

Martis, 31° die Maii, 1853.

Ordered, THAT a Select Committee be appointed to inquire into the Causes of the numerous ACCIDENTS IN COAL MINES, with a view of suggesting the best Means for their Prevention.

Jovis, 2° die Junii, 1853.

Committee nominated of,—

Mr. Hutchins.	Mr. Stephenson.
Mr. Fitzroy.	Mr. Mostyn.
Mr. Ingham.	Viscount Goderich.
Mr. Hussey Vivian.	Mr. Farrer.
Mr. Baird.	Mr. Child.
Mr. Cumming Bruce.	Mr. Henry Austin Bruce.
Mr. Cayley.	Mr. Cobbett.
Colonel Pennant.	

Ordered, THAT the Committee have power to send for Persons, Papers, and Records.

Ordered, THAT Five be the Quorum of the Committee.

Jovis, 9° die Junii, 1853.

Ordered, THAT Viscount Goderich be discharged from further attendance on the Committee, and that Mr. Locke be added thereto.

Lunæ, 27° die Junii, 1853.

Ordered, THAT the Committee have power to Report the Minutes of Evidence taken before them from time to time to The House.

REPORT	- - - - -	p. iii
MINUTES OF EVIDENCE	- - - - -	p. 1
APPENDIX	- - - - -	p. 133

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F I R S T R E P O R T .

THE SELECT COMMITTEE appointed to inquire into the Cause of the numerous **ACCIDENTS** in **COAL MINES**, with a view of suggesting the best Means for their Prevention, and who were empowered to Report from time to time to The House,—

HAVE made progress in the Matters to them referred, and have agreed to Report the Minutes of Evidence taken before them.

30 *June* 1853.

LIST OF WITNESSES.

Lunæ, 13^o die Junii, 1853.

Joseph Dickinson, Esq. - - - - - p. 1

Jovis, 16^o die Junii, 1853.

Herbert Francis Mackworth, Esq. - - - - - p. 32

Martis, 21^o die Junii, 1853.

Herbert Francis Mackworth, Esq. - - - - - p. 56

Joseph Dickinson, Esq. - - - - - p. 56

Jovis, 23^o die Junii, 1853.

Joseph Dickinson, Esq. - - - - - p. 91

Herbert Francis Mackworth, Esq. - - - - - p. 103

Edward Cayley, Esq. - - - - - p. 111

Lunæ, 27^o die Junii, 1853.

Herbert Francis Mackworth, Esq. - - - - - p. 113

Martin Jude - - - - - p. 125

A P P E N D I X.

LIST OF APPENDIX.

Appendix, No. 1.

Paper delivered in by H. F. Mackworth, Esq., and referred to in his Evidence, 16 June 1853 :

Instructions and Questions relative to the Parliamentary Committee, now sitting to inquire into the Causes of Accidents in Coal Mines - - - - -	p. 135
Tabular View of the Number of Accidents causing Death in the Coal Mines of Great Britain, in 1851 and 1852 - - - - -	p. 136
Tabular View of the Lives Lost in the Coal Mines of Great Britain, in the Years 1851 and 1852 - - - - -	p. 136
Hainault, Belgium. List of Accidents. Province of Hainault, comprising the Two Districts of Mons and Charleroi - - - - -	p. 137
Comparative Loss of Life in Coal Mines, per 10,000 Persons employed in and on the Mines per Annum on 460,000 Persons in England, 256,760 in Belgium, 73,275 in Westphalia -	p. 137
General Law concerning the Ventilation, Lighting, and employment of Gunpowder, in the operations of Mining, especially in Coal Mines subject to Fire Damp - - - - -	p. 138

Appendix, No. 2.

Paper delivered in by Mr. Herbert Francis Mackworth :

Comparative Abstract of Experiments on the Economy of Four Kinds of Fans, by Mr. Jochams,	p. 141
Abstract of Five Experiments on Fabry's Pneumatic Wheels, by Monsieur Jochams, Engineer of Mines - - - - -	p. 142
Comparative Table of Cost of Eight Kinds of Ventilating Machines, according to Monsieur Ponson - - - - -	p. 142

Appendix, No. 3.

Paper delivered in by Mr. Herbert Francis Mackworth :

Experiments on Ventilators - - - - -	p. 143
Comparative Economy of Furnace (underground and above), Steam Jet Ventilators, according to Mr. Glépin - - - - -	p. 146
Comparative first Cost of Establishment of various Machines, at per Horse Power -	p. 147
Comparative Cost of Working, at per Horse Power of Useful Effect, per Annum -	p. 147

A P P E N D I X.

Appendix, No. 1.

PAPER delivered in by *H. F. Mackworth, Esq.*, and referred to in his Evidence,
16 June 1853.

INSTRUCTIONS and QUESTIONS relative to the Parliamentary Committee, now sitting to
inquire into the Causes of Accidents in Coal Mines.

Appendix, No. 1.

(Copy.)

Sir,

You are no doubt aware that I have given notice to revive the Committee on Accidents in Coal Mines. The Government has consented to its revival, but wish it deferred until the return of two of the Inspectors, who are now inquiring into the system of inspection adopted in foreign countries, and other matters connected with the working of mines. I think it right to inform you, that you will be required to give evidence before the Committee.

The subjects to which I beg leave to direct your attention, as being those on which information is required, will be ventilation by furnace, steam jet, or any other mode either in use or which may be suggested as an improvement to those now generally adopted.

The capacity and size of the air-ways, and the best modes of carrying the air through the workings to the upcast shaft, so as either entirely to clear the goaves of foul air, or to leave as little in them as possible, and to prevent what may remain from escaping into the workings, so as to cause accidents by explosions. The methods of supporting the roof and sides, so as to prevent as much as possible the recurrence of accidents from falling masses of materials. The best mode of winding the men up shafts, so as to lessen their risk by the breakage of ropes, chains, or parts of the winding machinery, and any other precautions you may think necessary, to lessen the number of accidents which occur.

Your attention is also directed to the safety lamp; and your opinion is also solicited as to whether you agree with the Report of the Committee of 1852 on that subject; and whether, since that, any new discovery has been made which will tend to the improvement of the safety lamp.

Your opinion will also be required as to the system of inspection; whether or not you approve of having Government Inspectors; and if you do, whether or not you think the present number are sufficient, and if not, what increase you would suggest.

You will observe that in coroners' verdicts, in at least 99 cases out of 100, a verdict of "accidental death" is returned. This may be accounted for by the state of the law, which gives no discretion to coroners' juries, who are either obliged to return a verdict of accidental death, or manslaughter.

Your opinion is requested as to whether some law should not be made enabling a jury to assess damages in case of carelessness, or to assimilate the law to that of Scotland.

Your opinion is also desired as to whether power should not be given to magistrates or to the Secretary of State, on the representation of the Inspectors, to levy fines on the owners of collieries, where necessary precautions are not taken to prevent accidents; and also upon the workmen who uncover their safety lamps in dangerous situations, or commit any other reckless act, so as to endanger the lives of their fellow-workmen.

You will also probably be invited to give an opinion as to what system can be adopted, which would work best, for the establishment of schools for the children of workmen, and funds for the relief of themselves in case of sickness, and of the widows and orphans of those who may meet their death through accidents.

Any other information you may feel disposed to tender, that may enable the Committee to come to a conclusion on the several subjects connected with their inquiry, will be acceptable.

The Committee will probably assemble about the end of May; but due notice will of course be given to you as to the day on which your attendance is required. I shall be glad if, before that time, you will furnish me with a draft of the evidence that you may wish to tender, that I may have no difficulty in proceeding with your examination when you are called upon.

25, Eaton-square, London,
3 May 1853.

I am, &c.
(signed) *E. J. Hutchins.*

Appendix, No. 1.

TABULAR VIEW of the Number of ACCIDENTS causing DEATH in the COAL MINES of Great Britain, in 1851 and 1852.

Counties comprised in Districts.	In Shafts.	From Falls of Roof.	From Explosions of Fire Damp.	Miscellaneous.	TOTALS.	YEARS.
Lancashire, Cheshire, North Wales, Stafford, Worcester, Shropshire -	101	152	55	37	345	1851
Ditto - - - - -	87	177	51	31	346	1852
Scotland - - - - -	28	45	2	9	84	1851
Ditto - - - - -	19	23	5	10	57	1852
Northumberland, Durham, Cumberland - - - - -	15	31	10	39	95	1851
Ditto - - - - -	23	44	10	39	116	1852
York, Derby, Nottingham, Warwick - - - - -	19	29	17	10	75	1851
Ditto - - - - -	26	33	11	20	90	1852
Monmouth, Gloucester, Somerset, and South Wales - - - - -	22	50	14	13	99	1851
Ditto - - - - -	20	56	14	22	112	1852
TOTAL in Great Britain -	185	307	98	108	698	1851
Ditto - - - - -	175	338	91	122	721	1852

TABULAR VIEW of the LIVES Lost in the COAL MINES of Great Britain, in the Years 1851 and 1852.

Counties comprised in Districts.	In Shafts.	From Falls of Roof.	From Explosions of Fire Damp.	Miscellaneous.	TOTALS.	YEARS.
Lancashire, Cheshire, North Wales, Stafford, Worcester, Shropshire -	114	159	111	42	426	1851
Ditto - - - - -	103	190	116	39	448	1852
Scotland - - - - -	28	52	62	8	150	1851
Ditto - - - - -	20	23	5	13	61	1852
Northumberland, Durham, Cumberland - - - - -	15	32	57	39	143	1851
Ditto - - - - -	28	44	38	43	153	1852
Yorkshire, Derbyshire, Nottingham, Warwick - - - - -	19	30	76	10	135	1851
Ditto - - - - -	28	35	22	23	108	1852
Monmouth, Gloucester, Somerset, and South Wales - - - - -	41	54	15	20	130	1851
Ditto - - - - -	26	57	83	50	216	1852
TOTAL in Great Britain -	217	327	321	119	984	1851
Ditto - - - - -	205	349	264	168	986	1852

Note.—The serious explosions in 1851, were :

15 March -	Nitshill - - - - -	61	Killed.
20 December -	Warren Vale - - - - -	52	"
22 " -	Ince - - - - -	13	"
	TOTAL - - - - -	126	Killed.

The serious explosions in 1852, were :

24 April -	Norley Hall - - - - -	12	Killed.
6 May -	Hebburn - - - - -	22	"
10 " -	Dyffryn - - - - -	65	"
20 " -	Coppull - - - - -	36	"
22 December -	Elsecar - - - - -	10	"
	TOTAL - - - - -	145	Killed.

HAINAULT, BELGIUM.—LIST OF ACCIDENTS.

Province of Hainault, comprising the Two Districts of *Mons* and *Charleroi*.

	1849.		1850.		1851.		1852.	
	Accidents.	Killed.	Accidents.	Killed.	Accidents.	Killed.	Accidents.	Killed.
Descending by ropes or chains - - - - -	9	12	8	21 (a)	7	6	14	22
Descending by ladders - - - - -	7	4	3	2	4	1	6	5
In the shafts from other causes - - - - -	8	9	14	9	12	10	18	16
Falls of roof and coal - - - - -	31	19	49	32	46	40	41	38
Explosions of fire damp - - - - -	7	6	3	83 (b)	2	5	7	106 (c)
Inundations - - - - -	2	-	-	-	1	-	1	2
Explosions of powder in blasting - - - - -	2	1	1	-	2	-	3	-
Suffocated - - - - -	3	3	1	1	2	2	-	-
Accidents on inclined planes - - - - -	14	2	16	8	8	2	-	-
Accidents from divers causes - - - - -	10	5	14	4	5	2	26	21
	92	61	109	160	89	68	116	205

Accidents. Killed. Wounded.

The average Number of accidents for the 10 years before 1850 were - - - - -

114 71 93

(a) Includes 12 men killed by the breakage of a wire rope at the colliery *Masse St. François*.

(b) Includes 76 men killed at *Quaregnon*.

(c) Includes 69 men killed at *Long Terne Ferrand*, near *Elouge*, and 35 at *Longterne Trischer*.

	1850.	1851.	
Number of winding pits at work - - - - -	244	228	
Number of workmen employed - - - - -	34,800	35,468	
Quantity of coal - - - - -	4,420,761	4,753,186	Tons.

Average number of deaths in 1851 and 1852, which is much above the average - - - } 3.88 per annum per 1,000 workmen.

Average in whole of Belgium in 1851, is 2.2 per 1,000; in 1852, is 4.6 per 1,000; from 1845 to 1850, 2.82 per 1,000.

COMPARATIVE LOSS OF LIFE IN COAL MINES per 10,000 Persons employed in and on the Mines per Annum on 460,000 Persons in England, 256,760 in Belgium, 73,275 in Westphalia.

	Falls of Roof.	Explosions of Fire Damp.	Breakage of Ropes and Chains.	Ladders.	In Shafts.	Blasting.	Inundations.	Miscellaneous.	TOTAL.
Great Britain: 1851 and 1852 - - - - -	14.4	12.4	- -	9.0	- -	- -	6.1	- -	41.9
Westphalia (Grafschaft Mark): Years 1841 to 1852 - - - - -	10.0	1.0	- -	4.0	- -	- -	1.0	- -	16.0
Belgium: 1846 to 1850 - - - - -	9.4	5.4	3.2	0.8	3.6	0.6	0.2	5.0	28.2

Appendix, No. 1. **GENERAL LAW concerning the Ventilation, Lighting, and employment of Gunpowder, in the operations of Mining, especially in Coal Mines subject to Fire Damp.**

[REPORT TO THE KING.]

Sire,

1 March 1860.

THE presence of carburetted hydrogen gas (fire damp) in coal-mines has hitherto produced the most lamentable effects on the mortality of the workmen. The statistical tables show that the majority of these great catastrophes in our mines must be attributed to the ignition of this dangerous gas. The determining cause of these explosions is to be found principally in vicious methods of ventilation, in the imperfection of the means for lighting, and on the careless or ignorant use of powder in blasting mineral substances. It is there that the evil exists; it is there that the remedy must be applied. To prevent the recurrence of fresh calamities, the provincial councils, in unison with the Government, have sanctioned several rules of special police. But these arrangements not emanating from a single source, have not that similarity and general character which are required to render the application equally useful in all our coal basins; in other respects they are also wanting. In order to introduce uniformity of action in the administration, and better to caution the workmen against the perils by which they are menaced in their occupations, my department has charged a special commission to lay down a project for a public law concerning ventilation, lighting, and using powder in mining works, especially in fire damp mines.

This commission, composed of Government engineers and the directors of important collieries, offers every guarantee for the defence of the various interests engaged in the working of mines. The project which I have the honour to submit to your Majesty is the work of the commission. Most of the arrangements it encloses are in operation in the provincial regulations; their salutary effects have been already confirmed by practice; the rules hereby added are with the object of extending the application to all the coal basins. Several new arrangements guaranteed by experience and science, are intended to increase the safety of the workmen, in neutralising or removing the causes of danger. Finally, this law, in the manner in which it has been constructed, as well as by the protective measure which it holds sacred, and the similarity and unity of purpose which it presents, appears to me to respond entirely to the intentions of Government. The Article 67 of the Constitution confers on the chief of the State the power to make laws and bye-laws, when necessary, for the execution of the fundamental laws. The project hereto annexed being but the development and the putting in operation of the arrangements of police authorised by the law of 21 April 1810, and the decree of the 3d January 1813, the right of sanctioning it and rendering it obligatory, belongs essentially to the exercise of the constitutional prerogative of your Majesty. I venture to think, Sire, that if my proposals receive your Majesty's approbation, working miners and all persons who are interested in their welfare, will receive this law as a new evidence of the anxiety of the Government for the amelioration of the labouring class.]

LEOPOLD, &c.,

HAVING seen the law of the 21st April 1810, and the Imperial decree of the 3d January 1813, on mines:

Having reviewed our orders of 11th May 1840, 11th August 1841, and 29th June 1844, approving of the bye-laws concerning ventilation, lighting, and the use of powder in the mines of Liege and of Hainault, and particularly in the fire damp mines:

Having seen Article 67 of the Constitution, and Article 85 of the Provincial Law of the 30th April 1836:

Considering that it is useful to generalise certain measures, and to introduce into the administrative action unity of purpose, and every uniformity compatible with the particular circumstances of mining in various localities:

On the proposal of our Minister of Public Works, we have commanded, and do command:

CHAPTER I.—EXPLOITATIONS IN GENERAL.

Article 1. In every subterranean exploitation all the points of works to which the workmen can gain access to, shall be rendered healthy and safe by an active and regular current of pure air.

The velocity and abundance of this current, as well as the size of the galleries, which must be easily accessible in all their parts, shall be everywhere regulated according to the number of the workmen, the extent of the works, and the natural emanations from the mines.

2. The ventilation shall be effected and uniformly sustained by efficacious means, exempt from all danger.

3. Every current of air seriously vitiated by an admixture of inflammable or deleterious gas, shall be carefully separated from every working place and frequented road. The extent of the working faces shall be so from time to time limited, as to protect the workmen placed in the return current from the hurtful effects of too great a deterioration in the air.

4. The

4. The stoppings or gobblings established, either to support the rocks or to separate the tramways from the corresponding ventilation galleries, shall be everywhere rendered as firm, as well-maintained, and as impermeable as possible.

5. These gobblings shall advance to within a short distance of the working faces, so as to hinder, towards those points, the slackening of the current and the stagnation of hurtful gases.

6. The works shall be so disposed as to avoid the use of many doors to direct or divide the current of air.

Every door intended to divide the ventilation shall be furnished with a trap, the opening of which can be regulated as required. The use of double or treble doors, conveniently placed, is imperative in roads where they have to be frequently opened for the service of the mine.

CHAPTER II.—FIRE DAMP MINES.

Ventilation.

7. In fire damp mines the mining shall proceed, as far as possible, by successive stages, worked in descending order.

With the exception of cases authorised by the administration, the whole and every part of the works shall be so disposed as never to cause the descent of air more or less charged with inflammable gases.

8. The air shall escape by one pit, appointed for this purpose, and isolated from the other pits by a sufficient thickness of rock.

The exhaustion of the air shall be produced either by mechanical means, or by heating, to the exclusion of lamps or furnaces fed by the air returning from the mine. At the surface, every precaution shall be taken to protect every furnace from the gas which issues from the mine.

9. The intake and return air passages shall be separated by ribs, sufficiently thick to preclude damage being caused by an explosion.

10.

Lighting.

11. The use of safety lamps, of the kind admitted by the Administration of Mines, is compulsory in fire damp mines.

12. Safety lamps shall be locked; they shall be kept at the office, where special workmen shall be employed to examine, clean, and maintain them every day in good condition.

13. At the time of descending, the lamp is to be given to each workman, and he is required to assure himself that it is locked.

14. He is expressly forbidden to open the lamps in the works. Those which go out shall be sent back either to the surface, or to some appointed place in the mine, where they shall be inspected, re-lighted, and locked, by men specially appointed to this charge.

15. When fire damp may appear in a working place or gallery, in sufficient quantity to produce a continued lengthening of the flame of the lamps, the work shall be immediately stopped, until this danger has ceased.

Use of Gunpowder.

16. The use of gunpowder for blasting coal in fire damp seams is forbidden, with those exceptions which are permitted by the Administration.

17. The employment of this aid is only allowed for works in the rock, under the reserve expressed in the following conditions:—

1st. No substance is to be employed for lighting the match, which is capable of burning with flame.

2d. Not to fire the shot, until by inspection of the flame of the lamp it has been carefully ascertained that there is no inflammable gas in that part of the works.

3d. To appoint for the performance of this duty, and that of lighting the charge, master workmen, or experienced miners previously exercised in this duty.

CHAPTER III.

18. There shall be in every exploitation, especially in fire damp mines, besides the overmen, a certain number of miners (overlookers) specially entrusted with the details of the daily supervision of the means of ventilation and lighting.

The number of overlookers shall be fixed by the engineer of mines, according to the extent of the works, the nature and abundance of the gases, and the degree of security which the system of ventilation presents.

Appendix, No. 1.

19. These miners, as well as the blast lighter, shall be designated by the director on the register of the control of the workmen.

20. These miners in their capacity of overlookers, each in his appointed district shall—

A. Visit with care the air courses, and cause them to be maintained in good condition ; not allow the whole or part of a gang of workmen to enter the works until he has ascertained that the air there is pure, that the ventilation is sufficiently active, that all things are in order, and that there exists no kind of danger for the workman which is capable of being removed.

B. Maintain during all working hours a strict supervision in the working faces and most frequented roads in all that concerns the management of lamps, in the getting and removal of materials, in the opening of doors, in a word, in everything essentially connected with the efficiency of the ventilation, and the security of lights.

C. Inform against the authors of every breach of the rules of prudence and discipline, in order that they may be punished ; and denounce in a similar manner every workman who may carry a pipe, matches, or any materials for striking a light in works where the employment of safety lamps is compulsory.

D. Stop the work in every part where fire damp is seen, and direct with prudence the retreat of the workmen.

21. The engineers of mines shall exercise a strict control over the preceding arrangements ; they shall assist, when required, the managers with their advice ; they shall inscribe in such a case their recommendations in a register specially kept for this purpose in the office of the works, and which shall be substituted, in this instance, for the register of progress mentioned in the Article 6, of the decree of 3d January 1813. At each visit they shall inscribe on this register the result of their observations.

22. When they are called upon the permanent deputations of the Provincial Council can grant delays or conditional dispensations to secure the rigorous fulfilment of the preceding arrangements.

23. Any breach of the above regulations shall be prosecuted and tried conformably to the 10th Title of the Law 21st April 1810, on Mines and Quarries.

24. Our Minister of Public Works is charged with the carrying out of the present regulations of general administration.

Appendix, No. 2.

PAPER delivered in by Mr. *Herbert Francis Mackworth*.

COMPARATIVE ABSTRACT of EXPERIMENTS on the ECONOMY of FOUR KINDS of FANS, by Mr. *Jochans*.

NATURE OF THE RESULTS OF THE EXPERIMENTS.	KIND OF VENTILATING FAN EMPLOYED.				
	Fabry's.	Letoret's.	Pasquet's.	Motte's.	
Velocity of pistons, in feet per minute - - -	161	236	207	195	
Depression of water-gauge, in inches - - -	1.96	1.65	1.37	0.94	
Quantity of air extracted, in cubic feet per minute	19,758	18,540	16,002	10,932	
Motive power transmitted to the ventilator, in } horse-power - - - - -	10.37	11.37	9.56	6.50	
Useful effect obtained, in ditto - - - - -	6.22	3.58	3.52	1.65	
Proportion of useful effect to power transmitted -	0.60	0.32	0.37	0.25	
Coal consumed, per horse-power per hour, in lbs. -	12.2	12.87	15.9	17.4	
Water evaporated, per horse-power expended, per } hour, in lbs. - - - - -	73.4	77.2	95.4	104.7	
Coal consumed, per horse-power utilized, per hour, } in lbs. - - - - -	21.5	43.9	45.1	73.6	
Water evaporated, per horse-power utilized, per } hour, in lbs. - - - - -	129	263.3	270.5	441.4	
Cost of first establishment complete, in £. - - -	{ 403 <i>l.</i> 13 <i>s.</i> 355 <i>l.</i> 13 <i>s.</i> }	252 <i>l.</i>	195 <i>l.</i>	164 <i>l.</i> 9 <i>s.</i>	Without boilers.
Cost of first establishment, per horse-power of } useful effect, in £. - - - - -	{ 48 <i>l.</i> 42 <i>s.</i> 8 <i>d.</i> }	45 <i>l.</i> 2 <i>s.</i>	50 <i>l.</i> 7 <i>s.</i>	74 <i>l.</i> 13 <i>s.</i>	
Cost of the ventilator alone, in £. - - - - -	{ 220 <i>l.</i> 176 <i>l.</i> }	24 <i>l.</i>	43 <i>l.</i> 16 <i>s.</i>	42 <i>l.</i> 17 <i>s.</i>	
Cost of the ventilator, per horse-power of useful } effect, in £. - - - - -	{ 26 <i>l.</i> 5 <i>s.</i> 20 <i>l.</i> 19 <i>s.</i> }	4 <i>l.</i> 6 <i>s.</i>	11 <i>l.</i> 7 <i>s.</i>	19 <i>l.</i> 4 <i>s.</i>	
Cost of working, per year, in £. - - - - -	129 <i>l.</i> 17 <i>s.</i>	203 <i>l.</i> 3 <i>s.</i>	143 <i>l.</i>	128 <i>l.</i> 3 <i>s.</i>	
Cost of working, per horse-power of useful effect, } in £. per year - - - - -	26 <i>l.</i> 10 <i>s.</i>	56 <i>l.</i> 8 <i>s.</i>	56 <i>l.</i> 17 <i>s.</i>	57 <i>l.</i> 10 <i>s.</i>	
Maximum quantity of air extracted, in cubic feet -	23,590	26,256 *	21,982	15,397	* The ventilator not exhausting from the mine.
Corresponding depression of water-gauge, in inches	1.81	1.34	1.10	0.90	
Maximum depression, in inches - - - - -	3.38	2.04	1.77	1.10	
Maximum useful effect, in horse-power - - - - -	8.39	5.61	3.87	2.23	
Proportion of maximum useful effect to power } expended - - - - -	0.66	0.60	0.41	0.37	

ABSTRACT of FIVE EXPERIMENTS ON FABRY'S PNEUMATIC WHEELS, by Monsieur Jochams, Engineer of Mines.

	Velocity of Piston of Steam-engine, in Feet, per Minute.	Water-gauge, near the Ventilator, in Inches.	Cubic Feet of Air Exhausted per Minute.	Moving Force transmitted to the Ventilator, in Horse-power.	Work Utilized, in Horse-power.	Proportion of Useful Effect to Power expended.	Coal Consumed (per Hour, per Horse-power Expended), in Lbs.	Coal Consumed (per Hour, per Horse-power Utilized), in Lbs.	Weight of Water Evaporated (per Horse-power Expended per Hour), in Lbs.	Weight of Water Evaporated (per Horse-power Utilized, per Hour), in Lbs.
Fabry's Ventilator -	128	0.88	20,330	5.87	2.81	.52	14.43	27.6	86.6	165.7
Ditto - -	173	1.6	21,500	10.37	5.41	.52	12.10	28.2	72.6	139.2
Ditto - -	149.5	2.4	16,817	8.95	5.97	.67	11.4	17.2	68.9	120.6
Ditto - -	142	3.0	14,776	11.21	6.97	.62	11.20	18.04	67.19	108.24
Ditto - -	112	3.44	8,912	8.46	4.82	.57	11.28	19.82	67.71	118.93
<i>Note.</i> —They are quite new, fitted up in the best manner, with horizontal cylinders and direct action.										
Struve's Ventilator } at Eaglesbush }	204	1.55	16,950	5.85	4.14	.70	15.90	22.46	89.9	127.1

Note.—The engine is second-hand, the steam passages contracted, and the ventilator beam is attached to the engine by single link chains, 60 feet long.

COMPARATIVE TABLE of COST of EIGHT KINDS of VENTILATING MACHINES, according to Monsieur Ponson.

KIND OF VENTILATOR.	Cost of Ventilator, Engine, &c.	Cost of the same per Horse-power, Utilized.	Cost of the Ventilator alone.	Cost of same, per Horse-power, Utilized.	Working Expenses, Annual.	Cost of Working, per Horse-power, per Year.
	£.	£.	£.	£.	£.	£.
Cylinder and piston machines - - -	1,020	210	140	29	263	54
Single-acting airometers - - -	514	138	195	53	193	40
Curved vane fans - - -	198	184	45	42	136	126
Straight vane fans - - -	254	65	24	6	203	53
Motte's screw - - -	166	180	43	46	128	136
Fasquet's spiral - - -	195	59	44	13	143	43
Windmill ventilator (Lesoinne's) - - -	192	218	50	57	141	161
Fabry's pneumatic wheels - - -	355	54	136	27	130	20

Appendix, No. 3.

PAPER delivered in by Mr. Herbert Francis Mackworth.

EXPERIMENTS ON VENTILATORS.

1. *Motte's Pneumatic Screw.*—The first kind applied to the ventilation of mines in 1839 at Monceau Fontaine, near Charleroi, was awarded a premium by the Academy of Sciences. It is a double-blade Archimedian screw, 7 ft. 4½ in. in diameter, 8 ft. 7 in. in length, which is half the pitch of the blades. It revolves in a horizontal cylinder cased with masonry, and it is set in motion by a strap, which multiplies the velocity 7·2 times. At the outer end of the screw is an iron disc 5 ft. 7 in. in diameter, to prevent any reaction of air in the central part of the screw. The annular space for the escape of the air is therefore 11 inches wide.

Appendix, No. 3.
Vide Plan (A.)

The downcast shaft of the mine is 315 yards deep, area 61 square feet; the upcast shaft is 238 yards deep, and 22 square feet in area. There are three main currents or splits of air in the workings, and one sub-division. The sum of the length of the four splits is 8,660 yards; the average area 14½ square feet. When the pressure of the steam in the boiler was 38 lbs. the number of revolutions of the screw was 274 per minute; the water-gauge ·92 inch, the quantity of air exhausted 15,396 cubic feet per minute. The work utilised on the air was therefore 2·23 horse power. The work expended on the strap was 5·98 horse power, the ratio between these, being that of useful effect to power expended, is 37 per cent.

With the same power applied and the same number of revolutions, the resistance was increased to 1·12 inch water-gauge, the ventilation fell to 9,030 cubic feet per minute, and the ratio of useful effect to 27 per cent.

It has worked up to 1·8 inch water-gauge.

2. *Lesoinne's Windmill Ventilator.*—Similar in construction to Biram's Anemometer, was first constructed on a large scale in 1845. Vide Plan (B.)

At the Grand Bac Colliery, near Liege, the ventilator is 8 ft. 8 in. in diameter, and nine inches wide in the direction of the axis. Smeaton's angles for the direction of the sails of windmills have been adopted, and the vanes at the circumference are inclined at an angle of seven degrees to the diameter, and near the centre at angle of 19°. It is set in motion by a strap which multiplies four times. The steam-engine has a cylinder 7½ in. diameter, and a stroke of 22½ inches.

The downcast shaft is 273 yards deep, 70 square feet area; the upcast 35 square feet in area. The average length of the air-courses 2,200 yards, and area 30 square feet.

When the steam was at 30 lbs. in the boiler, there were 162 revolutions; the quantity of air 16,000 cubic feet per minute; the water-gauge ½ inch.

Another of these ventilators, of nearly the same dimensions, with 201 revolutions, gave 19,300 cubic feet per minute, with ·52 inch water-gauge, and the highest water-gauge ever obtained by Lesoinne's ventilator is ·56 inch.

3. *Pasquet's Spiral Ventilator* consists of a screw with six threads of sheet iron wrapped round a cylinder 6 feet 7 inches diameter, which is closed by a disc; the external diameter of the spirals is 8 feet 2 inches; the breadth of each thread or vane is therefore 15½ inches in the direction of the radius. Each vane passes one-sixth round the circle, and the amount of pitch, or the breadth of ventilator in direction of radius is 8 inches. Each aperture is 8 inches by 15½ inches, and the sum of the apertures for the escape of the air 5·16 square feet in area. Vide Plans (B.) & (C.)

The diameter of the cylinder of the steam engine is 12½ inches, stroke 2 feet. By wheel gearing, the velocity is multiplied 6·6 times.

At Moulin à Vent Pit, La Reunion Colliery, at Montigny-sur-Sambre, the downcast pit is 68 square feet in area, the upcast 26 square feet in area, and the depth of each is 317 yards.

There are three main splits, two of which are again subdivided; the total length of all the splits is 1,346 yards, and the average area 25 square feet. When the steam in the boiler was at 31 lbs., and the engine making 50 strokes, the spiral 330 revolutions per minute, the water-gauge indicated 1·8 inch; the quantity of air was 12,720 cubic feet;

Appendix, No. 3. the work utilised 3.60 horse power; the work communicated to the axis of the machine 10.87 horse power; therefore the ratio of useful effect to power was 33 per cent. When no air was allowed to pass through the ventilator, with a pressure of 32 lbs. in the boiler, there were 306 revolutions per minute, and the exhaustion upon the air measured by 2.4 inches water-gauge. The best effect is at about one inch of water-gauge.

Vide Plan (A.)

4. *Letoret's Inclined Vane Fan* has four flat vanes fixed at an angle of from 110° to 130° to radial arms. The air enters on each side at the centre, and passes out either at one square aperture, or the whole circumference is left open.

At Grande Veine, at Elouge, near Mons, the outside diameter of the vanes is 9 feet 2 inches; of the inner, and of the circular aperture for the entrance of the air, 4 feet 6 inches; the inclination of vanes to radius 120°; the vanes are 3 feet 3 inches high, and 3 feet 11 inches wide. The motion is given by a strap, which multiplies four times. The horizontal cylinder is 12½ inches diameter, the stroke 2 feet 0¼ inch, and the steam is cut off at 4/5.

The downcast pit is 308 yards deep, 9 feet in diameter. The upcast (ladder) pit 279 yards deep, 5 feet 9 inches diameter.

There are two main splits of air, and four minor; the total length of all the splits is 1,083 yards; average section 30 square feet. The two seams worked are 30 inches and 48 inches thick. The quantity of air extracted was 14,350 cubic feet, at 1,½ inch water-gauge, at 240 revolutions per minute of the fan. The useful effect was 28 per cent.

When one of the galleries was closed the fan made 228 revolutions; the air exhausted was 7,650 cubic feet per minute, at 2 inches water-gauge; the useful effect was 2.46 horse power; the moving force 12.18 horse power; the useful effect 20 per cent.

It has worked up to 2.32 inches water-gauge.

The ventilator and engine, without boiler, cost 160*l.*; the building, 68*l.*; the culvert and connexion with pit, 54*l.*; total, 280*l.*

Vide Plan (C.)

5. *Combes' Curved Vane Fan*.—The air enters on one or both sides of the centre, and is expelled from the circumference by from three to six curved vanes.

At Grand Hornu, near Mons, the diameter of the outer ends of the vanes was four feet eight inches of the inner, and of the aperture for the entrance of the air, three feet seven inches. The vanes, which were three in number, formed an angle of 15 degrees with the inner circle, and ended as tangents to the outer circumference. The axis was vertical, the upper side closed by a disc, the centre of the lower side was open to the shaft, and a ring or collar of sheet iron, five inches in depth, dipped into water to prevent the loss of air.

At 570 revolutions per minute, 5,870 cubic feet of air were exhausted at .86 water-gauge, and 0.78 horse-power were utilised; 4.96 horse-power were transmitted to the fan, and therefore the ratio of useful effect was 16 per cent.

With an improved fan of this kind, and with apertures on each side, as much as 26 to 29 per cent. of useful effect have been obtained by Monsieur Glépin. With 516 revolutions 8,460 cubic feet of air were obtained at a drag of .84 inch water-gauge.

Vide Plan (D.)

6. *Lemielle's Feathering Fan*.—It is on a horizontal axis, the exterior being closed with masonry, except the bottom, which is in connexion with the mine, and the top, which is open for the escape of the air.

That at Pit St. Henri, at Bairmont, has been erected three months, and is the only one in Belgium. It consists of a central six-sided prism, each side four feet six inches wide, and ten feet two inches long (which is the width of the fan); to the angles are attached flaps, four feet six inches wide, working on hinges. The flaps are opened and shut by connecting rods, working on an axis which is 18 inches excentric to the first-mentioned. The fan is constructed of sheet-iron.

The steam-engine, which is in bad order, has 12-inch cylinder, and 38-inch stroke; the motion is communicated by gearing, but not multiplied. Steam in boiler at 30 lbs. Revolutions, 17 per minute. Water-gauge, 1.32 inches, said to give 20,000 cubic feet of air per minute. At 24 revolutions the water-gauge is said to rise to two-and-a-half inches. One which was worked at Seraing, at from 40 to 80 revolutions, gave a water-gauge of four inches.

The experiments on this machine are not as yet sufficient to determine its advantages, but like that of Fabry, it has a slow motion, in which it will possess a great advantage over the other fans, although its friction will be greater in the working parts.

Vide Plan (D.)

7. *Fabry's Pneumatic Wheels*.—First erected in 1845, at Mambourg; were exhibited at the Great Exhibition in 1851. They consist of two wheels, each with three projections or cogs, the surfaces of which so work together, that little or no air can descend between them; and each wheel, in the upward portion of its revolution, drives out the air from the mine. The centres of the wheels are six feet six inches apart; they are six feet six inches long, measuring along the axis. The length of each tooth or cog from the centre is five feet seven inches. They are made either of sheet iron or of wood. The steam-engine has a 12-inch cylinder, and two feet stroke.

The downcast pit is 440 yards deep, and 67 square feet area. The upcast 330 yards-deep, and 27 square feet area.

There

There are three main splits of air, one of which is divided into six minor splits; the average length of each split is 560 yards; average area, 26 square feet. When the pressure in the boiler was 41 lbs., the number of strokes and revolutions, 48 per minute; the water-gauge 1·8 inch. The quantity of air was 24,400 cubic feet; the power utilised, 6·92 horse-power. The horse-power expended on the machine, 12·45. The ratio of useful effect was therefore 55½ per cent.

First Cost:	£.	
12-horse engine, boiler and ventilator - - -	420	
Erecting engine-house, chimney, culvert and machinery - - - - -	197	
	<u>617</u>	
Working Expenses:		£. s. d.
Working and repairs, per annum - - - - -		47 16 -
Coal - - - - -		61 16 -
		<u>109 12 -</u>

It is the intention of Mr. Fabry to simplify and reduce the cost of his machine, by substituting two teeth for three, and five ventilators of this kind are already ordered. This is of a similar kind to that patented by Mr. George Jones, of Lionel Foundry, Birmingham, but which as yet has only been applied to blowing cupolas and forges.

8. *Cylinder and Piston Ventilator.*—That at Hainchamps Pit, near Liege, has been at work for 18 years. It is composed of two wooden cylinders, open at the top, the bottom fitted with valves; they are 11 feet 7 inches in diameter. The pistons are suspended to the opposite extremity of a beam; they are fitted with valves which open upwards; the length of stroke is six feet two inches, and soap and water are used to lubricate the cylinder. Vide Plan (E.)

There are 20 valves in each piston and cylinder bottom. The steam cylinder is fixed over one end of the beam; the stroke, six feet two inches; diameter, 13 inches. With steam in boiler at 41 lbs., the number of strokes was 14, the quantity of air 17,000 cubic feet per minute; the water-gauge indicated 4·2 inches area, 1·8 inch maximum expansion and compression respectively, and a mean resistance represented by three inches of water. The work utilised on the air was, therefore, 7·98 horse power, and taking 50 per cent. off the power of the engine transmitted to the beam, the ratio of useful effect is 56 per cent.

9. *Plunging Bells, or Single-acting Airometers.*—The original and rude form of this machine has been very long known in Cornwall, under the name of the Duck Machine, as well as in the Hartz and other mining districts. It was improved by Mr. A. de Vaux, and erected in 1842 at Mairhaies, near Seraing. It consists of two airometers (similar to gasometers), 11 feet 6 in. in diameter, dipping into water, and having an alternative movement of 5 feet. Vide Plans (E.) & (F.)

With 12½ strokes per minute, the volume of air due to the motion of the machine was 12,890 cubic feet; but the quantity actually passed was only 11,500 cubic feet, owing to leakage and injurious space, &c. The water-gauge varied from 1·96 expansion to ·6 compression. The mean was 1·28 inches.

The work utilised on the air was 2·32 horse power, and the useful effect was 45 per cent. of the power transmitted.

General Remarks.—The ventilators of Combes, Lesoinne, and Motte are not suited to overcome a resistance of more than 5 lbs. per square foot (the second one not half so much); but they exhaust a certain quantity of air at a small cost of outlay and maintenance. Letoret's and Pasquet's ventilators have the additional advantage of working advantageously up to a drag of 10 lbs. per square foot; but the high velocities, as well as certain peculiarities in the use of all the above machines, causes a very considerable loss of power. In this last respect, Lemielle and Fabry's machine possesses a superiority, as well as in their capability of overcoming a resistance amounting to 15 lbs. per square foot. Although in the cylinder and piston machine an almost unlimited drag can be overcome, it is liable to many objections, amongst which are friction, resistance in valves, inadequacy for large ventilations. The single acting airometers, with the same advantage, present fewer defects. The air, however, enters and passes out only below the airometers. When made according to the patent of Mr. W. P. Struvé, of Swansea, with a casing over the airometer, so that the air passes in and out both above and below, it becomes double acting, and a great advantage is obtained. By the use of large valve-areas, each of the four sets of valves being equal to half the area of an airometer, and by working at a slow motion, a power, effect, and economy, exceeding that of all the other machines which I have named, can be obtained. With either two machines, or four, it is competent to produce the largest ventilation required in any mine in England, and to overcome, with economy, at least double the resistance which the ventilation of any mine at present offers. It is capable of

Appendix, No. 3. more expansive action to meet emergencies, and more regulated control, than ventilation by rarefaction.

According to Monsieur Ponson, the ratio of useful effect to transmitted power of eight of the ventilating machines, is as follows:—

Fabry's pneumatic wheels	-	-	-	-	-	-	53 per cent.
Single-acting airometers	-	-	-	-	-	-	48 "
Pasquet's spiral	-	-	-	-	-	-	26 "
Lesoinne's windmill ventilator	-	-	-	-	-	-	25 "
Letoret's fan	-	-	-	-	-	-	24 "
Cylinder exhausting machine	-	-	-	-	-	-	23 "
Motte's pneumatic screw	-	-	-	-	-	-	19 "
Curved vane fan	-	-	-	-	-	-	15 "

To do the same amount of work as the Espérance cylinder ventilator, viz., 17,000 cubic feet of air exhausted at 3 in. water-gauge, would require 138 jets on Mehu's plan $\frac{1}{4}$ in. diameter, tubes or cylinders 8 in. diameter, and 3 ft. 3 in. long, and 150-horse boiler power, with a steam pressure of 75 lbs,

COST.

	£.	s.	d.
Six boilers, each 30 horse power (one being a reserve)	922	-	-
138 Wrought iron tubes	30	-	-
138 Copper pipes, $\frac{1}{2}$ inch diameter, with cock to each	60	-	-
Cast iron tubes to convey the steam	33	-	-
Steam-engine of seven or eight horse power, for feeding boilers	224	-	-
Earthwork and masonry of ventilating gallery	5	10	-
Construction of furnaces and a brick chimney, 43 yards in height and two yards internal diameter	1,124	-	-
Erecting engine and contingencies	80	-	-
£.	2,468	-	-

WORKING EXPENSES.

	£.	s.	d.
Salaries: six firemen, two enginemen, per year	233	10	-
8,758 tons of coal	2,070	-	-
158 lbs. of neats-foot oil	3	10	-
106 lbs. of purified oil	2	10	-
106 lbs. of grease	2	-	-
185 lbs. of waste and hemp	4	-	-
Maintenance and repairs	24	-	-
£.	2,339	-	-

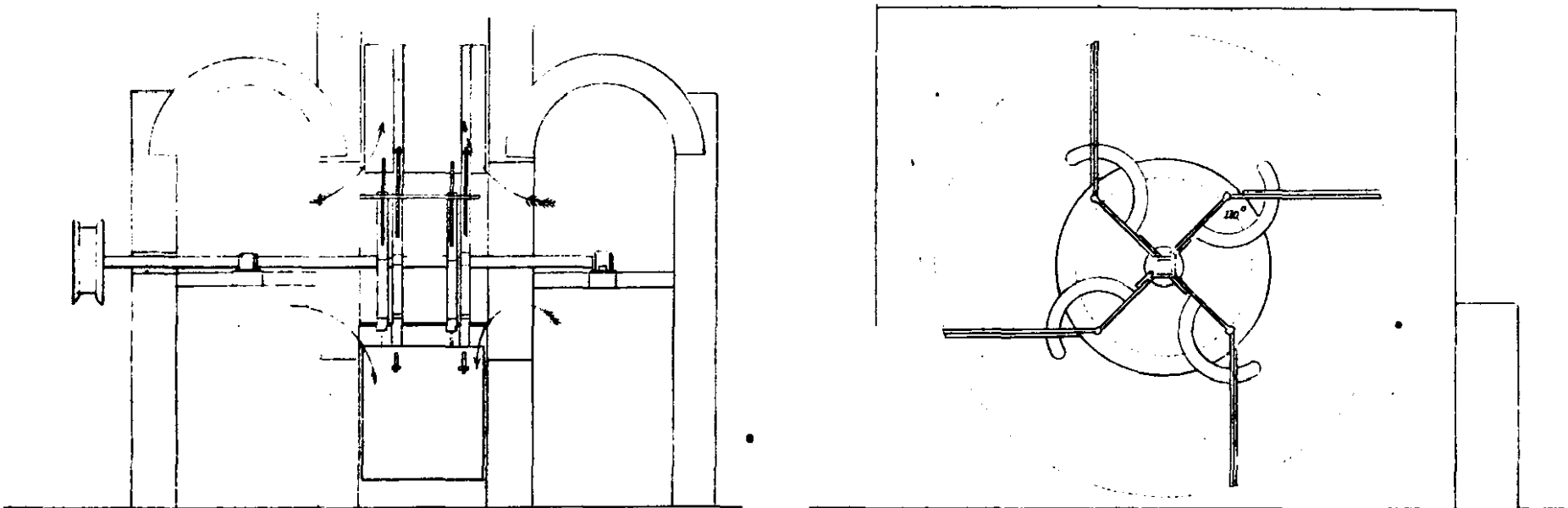
According to the experiments of Mr. Glépin.

COMPARATIVE Economy of Furnace (underground and above), Steam Jet Ventilators, according to Mr. Glépin.

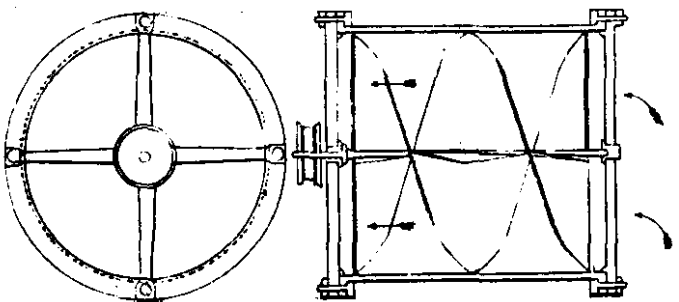
NAME OF APPARATUS.	Moving Power transmitted.	Moving Power Useful Effect.
Exhausting engines, reciprocating motion (Mairhaies)	100	25 to 40
Ventilator of Mr. Combes	100	27 to 29
Screw of Mr. Motte	100	20 to 24
Ventilator with straight vanes of M. Letoret	100	16 to 20
Ventilator of M. Pasquet	100	10 and 24
Steam jet in ventilating shaft	100	6.8
Steam jet of M. Pelletan	100	6 and 7
Ventilator with straight vanes in sheet iron	100	5
Furnace at the surface, with a chimney 45 to 55 yards high	100	4 to 5.5
Apparatus of M. Mehu (steam jet)	100	1.8 to 5.5
Steam-pipe in the ventilating shaft (exhausting)	100	3.5
Ventilating chimney, the furnace working a high-pressure engine	100	0.8
Ditto - ditto ordinary steam engine	100	0.5

*COMPARATIVE

Letorel's Ventilator Fan.



Motte's Pneumatic Screw.



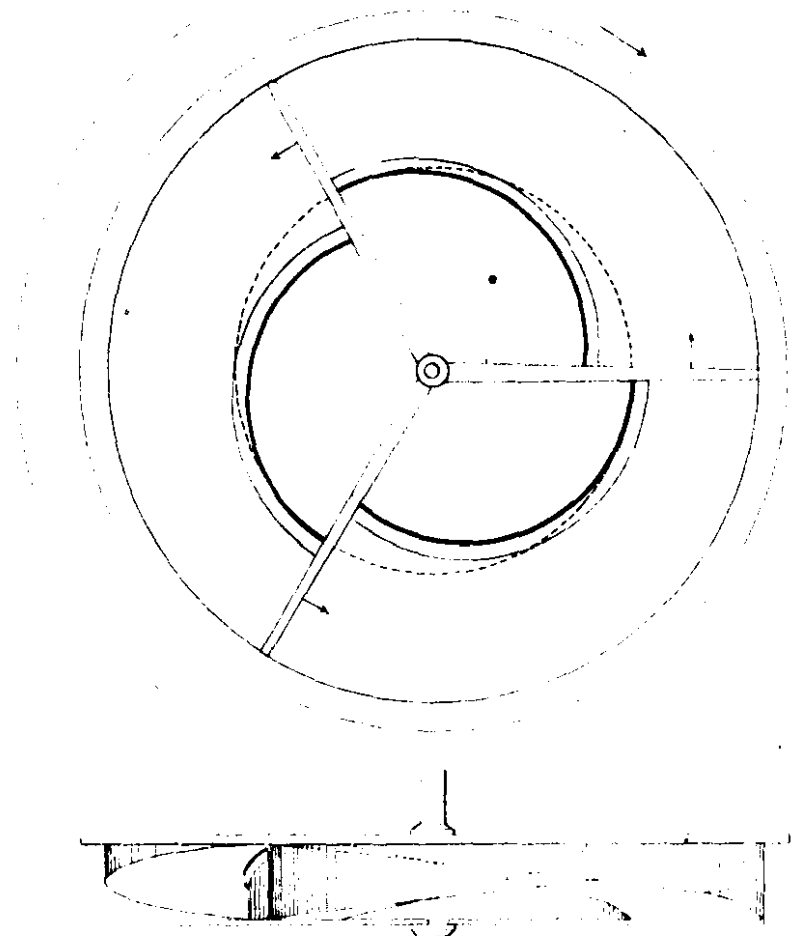
N^o 691.

Ordered, by The House of Commons, to be Printed, 30th June 1853.

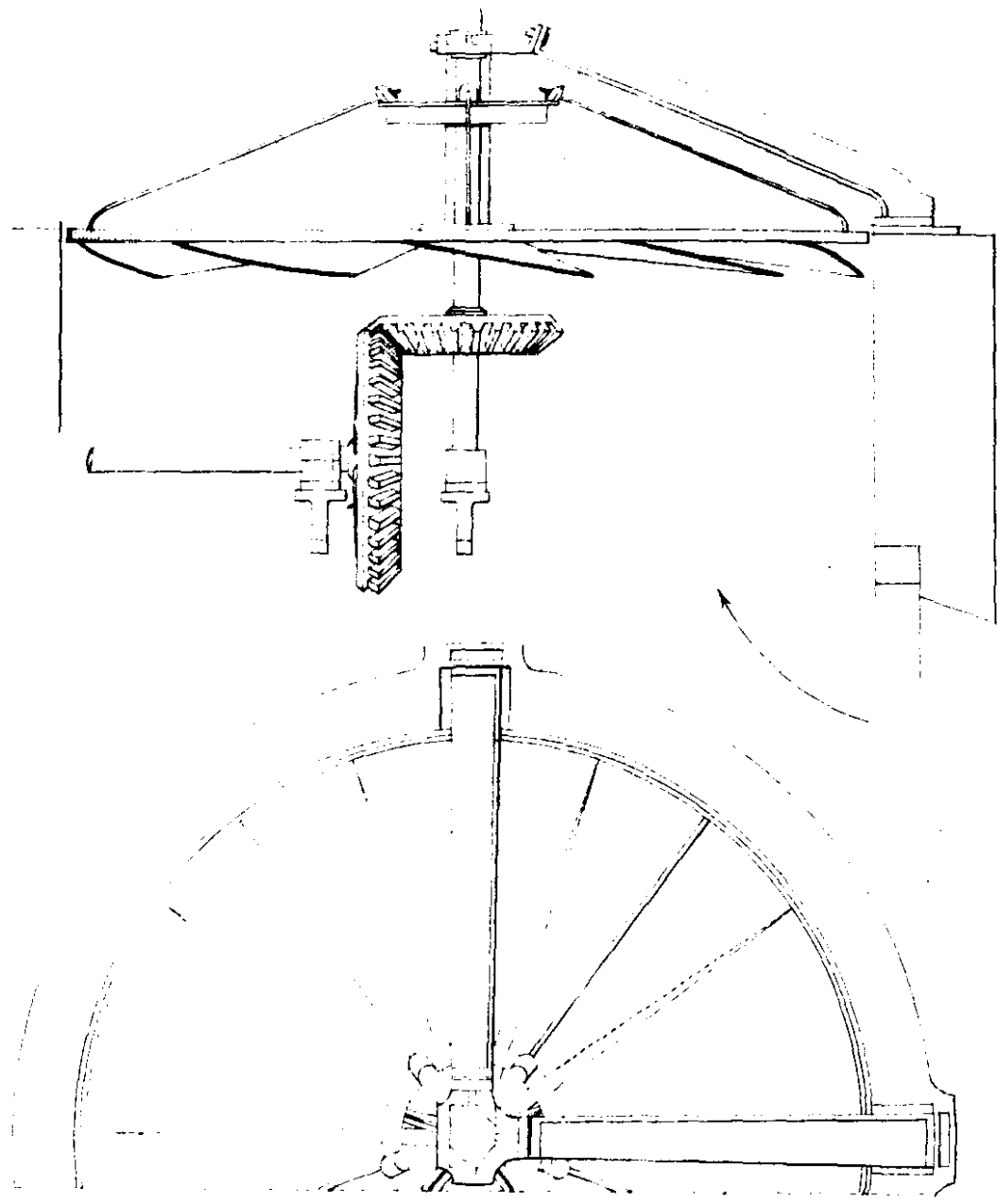
Henry Kimward, Printer.

Machine, 1853.

Pasquet's Ventilator



Lescaupes Windmill Ventilator

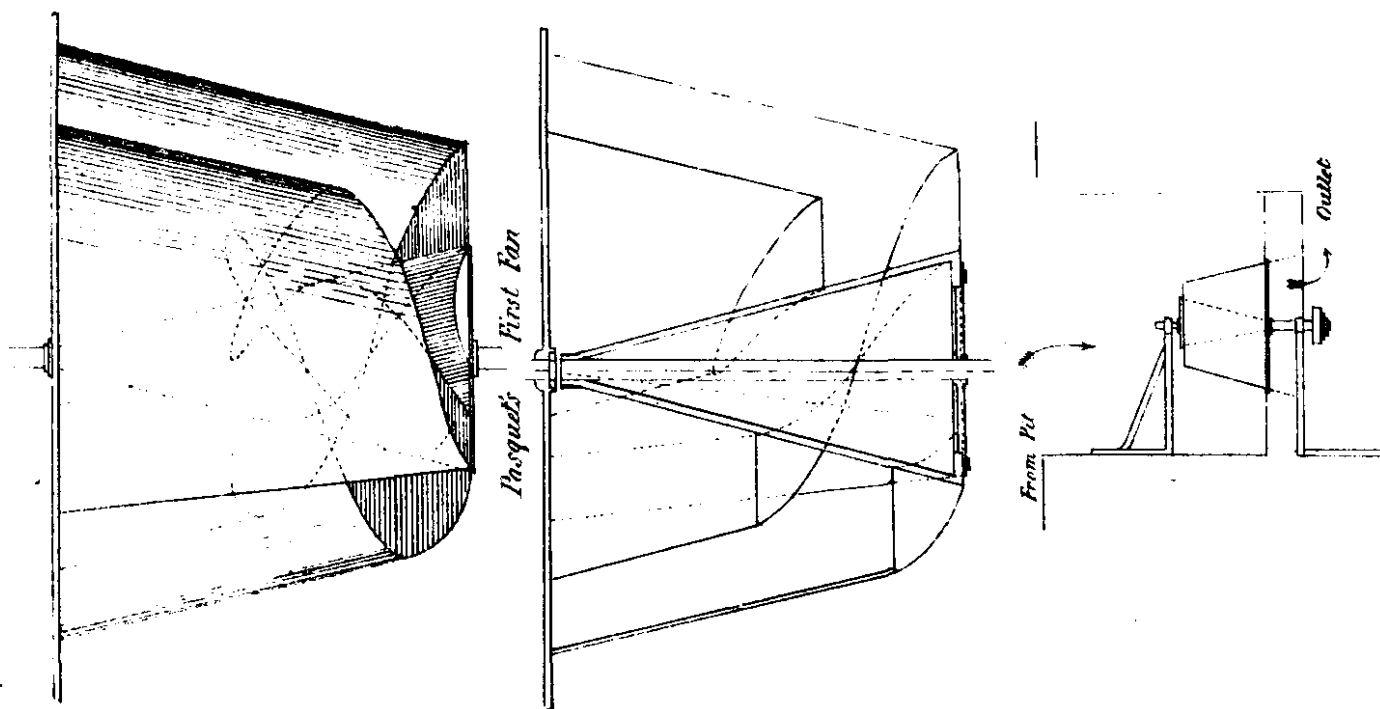
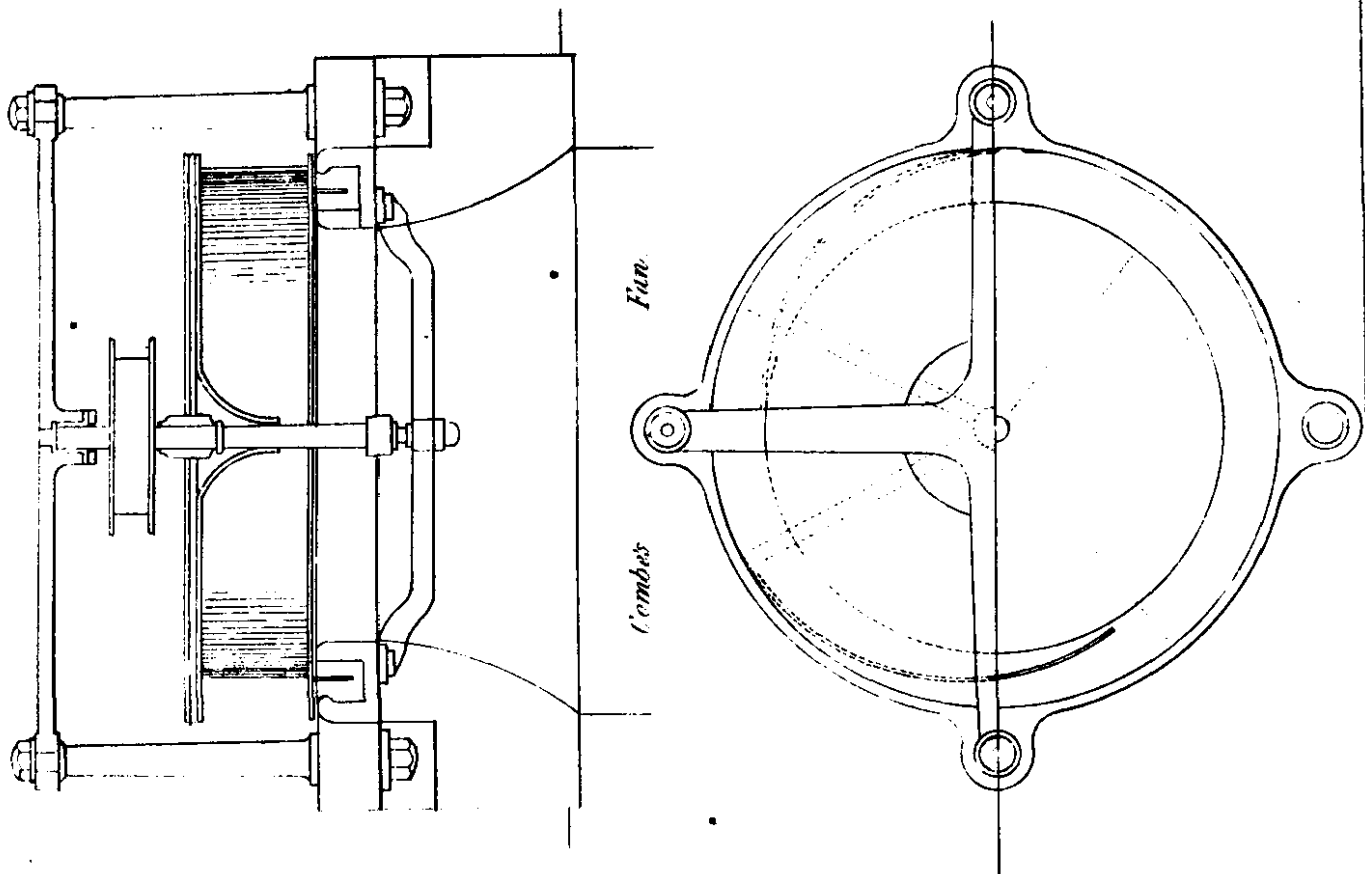


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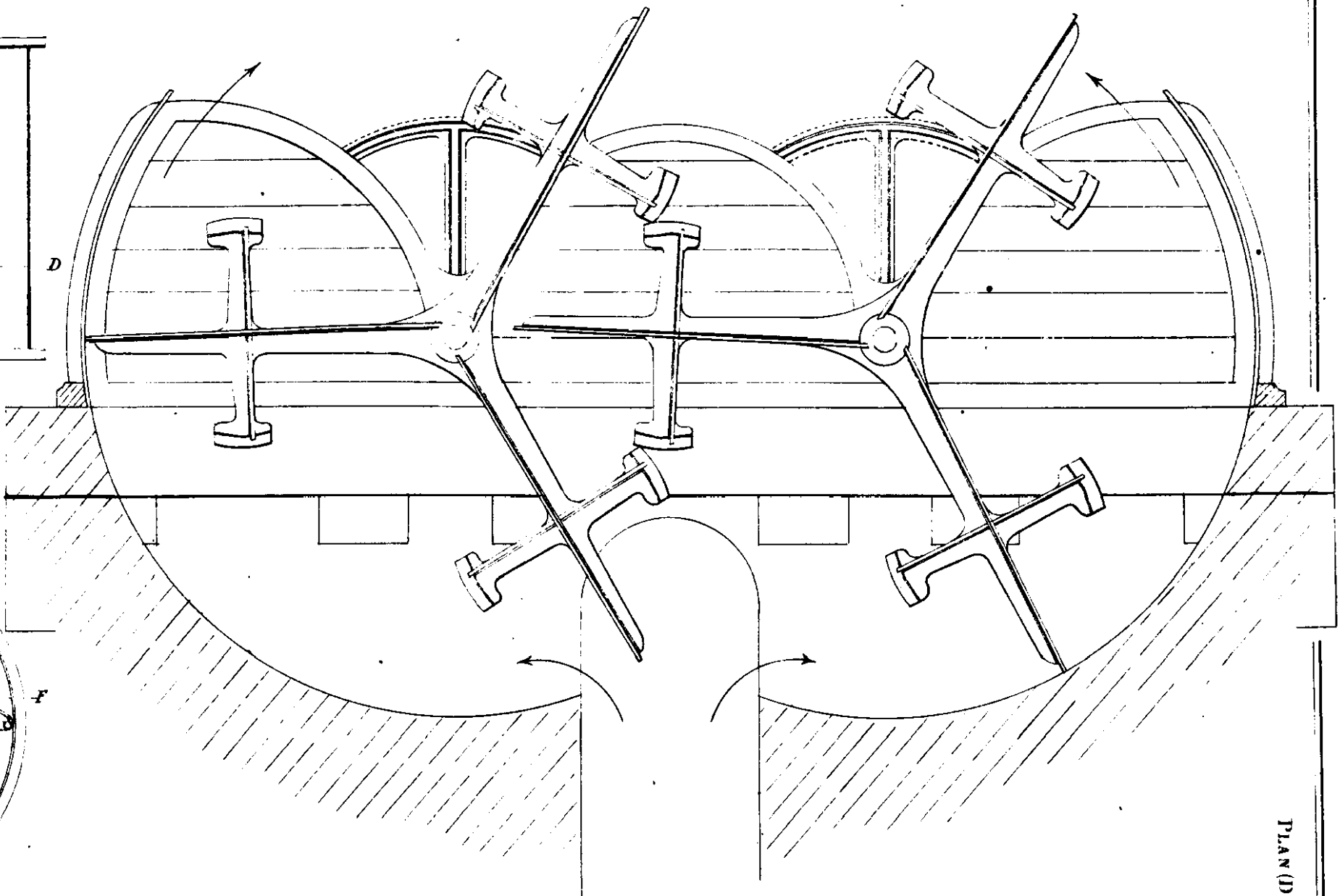
Ordered, by The House of Commons, to be Printed, 30th June 1853.

Henry Hanward, Printer.

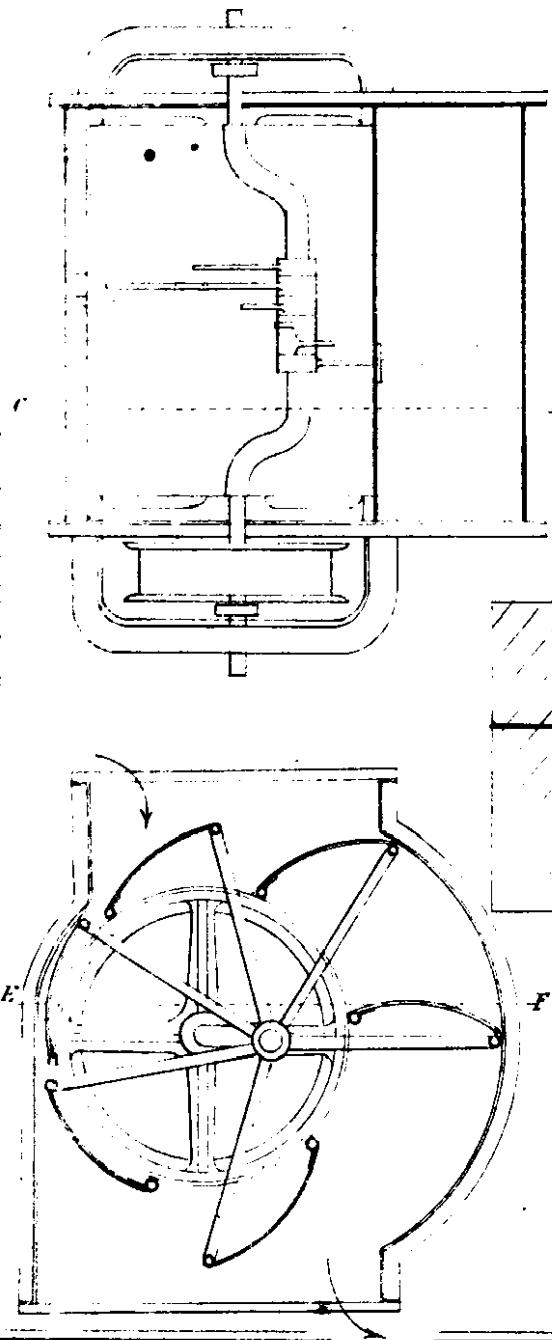
PLAN (C)



Fabry's Ventilator in Wood.



Louette's Feathering Fan.



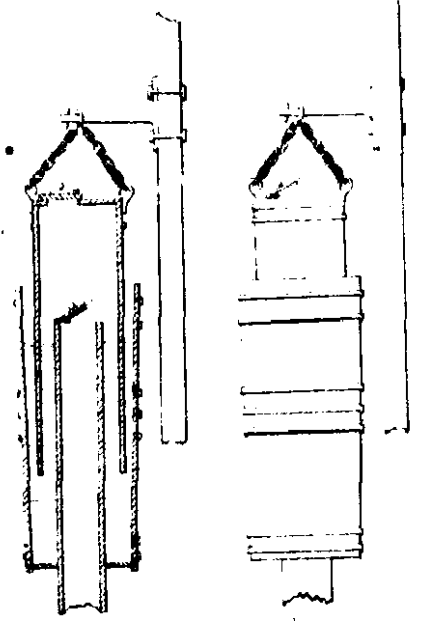
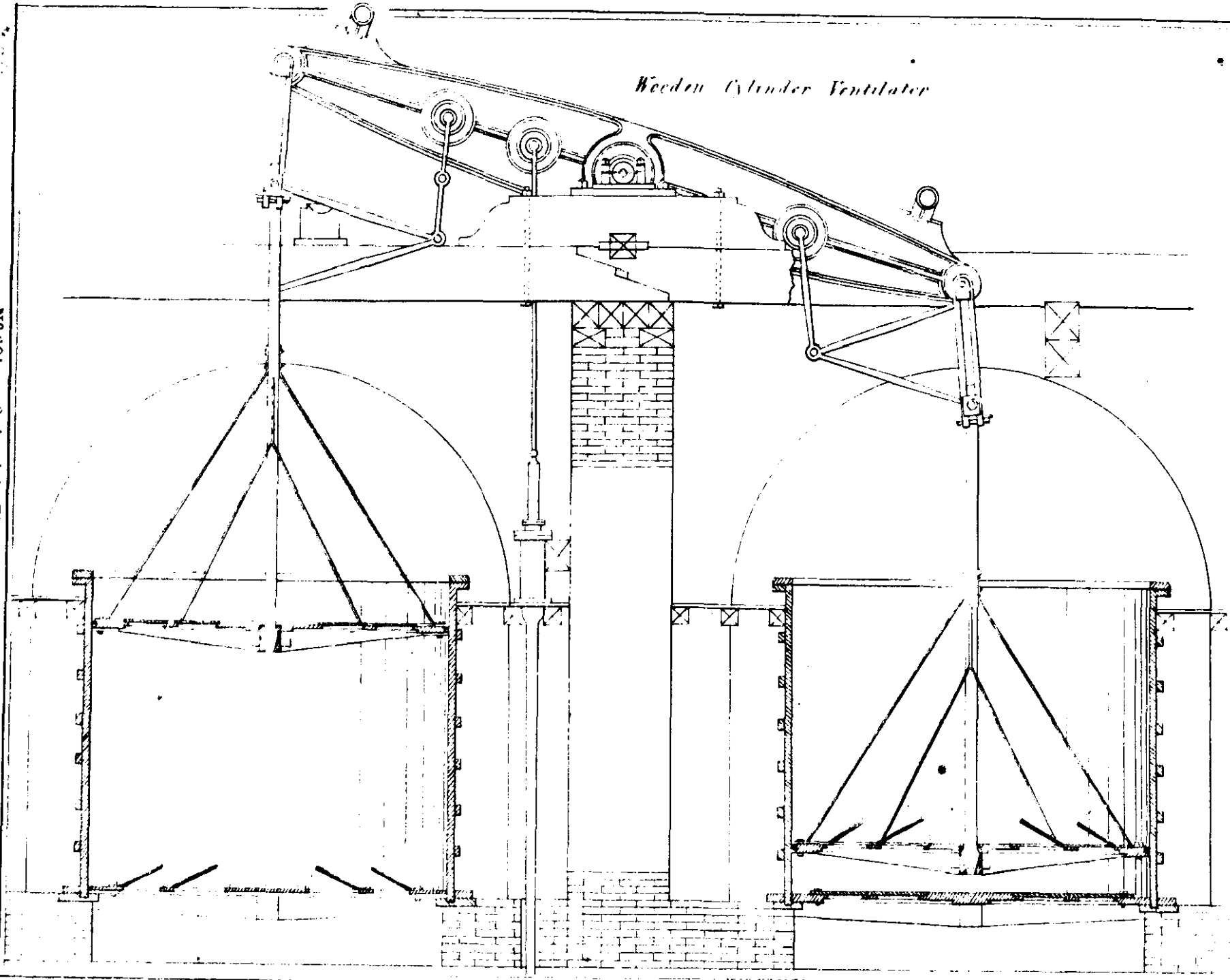
PLAN (D.)

N^o 691.

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Henry Horwood, Printer.

Wooden Cylinder Ventilator

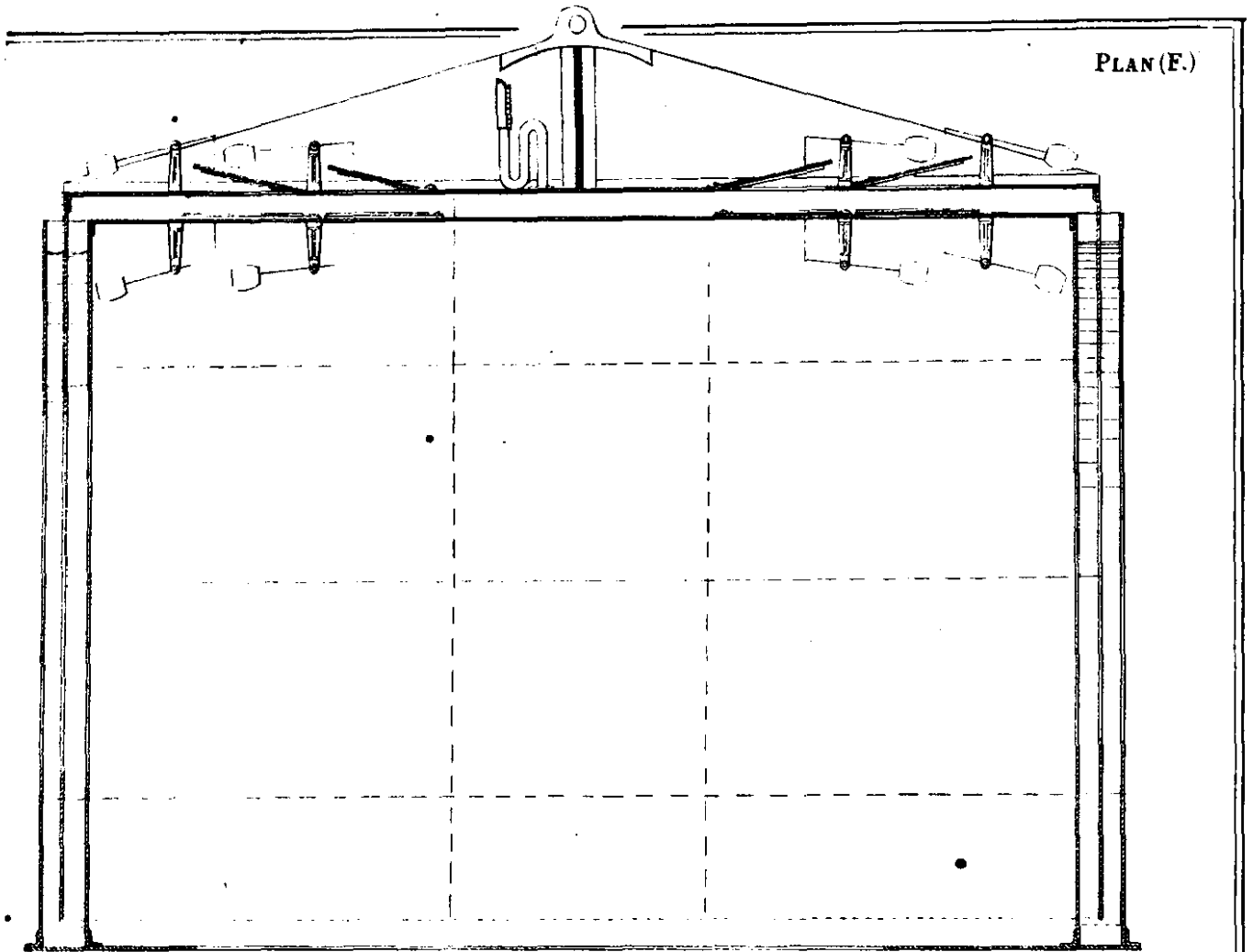


*Exhausting Bell or Duck Machine
used in the Hartz*

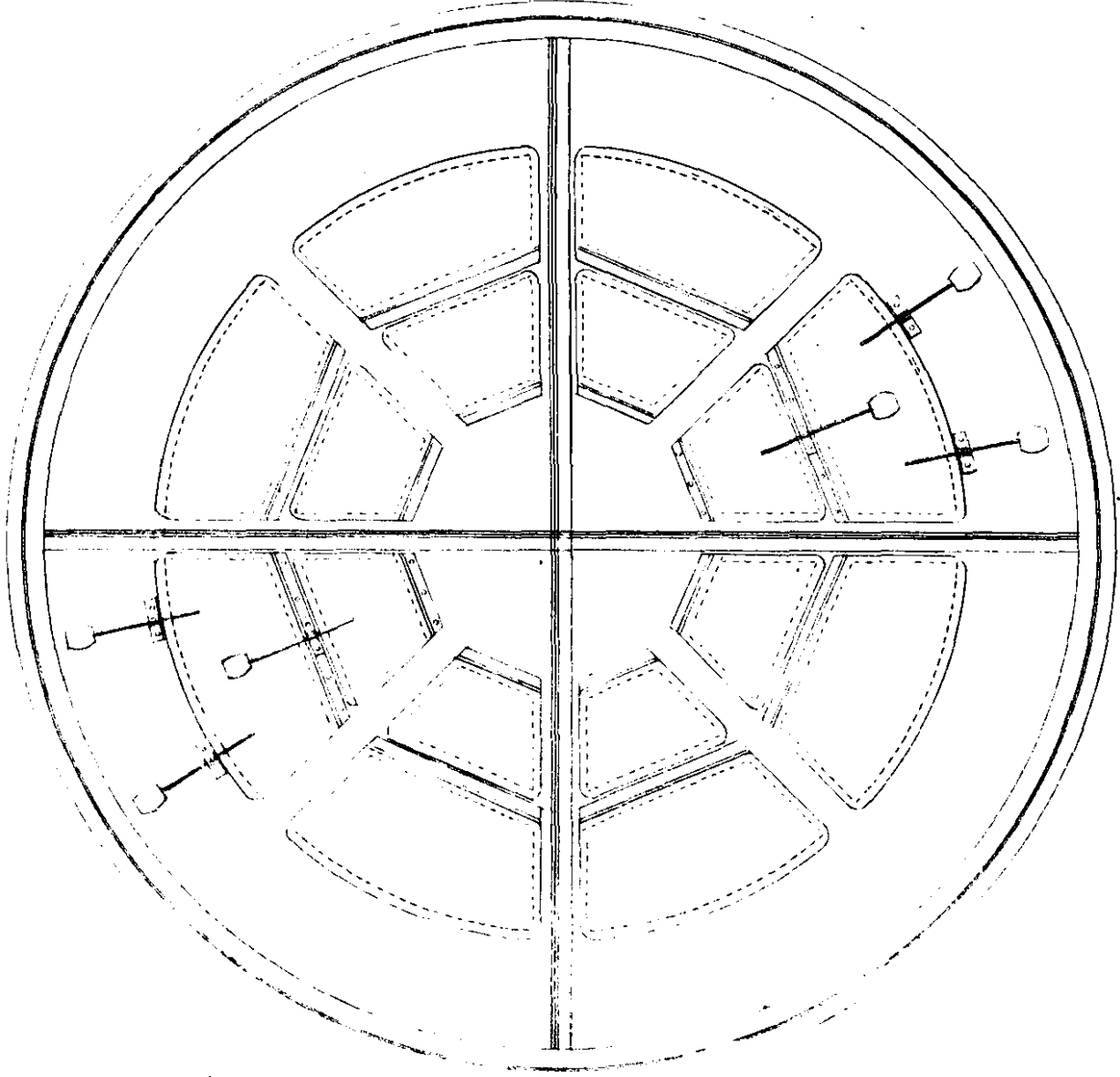
PLATE I

No 691. Ordered, by The House of Commons, to be Printed, 30th June 1853.

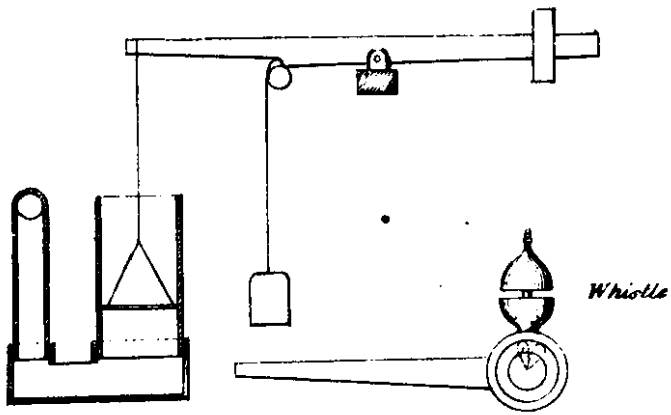
Henry Howard, Printer



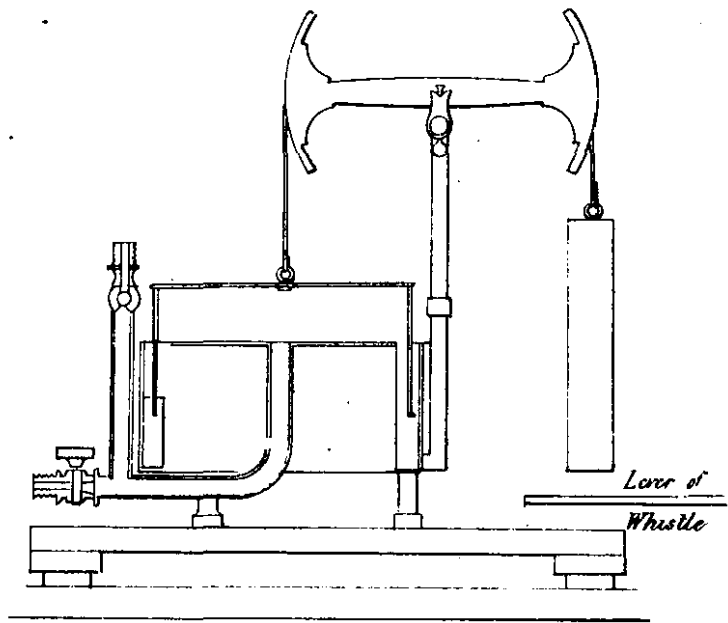
Plan and Section of Single Acting Airmeters.



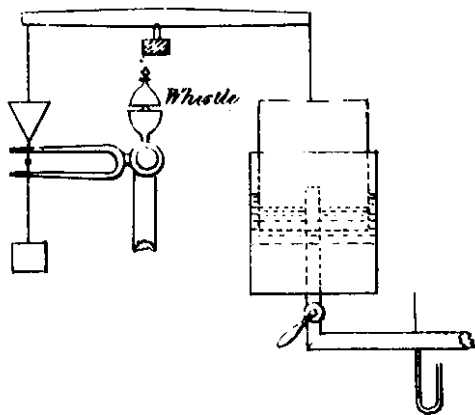
Ventilator Danger Signal.



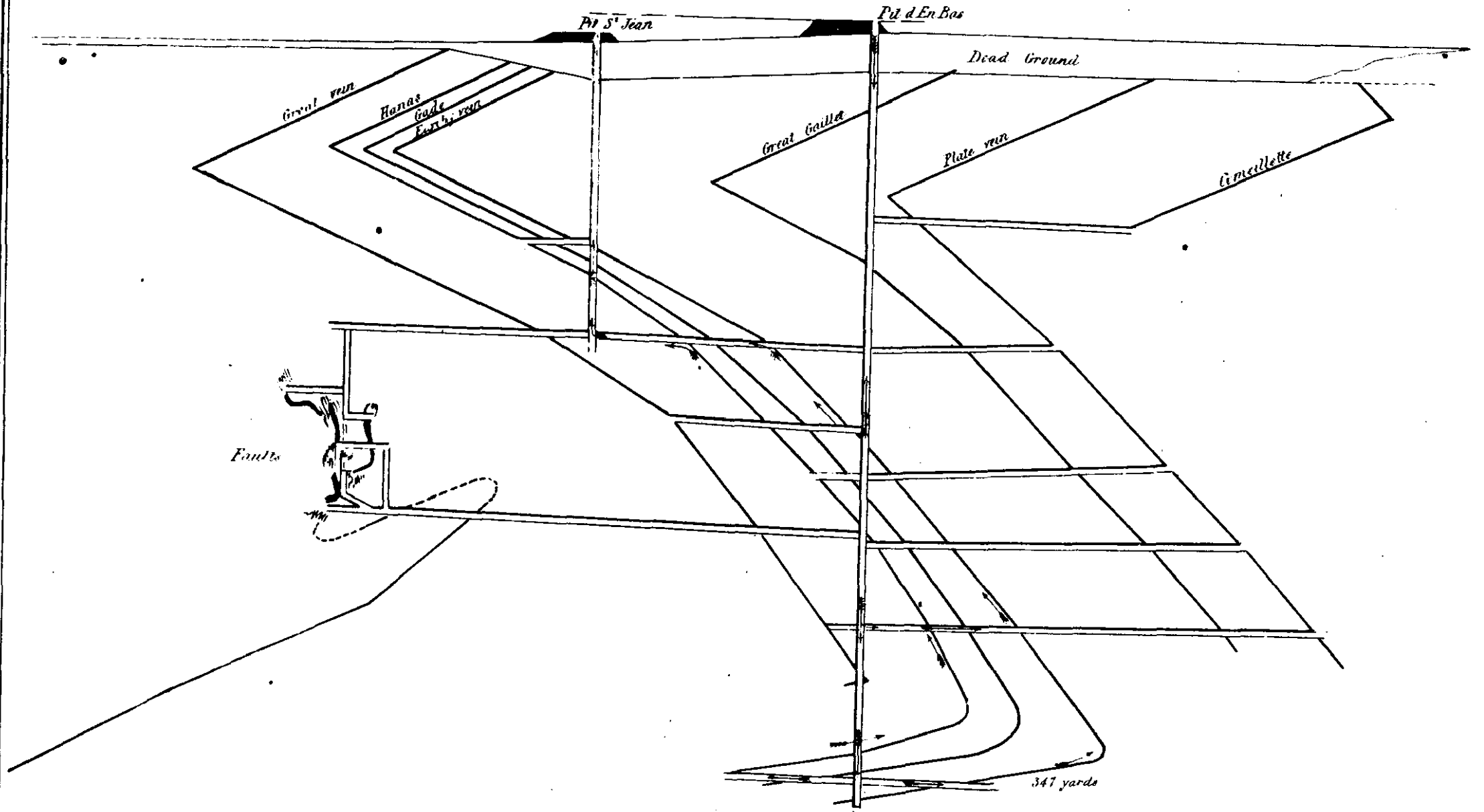
*Patent Ventilator's
Donger Signal.*



Ventilator Danger Signal



Colliery of Boussa & S^t Croix S^t Clare near Mons.



N^o 691.

(Ordered, by The House of Commons, to be Printed, 30th June 1853)

Henry Baskard Printer

1853

COMPARATIVE first Cost of Establishment of various Machines at per Horse Power.

	f.	s.	d.
Underground furnace, utilising 0·8 of the total heat developed	6	10	-
Furnaces of Anzin, - ditto - ditto	17	10	-
Furnace in the mine	27	-	-
Furnaces of Anzin	70	-	-
Ventilator of M. Combes	180	-	-
Ventilator of M. Pasquet	201	-	-
Screw of M. Motte	201	-	-
Ventilator of M. Letoret	244	-	-
Steam jets of M. Pelletan	247	-	-
Cylinder pumping engine	267	-	-
Single acting aerometer	286	-	-
Apparatus of M. Mehu (steam jets)	314	-	-
Ventilator with straight vanes in sheet iron	617	-	-
Furnace at the surface	823	-	-

COMPARATIVE Cost of Working, at per Horse Power of Useful Effect, per Annum.

Underground furnace, utilising 0·8 of the heat developed	49l.
Reciprocating blowing engines	52l. to 56l.
Ventilator of M. Combes	60l.
" M. Motte	70l.
" M. Pasquet	70l.
" M. Letoret	92l. 10s.
Underground furnace, utilising 0·25 of the heat developed	150l.
Jet of M. Pelletan	225l.
Apparatus of M. Mehu	286l.
Ventilator with straight vanes	330l.
Furnace near the surface	616l.

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