with candles, they increase considerably in size, and become more luminous.

On approaching the firing point with steel mills, they grow still more luminous, and assume a kind of liquid appearance, nearly resembling the sparks arising under the hammer from iron at the welding heat. They also adhere, more than usual, to the periphery of the wheel, encompassing it, as it were, with a stream of fire: and the light emanating from them is of a blueish tint.

When the inflammable gas predominates in the circulating current, the sparks from the steel mill are of a blood red colour; and as the mixture increases, the mill totally ceases to elicit sparks. They have the same bloody colour in carbonic acid.

The improved system was introduced into the collieries on the Tyne and Wear, about the year 1760, and has ever since continued in general use in collieries abounding with inflammable air—without any rival method being thought of, or any improvement excepting the mechanical auxiliaries detailed in the descriptions of sections III, IV, V. But notwithstanding the admirable perfection to which this improved system of ventilation has arrived, and the comparative security it gives to the lives of colliers under active and judicious management; yet in the following cases it has hitherto been inadequate to the intended purpose.

1st. When sudden discharges of inflammable gas mix the whole circulating mass of air to the firing point.

2nd. When the wind is at south east, the weather wet, or hazy, and the barometer sinks below 29 inches. In this case the atmospheric current, which under the most favourable state of the air is merely sufficient to sweep off the noxious effluvia of some mines, gets so contaminated by the increased discharge of inflammable gas, and the slowness of its own progress, as to become exceedingly unsafe, and generally inaccessible with candles.

3rd. When inflammable air fills a part of the mine between the workmen and the upcast shaft, and a fall of stone from the roof, or other causes, occur to force it back upon the workmen's candles.

4th. When the gas is ignited by lightning as it ascends the upcast shaft.

To obviate these defects as much as possible I have lately introduced the double or compound ventilation, the steam ventilator, the air pump, and hot cylinder before described, applying such of them as are best suited to the various cases to which they are applicable.

The standard air-course, or current of atmospheric air, which I employ in the ventilation of the collieries under my care, abounding in inflammable gas, moves through an aperture from 30 to 40 feet in area, with a velocity of 3 feet per second, which equals from 5400 to 7200 cubic feet, or from 525 to 700 hogsheads per minute.

This standard of ventilation I conceive to be equal to dilute, and render perfectly harmless, a stream of gas issuing at any rate between 170 and 230 hogsheads per minute. But when the discharge of gas exceeds that quantity, the current of atmospheric air employed is evidently inadequate to effect its intended purpose.

On the strength of my own experience in collieries thus circumstanced, I freely hazard my opinion, that any further application of mechanical agency towards preventing explosion in coal mines would be ineffectual, and therefore conclude that the hopes of this society ever seeing its most desirable object accomplished must rest upon the event of some method being discovered of producing such a chemical change upon carburetted hydrogen gas, as to render it innoxious as fast as it is discharged, or as it approaches the neighbourhood of lights.

In this view of the subject, it is to scientific men only that we must look up for assistance in providing a cheap and effectual remedy.

In concluding this Letter, I beg the indulgence of observing, that as colliers are exposed to many accidents besides fire, it mays not, perhaps, be deemed improper to combine with the objects of this Society, the formation of a general Permanent Fund, for the relief of the widows and orphans of such colliers and others, as may lose their lives in the collieries on the Tyne and Wear, and for the support of such as are maimed and disabled. On an average, through this district, I believe that the ordinary and unavoidable casualties in collieries occasion more calamity than explosions of inflammable air.

Should the Society think proper to turn its attention to this suggestion, I shall have much pleasure in submitting the outline of a plan for its accomplishment to the Committee. The basis of which is to raise the fund principally by a proportionate contribution on the earnings of the workmen, to be aided by a subscription from the coal and land owners, &c. of Durham and Northumberland.

I am, SIR,

Your most obedient humble Servant,

JOHN BUDDLE.

GLOSSARY

OF

TECHNICAL TERMS.

An Air Funnel.—A large wooden box, generally of a circular shape, open on one side, with a fane on the opposite side, to turn its mouth to the wind. They are occasionally used in the downcast pits, to increase the current of air by the force of the wind.

Brattice.—A partition, generally of deal, placed on the shaft of a pit, or in a drift or other working of a colliery, for the purpose of ventilation. The former is called the shaft-brattice; the latter the drift, head-ways, board, &c. brattice, according to the situation in which it is placed. Its use is, to divide the place in which it is fixed into two avenues, the current of air entering by the one, and returning by the other.

Bearing Door, or Main Door.—A door which forces the air through more of the workings than one sheth of boards.

Bearing Stopping.—Answers the same purpose as a bearing door.

A Blower.—A fissure in the roof, floor, or side of a mine, from which a feeder of inflammable air discharges.

Board.—A passage driven in the transverse direction of the coal, and at right angles out of the head-ways. The boards are the places from which the daily supply of coal work is obtained.

A Crossing.—A brick arch, or lofting of plank, where the current of air decussates.

Coursing the Air.—Passing the current of air up one board and down another, or passing it up two or more boards and down an equal number, called single, double, treble courses, &c. The boards up which the current of air passes, are called *up-go* boards, the others *down-go* boards. One up-go and down-go, or two or more up-go and the same number of down-go boards form a *Sheth.*

Coal Work.—Working coals, in contra-distinction to *shift*, or by-work, as sinking pits, driving stone drifts, &c.

Holing.—See wall.

Firing Point.—See page 18.

Mothergate.—The principal avenue used as a road from the bottom of a pit, or central point of a pit's workings, and leading in a board-ways course direction.

Overman.—The person who has the sole direction of the underground economy of a pit. He takes his instructions from the Viewer, and every person else in the pit is subordinate to him. The office of an Overman is of the utmost importance in the management of a coal mine, and none but men of tried experience, integrity, and sobriety, should be appointed to fill it. They are dismissed for negligence.

Deputy Overman.—Assistants to the Overman. An Overman is allowed as many deputies as may be necessary, according to circumstances.

Head-ways, or Head-ways Course.—A passage, single or double, according to circumstances, driven in the longitudinal direction of the coal, that is, in the same direction as the facings of the coal. The boards are always driven out of the head ways at right angles. The two parallel drifts between the shafts are called the double or winning head-ways, on account of their being the earliest excavations made in the mine. The single or working head-way forms the last line of walls of a sheth of workings.

Pillars.—The oblong masses of coal left between the boards, for the support of the roof.

Roof.—The roof of a seam of coal is the stratum of stone which lies upon the coal.

Sheth Door.—Doors placed in the walls between the last down-go and first up-go board of each sheth. They are only placed in the working head-way course next the face of the boards, as a substitute for the sheth stoppings, to allow a free passage for carrying on the work.

Sheth of Workings.—See coursing the air.

Sheth Stoppings.—The stoppings placed in the walls between the boards, to form them into sheths.

Shething the air.—Separating the boards by stoppings placed in the open walls or *thirlings*, between every 2nd, 3rd, 4th, 5th, &c. board, as shewn in Fig. VIII. but without coursing the air, so that the air may be shethed without being coursed; when merely shethed, no sheth doors are used.

Stenting.—An opening between a pair of double head-ways, drifts, or boards, through which the current of air circulates.

Steel Mill.—An instrument for striking light with flint and steel. A brass wheel about five inches diameter, with fifty-two teeth, works a pinion with eleven teeth. On the axle of the latter is fixed a thin steel wheel, from five to six inches in diameter. The wheels are placed in a light frame of iron, which is suspended by a leather belt round the neck of the person who *plays* the mill. Great velocity is given to the steel wheel by turning the handle of the toothed wheel, and the sharp edge of a flint is applied to the circumference of the steel wheel, which immediately elicits an abundance of sparks, and emits considerable light.

Thill.—The floor of the seam.

A Trapper.—The person, generally a boy, who opens and shuts the doors. The trappers have seats near their doors, and remain by them all the time the pit is at work. This is the first branch of pit work which the boys go to.

Wastemen.—The people who are employed to keep the air course of a colliery open. They travel the old workings daily, and clear away falls of the roof, and other obstructions: they also examine and repair the air stoppings, water courses, &c.

Wall.—The passages between the boards, at the ends of each pillar.

SOCIETY FOR PREVENTING ACCIDENTS IN COAL MINES.

Instituted the 1st October, 1813.

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*** Committee-meeting first Tuesday of every month, at the Sunderland Library, at twelve.

ERRATA.

Fig. IV. a a is set too close to one side of the cylinder.
Page 9. line 1, the comma is put after g. instead of c.
Fig. VII. e and f are put in the pillars instead of the drift.
Page 16. line 15, e is put for f.

EDW. WALKER, PRINTER, NEWCASTLE.

Plate 1

Fig. I.

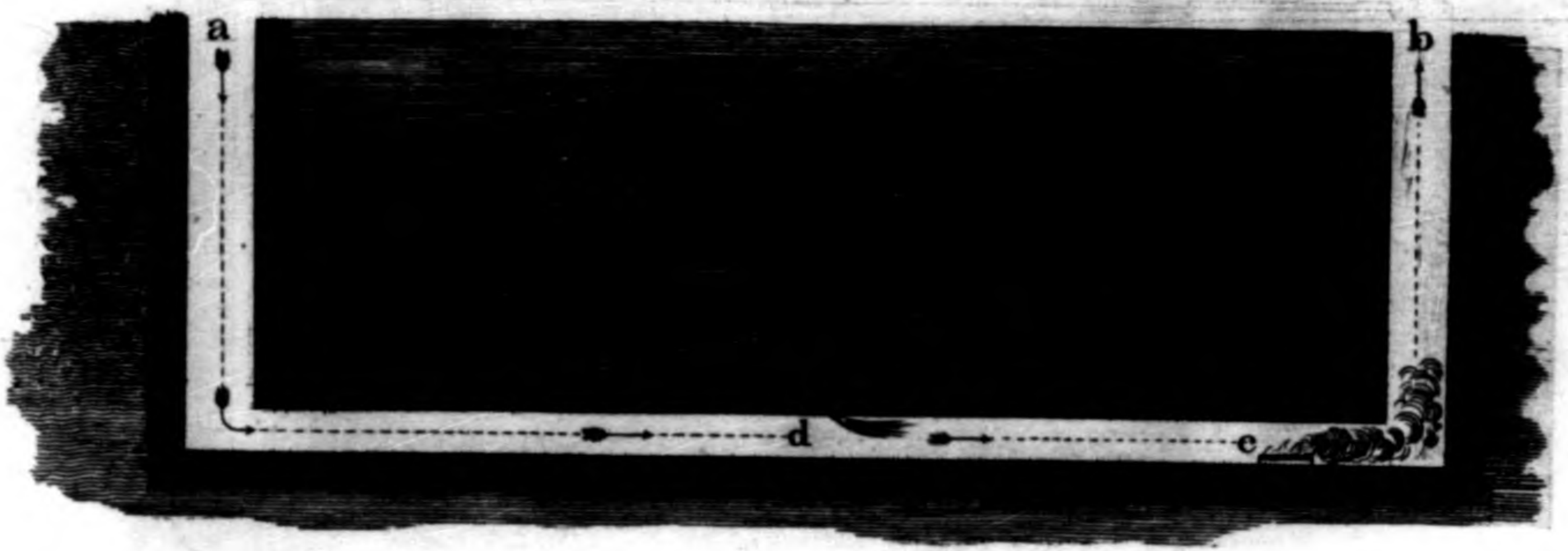

Plate 2

Fig. II.

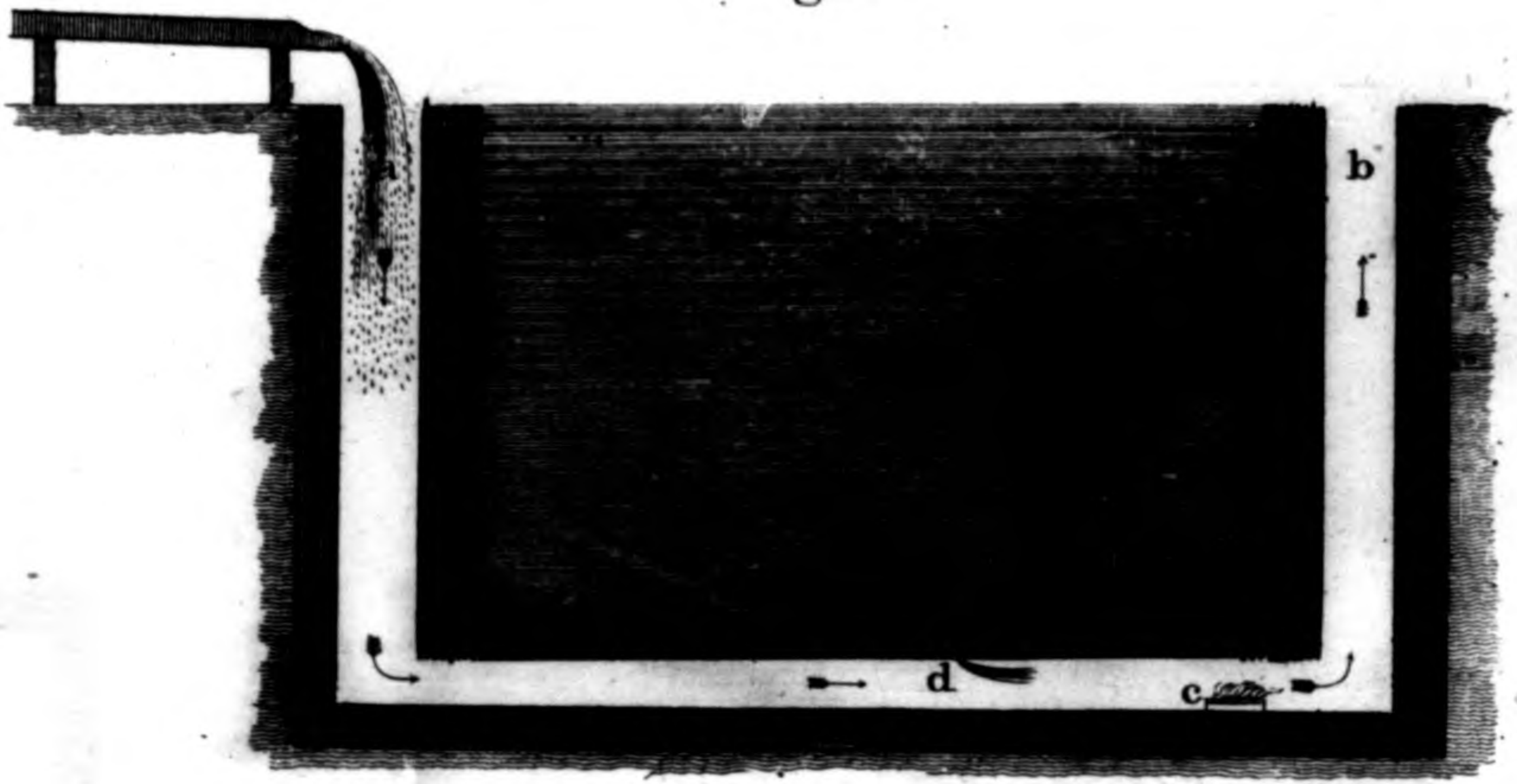

Plate 3

Fig. III.

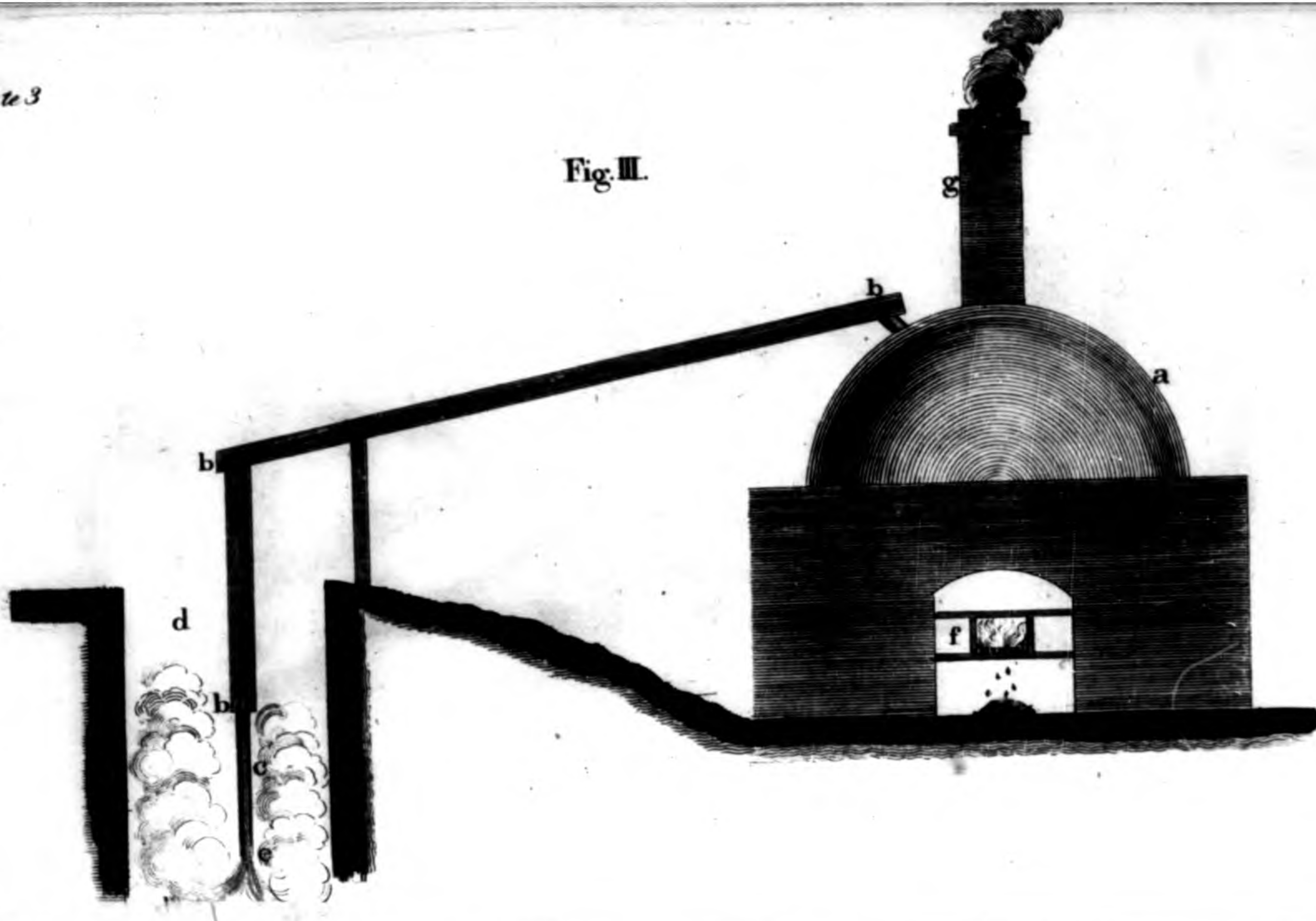

Plate 4.

Fig. IV

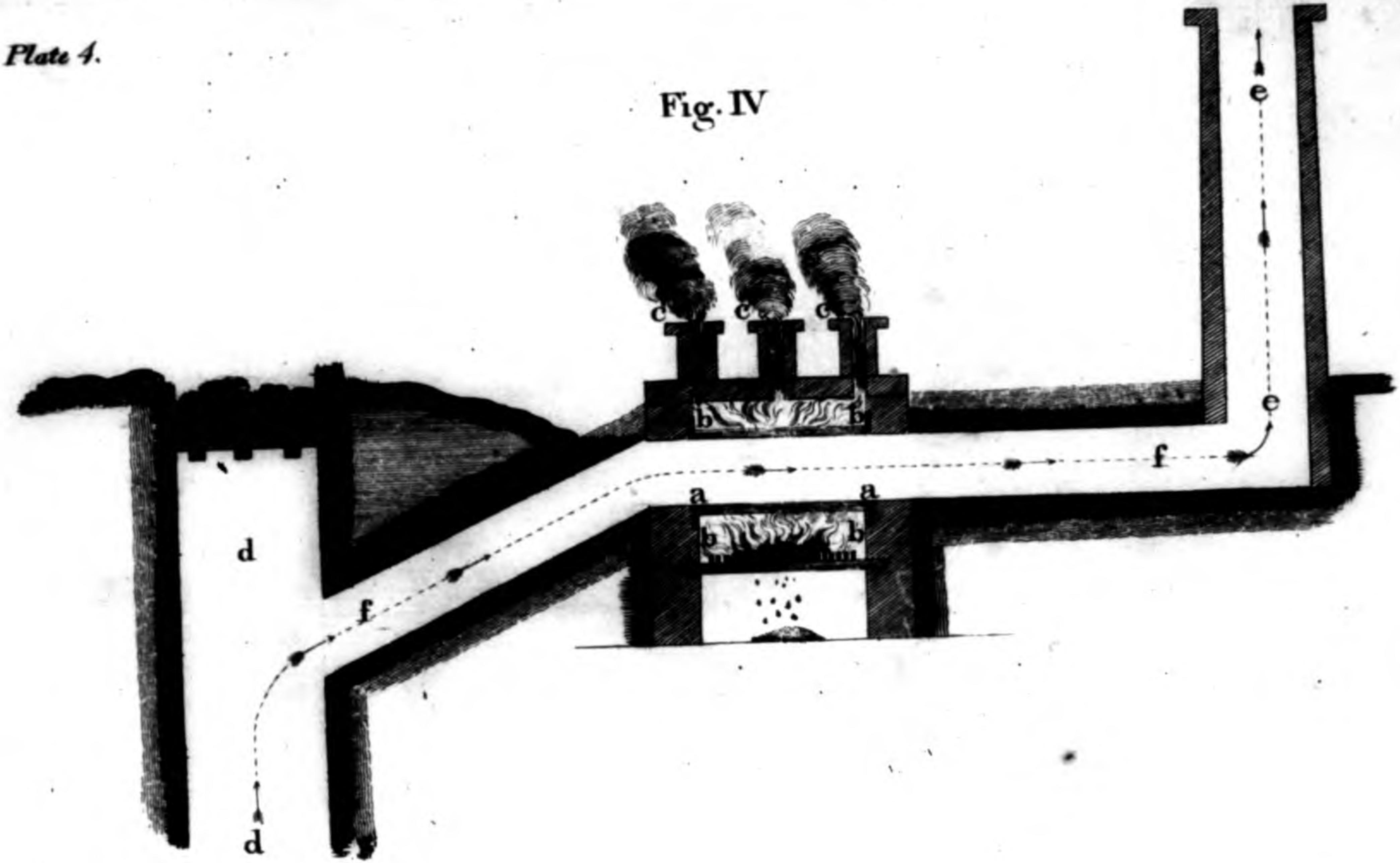

Plate 5.

Fig. V.

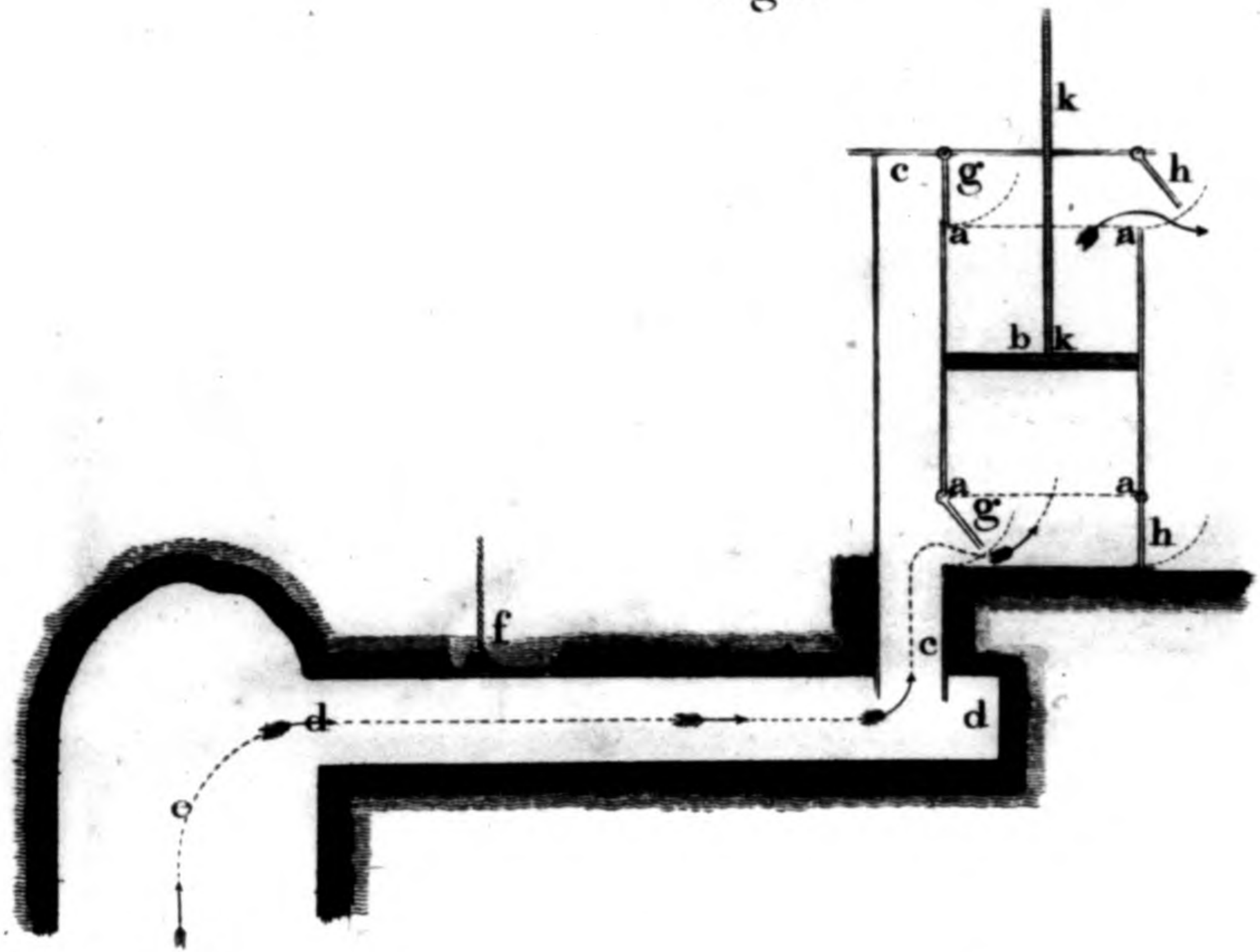

Plate 6

Fig. VI

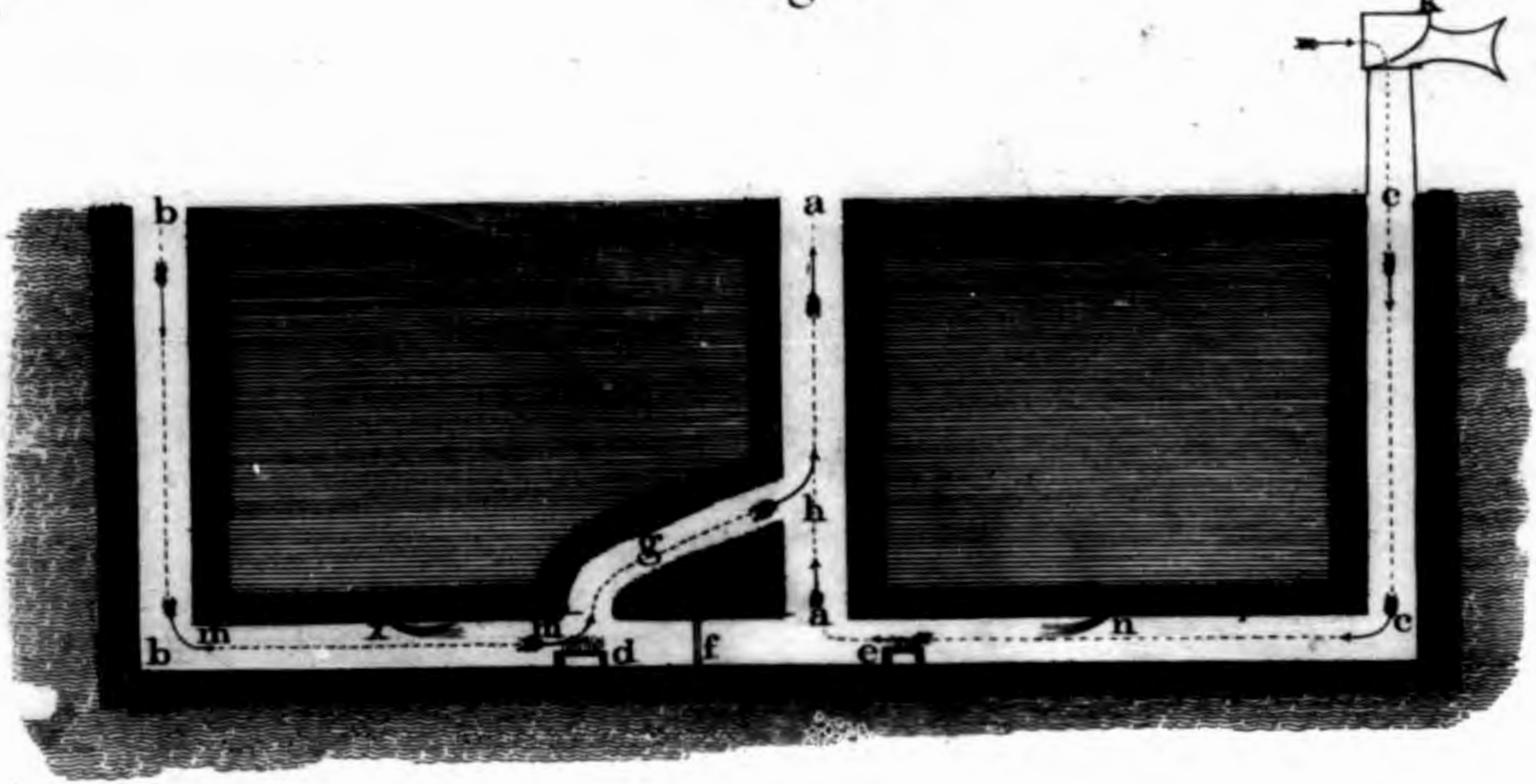

Plate 7

Fig. IX.

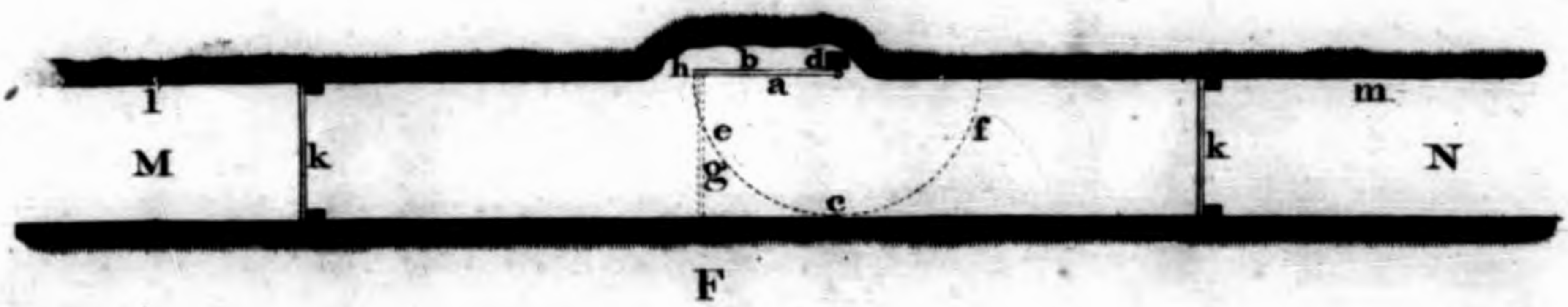

Fig. VIII.

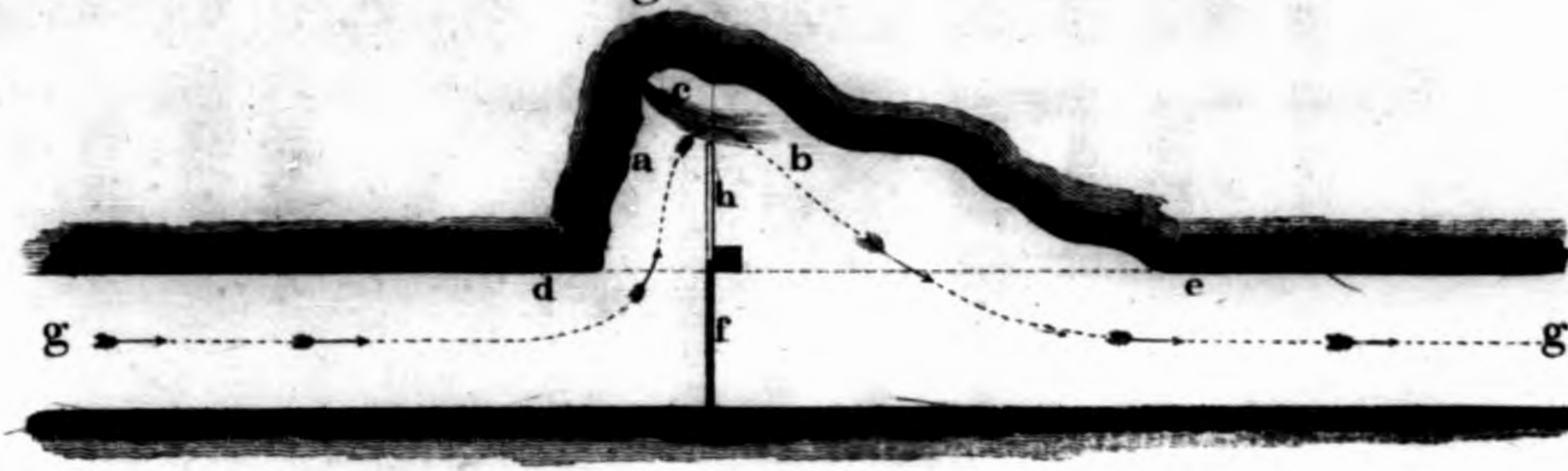

Plate 8

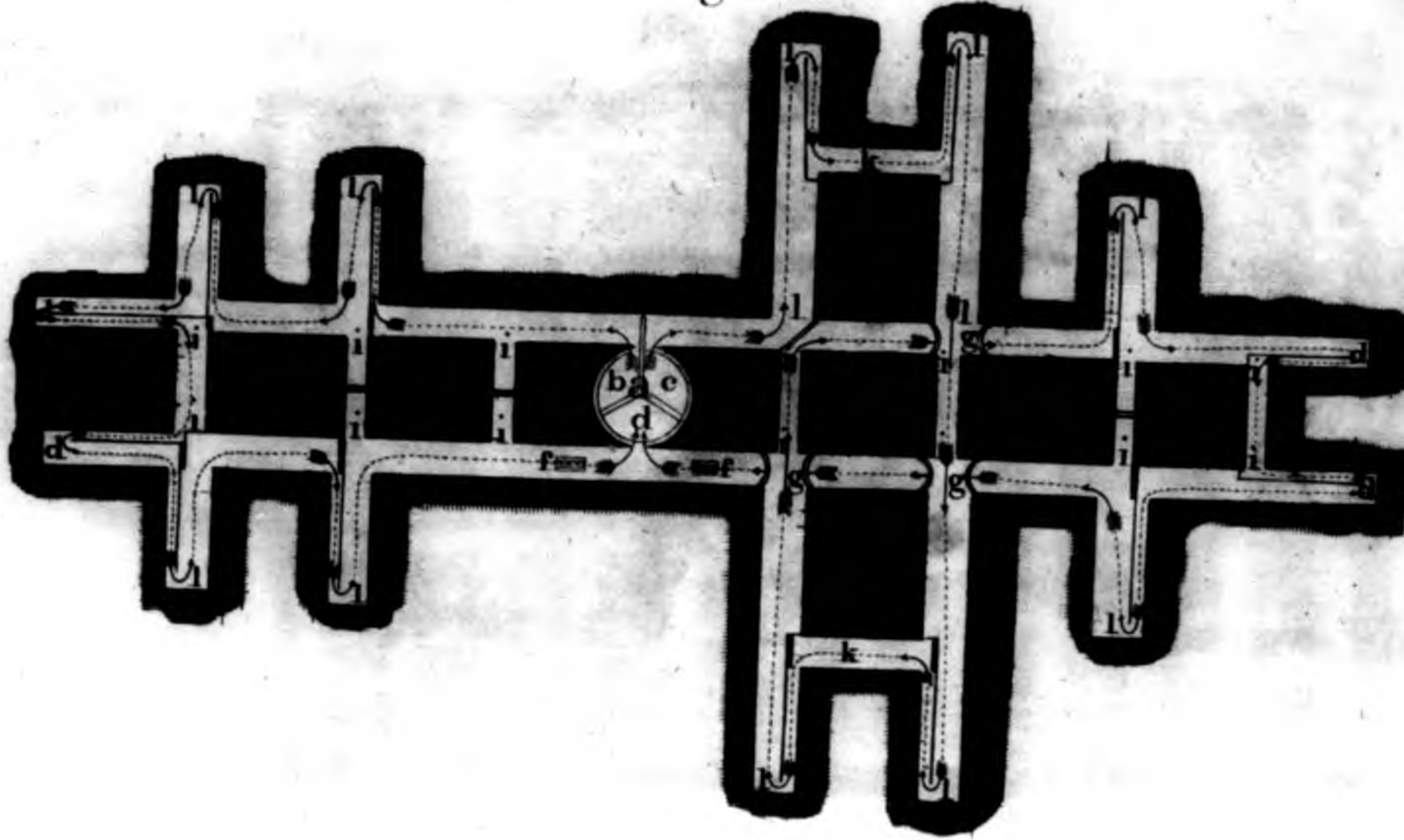

Fig. X.

Plate 9

Fig. XI.