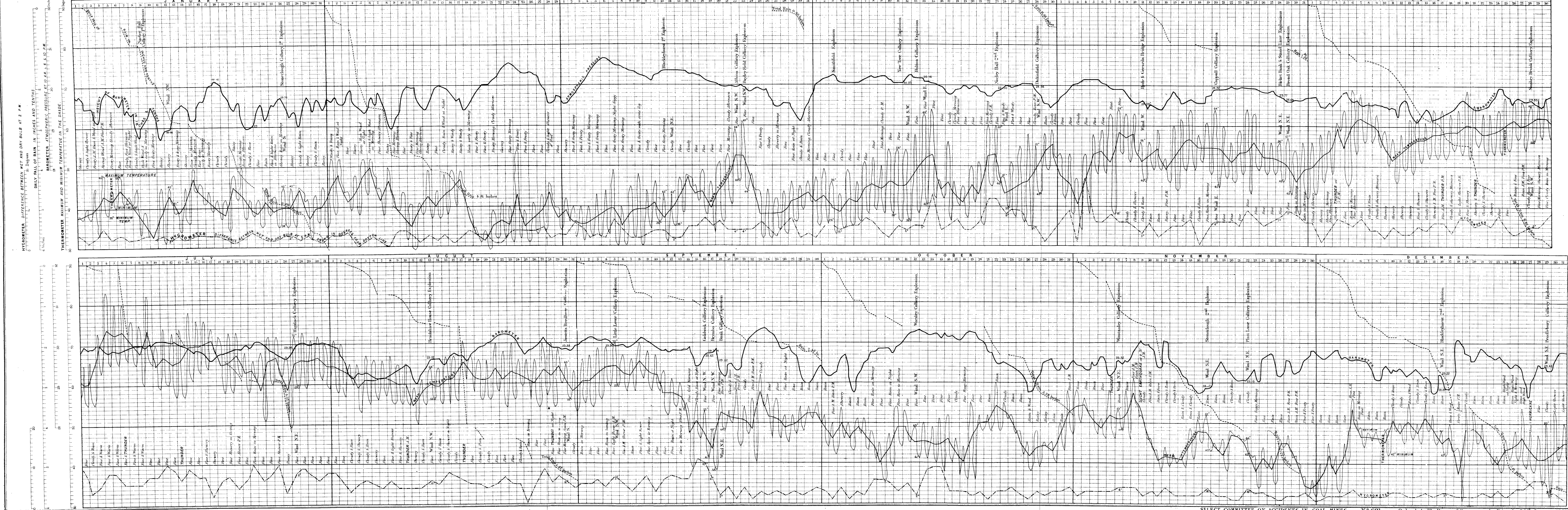


DIAGRAM OF METEOROLOGICAL OBSERVATIONS AT MANCHESTER (as taken by Mr. Cassaroli, Optician) IN CONNEXION WITH THE FATAL EXPLOSIONS OF FIRE DAMP IN THE COLLIERIES IN LANCASHIRE, CHESHIRE AND NORTH WALES, DURING THE YEAR 1852. BY JOSEPH DICKINSON, GOVERNMENT INSPECTOR OF COAL MINES, MANCHESTER.



J. Dickinson, Esq.

21 June 1853.

971. State to the Committee the result of your experiments?—I may state this: that the Seaton Delaval application of the steam-jet is not one of the best I have seen; I think the jets, as recently applied by Mr. Darlington, at Ince Hall, are done in a superior manner to Seaton Delaval.

972. Have you in your hand the report of those experiments?—This is the report of the Seaton Delaval experiments.

973. Which way was the steam-jet applied at Seaton Delaval?—It is all set forth in the report.

974. *Mr. Locke.*] What was the depth of the main shaft at Seaton Delaval?—The colliery is ventilated by four down-cast shafts and one up-cast shaft, each eight feet in diameter, and 212 yards in depth.

975. What is the average distance from the four down-cast shafts to the up-cast shaft?—They are all in a group together.

976. *Chairman.*] How many splits of air are there?—Three main splits.

977. *Mr. Locke.*] What is the distance that the air has to travel underground from the down-cast shaft to the up-cast?—The longest split is seven thousand six hundred and fifty yards.

978. I should still like to know what the distance was between the two shafts; you have given us the course of the air; what is the absolute distance between the two shafts?—We did not measure it, but I should think about 100 yards.

979. *Chairman.*] What is the ventilating power at Seaton Delaval?—Four boiler-fires, 33 steam-jets, and the discharged steam from an underground engine, and a gas apparatus, of which five retorts are kept at work, all placed near the bottom of the up-cast shaft.

980. In addition to the steam-jet, these boiler fires tend to the rarefaction of the air in the shaft?—No doubt of it.

981. Describe the operation of the steam-jet?—I think it acts partly by propulsion, and partly by rarefaction.

982. Where is the steam-jet placed at Seaton Delaval?—Close to the bottom of the up-cast pit.

983. *Mr. H. A. Bruce.*] There are a great number of steam-jets; are they all in the same place?—They are placed on radial arms.

984. All at the bottom of the pit?—All at the bottom of the pit.

985. *Mr. Locke.*] When you said, placed at the bottom of the pit, how far from the floor of the mine, or from the roof of the mine?—It may be about 20 feet above the roof. I did not measure that, but I should suppose about 20 feet.

986. *Chairman.*] In the pit?—Yes.

987. State to the Committee the experiments that you made, and the greatest velocity of air you obtained?—I may state that we took our measurements twice. Finding those of the first day differ so very materially from those which had been put forward by Mr. Forster and others, we determined to repeat them the following day. We did so, and with numerous checks. We measured the air twice in the up-cast pit, both which measurements correspond very nearly together. We also measured the air twice over in the different splits, and all these different measurements agreed very closely together. The following is an abstract: "Total air going into the workings, with the 33 steam-jets, 4 boiler fires, and gas apparatus at work: temperature of up-cast, 130°; temperature of down-cast, 42°; difference of temperature between down-cast and up-cast, 88°. Water-gauge, $1\frac{51}{100}$ inches. Barometer, 28½ inches; 33,626 cubic feet of air per minute.—Total air going into the workings without the jets; temperature of the up-cast shaft 120°; temperature of down-cast, 45°; difference of temperature of up-cast and down-cast, 75°; 29,999 cubic feet of air per minute.—Increase by jets and an increase of 13° of temperature between the up-cast and down-cast on the 16th of December, 3,627 cubic feet of air per minute.—Increase by jets on the 15th of December, 3,474 cubic feet of air per minute.—Increase of water gauge by jets and temperature 16th of December, $1\frac{51}{100}$ — $1\frac{21}{100}$ = $\frac{30}{100}$ inch. Amount of air obtained per lb. of coals consumed by the boiler fires and gas apparatus, 1,372 cubic feet."

988. At what part of the up-cast was the temperature measured?—At 30 yards.

989. *Mr. Stephenson.*] From the surface?—Yes.

990. Did you not take the temperature down at the bottom also?—We did not;

Martis, 31^o 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^o 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^o die Junii, 1853.

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

Lunæ, 27^o 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.

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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.

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MINUTES OF EVIDENCE.

Lunæ, 13^o die Junii, 1853.

MEMBERS PRESENT.

Mr. Hutchins.
Mr. Fitzroy.
Mr. Hussey Vivian.
Mr. Baird.
Mr. Cayley.
Mr. Stephenson.

Mr. Mostyn.
Mr. Farrer.
Mr. Child.
Mr. Cobbett.
Mr. Locke.

EDWARD J. HUTCHINS, Esq., IN THE CHAIR.

Joseph Dickinson, Esq., of Manchester, called in; and Examined.

1. *Chairman.*] YOU are a Government Inspector of Mines?—Yes.
2. Have you been so since the first appointment of inspectors after the passing of the Act?—Yes.
3. For what district are you inspector?—My present district is Lancashire, Cheshire and North Wales.
4. Is that the district of which you were inspector when you were examined before the Committee in 1852?—It is the same district, but the Staffordshire district was formerly a portion of my district. The South Wales district was also entrusted to my care for about four months, during the vacancy occasioned by the resignation of Mr. Blackwell.
5. Have you been recently engaged, with Mr. Mackworth, on a mission of inspection?—Yes.
6. By whom were you sent?—Lord Palmerston.
7. What countries were you instructed to visit?—Belgium, France, and Germany.
8. You visited those countries?—We did.
9. What is the common system of working in Belgium?—The common system of working is long work; the seams are very much contorted and twisted about; so much so, that the working in the same seam sometimes overlaps; but whether the seam lies perpendicular or horizontal, the same system is adhered to.
10. Will you describe the system of long work?—Long work is carried on in Belgium; and it is done by the ordinary system practised in this country, of taking all the coal away at first, and keeping up the waggon roads through the gob. There is scarcely an instance in Belgium where the levels are driven out to the extremity, and the coal worked backward; they get a better quality of coal by working the coal forward, and it is done at a cheaper rate.
11. Is it difficult to carry on ventilation under that system?—There is difficulty in carrying it on unless the gob is packed very tightly, and the sides of it clayed to prevent leakage through the gob; but where the run is short this is not found insuperable in practice. In fire-damp mines, in my opinion, the proper way is, to drive out the galleries to the extremity of the mine, and to work the coal backward, as this ensures a permanent air-way at all times; but where the run is short, there is seldom much difficulty in getting sufficient air to the face of work; the roof settles down on the gob, and presses it tight.
12. As a practical system, the way to work long work would be to carry the air ways through the gob?—That is the system generally resorted to. I do not consider it the best in fire-damp mines.
13. Is there any difficulty in keeping the gob free from leakage?—Where

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13 June 1853.

A. Dickinson, Esq.

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the run is short, and the sides are well clayed, the difficulty is seldom found insuperable in practice.

14. Supposing a seam should be perpendicular, is the same system pursued?—Yes.

15. Is there much difficulty in that case?—Not any difficulty.

16. *Mr. Stephenson.*] When the inclination of the seam is very great, you would not recommend the system of driving out to your boundary, and working backwards?—In a fire-damp mine I should recommend it, whether the seam was perpendicular or horizontal.

17. How would you confine the gob in a perpendicular seam, where it would be above your head?—You timber the level, and put brushwood on the top of it, and lay the gob on the top of the timber and brushwood.

18. You say that in Belgium the system of working backways is not adopted; is that system adopted when the seam is nearly perpendicular?—With very few exceptions, they drive all the coal before them in Belgium, and leave the gob behind, supporting the gob by timber and brushwood.

19. When a seam is nearly horizontal, in your opinion, the better way would be to drive out to the boundary and work backwards?—Yes.

20. But in Belgium, they work forwards towards the boundary, taking away the coal?—Yes.

21. What is the length of face which is taken?—It depends on the inclination, to some extent; about 30 yards is the average.

22. Not more?—Not more; that is the average depth.

23. When the inclination is very great, supposing fire-damp to exist in a mine in great abundance, do you prefer the plan of going to the boundary, in consequence of the lightness of carburetted hydrogen, which will always ascend from the working face into the gob, and there remain at rest?—I see no greater difficulty in ventilating a mine with air-ways in the solid coal than with air-ways maintained by gobbing. You have no liability to leakage, if you have the air-ways in the solid coal; but if the air-ways depend on gobbing, there is a liability to leakage through the gobbing, which is avoided by driving out the level to the extremities, and working the coal backward.

24. You overcome the difficulty by keeping them tight?—Yes.

25. *Chairman.*] Is not the roof falling attended with great danger?—No; it is not attended with unusual danger.

26. Supposing there is not enough rubbish to fill the gob, how do they proceed?—In the thin mines, there is generally sufficient rubbish.

27. Have you seen the work in thick mines?—I have seen it in every description of mine; all the mines in Belgium are thin.

28. Supposing it should happen that there be not sufficient rubbish to fill the gob, how would you proceed?—In the south of France the thick coal, which varies in thickness up to 65 feet, is worked by long work. The usual system is, to work eight feet on the bottom in the ordinary way; and as the mine seldom makes sufficient rubbish to fill up the whole of these workings, the rubbish is brought from the surface. After the first working of eight feet, there is another working a few yards behind; and these successive workings, one above the other, are filled up with rubbish, either from the mines, or brought down the pits from the surface. The thick coal of Staffordshire, also, is worked long work. It has been worked long work in two ranges, of about five yards each, for between 20 and 30 years, at Mr. Forster's works at Shut End, near Dudley; and also for some years in Mr. Gibbon's colliery, at Shut End; and it has recently been introduced into the colliery of the New British Iron Company, at Corngreaves. It seems to be a great improvement on the old system of working the thick coal in Staffordshire; and it is worthy of remark, that in no instance that I have heard of, where long work has been introduced, has that system been abandoned, and the old system resorted to. I have examined the working in the thick coal mines of a great number of the principal establishments in Staffordshire, and I think that a more unminer-like system of getting this ten-yard coal than the old systems, which are still commonly practised, it is impossible to see. It is working in a series of unsightly caverns; the men are perched high on scaffolding and ladders, and they are at work underneath the sides, which are overhung many yards beneath the roof, which is liable to fall, and cannot be supported. Indeed the workmen are brought up to it from their childhood, and they may be compared to soldiers in a campaign, for sudden deaths are perhaps as common in the case of the one as in the other. If all the

the

the casualties in thick coal collieries were enumerated, I believe that the annual list would outnumber the killed and wounded in a general engagement. *J. Dickinson, Esq.*

29. *Chairman.*] As a general rule, do you think the system of long work is efficacious?—There is generally no system so efficacious as long work. *13 June 1853.*

30. Is more coal got by it?—All the coal is obtained by it, and the ventilation is much simplified.

31. *Mr. H. Vivian.*] Has not a modified system of long work been adopted in the north of England?—Long work is common in the Midland counties, as far west as Shropshire.

32. Has not a modified system of long work been recently adopted in the north of England, with great success?—In some collieries it has.

33. Will you describe the system of long work?—Long work consists in breasting away extensive ranges of the seam in one working.

34. *Chairman.*] On that system you cannot go down to the dip?—The great secret of success is to keep the packing well built, and close up to the face of work, and not attempt to breast down to the dip, which would throw the weight of the superincumbent strata upon the face of the work, and make it dangerous for the men, and would also crush the coal.

35. In beginning the system of long work, is not the first weight that comes on attended with very considerable danger?—The first weight is generally a dangerous weight; in the course of a few days after the first subsidence has taken place, the roof subsides regularly behind, and there is no more difficulty.

36. Are the men aware of their danger at first?—Yes.

37. Do they work when the roof is settling down?—They sometimes abandon that portion of the work, until the first subsidence has taken place; and where long work has been attempted to be introduced into new collieries, by persons who did not understand it, when this first weight has been coming on, which is the critical weight, the system of long work has frequently been abandoned; had they waited until the subsidence had taken place, their efforts might have been successful.

38. In your district, is the coal worked by long work at all?—We have isolated cases of it in Lancashire and Cheshire, and it is very common in North Wales.

39. And in Shropshire?—In Shropshire it is common, and also in Staffordshire.

40. In South Wales?—In South Wales it is met with in rare cases.

41. Is it as well done, in the districts in England in which you have seen it, as it is in Belgium?—Quite.

42. And the ventilation is sufficiently carried on?—Yes.

43. Is it applicable to South Wales?—It is applicable to the South Wales coal field, as a general rule; its introduction there, I believe, would be the means of reducing the cost of getting the coal, and it would save the immense loss which takes place in pillars under the present system. It is peculiarly applicable to the ironstone mines.

44. Supposing you were working in a seam of 30 feet, how would you proceed?—The system of working the Staffordshire thick coal is, by first working the top half of the seam.

45. How much of the first lift is removed?—They work about eight feet long work, and they breast backward over the gobbing, in getting the main portion of the seven feet.

46. In your opinion, is long work the cheapest and best, and applicable to thick and thin seams of coal?—It is.

47. Is it also better for the carrying on of ventilation?—Yes.

48. In all cases?—There may be exceptional cases; but, as a general rule, it is so.

49. *Mr. Cayley.*] Could the system of long work be applied to mines which are already established?—In most cases it might be applied to the present mines; but perhaps not in all.

50. Would it entail great expense, if it were applied to old mines?—In some cases; but the great difficulty is with the workmen; they are not accustomed to the system, and they are very loath to begin it in their old age.

51. Is it more applicable to deep or to shallow shafts?—I do not think it makes any difference. It is equally applicable to the one as to the other.

52. Is the system of long work universal in the north?—It is not so universal in the north, except in Scotland.

53. You say it is better for ventilation; in what respect is it better?—In

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working pillar and stall work, you leave a great number of galleries open, and all those galleries require to be ventilated. With long work you have simply the working face open; you leave an in-take gallery for the air to go in; it then passes up the face of work, and returns by the return drift; whilst in pillar and stall work you have a number of galleries, which require to be ventilated.

54. You have no splitting of air?—Yes; you may split the air at different faces of work; you may have one or you may have ten faces of work going on in the same pit; and you can split the air, if it is desirable, in proportion to each face of work.

55. *Mr. Locke.*] Is there any difficulty in splitting the air?—None.

56. Do you find any inconvenience at all?—None.

57. Then where is the difference in pillar and stall work, as to its more efficient means of ventilation, if there is no difficulty in splitting the air?—You have a greater number of galleries to ventilate in the one case than in the other.

58. You do not think the splitting of air is an objection to the mere transmission of air?—It is impossible to ventilate a large colliery properly without splitting the air.

59. Where is the increased difficulty in ventilation by pillar and stall work, as compared with long work?—In the one case you have a larger number of galleries to ventilate than you have in the other.

60. Still the area would probably be the same?—The distance over which air travels in long work is shorter than that which it travels with pillar and stall work, because you have only the in-take gallery and the face of work, and the return air course to ventilate; there is no intricate working in the midst of the colliery to be ventilated, as there is in pillar and stall work; consequently the air has not to be coursed through.

61. Does your objection apply to the increased distance which the air has to travel, or to the intricacy of the course?—It applies to both.

62. *Chairman.*] Do you keep the gas penned up, or do you clear it out?—As a general rule, the gob is not ventilated.

63. *Mr. Stephenson.*] In explanation of an answer which you gave just now, respecting the comparison between the ventilation of long work and the ventilation of pillar and stall work, in splitting the air in pillar and stall work have you not a number of doors to employ?—Yes.

64. Those doors being left open, may leave any one or more of the stalls foul?—Yes.

65. In long work there is simply a current of air going from the down-cast shaft to the face of the work, running along the face of the work, which is only a channel about six or seven feet wide, perhaps, and returns (as you have said) by a drift to the up-cast; that is the simple mode of ventilating long work?—It is.

66. With the pillar and stall work, if you have 20 stalls, you may split the air into four parts, each current of air, or each one-fourth, having to course through four stalls, with a door between each four stalls; is not that the usual mode?—It is.

67. Independent of splitting the air, you have to course up and down the stalls, and therefore each current of air has to pass up one half of the stall and down the other?—Yes.

68. In that case, is not the resistance to ventilation materially increased?—No doubt of it.

69. Must not a greater force be applied to secure good ventilation on the stall system, as compared with the long work system?—Undoubtedly.

70. Is there not also the risk of doors being left open?—Certainly.

71. In the other case there is no risk of that kind?—No; because there are no doors, except there be main doors, to leave open.

72. I am speaking now of the face of the work; I am quite aware there are doors required in other parts of the mine, but they would equally be required on the stall system?—Yes.

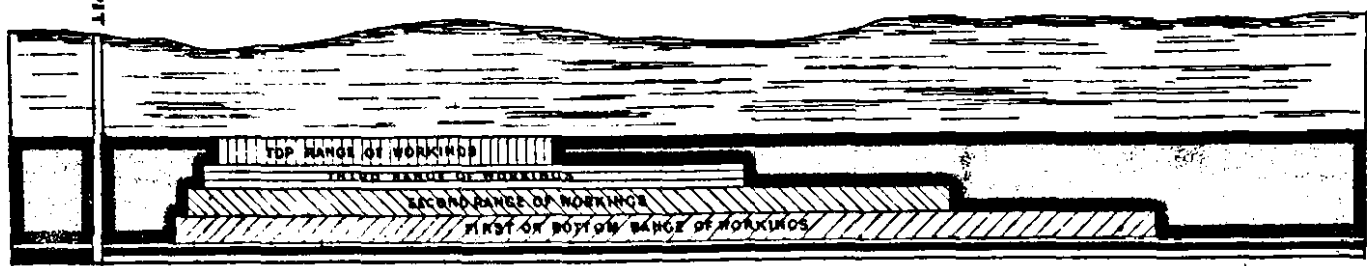
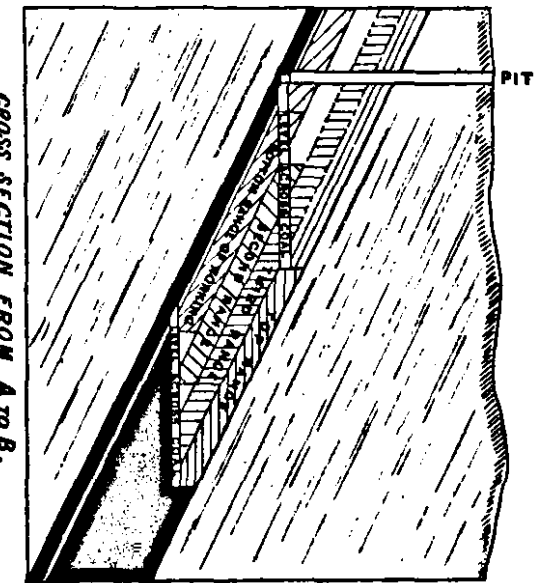
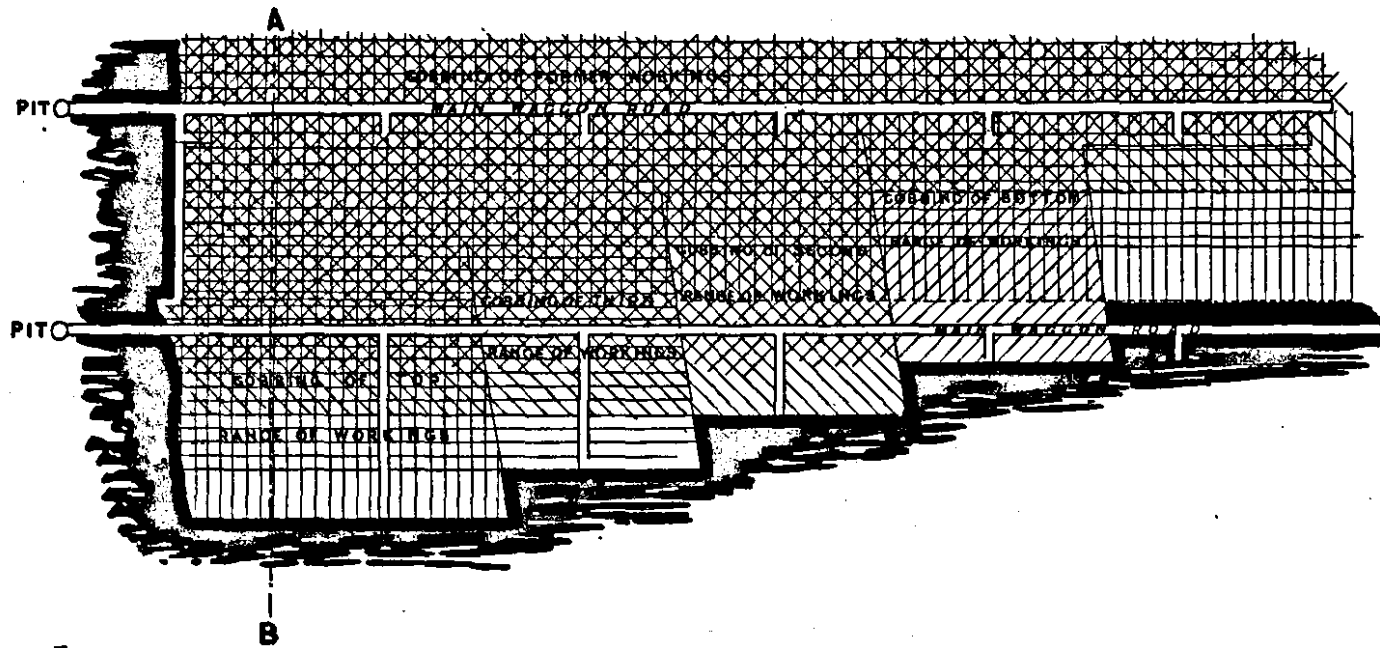
73. And, therefore, where the face of the coal has usually given vent to an enormous quantity of gas, there are no contingencies arising out of doors?—Such contingencies are very much fewer than in pillar and stall-work; the air is all passing up in the particular places where it is required.

74. *Chairman.*] Therefore it sweeps the face of the coal, and all behind it is so tightly packed up, that the air cannot get into it at all?—Generally it is.

75. Therefore

SKETCH OF A METHOD OF WORKING THE GREAT BED OF COAL AT ST. ETIENNE IN FRANCE.

The Seam varies in thickness up to 65 Feet, and is worked Long Work, in heights of about 8 Feet each, commencing at the bottom of the Seam. The lower ranges of work are kept in advance of those above, and when the workings do not produce sufficient rubbish for packing the Gob, the necessary rubbish is taken down the pits from the surface. The workings are liable to spontaneous combustion, to avoid which, the Waggon Roads are driven below the Main Seam, so as to admit of their being isolated from any part of the workings should spontaneous combustion take place.



SECTION.

Joseph Dickinson
 Inspector of Coal Mines
 June 1853

[To face Page 5.]

SELECT COMMITTEE ON ACCIDENTS IN COAL MINES.

M. W. J. Scott, Mine Surveyor,
 25 Great George St. W. 1853

75. Therefore the whole current sweeps up where the men are at work out of the main level. Is that so?—Yes. *J. Dickinson, Esq.*

76. *Mr. Stephenson.*] You have stated that the long work system is, in all cases, more economical and safe than the pillar and stall system. Are you aware that the success of the long work system depends very much upon the character of the roof?—It is frequently stated to depend on the character of the roof; but I think I have seen coal, with almost every kind of roof, worked successfully by long work; and many persons work long work with both good and bad roofs. In the case of working the thick coal of Staffordshire, where the top part of the seam is worked first, and there is nothing but the old gob for the roof of the second working, *Mr. Gibbons*, who is an authority on these matters, having worked the coal for several years under the system, says he prefers a bad roof to a good one.

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77. If the roof be a very good one, is it according to your experience, a very bad plan to introduce the long work system?—If you have a hard, solid rock for a roof, which will not break, it is very apt to crush your coal; and it would be attended, perhaps, with more danger than would otherwise be met with, if you had a tender roof.

78. Have you ever seen a roof in a coal mine, consisting of what is called in the north, post roof or white sandstone, which is almost peculiar to the coal fields of Durham and Northumberland, and is sometimes eight or ten fathoms in thickness?—Yes; there is also a much harder rock which is called quor, in South Wales.

79. Under such a post roof, have you seen the long work system practised successfully?—I have seen a modified system of long work practised very successfully under a quor roof. It is not the ordinary system of long work, but it is called long work in South Wales; it is by driving a stall, eight yards wide, and bringing back the same width of pillar. All the coal is obtained in that working, and perhaps it is the only successful working of coal which there is in South Wales. All the rest, under the bad roofs, is attended with a very considerable sacrifice of pillars.

80. *Mr. H. Vivian.*] Under a roof of that kind, do you conceive that the ordinary long wall system of working could not be carried out?—I do not think that it is so desirable to introduce long work under such a roof, and perhaps it is not in every case practicable. Under good roofs there is seldom any loss of coal by the pillar and stall system, so that no improvement could be effected in economy, or in the clean working of the coal.

81. Do your remarks apply especially to the cleanness of working out the coal, rather than to the ventilation of the mine?—My last remarks apply especially to the cleanness of working, but generally they apply equally to the ventilation.

82. In a 12-foot seam of coal, where the roof falls up to a certain point and arches itself, and does not fall so that the bottom meets the top, how would you support the roof?—You are speaking of pillar and stall working.

83. I am speaking of long wall working?—I have got a drawing of a system which I examined in the South of France, showing the mode of working in a thicker seam than you have described.

[*The Witness delivered in the annexed Drawing.*]

84. In a 12-foot seam of coal, where the roof does not fall to a sufficient extent to support the superincumbent strata, in what way would you deal with long wall work?—I know the South Wales seams very well, having been engaged upwards of seven years in the largest colliery there; but I do not know one where, if you took away the whole of the coal, the roof would not come down behind on your packs.

85. I am now working a colliery to a large extent in South Wales, where the roof will stand for months without falling completely. If it were necessary to support the ground behind the workmen, which is necessary in long wall work, the men would be for months exposed to falls of roof; in that case, could long wall work be carried out except in a modified degree?—Can you describe the sort of roof?

86. It is for some distance a plate roof?—That would work very well long work.

87. I have gone over the goaf myself when the coal has been worked for months, and the roof has not fallen, up where the pillars have all been taken out?—It is a general rule that the plate is one of the best roofs for working long work.

88. It bends rather than breaks at first?—I think that long wall work would be quite applicable to such a roof as you describe.

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89. Would you work the upper or the lower portion first in long wall-work?—In Staffordshire the usual way is to work the upper portion, but I think the best way is to work the lower part first, taking care to pack the gob very tight with rubbish.

90. How would you commence the long work system?—I should keep the lower levels in advance of the upper; for you generally find that if you attempt to keep the upper levels in advance of the lower, there is a tendency to throw the weight of the roof on the face of the work, which makes it more dangerous for the men, and also has a tendency to crush your coal.

91. Assume that your pit is sunk to the bottom of the seam, and that you have to consider how you will commence your work; where would you start your drifts?—As the weight always tends to the dip, I would start them so as to keep the lowest drifts rather in advance of the upper, and throw the weight of work on the gob, and not on the face of the work.

92. Would you start two drifts on the level course and two to the rise?—After opening the pit, and getting the ventilation connected between the down-cast and the up-cast, if it were not a fiery mine, I should breast all the coal forward, carrying the airing along the deepest level, and bringing it back along the upper level.

93. You would work it straight before you?—Yes.

94. In that case, you would not, as in the first instance you recommended, drive out to the extent of your boundary?—If it were a very fiery mine I should recommend driving out the galleries to the extremity, and work backward instead of forward.

95. *Chairman.*] So that all the gas would be left behind you?—Yes; and you would be always sure of maintaining the ventilation by having the galleries in solid coal, and not subject to leakage through the gob.

96. *Mr. H. Vivian.*] You would take the breast of coal forward?—Yes.

97. Then you would leave the gob behind you?—Exactly.

98. Are not goaves very dangerous things, from the gas constantly oozing in enormous quantities from the roof?—An imperfectly ventilated goaf is about the most dangerous thing you can have in a colliery, that is, where the fire-damp is mixed with enough fresh air to bring it to the explosive point; when the goaves are not at all ventilated the fire-damp in them is generally too pure to be explosive, and I have known cases where a goaf which has been full of fire-damp has fired along the edge, where it has been mixed with fresh air; but there not being sufficient air with the fire-damp in the goaf, it has merely been an explosion for the width of a yard or two along the edge; a goaf of that kind is less dangerous than a goaf partially ventilated, until it has arrived at an explosive state. Most goaves admit of being entirely ventilated, but if this cannot be done, the ventilation of them should not be attempted.

99. On your principle of working, you would, after you had sunk your pit to the seam of coal, work your breast of coal right forward, leaving the goaf between you and the pit?—That is the ordinary system.

100. That is the system you recommend?—Yes, where there is not fire-damp, and where the run is short.

101. *Chairman.*] You consider, with regard to the ventilation of the goaves, that it is necessary either to ventilate them thoroughly, so as to clear out the whole of the fire-damp, or not do it at all?—Yes.

102. *Mr. Cayley.*] Is it not true of the whole of the mines generally, that before the system of ventilation was improved, as it has been of late years, in consequence of there not being a sufficient admixture of atmospheric air, explosions did not take place?—Badly as some of our coal mines are ventilated, there are very few which are in such a state as that.

103. When a mine is in a very foul state, it may not be explosive, from the non-admixture of a sufficient quantity of atmospheric air?—In all the coal mines I was ever in, I never, except after an accident, met with a case of that kind, where, in the working galleries of the mine, there was sufficient gas to become explosive if more air were admitted.

104. As a scientific principle, is it true equally as regards the mine as the face of the gob?—Yes.

105. The air may be so foul that it is not inflammable?—No doubt of it.

106. In that state, is it capable of respiration?—No; when you get into a strong admixture of fire-damp you cannot respire it. I had a case, in my district, of two men being suffocated by inhaling a strong admixture of fire-damp.

damp. The effect on the pulse is to quicken the pulse; I have tried my own pulse before going in: it was at 78 on entering this admixture of fire-damp, and after being in for a few minutes, it ran up to 84; I tried a manager's pulse, and it ran up from 80 to 84; I tried the fireman's pulse, and it was at the very unusual height of 120, and it ran up to 126. A person is only enabled to remain in the gas a few minutes, otherwise he must have fallen down, and his breathing would soon stop.

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107. Was that gas explosive?—At the edges it was explosive.

108. Was it intermixed with atmospheric air?—Yes.

109. In order to be explosive, what proportion of admixture is required?—I should think that, generally, an explosive mixture is one part of gas and seven of air.

110. When does it cease to be explosive?—I think at about 15.

111. Fifteen parts of atmospheric air to one of fire-damp?—Yes.

112. When there are only three or four parts of atmospheric air to one of foul gas, does it cease to be explosive?—There is not sufficient air for it to become explosive.

113. At what point does it become explosive?—I think it is about one part of gas to three or four of air.

114. Then so far as explosions are concerned, a mine is in the safest condition, when it is so full of a deleterious gas that there is not air enough to explode; or when the amount of ventilation is so great that even when the foul air is mixed with it, it ceases to be explosive?—I should only apply that, with the reservations which I have stated, to the goaves; as to the mine being in such a state as to have the galleries filled with a larger proportion of gas to atmospheric air than would be explosive, as I have said, I do not think there is such a thing to be met with in the country; and I do not recollect ever having met with such a badly ventilated colliery as that.

115. *Mr. Fitzroy.*] Would it be possible for a man to exist under such circumstances?—No; besides, there must be a point where the air, coming down the down-cast pit, and travelling along the workings, and intermixing with this gas in the galleries, it must be explosive.

116. *Mr. Cayley.*] With respect to goaves, where there is any change in the pressure of the atmosphere, is it not the fact that at that time the gas will ooze out of the goaves, when it does not under an ordinary state of the atmosphere?—There is no doubt that with a falling barometer there is a greater liability to explosion than with a rising barometer. I think it is more a subject of interest than of importance. According to Brande, 96.6 of atmospheric air expands to 100 cubic inches, on the barometer falling from 30 to 29 inches. A fall of the barometer, therefore, of only one inch, would have the effect of increasing the volume of the air to the extent of between three and four per cent.; and in addition to this diminution in the density of the air, which is tantamount to a diminution in the quantity, the fire-damp would be liberated more freely from every pore of the strata; and whatever fire-damp existed in the goaves, or in any other part of the workings, it would become expanded in the same ratio as atmospheric air, and the surplus would be discharged into the workings.

117. Is it not a fact, that the only way in which you can account for some of those explosions, which are attended with such fearful calamities, is, that they are occasioned by some change in the barometric pressure?—Taking the number of explosions which have happened in my district, there is, perhaps, a larger proportion to be noticed as having occurred in the summer months, with the increase of temperature from winter to summer; but this is by no means a very great difference; and even with the falls of the barometer, it is very difficult to trace out any connexion with the explosion. I have gone over the whole of the accidents which have happened in my district during the last year, which was a very peculiar year for atmospheric changes; there were very great variations in the barometer and in the thermometer; we had an earthquake in South Wales in the spring, and we had an earthquake in North Wales and Lancashire in the autumn; the fall of rain was great, and there was much thunder; and with all these peculiarities it is very difficult to say that there is any connexion between explosions and atmospheric changes. I have a Diagram, which I beg to hand in, of every explosion which has taken place in my district during the year 1852. It shows the days on which the explosions took place, the variations of the barometer, taken three times per day, the

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variations of temperature, and the difference between the wet and dry bulb of a thermometer, and the daily fall of rain. The first explosion, at Norley Hall colliery, took place when the barometer was rising; the second took place when the barometer was at its summit; the third took place when the barometer was rising. (*The Witness delivered in the same.*)

118. As a general rule, is it not the weight of the atmospheric air, which is going down the gallery, which keeps the foul air back in the goaves?—As I have stated, a fall of an inch in the barometer would make a difference of between three and four per cent. in the quality of the air transmitted through the workings.

119. If it is the weight of the atmospheric air which passes by the face of these goaves which keeps back the foul air, if there is any alteration in the weight of the air, would it not allow the foul air to escape from the goaves naturally?—The foul air, and any other gas, under a diminished pressure, would become expanded in the same ratio as atmospheric air, and would consequently be liberated into the ventilation.

120. It becomes explosive, unless the ventilation be sufficient to produce a sufficient admixture of atmospheric air?—No doubt of it, unless the ventilation is sufficient to render it non-explosive.

121. *Chairman.*] You were understood to state, that the great point in successfully working the long work, is to have the gob so closely packed that no foul air can escape from it?—You cannot always do that; but with a properly ventilated colliery, the ventilation ought always to be such as to sweep away any discharge of fire-damp from the goaves. The temperature of the atmosphere, which has not received the same attention in regard to its connexion with explosions in coal mines, appears to have as important an effect on explosions as atmospheric pressure. According to Brande, air dilates at the rate of $\frac{1}{480}$ th of the volume which it occupied at 32° for every degree of Fahrenheit's scale, and all other aëriform bodies expand in the same ratio. A variation of temperature, therefore, of only 10°, from 60° to 70°, would have the effect of expanding the air, and of making a difference of about two per cent. in the diluent quality of the air through the workings; and if there be fire-damp in the mines, either in goaves or other accumulations, and they be increased in temperature, the fire-damp which they contained would also be expanded in the same ratio, and the surplus would be discharged into the working; but a daily variation of 20° or more degrees are common, and they would make a difference of five per cent. in the virtual quantity of air circulated through the working.

122. *Mr. Cayley.*] Will you explain on what principle that occurs?—It is the principle of expansion; all bodies expand by heat; air expands by heat.

123. Fire-damp and atmospheric air both expand by temperature increased; why is the change likely to be a cause of danger in the mine?—Supposing you had a ventilation of 100,000 cubic feet of air per minute running through your working, at a temperature of 60 degrees, and the external temperature increased from 60 to 70, and you still had 100,000 cubic feet of air per minute running through the workings, that air, by the expansion which had taken place in the increase of temperature, would be expanded at the rate of two per cent., which would reduce the virtual quantity of air to 98,000 cubic feet, although you had the same number of cubic feet per minute running through the workings. 98,000 cubic feet of air at a temperature of 60° would neutralise as much fire-damp as 100,000 cubic feet of air at 70°.

124. *Mr. Stephenson.*] That is, assuming the velocity to remain the same?—Yes.

125. *Mr. Cayley.*] Then the increase in the temperature diminishes the amount of the ventilation?—Yes, as I have described; and with increased external temperature, if the ventilating power be rarefaction, as by the common furnace, or if there be no ventilating power at all (as is too common), a further diminution in the quantity of air circulating through the workings might be looked for, consequent upon external temperature approximating to the temperature of the rarefied column of the up-cast shaft, and thus lessen the balance of power which gives motion to the whole current.

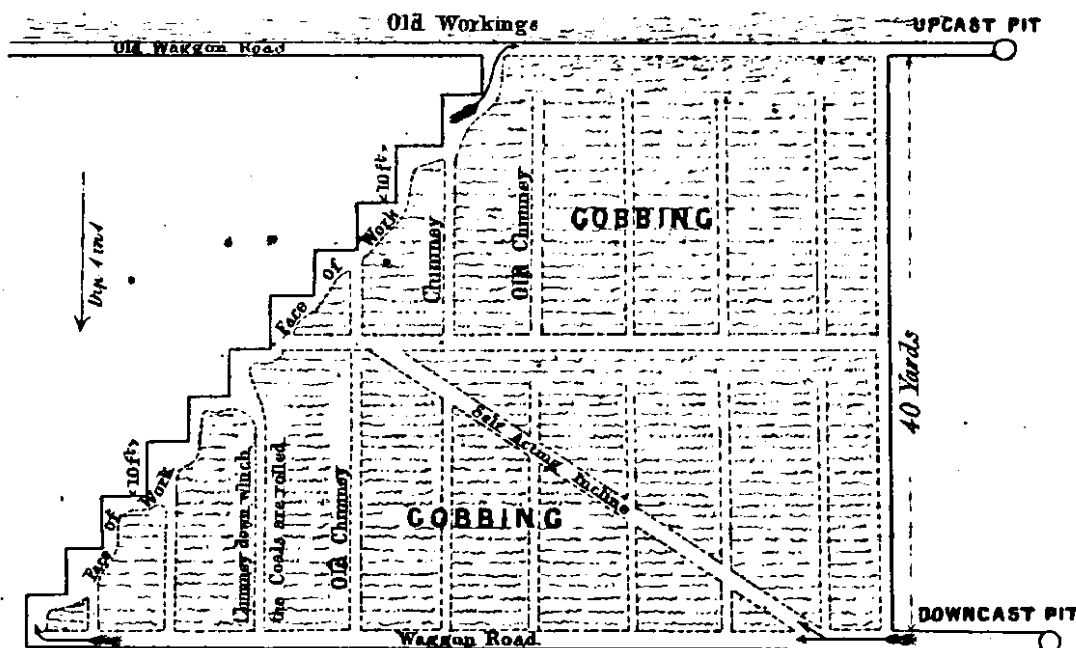
126. You have stated that in the spring time there is a tendency to an increase in the number of accidents?—I said there was a tendency to accidents; it is perhaps perceptible, but it is barely perceptible, if there is an increased number.

SKETCH OF LONG WORK IN THE STEEP COAL SEAMS IN BELGIUM.

N^o 1.

Plan of Workings in a Seam 18 inches thick and dipping 1 in 1.

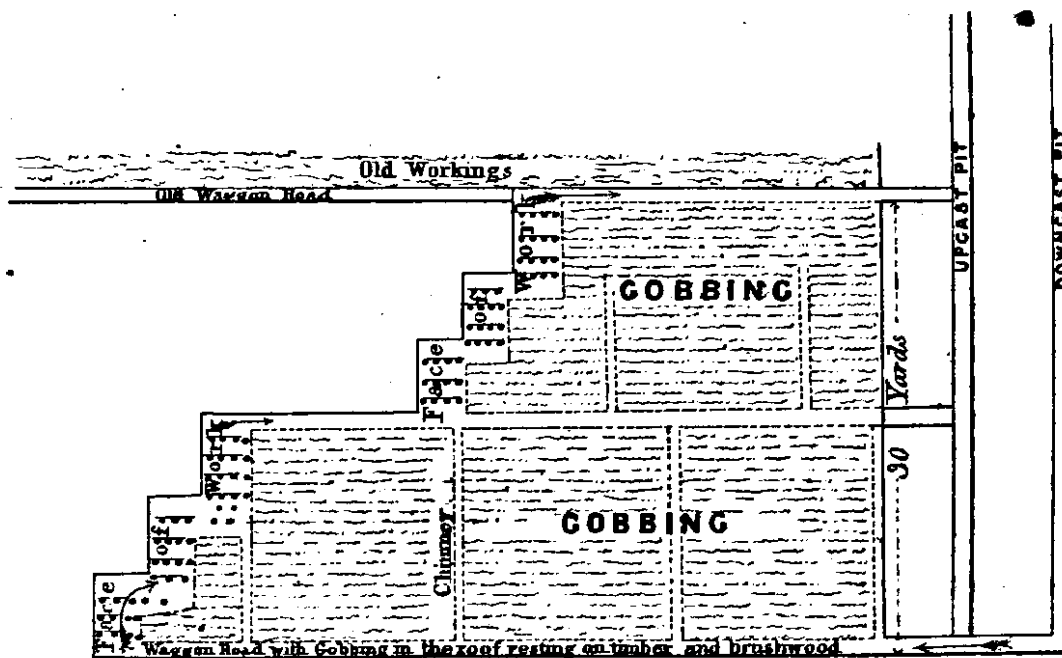
The face of Work is divided into 12 small faces, each 10 feet in length, and each of which is one man's place of work. The men work horizontally, and the Coals are rolled down to the Waggon Road through openings in the gob, called Chimneys.



N^o 2.

Section of Workings in a Seam dipping perpendicular.

The perpendicular Seams are worked off platforms resting upon stays fixed into the sides of the Seam. The men work horizontally in faces about 5 yards high, & the Coals are dropped down to the Waggon Road.



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127. Does the liability to that state of things apply equally to natural ventilation, and to any artificial ventilation arising from rarefaction?—Undoubtedly; the latter objection applies to all artificial ventilation arising from rarefaction. It does not apply to mechanical ventilation. *J. Dickinson, Esq.*
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128. Mr. *Locke*.] If the volume of air passing through the mine remained the same, would your objection still be applicable?—Yes, as regards expansion; but I was speaking of the effect which it would have upon the approximation of external temperature to that of the rarefied column in an up-cast shaft.

129. *Chairman*.] Can you, by the next meeting of the Committee, prepare a drawing of the system of long work as practised in Belgium?—Yes.

130. Mr. *Locke*.] Will all the evidence you have given this morning on the question of long work be applicable to the diagram you are going to furnish to the Committee?—I will endeavour to make the drawing apply to it all.

131. What are the means of ventilating in Belgium?—Mechanical appliances are very common in Belgium, and they appear to be on the increase. In 1845 there were 35 ventilators at work, and in 1849 they had increased to 64, and others have been erected since. The average steam power to each in 1849 was nine horses.

132. Are there any other means?—Yes; the furnace is sometimes resorted to. A great number of mines in Belgium, France and Germany are carried on by natural ventilation only.

133. Mr. *Fitzroy*.] Describe some of those mechanical processes to which you refer?—There are seven different varieties. The first is that of Mr. Fabrey; it is a mechanical arrangement, and has two shafts revolving in contrary directions, with three vanes fitted to each shaft, with the effect of isolating the return air, and discharging it. The second is Mr. Letoret's, which is the common fan.

134. Mr. *Locke*.] For exhausting air?—Yes, they are all exhausters; to Mr. Letoret's there are four arms; the arms are not carried out at right angles to the full distance; at about half the diameter they are bent back at an angle of 110°. The third is Mr. Pasquet's; it is on the principle of the revolving chimney top; it has hitherto been made with three vanes, but a large one is being now constructed with six vanes. Mr. Pasquet has also a ventilator similar to Mr. Fabrey's. The fourth is Mr. Lessoine's, which is similar to Mr. Pasquet's, but has more vanes. The fifth is Mr. Môtte's, on the principle of the Archimedean screw. The sixth is the piston; this is similar to Mr. Struve's, in this country.

135. Mr. Struve's drawing was before the Committee of 1849?—Yes; the piston differs from Mr. Struve's in being single-acting, and in having the valves horizontal instead of nearly vertical. Mr. Struve's also works in water, which prevents leakage. A ventilator of this kind has been at work near Liege for 18 years, without a break down.

136. Mr. *Cayley*.] Do you mean without any failure in the machinery?—Without any important failure. The seventh is Mr. Lamielle's; this is a new ventilator; there is only one of the kind at work. It consists of a revolving hexagonal cylinder, the sides of which are opened and shut by an excentric, and by which means the air is isolated and thrown out.

137. Are any of these like Byram's?—Mr. Pasquet's and Mr. Lessoine's are similar in construction to Byram's.

138. Those are on the principle of the windmill?—Yes; and Mr. Nasmith's fan resembles Mr. Letoret's, with the exception of the angle in the vanes, and it is apparently not so good as the original.

139. *Chairman*.] Which of these ventilators is considered the best in Belgium?—Mr. Fabrey's.

140. Is that most commonly used?—Yes.

141. Do you agree that Mr. Fabrey's is the best?—Yes; I think Mr. Fabrey's is the best. None of these ventilators appear to be adequate to give what would be considered a large amount of ventilation in this country. The average amount of ventilation they are giving, is about 20,000 cubic feet of air per minute; and in few, if any, cases do they reach 40,000. I have a list of experiments which have been made in certain mines.

[*The Witness delivered in the List, which is as follows:*]

BELGIUM.—COAL MINES.

EXPERIMENTS with VENTILATING MACHINES. (The Volumes of Air were measured by Powder Smoke.)

NAME of the VENTILATOR.	NAME of the COLLIERY where the Experiment was made.		REVOLUTIONS per Minute.		Water Gauge, in Inches.	Cubic Feet of Air extracted per Minute.	DIMENSIONS of VENTILATOR.	
			Strokes of Steam Engine.	Revolutions of Ventilator.			Diameter across the Fans, in Feet and Inches.	Breadth, in Feet and Inches.
							<i>Ft.</i>	<i>In.</i>
Mr. Fabrey's - 1	-- Grand Puisson at Hornu - - -	Maximum - - -	-	30	2.16	21,213	—	—
		Minimum - - -	-	23	1.02	11,653	—	—
Ditto - 2	-- Bonne Esperance at Montegnies - -	Maximum - - -	44	-	2.36	20,157	—	—
		Minimum - - -	30	-	1.10	17,271	—	—
Ditto - 3	Gouffre - - -	Maximum - - -	39	31	1.65	17,165	—	—
Mr. Letoret's - 4	-- Capatout, No. 8, Belle Vue - - -	Maximum - - -	70	210	1.77	27,125	} 9 10	4 11
		Minimum - - -	30	90	0.39	10,656		
Ditto - 5	-- Grande Veine d'Elouges - - -	Maximum - - -	60	240	2.16	19,441	} 9 2	3 10
		Minimum - - -	30	120	0.90	10,939		
Ditto - 6	-- Escouffiau, No. 1, at Hornu - - -	Maximum - - -	75	337½	1.77	16,741	6 6	3 3
Ditto - 7	Long-terne - - -	Maximum - - -	87½	325	1.81	10,939	} 8 2	3 3
		Minimum - - -	45	168½	1.37	8,476		
Ditto - 8	Agrappe, No. 2 - -	Maximum - - -	70	200	1.37	38,145	9 10	4 11
Ditto - 9	St. Antoine, Nord - -	Maximum - - -	65	217	2.36	23,946	} 9 10	4 11
		Ordinary - - -	43	143	1.18	20,026		
Ditto - 10	Vidette, Nord - - -	Maximum - - -	38	152	1.53	16,618	9 10	4 11
Ditto - 11	Sentinelle, Nord - -	Maximum - - -	41	164	1.47	21,685	9 10	4 11
Mr. Fabrey's - 12	Enbas - - -	Maximum - - -	21	21	1.47	23,692	6 6	9 10

No. 9.—The pits are 209 yards deep. Two seams are being worked. The air is in three splits, 1,200 yards each; airway, 28 feet area; downcast pit, 26 feet area; upcast pit, 58 feet area.

No. 10.—Pits 298 yards deep. One current, 2,500 yards long. Downcast, 58 feet area; upcast, 53 square feet; area of airway, 26 feet.

No. 11.—Pits 360 yards deep. One current, 1,330 yards long. Downcast, 55 feet area; upcast, 44 feet.

No. 12.—Pits 283 yards deep. Five currents; 1st, 1,100 yards; 2d, 450 yards; 3d, 450 yards; 4th, 1,200 yards; 5th, 1,200 yards. Two downcasts, 95 feet area; one upcast, 74 feet area.

Taking the maximum results of the experiments with Nos. 9, 10, 11 and 12 ventilators, which were worked by steam-engines of 12, 15, 15 and 18 horses power, the quantity of air obtained by each machine was at the rate of 21,485 cubic feet per minute; and allowing 12 lbs. of coals per horse-power per hour, 7,162 cubic feet of air was obtained per lb. of coals consumed in the boiler fires.

COST of Nos. 9, 10, 11 and 12 VENTILATORS, together with the STEAM ENGINES and ERECTIONS.

No.	Horse Power of Steam Engine.	ENGINE and VENTILATOR.	BOILERS.	ACCESSORIES.	BUILDINGS.	TOTAL COST.			
							<i>£.</i>	<i>s.</i>	<i>d.</i>
9	12	152 - -	146 - -	16 - -	188 - -	302 - -			
10	15	190 - -	147 - -	- - -	168 - -	505 - -			
11	15	190 - -	148 - -	- - -	155 - -	493 - -			
12	18	364 - -	147 - -	- - -	180 - -	691 - -			

142. Do you think either of them is as good as Mr. Struve's, as a mechanical apparatus?—Perhaps, if there is a line to be drawn, I should be disposed to think Mr. Struve's plan preferable to any of them.

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143. Do you mean with reference to cost?—With reference to economical working.

144. What is the depth of the shaft in the Belgian mines?—Many of them are very deep; they are upwards of 500 yards deep.

145. Mr. Locke.] To what extent do they work from the shaft?—In many cases nearly a mile. As a general rule, they are much shorter, with a number of levels at work in different seams.

146. Is that the description of mine where they only supply 20,000 cubic feet?—That is the whole amount of the ventilation for the whole working of a mine of that kind.

147. Can you state the number of men who are generally employed in a mine of that description in Belgium?—About 250.

148. Chairman.] Do you consider that this mechanical system of ventilation is a satisfactory system, and is it such a system as you would recommend to be adopted in this country?—No; I am not an advocate of it.

149. Will you state your reasons for that opinion?—It is not generally so steady in its action as the furnace; with a furnace at work you are not liable to very sudden interruption, which is a very important objection.

150. Can you furnish some information to the Committee as to the cost of putting up these machines; does it vary from 500 *l.* to 700 *l.*?—Yes.

151. Is there a large quantity of fire-damp in Belgian coal mines?—As a general rule, there is not a large quantity of fire-damp in any of the Continental mines. There is most at Liege; and it appears to decrease westward, until in the same basin, at Valenciennes, in France, in mines 500 yards deep there is scarcely any.

152. Should you rank the most fiery mines of Belgium with the moderately fiery ones of this country?—I should rank the most fiery mines of the Continent with the moderately fiery mines of this country, from personal observation, and from all I could learn with reference to the amount of fire-damp.

153. You would not compare them with the fiery mines of the North of England?—They do not appear to yield as much fire-damp.

154. Is the furnace used at all in Belgium?—Yes, to some extent.

155. Is the system of steam jet used in Belgium?—No; there is an opinion that steam jet is not a sufficient ventilating power.

156. Do they admit the furnace in mines where fire-damp is found?—No; it is inadmissible in mines which are called fire-damp mines.

157. When you say "inadmissible," do you mean that the inspectors do not allow it?—It is inadmissible by law, unless fed by a scale of fresh air; and the amount of fresh air which is supplied to the furnace in Belgium is generally very small, and the temperature of the up-cast shaft is disproportionately low, and the amount of air passing through the working is small accordingly.

158. You mean to say that there is not enough air passing over the furnace to create a brisk circulation of air, and make the furnace burn sufficiently strong?—There is not. I think that if they gave the furnace a larger amount of fresh air, they would increase the combustion of coal; they would raise the temperature of the up-cast, and materially increase the quantity of air circulating through the workings.

159. Do they build high chimnies in Belgium?—They do.

160. Where do they put them?—They build them at the top of the up-cast shaft, for the purpose of assisting the furnace, or for the purpose of carrying on the mine by natural ventilation. Some of those chimnies near Liege are 220 feet high by 9 feet diameter, diameter inside.

161. Mr. H. Vivian.] Have you taken the temperature of any of the up-cast shafts in Belgium?—We did not; but in going down them it is very easy to ascertain whether it is a high temperature or a low temperature.

162. Did you go down without the slightest inconvenience?—Yes.

163. Are they devoted entirely to the up-cast, or do they draw through them?—They sometimes draw through them.

164. Generally?—Generally speaking, they have a separate shaft for the up-cast.

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165. Are they bricked shafts?—No; the Belgian pits are even worse secured than our own.

166. You are aware that the efficiency of a furnace depends a good deal upon the state of the shaft?—Yes.

167. If a shaft is not bricked you cannot raise the temperature so much as you can if the shaft is bricked; and consequently, you may state, as a general rule, that a furnace not working into a bricked shaft is not in a condition to produce the best effect?—There is no doubt that an up-cast shaft is better for being bricked up from top to bottom; I think that all shafts should be bricked up from top to bottom. It is not common, either in Belgium or in France, or Prussia. In all the collieries that we visited, we only met with one colliery (and that was a very large one, and managed in a superior manner) where the shafts were bricked throughout.

168. *Chairman.*] Where was that?—At Mariemont.

169. Do you confine that observation to the up-cast shaft?—It applies to all the pits.

170. *Mr. H. Vivian.*] Then it may be assumed that the furnace, as applied in Belgium, is not well applied?—It is not applied in the efficient manner in which it is applied in this country.

171. What is the highest amount of ventilation that you have seen obtained by the furnace in Belgium?—I have stated that it is very small. I do not know that we saw any case where the furnace ventilation exceeded 20,000 cubic feet per minute.

172. And the diameter of the shaft?—Some of the old up-cast shafts are very small in Belgium. I have stated the size of several of the shafts in the table which I have put in.

173. Then, as a whole, the system of ventilation by furnace is very imperfectly carried out in Belgium; the shafts not being bricked, and being small in diameter?—Yes, and owing to the other causes which I have stated.

174. *Mr. Cayley.*] Can you account for their having applied themselves to mechanical power, rather than to the furnace?—The principal object is to avoid explosions at the furnace.

175. Did they pursue the furnace system before they applied the mechanical system?—I do not know whether they did or not; but an immense quantity of ventilation, on the Continent, is carried on by natural ventilation.

176. *Mr. Fitzroy.*] What do you call “natural ventilation?”—Where no ventilating power is applied.

177. *Mr. Cayley.*] Did you make any inquiry as to the extent to which the furnace system had been tried in Belgium?—Yes; we made a general inquiry as to the mode of carrying on the mines, both by mechanical means and by furnace.

178. Have you any well-ascertained experiments as to the comparison between the furnace system and Mr. Fabrey’s fan?—There is no case where the furnace is at work at the same time as Mr. Fabrey’s ventilator.

179. Have they ever tried one first and the other afterwards?—There are cases where these mechanical appliances are at work occasionally, and where the top of the shaft is thrown open, and the mine carried on by natural ventilation, the mechanical appliances being stopped.

180. Has the furnace been tried first, and then the mechanical system; and can you state which produced the greatest amount of ventilation?—If any experiments of the kind have been made, I have not obtained them.

181. Is it at the Government instigation that these mechanical means are used?—I am not aware that there is any law to compel them to resort to any particular system of ventilation; but, in the police of mines, it is necessary to have some current of air in all parts of the working, and that every part of the working shall be well ventilated, and not in an explosive state; if any part of the mine becomes explosive, or if gas is apparent on the flame of the lamp, the workmen must retire.

182. Does the police act under the inspectors?—Yes; the inspectors carry out the Police Act, which is a part of the code of mining laws.

183. Are there any instruments in the mine to test whether there is a sufficient amount of ventilation going on?—Nothing of the kind; indeed instruments seem to be very little used in any of the continental mines; we saw two of Mr. Combe’s anemometers.

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184. Do they insist on any particular rate of current going on through the mine?—No; there is no such regulation.

185. What test of safety do they apply?—The only test of safety is, as I have described, that the mine must be well ventilated in all its parts; it must not be explosive; and if the flame indicates the presence of gas without being explosive, the workmen must retire. In cases of very great danger, I think they are bound to report it to the inspectors.

186. Mr. Fitzroy.] Is the proprietor of the mine responsible for the safety of his men?—Certainly.

187. Are there any regulations laid down by the Government inspectors for the purpose of introducing any particular system?—No; I am not aware of any law.

188. Mr. Locke.] Nor any stipulation for the use of the furnace, or fan, or jet, or anything else?—No.

189. Is the actual state of the mine the index by which the inspector would judge of the necessity for any change of system?—It is.

190. Mr. Fitzroy.] Are there no regulations whatever laid down by the Government inspectors?—There are certain regulations; for instance, one is with regard to the furnace. If admitted into a mine which gives off fire-damp, it must be fed with fresh air exclusively.

191. Mr. Locke.] Is that so?—In all the furnaces that I saw it was so.

192. Mr. Fitzroy.] Is there any penalty for the infraction of the regulations?—A book is kept at each mine, in which an inspector on visiting the mine, and finding danger, writes it down, and directs attention to the danger; and in the event of his recommendation not being carried out a punishment is awarded, according to a scale which is laid down.

193. Is the control which is exercised by the Government inspectors in Belgium, more stringent than that which is exercised by the Government inspectors in this country?—Much more.

194. Are their powers more extensive?—They are.

195. In what way?—They can enforce the use of the safety-lamp in the Belgian mines, which we cannot do here. There are only four lamps which were approved of by the Belgian Government. Any current of air which may have become mixed with fire-damp must continue to ascend until it reaches the out-cast shaft. It is an essential principle of ventilation, in Belgium, and no departure from it can be allowed, unless it is formally sanctioned by the inspectors; a consent which is seldom given. Restrictions of that kind are in force in the Belgian mines.

196. Have the Government inspectors power to stop the working of any ill-ventilated or dangerous mine?—When they find any danger, as I have said, they make a note of it in a book, which is kept for that purpose at the colliery; and in the event of their notice of its being disregarded, and an accident ensuing, and life being lost, a degree of punishment is awarded for that neglect. When the danger is imminent they can order the men out.

197. Can they stop the working of the mine?—Yes.

198. Under what penalties are these regulations enforced?—There is a scale of penalties, but I am not prepared to state them.

199. Pecuniary?—Both pecuniary and otherwise.

200. Do the proprietors become liable, in any case, for the maintenance of the families of workmen who are injured in the mines?—I am not aware of it.

201. Mr. Cayley.] In Belgium, are they very strict as to the size of the air courses?—The size of the air-courses is not defined. The only regulation with regard to the air courses is, that the gobbing must be packed as tightly as possible, and the air-ways must be accessible in all parts, and must be travelled at certain intervals of time, which are specified.

202. Then there are no other means of testing the safety or danger of the mine, except the length of the flame in a safety-lamp?—That is the plan adopted.

203. Have you ever heard of Chuard's gascroscope?—I have heard of it.

204. Are you aware whether it is of value?—I am not.

205. Mr. H. Vivian.] Is the lamp a very accurate test?—Yes.

206. Mr. Cayley.] Are the lamps first used by the overmen at the commencement of each day, or at particular periods of the day, to test by the lamp the

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state of the air in the mine?—There is a fireman, as in this country, who must examine every working place before the men enter in the morning; in fire-damp mines only safety-lamps are admitted.

207. That is compulsory?—Yes; and if powder is permitted to be used in a fire-damp mine, the shots must be fired by an experienced person, appointed for that purpose; the men who fire the shots are like the firemen in this country; on no account must the mine be left without one of these firemen or overmen being in the mine during the time the men are at work; it is also a part of their duty to report breaches of discipline to the manager of the colliery.

208. Mr. Child.] In point of fact, there is a Government inspector?—He belongs to the colliery.

209. Chairman.] The inspector has two duties, one with reference to the safety of the mine, and another as collector of the tax for the Government; is that so?—Yes.

210. Mr. Cayley.] How often do the inspectors visit the mine?—It depends very much upon circumstances; some mines they visit oftener than others.

211. Chairman.] You have been asked whether any experiments had been tried as to the furnace, and what was the reason of the failure of the furnace, and you were understood to state that the furnaces were improperly worked, inasmuch as there was not sufficient atmospheric air passed over the furnace; is that so?—Yes.

212. If any experiments had been tried with furnaces and mechanical ventilation, those improvements would have been in vain, because the power of the furnace would not be brought out?—Exactly so.

213. Do you conceive there would be any danger in carrying more fresh air over the furnace, provided the same quantity of foul air were brought over the furnace with it?—In this country we generally consider it safe to work the return air over the furnace; and the furnace works most economically when all the return air is worked over it.

214. Mr. H. Vivian.] In many instances, where the returns are very much loaded, you have a dumb drift?—In mines where there is any chance of the return air being highly loaded with gas, or where the mine is liable to sudden eruptions of gas, the proper way is to have the dumb drift; but it is only in exceptional cases where dumb drifts are to be met with.

215. In that case, is all danger from the furnace avoided?—It is.

216. Mr. Child.] What is the longest level you saw in Belgium?—A mile from the shaft.

217. Was that an explosive mine?—I think there was a little fire-damp in it.

218. Was it adequately ventilated by means of mechanical power?—It would be considered adequately ventilated in Belgium; but in this country we should give it a much larger supply of air.

219. Mr. Cayley.] You have stated that, in Belgium, the steam jet has not been favourably received?—It has not been approved of.

220. Has that arisen from trial or from prejudice?—Experiments have been made with it, and it has been condemned for some time in Belgium.

221. Have you reason to believe that it was properly tried, or that it was tried by those who understood it?—I should think that, with such a number of scientific men as the Belgian mining engineers, it is scarcely to be supposed that they would come to a unanimous opinion upon the point without a fair trial.

222. Do you know of any particular instance in which it was tried, and under what auspices?—There were some experiments tried; and I think Mr. Mackworth will put them in.

223. Notwithstanding the scientific attainments of the mining engineers in Belgium, you have stated that they have not tried the furnace system properly?—In my opinion the furnace is not carried out so well as it is carried out in this country.

224. Chairman.] With regard to inspection: will you describe the system of inspection, and the number of inspectors, in Belgium?—In Belgium there is one inspector-general at Brussels, three engineers-in chief (only two of whom are at present on duty), 10 sub-inspectors, and 40 aspirant engineers; this is for the coal and other mines, and for the manufactories of raw materials; there being other inspectors for the railways. The engineers and sub-engineers are selected as experienced men; the aspirants are scientific men, and must be

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be 23 years of age, and must have previously studied two years at a preparatory school, and three years at college, with occasional visits to the mines; the sub-engineers are sometimes elected from the aspirants, but not always.

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225. *Mr. Fitzroy.*] How many sub-engineers are there?—There are 10 sub-engineers; I called them sub-inspectors, which is the same thing.

226. *Mr. Cayley.*] There are 54 of them altogether?—Yes.

227. *Chairman.*] Are the 40 aspirants paid?—Yes.

228. *Mr. Fitzroy.*] Is it their duty to inspect mines, and to report upon them?—The duty of the aspirant engineers is to inspect the mines, and to report to the officers above them.

229. In point of fact, to carry out the police of the mine?—Yes.

230. *Chairman.*] The aspirant engineers do not always become sub-inspectors, but very often become managers of mines, and take any other employment they think fit?—That is so.

231. *Mr. Fitzroy.*] What are the duties of the three engineers-in-chief?—They visit mines occasionally, and see to the working of the corps over which they preside. The aspirant engineers' duty is to be constantly visiting mines; the sub-engineers, above them, visit mines when their attention is directed to any danger which the aspirant engineers think is capable of being removed; and if anything particular takes place, one of the engineers-in-chief is called in. They have also to make up the statistics of the number of accidents which take place in the districts; and they have also to check and verify the plans of the colliery, and to look after the per-centage which is payable to the government; a duty which is performed in this country by the check-viewers, who are employed and paid by the lessors.

232. Are the Committee to understand, that in point of fact the inspection of the mines is performed chiefly by the aspirants, and that the sub-inspectors only visit the mines when representations are made of some danger being likely to happen?—I think they direct their attention, first, to a point which has been drawn to their attention; but I believe it is a part of their duty to visit the mines also.

233. What other duties do the sub-inspectors perform, besides that of inspecting any particular mine to which their attention is drawn by the aspirants?—They perform the very important duty of looking after the per-centage on the profits of the colliery, which is payable to the Government. In Belgium, 2½ per cent. of the profits is payable to the Government.

234. *Chairman.*] In every case?—Yes.

235. *Mr. Fitzroy.*] Then in the event of any danger being likely to arise in a mine, is it necessary that the aspirant should report to the sub-inspector, and the sub-inspector to the superior authority, before any steps are taken to check the danger?—An aspirant engineer can only act according to the instructions which he has received from the administration.

236. He can only report?—In case of any great danger, I believe he has the power of stopping the mine.

237. Then, in point of fact, he is the judge of the danger, and of the necessity of taking immediate steps?—Yes.

238. In point of fact, the aspirant fulfils all the duties which now devolve upon a mine inspector in England?—With this difference, that he has superior officers who have had experience in the mines to consult, and we have no superior officer, except the Secretary of State; we must act on our own judgment in such matters in all cases.

239. Is the duty of the aspirant only to represent danger, or to take measures to avert danger?—Partly to avert danger, and also to look after the interest of the Government, which is tantamount to a lessor of coal in this country. It is the duty of all the corps to look after the interest of the Government.

240. Can the aspirant act independently to preserve the safety of the mines?—I think he can; but no doubt, in a critical case, he would immediately consult his superior; he might, in a case of urgent danger, stop the mine; but such a thing very rarely happens, and it is almost unknown for a mine to be stopped.

241. You have stated, in a former part of your evidence, that mines are stopped in cases of danger; upon whom would that duty fall?—In the first place, upon the aspirant engineer; no doubt he would consult his superior officer; and the superior officer would visit the mine as early as possible.

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242. *Chairman.*] Have the inspectors in England that power?—We have no such power.

243. *Mr. Locke.*] Will you turn to the rules of the police in Belgium, and state what is the power which the aspirants have of stopping the mine?—Mr. Mackworth and myself have arranged the evidence between us, and we have an interpretation of the police rules, which Mr. Mackworth will give in his evidence.

244. *Chairman.*] You say that the Government receives 2½ per cent. of the profits. Of course the profits would depend very much upon the success of the undertaking, and the success of the undertaking would depend very much upon whether the mine was worked properly or improperly. Is it the duty of any of these officers to see that the mine is worked in a proper way, so that the Government are not damnified by improper working?—It is an important part of their duty, in addition to looking after the safety and health of the workmen, to look after the interest of the Government.

245. If, therefore, a mine was worked in such a way that the Government received less profit than they ought to receive, and had the opportunity of stopping the mine and getting it worked in a proper manner, is that a part of their duty?—I do not know that it is put forward as a part of their duty, but practically they have an interest in seeing the mine properly worked.

246. *Mr. Fitzroy.*] What is the duty of the three engineers-in-chief?—They go down the mines occasionally; some of the engineers take the charge of iron-works and other manufactories as well as of coal mines; one of the engineers at Liege, Mr. Gernaert, looks after the interest of the Government in the management of the Seraing Iron-works.

247. *Mr. Locke.*] Do you know of an instance in which the extreme step of stopping a mine has been taken, without special reference having been made to the engineer-in-chief?—I do not know of any case where a mine has been stopped; if such cases have occurred they are very rare.

248. Do you think, from your knowledge of the management of the mining system in Belgium, that if such a course were decided upon it would be decided on without the consent of the engineer-in-chief?—I think that before an aspirant engineer, who is generally young and although of great scientific attainments, they are not always experienced colliers; before they would take such a step as to stop the working of a mine, I think he would point out the danger, and request that the working of the mine should be stopped until the opinion of his superior officer had been taken; and, upon the superior officer visiting the mine, if he considered, with the aspirant engineer, that the danger was imminent, and the proprietor of the mine thought that it was not imminent, steps might then be taken, but not until the superior officer had been called in.

249. *Mr. Fitzroy.*] Has an aspirant engineer the power of stopping a mine?—I believe he has that power.

250. Of that you are certain?—The duties of all the corps are laid down in the code of mining laws, and as my time for visiting the mines was limited, I devoted myself more to the practical part of the subject than to the laws which may be read at any time.

251. *Mr. Cayley.*] With what particular object were you sent to Belgium?—The principal object was to ascertain the best system of ventilating mines. There has been so much difference of opinion on the subject, and since the appearance of the Report of the last Committee on coal mines there has been such a ferment created among the colliery managers, that our object was to ascertain the opinion of Belgian engineers; also to ascertain, by actual inspection, whether they had any better system of ventilation than we have in this country, and if so, to introduce it for the purpose of improving the management of mines here; and also to ascertain generally, whether on any other points the mines were better managed than they are in this country, so that improvements might be introduced here.

252. Was not one of the principal objects with which you were sent, to examine into the system of inspection of mines in Belgium and other countries?—It was no part of my instructions to inquire into the inspection.

253. *Mr. Fitzroy.*] Your instructions referred to the general management of the mines?—Yes; the subject of inspection having been reported on by Mr. Tremenheere, who has given the general outlines of the system which is adopted, it was only important to inquire into it so far as it bore upon the practical operations of the mines.

254. Of course the inspection of mines would form a very material part of the management of mines?—No doubt. *J. Dickinson, Esq.*

255. *Chairman.*] Both going together, and having a great deal to do in a short time, it was natural that you should have applied yourself to one branch of the subject, and that Mr. Mackworth should have applied himself to another?—My attention was chiefly directed to the system which was adopted of working and ventilating the mines, and to any management which tended to preserve life.

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256. *Mr. Cayley.*] Is it to be understood, that in that division of labour Mr. Mackworth attended more to the Government system of inspection, and that you examined more into the system of ventilation?—No.

257. With regard to the size of the districts; how large is the district of each aspirant engineer?—I may answer that question by adverting to the quantity of coal which is raised, or to the number of persons who are employed.

258. How often do the aspirant engineers visit the mines?—In the best managed collieries, where every precaution is taken by the managers, I believe they do not visit them more than once a year, or more than once in two years, or merely for the purpose of verifying the plans when a working is being finished; but mines which are considered unusually dangerous are visited very frequently, I believe sometimes once a month.

259. Do the 40 aspirant engineers indiscriminately visit the mines, or is one district assigned to one aspirant engineer, or to a given number of aspirant engineers?—A certain district is assigned.

260. What is the size of that district?—I can give the quantity of coal raised in the whole of Belgium; and you have the number of engineers.

261. How many mines does he superintend?—I cannot state the exact number; there is no given number.

262. Is the number of mines in Belgium very large?—No; it is about one-eighth part of the number we have in this country.

263. You state that in very fiery mines, the visits of the inspectors are on an average monthly?—Not in the very fiery mines, but in the badly managed mines. In mines which are well managed, even although there be a large quantity of fire-damp, the inspectors' visits are few and far between; but in mines which are badly managed, their visits are much more frequent.

264. Are the visits of the inspectors in Belgium more frequent than they are in this country?—Of course.

265. For what reason?—There are only six inspectors for this country; and if we have eight times the number of collieries apportioned among six, of course the visits must be very much fewer here.

266. How long would it take you to visit the whole of your district?—Several years.

267. How many years?—I do not think that I could visit each colliery under four or five years.

268. You could not go through your district under four or five years?—I do not think I could.

269. What salaries do the engineers receive in Belgium?—I cannot answer the question.

270. Can you compare the sub-engineers to any class in this country?—They are men of good education, and are supposed to have had experience in mines, and to understand the working of mines practically.

271. Where do the aspirant engineers reside?—In the districts which they overlook.

272. Where do the sub-engineers reside?—They reside also in the districts which are assigned to them.

273. Where do the three engineers-in-chief reside?—They reside also in the districts which are assigned to them.

274. Then they are not a council of three, but they are three engineers-in-chief, occupying three different districts?—Yes.

275. What is the office of the inspector-general?—He is a person who takes charge of the general working of the corps.

276. He is a sort of Government Commissioner of Mines residing in the metropolis?—Yes; and who rarely, if ever, goes into the mines; but who is, I believe, always an experienced man.

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277. In what case is reference made to him?—I think reference is very rarely made to him; but either in an extremely critical case, or perhaps on the occasion of anything novel being introduced into the mine, he might go for the purpose of seeing it.

278. Is he the medium of communication with the Government?—Yes.

279. *Chairman.*] Is there a book kept at each mine for the engineers to write remarks in?—Yes

280. If there is danger, do they so remark?—If there is any danger which they think can be removed, they make a note of it in the book; and if steps are not taken to remove the danger, and an accident happens, the colliery proprietors are made responsible, and they are fined or punished accordingly.

281. Who levies the fine?—It is done through the magistrates.

282. Upon the information of the sub-inspectors, or of the engineers-in-chief?—It depends on which of the inspectors have seen the danger.

283. Suppose it is an aspirant engineer?—He would give the evidence.

284. He would go before the magistrate and give information, and the fine would be levied if his orders were not obeyed, and an accident took place?—Yes.

285. *Mr. Fitzroy.*] Are you aware of a class of workmen who are charged with the inspection of a mine, and have power to stop a mine in case of danger, and whose duty it is to ascertain that a mine is safe before the workmen go in?—They are a class of men who are employed by the proprietors of the mines; they are similar to our overmen and firemen in this country; they are not paid by the Government.

286. The number of them is fixed by the inspector 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 provides?—Yes.

287. Are they Government officers or not?—No.

288. Are they appointed by Government officers?—No.

289. *Mr. Cayley.*] Do they undergo any examination?—Yes, the Government engineers have all to pass examinations; if an aspirant engineer, on being appointed an aspirant engineer, passes a very excellent examination, he may be at once admitted a sub-engineer, without going through the degree of aspirant engineer.

290. Do the aspirant engineers, or whoever has the control over the overmen, insist with the proprietors of mines, that the overmen, on whom the safety of the mine depends, shall pass an examination, or have any particular qualification for their office?—I do not know that they do.

291. *Chairman.*] The aspirants themselves must be of a certain age?—Yes.

292. *Mr. Cayley.*] The object of my question is to ascertain whether the Government so far interferes, that although it does not absolutely appoint the overmen to watch over the safety of the men, yet it exacts that they shall be of any particular class, or possess some particular qualifications?—They must be experienced men, and competent to carry on the work; I do not know of any examination, and I believe there is none.

293. *Chairman.*] Are naked candles ever used in the mines in Belgium?—Yes; in mines which do not contain fire-damp; but in fire-damp mines lamps are used exclusively.

294. How are they used in the waggon roads?—In many of the mines the waggon roads are lighted by lamps hung from the roof, as we sometimes find in this country.

295. *Mr. Locke.*] What kind of lamps?—Safety-lamps.

296. *Chairman.*] Near the up-cast pit do they use naked candles?—No; they are very careful to have no naked candles on the surface near the mouth of the up-cast pit, and safety-lamps hung up in the engine-house, where a ventilator is at work.

297. Are there any descriptions of safety-lamps which are exclusively used?—There are only four lamps which are approved of by the Government; namely, Davy's, Museleer's, Boty's, and Eloin's.

298. All those which are used are glass, except Davy's?—Yes.

299. Which is most commonly used?—The Museleer lamp is the lamp which is commonly used. Very great confidence is placed in it in Belgium.

300. Do the glasses often break in those lamps?—It depends on circumstances. The proportion, as stated to us at some of the large collieries, where there

there were between 300 and 400 lamps in use, was at the rate of one glass per week for every 200 lamps in use. *J. Dickinson, Esq.*

301. Mr. *H. Vivian.*] Would that be cracks of the glasses, or fractures?— That is the proportion of new glasses required. 13 June 1853.

302. From a simple crack no danger could occur, and from an actual fracture of a lamp danger might occur?—It is better not to use cracked glasses, as flame passes through a smaller hole in glass than in iron; all the lamps which are approved of, except Davy's, are self-extinguishing lamps, in Belgium; so that there is not a continual flame kept up in the inside of the lamp, which might break the glass.

303. *Chairman.*] Can you state the difference in the cost of these lamps?—Each mine generally makes its own lamps in Belgium.

304. The whole of the lamps?—Yes; they are generally very rough as compared with our lamps. This Davy lamp (*pointing to a lamp on the table*) would not be considered a good lamp here; it has no cap to it; it has no ring at the bottom to prevent the gauze from bulging out; it is sold at 3*s.* 4*d.* The Museleer lamp is sold at 5*s.*, and if it is made with copper wire, for dialling with, it is sold at 7*s.* 6*d.* The Eloin lamp is sold at 8*s.* 4*d.* if it is made of brass, and 5*s.* if it is made of iron.

305. What is the price of an ordinarily constructed Davy lamp in England?—About 5*s.* 6*d.* for a good lamp.

306. Is there any difference in the weight of them?—The Museleer is the heaviest.

307. Is there any difference in the quantity of light?—The Eloin lamp gives the best light; the supply of air all comes from the bottom, and it is thrown upon the flame by an argand burner.

308. Which do the men prefer?—The Museleer is generally preferred. The Eloin lamp is a new lamp, and we did not see it in use in any mine in Belgium; it was only recently introduced.

309. Mr. *H. Vivian.*] Is the expense an objection?—No; that does not appear to be made an objection. The Museleer lamp is about the same price, and it is in common use.

310. *Chairman.*] Do the proprietors of the mines provide the lamps?—Yes.

311. Mr. *Cayley.*] Are they compelled to keep them locked?—Yes; the lamps are always locked; and they must not be opened in the mine, unless at the bottom of the downcast pit, where there is a place set apart for the purpose.

312. Is it not the habit of the workmen in this country to unscrew the top of the lamp and work with the flame?—Sometimes; but they can be punished for doing so.

313. In this country?—Yes. The magistrates do not appear to be unanimous in their opinion upon that point, for in some cases they convict and in others they do not. At Wigan there is no difficulty in convicting the miners; they proceed under the 4th of George the 4th, chapter 34, section 3.

314. What is the method pursued in Belgium, to prevent that habit which exists among the colliers in this country, of unscrewing the tops of their lamps and burning the naked flame?—I know of no other precaution except locking the lamps, and they are very strict in punishing. In fact, discipline is kept up in the Belgium mines rather better than in our mines; the men are in excellent discipline, and for a man to open a lamp, I think, is a thing hardly ever heard of.

315. Do you attribute that better discipline to a better system of inspection?—I think it pervades the miners generally.

316. Are the men better educated?—As a general rule, I think they are.

317. Are the overmen better educated?—No; I do not think they are a better class of men than ours.

318. *Chairman.*] Do you think the men themselves are more sensible of the danger of unscrewing their lamps in Belgium than they are in England?—I think they are; some of our men in certain parts of England are very careful, and would not on any account think of opening their lamps. Other men are very reckless; and unless they are well looked after they will do it.

319. Mr. *Fitzroy.*] What is the penalty in Belgium for opening a lamp?—It is a thing which is almost unknown. An order is given that the lamps shall not be opened, and the order which is given is carried out. They would be taken before a magistrate, and punished for an infringement of the order.

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320. You do not know of any penalty?—I do not know of any specific penalty.

321. Mr. *H. Vivian*.] What penalty has been inflicted at Wigan?—Three months' imprisonment.

322. Mr. *Cayley*.] What is the object of the miners in this country in taking off the top of the lamp?—With a view of getting a better light, and sometimes for the purpose of trimming the wick, and sometimes without any apparent motive.

323. Does the gauze obstruct the light very much?—Yes.

324. Is it a fact that they generally work with the lamps behind them?—Partly behind them, and partly at their side.

325. When they are working with the lamps behind them, they do not see the flame lengthening, so as to indicate the presence of foul air?—No.

326. Do you consider that the meshes are sufficient to prevent the flame coming through?—The large size of the mesh appears to be a weak point in Eloin's lamp; but being at the top of the chimney, nothing but consumed air passes through it. I have never myself been able to pass gas through the gauze.

327. Is the Eloin lamp a lighter lamp for a miner than the Davy lamp?—No; it is rather heavier than the Davy.

328. Does it give more light?—Yes; there is an argand burner applied to the Eloin lamp, which draws the air on the flame, and creates a very perfect combustion.

329. Would it not add much to the light which is given out from the Davy lamp if it were made of polished wire gauze, instead of black iron wire?—The lamps are made of wire, which, on being brushed with a little Bath brick, or ashes, become perfectly bright. Since the recommendation of the last Committee, I have ordered what are called reflecting lamps, and this is one of them (*pointing to a lamp on the table*). The wire gauze is coated with tin, and immediately on becoming exposed to an explosive atmosphere the tin melts and runs down in globules. It becomes much discoloured, and the meshes of the gauze get filled up with the globules of tin. It is by no means so good as the ordinary wire.

330. *Chairman*.] Supposing it be an advantage to have the wires polished and perfectly bright, how long will they keep clean after being down the mine?—They must be brushed every night.

331. Would they keep clean a whole day?—In a dry mine, if you tap the lamp the dust falls off.

332. There is no great quantity of smoke?—If the flame is too large the smoke will blacken it; but if the flame is kept small, you may avoid the soot.

333. Mr. *Cayley*.] Does not the safety and sufficiency of the lamp depend altogether upon its being kept clean?—Yes.

334. What system is pursued in Belgium to ensure the cleaning of the lamps?—They are cleaned every night. There is a lamp-house at the door of the pit, where the lamps are left as the men go out, the same as we have in many of our best managed mines in this country. The lamps are cleaned, and are given to the men as they go to work in the morning.

335. Mr. *Fitzroy*.] How many hours will a common Davy lamp burn?—It is always made to burn 12 hours, so that a man may not have an excuse for leaving his work.

336. Mr. *Cayley*.] Will you describe the objection which you have stated with regard to the melting of the reflector?—The coating of tin which is put on the wire gauze melts.

337. Was not the proposition that they should be electro-plated with silver?—I ordered those lamps of one of the first makers in the country, Mr. Watson, of Newcastle-on-Tyne; and upon making an experiment with them, I found that instead of possessing any advantage, as polished wire-gauze lamps, they possessed the very great disadvantage which we are cautioned against by Sir Humphrey Davy himself.

338. Would they have melted if they had been silver plated instead of tin plated?—I should think silver would melt. It would not melt at so low a temperature as tin. If you pay proper attention to the wire gauze, and brush it every night with a little Bath brick, or fine ashes, or a little chalk, or anything, it will throw a polish on the wires and make them as bright as silver; and in some cases, where the gauze is properly brushed, you have it as bright as silver.

339. *Chairman*.]

339. *Chairman.*] You stated that you had not paid any attention to the recommendation of the Committee as to coating them with silver; and, therefore, you cannot state what the expense would be if they were coated with silver?—I cannot; I ordered the polished wire gauze.

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340. *Mr. Cayley.*] If there is a constant habit, among miners in this country, in order to obtain a better light, to unscrew the tops of their lamps, is it not a matter of very great importance to have a lamp of some kind which will give them that better light, without unscrewing the top?—Yes; it is very desirable.

341. Is it a fact, that in visiting the mines in your district, you found the lamps in the polished state which you have described?—In some cases; but I think, in the majority of cases, they are not properly brushed.

342. In point of fact, do the lamps now tend to absorb the light?—A great proportion.

343. If the silver-plated lamp would have the effect of reflecting a greater light, it would not be liable to melt at the heat which is in the lamp; would not that be a desideratum?—I think the same object would be attained by polishing the gauze; it is necessary, I consider, to have the lamp clean to ensure safety, and in cleaning the lamp you polish it, so that you attain the same object at a cheaper rate.

344. In point of fact, practically, the lamp is not in that state of polish on the average?—That is, where the lamps are not clean.

345. You stated that practically lamps were not in that polished state in which you think they should be in order to gain that greater light which you consider a great desideratum?—Yes.

346. You are aware that silver does not melt except at white heat?—I do not recollect the temperature at which it melts; but I am aware it is considerably higher than the atmosphere at which tin melts; if we were to have the wire coated with silver, very great care would be required to prevent tin being substituted.

347. *Mr. Fitzroy.*] You were understood to state, that there were some mines in which the lamps were properly looked after?—Yes.

348. Whose business is it to look after the lamps?—There is sometimes a person appointed for the purpose, and sometimes the men take them home and clean them themselves.

349. Each man looks after his own lamp?—Yes.

350. Is there any person whose business it is to see that the regulations of which you have spoken are carried out?—There ought to be always either a fireman or an overman in a mine, or more than one if the mine is a large one, to look after these matters and see that the regulations are properly carried out.

351. In the average number of mines is it so?—In some cases it is not so; and the mines are left without any proper officer being present, and the men may then do as they think fit without detection.

352. *Mr. Child.*] What is the usual course?—In the best managed mines there is always a person left in the pit, and in the worst managed mines there is no person.

353. *Mr. Fitzroy.*] What proportion do the well-managed mines bear to the whole number of mines within your district?—The best managed mines are the smaller proportion; as a general rule, the majority of mines in this country admit of improvement.

354. Then in point of fact, in the great majority of mines within your district, there is no practical check upon the miner opening his lamp whenever he feels so disposed?—I think there is some check; for although in the worst managed mines, the overman or fireman may not be constantly in the pit, he may at all events visit the working once a day; it is very bad indeed where it is not visited once a day, and when he is going his rounds, he would probably at one time or other meet with any person who had his lamp open; and he ought at once to take steps to punish that man.

355. Do the workmen act at all as a check upon each other?—No; you must rely upon your own observation.

356. Are the proprietors of mines aware when your visits of inspection are likely to take place?—As a general rule, I do not give them information when I intend to pay a visit; I believe some of the inspectors do.

357. Are your visits of such a nature, and so made, as to enable you to ascertain whether such a practice is carried on in mines or not?—I have met now and then with a lamp open.

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358. Then you can hardly form any idea of the extent to which the practice prevails?—When an accident happens the fact comes out; and it very frequently appears that the men have had their lamps open, contrary to their instructions.

359. Then is it your impression that that practice does prevail to a great extent?—I have no doubt of it.

360. *Chairman.*] Do you think it desirable that in any case where a safety lamp is required to be used, the miner should take it home and clean it himself?—You generally find that the gauze of the lamp is better cleaned and the gauze much brighter when a man is allowed to take it home.

361. Suppose there was any defect in the lamp?—The gauze ought to be examined every morning at the pit head, before it is taken into the pit. At many mines, they leave the oil can in the lamp room; and the man is allowed to take the gauze home and clean it himself; and, in some cases, a premium is given to the person who keeps the cleanest gauze; and in these cases the lamps are very well cleaned.

362. On bringing the lamp back, it is always necessary, before the man enters the pit, that some proper person should inspect the lamp, and see that there is no defect in the gauze?—When the oil can is screwed to the gauze, it ought to be the duty of the lamp-man to examine the gauze, and see that it is all right.

363. Is that always done in every colliery?—It is generally professed to be done.

364. Supposing it were not done, and an overman in going round the pit were to see a man burning a lamp, he could not tell from his own observation, without an examination of the lamp, whether there was a flaw in the gauze or not?—It is quite possible that an overman might overlook such a lamp in going his rounds; I have met with defective gauzes when I have been inspecting. A person should be appointed to the duty of inspecting the lamps every morning before they are used, and the collier should also be held responsible for the efficiency of his lamp.

365. *Mr. Fitzroy.*] Could an overman doing his duty overlook the fact of a miner's lamp being open?—No.

366. Has an overman any other duties to perform except to superintend the workmen?—He has to look after the ventilation and general working of the mine; and he or the viewer measures the narrow work, which is paid for by measure.

367. Do you think that the safety of workmen would be much assisted by appointing either an additional overman, or by limiting the duties of the overman simply to the superintendence of the workmen?—I do not think you could make such a division of labour in a mine; the overman is also responsible for the carrying on of the mine.

368. If that part of his duty were devolved upon some one else, would he not have more time and more opportunity of securing the safety of the workmen, by preventing their opening their lamps, and exposing themselves to danger?—In some collieries there are a number of overmen and firemen employed.

369. In those collieries do accidents occur as frequently from the carelessness of workmen, as in collieries where a smaller number are employed?—Where the men are more looked after there are generally less accidents than where they are allowed to commit breaches of discipline with impunity.

370. Then, in point of fact, one element which you would recommend, as contributing to the safety of mines, would be a more careful superintendence?—No doubt that is a most important point.

371. *Mr. H. Vivian.*] Do you consider that the law, as it exists at present, is sufficiently stringent in punishing men who are guilty of an infraction of regulations?—If the Act of George the Fourth were generally administered, it seems to be quite sufficient to meet the case. Three months' imprisonment is a long term for opening a lamp; but the magistrates are not unanimous in their administration of the law on that point. If the law were properly administered I think it would be sufficient.

372. You say that in some cases the magistrates convict, and in others they do not convict; do you consider that the law is sufficient to punish men who are guilty of such offences?—I apprehend it must be sufficient, otherwise those magistrates who convict must be exceeding their duties.

373. *Mr.*

373. Mr. *Child*.] Have there been any appeals against decisions?—I am not aware; a conviction took place very recently in Lancashire. J. Dickinson, Esq.

374. Mr. *Cobbett*.] Have you attended before magistrates when such complaints have been made?—Yes. 13 June 1853.

375. Do you know the reason that magistrates have refused to convict?—I have not attended when magistrates have refused to convict.

376. Mr. *Fitzroy*.] Does not the carelessness on the part of the miners arise very much from a recklessness of danger?—By constant exposure to danger they become hardened to it, and do not take proper precautions.

377. Do you think that a man who is so reckless of his own life and the lives of those who are working with him as to expose the flame of a lamp, will not be equally reckless at the risk of three months' imprisonment?—I think if there were an apprehension of punishment by imprisonment it would act as a greater check, because no man, on going into a mine, expects that he is going to be killed; although they do not take proper precautions, they expect that no accidents will happen; but if they knew that upon their being found with an open lamp, they would be liable to imprisonment for three months, I believe it would have a very salutary effect.

378. Mr. *Farrer*.] Are the men generally aware of the risk which they run?—I do not think they consider they are running any risk.

379. Are any special instructions given to them, on first going to work in mines?—In some cases.

380. Not generally?—Not so generally as they ought to be.

381. They begin frequently very young?—Yes, as boys.

382. As they advance in years, and find that no accidents occur, do they suppose that no accidents will occur?—I think that is the ground on which a great many of them act.

383. Mr. *H. Vivian*.] With regard to smoking in mines, does it occur that men draw the flame through the wire gauze in order to light their pipes?—Yes.

384. Do you think that any power could be given, either to inspectors or owners of mines, to insist upon smoking not being carried on in mines, and that upon an infraction of the regulation a fine should be imposed?—There is no difficulty in preventing smoking, if the manager will take proper precautions; but if the manager and the overman wink at men when they are smoking, it becomes a common custom among them. In a Newcastle pit, no man dare take a pipe underground with him; he is at once either fined a sovereign, or discharged if he refuses to pay the fine. If you keep up discipline among the men you may easily prevent smoking; but if the overman finds a man smoking, and he does not at once notice it, it creeps into a custom.

385. Mr. *Cayley*.] Is the fact of men lighting their pipes through the gauze, any very particular test that the flame will not come through the gauze?—I think it is possible to light tobacco without drawing the flame through the gauze.

386. You think that tobacco will light without the flame coming through the gauze?—Yes.

387. Mr. *H. Vivian*.] In placing a pipe to the lamp do you not create a very strong draught?—It cannot be very strong, when you consider the small tube through which you draw it, and the very large surface that is exposed.

388. You are aware that it was pointed out by Sir Humfrey Davy, that a strong current of flame would pass through the gauze?—Yes.

389. Mr. *Cayley*.] Then the lamp is not to be considered an absolute security, under all circumstances?—Not under all circumstances.

390. At what rate of current would you say there was a chance of explosion through the meshes of the lamp?—Eight miles per hour; I do not know that that might cause an explosion through the gauze; but I think that no prudent person would expose a lamp in an explosive atmosphere to a current running at that velocity.

391. Supposing the flame was lengthening, and the man apprehended danger, and were to run away, would not the current be so much increased as to produce an explosion?—No; not if we suppose that the flame is merely indicating fire-damp, and has not arrived at the explosive mixture.

392. Suppose he was carrying a lamp with him?—You assume a case where you have not arrived at an explosive mixture, but merely a case between an explosive mixture and one which is non-explosive.

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393. Suppose the atmosphere were such as to indicate danger by the lengthening of the flame, and an explosion not to have occurred?—Such atmospheres are very common, without being explosive.

394. *Chairman.*] Is there not a mode of putting out the lamp?—Yes; you can draw the wick down into the tube.

395. Supposing a man were properly instructed, is it likely that he would run away when he has got his lamp in an explosive state, and would he not be much more likely to put the lamp out?—If he got into such an atmosphere as is spoken of: an atmosphere which was not explosive, but merely indicated the presence of gas, he would at once put his lamp out by drawing the wick down into the tube; but supposing he got into an atmosphere which was explosive, and he had a common Davy lamp with him, and the gauze became full of fire-damp, he might draw the wick into the tube, but so long as the flame was fed with gas it would still continue burning in the cylinder; and as long as that flame continued to burn it would be impossible to put it out without retiring from the explosive mixture.

396. *Mr. H. Vivian.*] Then, in that case, by shielding his lamp, he would prevent any current of air passing through it?—He might put it under his coat and retire. The Museleer lamp becomes extinguished immediately that an explosion takes place in it, and so does the Eloin and the Stephenson lamp.

397. And the Clanny lamp also?—I think it is possible in an explosive mixture to keep up flame in the top of the wire-gauze tube.

398. *Mr. Cayley.*] If the air was in an explosive state, and the man should not have that presence of mind, which is not very common in danger, would his running or stumbling, or any accident of that kind, produce the very explosion which the lamp is intended to prevent?—It might; but we are now imagining cases which ought never to happen, and which do very rarely happen.

399. Have you not attributed some of the explosions to the fact of the miners being indiscreet in opening the top of their lamps?—That is another thing.

400. Is it not possible that an explosion, when no evidence has been given on the subject, may have taken place from these circumstances?—In the course of my experience I have only met with two cases where the gas appeared to have fired through the gauze.

401. If an explosion took place twice under the circumstances you mentioned, what reason is there to prevent its occurring a greater number of times?—No reason; only that the ventilation of the mine ought to be better attended to; the mine ought not to be allowed to get into such a defective state.

402. You think that greater dependence should be placed on the ventilation, than upon anything else?—I would use the safety-lamp as a precaution against outbursts of gas, either from some sudden irruptions from the roof, or floor of the mine, or from the seam itself, and also against sudden irruptions from goaves or other accumulations.

403. As a general principle, may it be assumed that you consider the best source of safety to consist in improved ventilation?—Yes; but even with good ventilation a mine might be liable to the circumstances which I have mentioned.

404. But the better the ventilation the less liable it would be to those circumstances?—No doubt.

405. *Mr. Farrer.*] Do you see any objection to having the lamps locked, so that they cannot be opened in the mines?—I think all lamps should be locked.

406. Are they in general locked?—In some cases they are locked.

407. You see no reason why they should not be locked in all mines?—I think they ought to be locked in all mines.

408. If that were done, a great number of accidents would be prevented?—It would often prevent the men opening their lamps who now open them, but it would not in all cases prevent them; the men get keys occasionally.

409. Supposing the overman kept the key, and some person were appointed to lock all the lamps in the morning before the men came to work, would the difficulty be overcome?—Not if a man had a key in his pocket.

410. If he had a key in his pocket how could he open the lamp?—He could open his own lamp.

411. How could he do that without the connivance of the overman?—If strict discipline is carried out, and the overman, on finding a lamp open, makes a point

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a point of having the man dismissed, there is no difficulty in keeping the lamps locked; it is only where these matters are overlooked that lamps are opened.

412. Mr. H. Vivian.] If there were a specific enactment for punishing men, in case of their endangering the lives of their fellow-workmen by opening their lamps, or smoking, do not you think a great moral effect would be produced?—No doubt.

413. Mr. Cayley.] Do you think that the system of inspection in Belgium at all diminishes the sense of responsibility on the part of the owners of mines?—No, they are still left responsible.

414. Chairman.] In Belgium, is the system of splitting the air understood?—Yes; the air is very well split.

415. Is there any peculiarity with regard to the system of ventilation as to return air?—That is particularly attended to in Belgium. Every vitiated current must continue to rise until it reaches the up-cast shaft.

416. The air is not allowed to go up one way and down another?—No; not without the formal consent of the inspector, which is rarely given.

417. Do you consider that is an important principle in ventilation?—Yes, very important.

418. Is it a principle which you would recommend for adoption in this country?—I am afraid you could not make it imperative in this country. In working fire-damp mines in Belgium, where the seams are very steep, it is one of the Government regulations that, in the first place, the upper range must be worked, and so on in descending ranges of about 30 yards each, leaving the upper range for the return air-course; so that as the pit is sunk to a new level at each 30 yards, that which was the deep level of the former working becomes the level for the return air of the deeper working. In our flat seams of this country, or where the dip is one in 20, or in 12, or one in 6, it would add very much to the expense of getting the coal, to render it illegal to bring the air-current down again.

419. Mr. H. Vivian.] Assuming that you have a 50 fathom pit to your rise, and a 250 fathom pit to the dip, and that that deep pit is heated to a very great extent, would you not gain enormously by taking your air down to that pit, and taking it up in a highly rarefied state rather than allowing it to go up the 50 fathom pit?—Under such circumstances you would gain by the rarefaction, but it would not be acting in accordance with nature.

420. Chairman.] And therefore you think that adherence to this principle in Belgium is not always beneficial?—I think it ought to be attended to in every case where it is practicable; indeed, in this country, where it is practicable it is generally attended to; but it is not practicable in every case. I do not think it should be made compulsory.

421. Can you state the number of persons who have lost their lives in coal and other mines in Belgium during a period of five years ending 1849?—During the five years ending 1849, in Belgium, 724 persons lost their lives in the coal and other mines, being an average of 144½ lives per annum. They took place as follows:—

	TOTAL LIVES LOST.
In Shafts:	
By ropes and chains - - - - -	84
By ladders - - - - -	20
Miscellaneous - - - - -	94
	—198
Falls of roof and sides of workings - - - - -	240
Explosions of fire-damp - - - - -	138
Inundations - - - - -	6
Explosions of gunpowder - - - - -	13
Miscellaneous - - - - -	129
TOTAL - - -	724

The average number of persons employed at the mines during the above period was 51,352. The loss of life was consequently at the rate of 2½ lives per annum per

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per 1,000 persons employed. Most of the accidents happened at the coal mines. The quantity of coal raised during this period averaged 5,055,196 English tons per annum. During the years 1851 and 1852 about 54,000 persons were employed, and the loss of life averaged $194\frac{1}{2}$ per annum; there having been two great accidents by explosions of fire-damp in 1852, in one of which, at Longterne Ferrans, 69 lives were lost; and in the other, at Longterne Trischer, 35 lives were lost. The loss of life for 1851 and 1852 is as follows:

	1851.	1852.
In Shafts:		
By ropes and chains - - - - -	9	26
By ladders - - - - -	1	8
By miscellaneous - - - - -	16	25
	26	59
Falls of roof and sides of workings - - - - -	56	57
Explosions of fire-damp - - - - -	17	106
Inundations - - - - -	-	16
Explosions of gunpowder - - - - -	2	2
Miscellaneous - - - - -	20	28
TOTAL - - -	121	268

The loss of life in all the Belgian mines for 1851 and 1852 was at the rate of $3\frac{6}{10}$ lives per annum per 1,000 persons employed. In all the Prussian mines, during the years 1847, 1848, 1849, 1851, and 1852, the accidents were at the rate of $1\frac{64}{100}$ lives lost per annum for every 1,000 persons employed. Taking the coal mines alone, the average is two lives per 1,000 persons per annum.

[The Witness delivered in the following List:]

LIST of ACCIDENTS in COAL and other MINES in Prussia during the Years 1847, 1848, 1849, 1851 and 1852, furnished by Mr. Von Carnall.

NAME of DISTRICT.	Number of Persons Employed.	NUMBER OF LIVES LOST.								Rate per 1,000 Persons Employed.
		Falls of Roof, &c.	By Gunpowder.	Ropes and Chains.	Man-Engine.	Ladders.	In Shafts.	Miscellaneous.	TOTAL.	
1847:										
Silesia - - -	18,428	17	-	-	-	1	3	5	26	1.93
Saxony - - -	4,653	3	-	-	-	-	5	-	8	1.72
Westphalia - - -	11,619	17	-	-	-	1	7	-	25	2.15
Rhine - - -	22,044	26	-	1	-	2	6	1	36	1.63
Rüer - - -	502	1	-	-	-	-	1	-	2	3.98
	52,246	64	-	1	-	4	22	6	97	1.86
1848:										
Silesia - - -	12,147	15	-	-	-	-	4	6	25	2.06
Saxony - - -	6,010	6	-	-	-	-	1	-	7	1.40
Westphalia - - -	10,648	13	-	-	-	-	7	-	20	1.88
Rhine - - -	19,101	16	2	-	-	-	8	-	26	1.36
Rüer - - -	550	3	-	-	-	-	-	-	3	5.45
	47,456	53	2	-	-	-	20	6	81	1.71
1849:										
Silesia - - -	11,550	6	-	1	-	1	11	2	21	1.82
Saxony - - -	6,061	1	-	-	-	1	2	-	4	0.79
Westphalia - - -	12,122	17	1	-	-	-	3	-	21	1.73
Rhine - - -	18,846	9	1	-	-	1	7	-	18	0.95
Rüer - - -	637	2	-	-	-	-	-	-	2	3.14
	48,216	35	2	1	-	3	23	2	66	1.39

NAME of DISTRICT.	Number of Persons Employed.	NUMBER OF LIVES LOST.								Ratio per 1,000 Persons Employed.
		Falls of Roof, &c.	By Gunpowder.	Ropes and Chains.	Man-Engines.	Ladders.	In Shafts.	Miscellaneous.	TOTAL.	
1851:										
Silesia - - -	14,216	7	-	1	-	1	6	-	15	—
Saxony - - -	6,829	5	-	-	-	1	4	-	10	—
Westphalia - - -	12,316	12	-	-	-	2	8	-	22	—
Rhine - - -	20,000	27	1	2	-	2	6	-	38	—
Rüer - - -	746	3	-	-	-	-	1	-	4	—
	54,107	54	1	3	-	6	25	-	89	1.62
1852:										
Silesia - - -	14,956	18	-	-	-	-	6	-	24	—
Saxony - - -	7,884	15	-	-	-	-	3	-	18	—
Westphalia - - -	14,086	15	1	1	-	2	3	1	23	—
Rhine - - -	24,000	21	1	-	-	5	5	-	32	—
Rüer - - -	875	1	-	-	-	-	-	-	1	—
	61,301	70	2	1	-	7	17	1	98	1.60

LIST of ACCIDENTS in Prussia in COAL MINES only, 1847 to 1851.

	1847.		1848.		1849.		1850.		1851.	
	Number of Persons Employed.	Number of Lives Lost.	Number of Persons Employed.	Number of Lives Lost.	Number of Persons Employed.	Number of Lives Lost.	Number of Persons Employed.	Number of Lives Lost.	Number of Persons Employed.	Number of Lives Lost.
Silesia - - -	8,672	26	8,550	25	8,869	21	8,269	18	9,096	16
Saxony - - -	831	-	838	-	860	-	327	-	365	-
Westphalia - - -	11,619	18	10,648	25	12,122	20	13,110	21	12,316	22
Rhine { Saarbrück -	5,494	8	4,580	4	3,865	1	3,374	5	3,961	6
{ Düren -	3,400	7	3,309	9	3,126	6	3,177	13	3,247	13

Being an average of two lives lost per annum for every 1,000 persons employed.

422. Belgian mines being more dangerous than Prussian mines?—The Belgian mines are much more fiery than the Prussian mines or the French mines.

423. Mr. Locke.] Of the 724 persons who lost their lives during the five years you have mentioned, only 138 were from explosions of fire damp?—Yes, and in 1851, there were 17 from explosions of fire-damp, and in 1852 there were 106 lives lost by explosions of fire-damp, there having been two great explosions.

424. As against 121, the total number of deaths from all accidents in 1851; and as against 268, the total of 1852?—Yes.

425. Mr. Fitzroy.] Is the proportion of deaths in Belgium from explosions of fire-damp, as compared with deaths from other accidents, greater or less than in England, with respect to the same classes?—In England, the number of lives lost by explosions of fire-damp in 1851, was 321.

426. And how many in consequence of other accidents?—Six hundred and sixty-three; the total loss of life being 984. In 1852, there were only 261 lives lost by explosions of fire-damp in England, being a reduction of 60.

427. How many from other accidents?—Seven hundred and twenty-five; the total being 986.

428. Chairman.] According to the return you have given, 198 lives were lost in going down shafts; will you state whether the mode which is adopted of sending men up and down shafts, is better or worse than the system which is adopted in England?—In some cases the ascent and descent of mines by ropes is forbidden; and ladders, which are considered safer, are resorted to. In some cases, the men must descend by ladders, but are allowed to ascend by a rope; in other cases, both the ascent and descent by a rope is forbidden. The ladders are considered safer than the rope; but I think we should have very great difficulty

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difficulty to get men to ascend or descend our deep pits by ladders, and it must be very unhealthy, the work being so very laborious. The following is a list of the loss of life by colliery accidents in England, Wales and Scotland during the years 1851 and 1852, as reported by the inspectors of coal mines.

1851.	1852.		1851.					1852.				
			Lives Lost.					Lives Lost.				
TOTAL.	TOTAL.		Miscellaneous.	In Shafts.	Falls of Roof.	Explosions of Firedamp.	TOTAL.	Miscellaneous.	In Shafts.	Falls of Roof.	Explosions of Firedamp.	TOTAL.
210	197	In Staffordshire, Shropshire, and Worcestershire - - -	18	75	111	41	245	14	46	134	25	219
135	149	In Lancashire, Cheshire, and North Wales - - -	24	39	48	70	181	25	57	56	91	220
95	117	In Northumberland, Durham, and Cumberland - - -	39	15	32	57	143	43	28	44	38	153
75	90	In Yorkshire, Derbyshire, Nottinghamshire, Warwickshire, and Leicestershire - - -	8	23	28	76	135	20	30	34	24	108
99	112	In South Wales, Monmouthshire, Gloucestershire, and Somersetshire - - -	20	41	54	15	130	55	26	57	78	216
88	57	In Scotland - - -	8	28	52	62	150	13	20	23	6	61
697	722		117	221	325	321	984	170	207	324	261	986

Taking the annual output of coals at 47 million tons per annum, the loss of life is at the rate of one life per 47,715 tons of coal.

429. Mr. Locke.] How does it happen that so large a proportion of persons are killed in the shafts in Belgium, if ascending and descending by ropes is prohibited?—Many shafts are not walled. A stone may fall from the side of the shaft.

430. Do you think it is a principal stipulation on the part of the Belgian authorities, to restrict the men from ascending and descending by means of ropes?—Their new pits are fitted with guides, and in those cases I do not think it is a prudent stipulation; but in the great majority of cases, the winding is by large buckets slung in chains; these buckets are liable to catch each other in passing, which may throw the men out; under the latter circumstances I think it is judicious. I should not go down such a pit myself unless I had business to take me there.

431. Mr. Cayley.] Would you consent to go down a deep pit with a chain and no rope?—I do not object to go down deep pits with flat chains, where there are three links, if the machinery is strong; but with a single link chain I do strongly object to go down. I am obliged to do it sometimes, but I do it with great reluctance. Where the manager is a competent man, and goes down the pit himself, you seldom have a single link chain.

432. Is Mr. Fourdrinier's patent in operation at all?—Yes; it is used in isolated cases.

433. Do you consider that is a great protection from accidents?—I have more faith in good tackle and in good winding arrangements than in Mr. Fourdrinier's arrangement. I think that, with proper attention to the rope, an accident by the breakage of the rope need very rarely occur.

434. You think the rope is safer than any other material?—Yes; either hemp or wire. For deep pits a wire rope seems to be peculiarly applicable. It is lighter than a hemp rope.

435. Chairman.] Do many accidents occur in Belgium, from people walking down pits?—A great number of such accidents happen in this country; but such a thing on the Continent is almost unknown. An unfenced pit is almost unknown. Almost every winding pit in Prussia is secured by a railing round all parts of it, except where the trams pass to and from the cage, and even this part is generally secured by having a gate which slides up and down, being balanced by a pulley and weight.

436. Is it not perfectly possible to have a cage to drop down on the pit, so that when the machinery is in motion there will be no danger of a man losing his footing and falling down the pit?—It is quite practicable, and is occasionally resorted to in this country, to have a loose frame which the cage lifts up when it comes out of the pit, and drops when it descends; that is an effective precaution against loss of life by falling down pits, which is very common.

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437. Mr. *H. Vivian.*] Is there not great danger of the rope jamming?—No; it is merely a loose railing. With regard to my inspection of the continental mines, and also my inspection of mines in this country, there are certain points which I think might be laid down as fundamental rules, and which would be agreed to by the majority of our experienced managers, and which may be carried out in practice; they are as follows: First, every old pit should be properly fenced to prevent persons falling into them, some lives being lost from this cause every year; the unfenced old pits in Staffordshire, Shropshire, Worcestershire, and Denbighshire are a disgrace to this country, and the apathy with which they are viewed is almost incredible. Second, the mouths of working pits should also be fenced as far as practicable; this may be effectually done by a light railing, to be lifted by the cage as it ascends, and dropped as it descends; an arrangement of this kind would also save a number of lives annually. Third, pits should be all walled or cased from the top to the bottom; this adds little to the expense of a pit when being sunk, and lives are now annually thrown away by falls from the sides of shafts. Fourth, the use of guides should be enjoined, as far as practicable, when men ascend and descend; and every cage or skip should have a cover over it to ward off falling materials. Fifth, machinery with broken cogs should be at once replaced by new wheels, some serious accidents having arisen from false teeth becoming loose. Sixth, the ropes should always be once run up and down the pit in mornings to see that all is right before men descend, and the weight of men should never exceed more than half the ordinary weight of coals drawn. Seventh, boys ought not to ascend or descend unless accompanied by a man. Eighth, no one should be allowed to come up on full tubs, or to descend by an engine which is drawing full tubs up either the same or any other pit. Ninth, single link chains, except a few feet at the end of the rope, ought also to be forbidden for the ascent and descent of men, and the rope used for winding up the shaft ought not to be used for winding with from the dip, or along the galleries of the mine. Tenth, the shaft-ropes should be constantly watched by the banksman, or some appointed person at the pit-head; with ordinary care in this respect, accidents by breakage of ropes may almost invariably be prevented. Eleventh, an adequate supply of pitwood to be provided, and the overmen enjoined to see that sufficient of it is fixed. Twelfth, every winding-engine should have an indicator to give warning by a bell, when the cage is near the top and bottom of the pit. The boilers, also, in addition to one open safety-valve, should be provided with one safety-valve under cover, accessible to the principal engineer, or manager only. There should also be a whistle to indicate the height of the water, and the pressure of steam when in excess; also a float, to show the height of the water, and a steam-gauge to show the pressure of steam. Thirteenth, with regard to ventilation, adequate ventilating power should be provided; and spacious air-ways, so as not to force the current beyond 500 or at the utmost 1,000 feet per minute. Good brick, or stone and mortar stoppings, for preventing leakage. Good air-doors, and to have at least two doors where the arteries of ventilation are crossed; to have the air bratticed close up to the face of the workings; and if a place has to be left standing, it should always be first cut through and permanently ventilated to the face. In critical cases, where there are accumulations of fire-damp in goaves, or other parts of the mine, which might ignite at the furnace, the furnace should be fed with fresh air; and in very fiery mines, liable to give sudden discharges of gas, the furnace should be fed with fresh air, until the workings had advanced a sufficient distance from the up-cast shaft. Safety-lamps ought also to be used exclusively under such circumstances, and no one but a competent person allowed to fire shots. Fourteenth, the regulations of every mine should be laid down in a good code of printed rules; and there should be a competent manager, good overmen, and firemen, whose duty it should be to see each place safe before a workman entered it; and one or more of whom should be always present in the mine to keep all right during working-hours, and whose duty it should be to see that the mine continues safe, and to report breaches of discipline to the manager.

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438. *Mr. Cayley.*] Is it your opinion, upon the whole, that the Belgian system can teach us more on the subject of inspection than on the subject of ventilation?—As a general rule, I think our best managed mines are better managed in this country than the mines in Belgium, or any of the continental mines.

439. What is your opinion with regard to inspection?—I do not think the mines of this country require the number of inspectors which the continental Governments have for their mines, for the reason I have stated; namely, that they have other matters to look after, and that in this country we have a more experienced class of managers in our collieries.

440. With regard to the size of the districts, and the number of inspectors, and the powers which are given to the inspectors, do you think that any improvement could be introduced from Belgium?—I have given an outline of regulations which I think will be agreed to by experienced men. I think if those regulations were made compulsory, and upon an accident happening from the want of such provisions a punishment was inflicted, either by fine or imprisonment, the present number of inspectors, or a very moderate increase of the number, would be quite sufficient for all the wants of this country, and would tend very much to diminish the number of accidents which take place.

441. *Mr. Locke.*] Does the Table you have put in specify the accidents which arose, in Prussia, from fire-damp?—There is very little fire-damp in Prussia, and the few accidents which have occurred from fire-damp are included under “Miscellaneous.”

442. The accidents which are given in the Table you have put in, arose chiefly in the shafts, from the use of ladders, and by the falling of roofs?—Taking the year 1852, there were 70 lives lost, in Prussia, from falls of roofs; by explosion of gunpowder, two lives were lost; by ropes and chains in the shaft one life was lost; accidents by ladders in the pits, 7; other accidents in shafts, 17; miscellaneous, 1.

443. So that, during that year, there being only one “miscellaneous” life lost, the loss of life arising from fire-damp may be said to have been nil?—In the return which was furnished by the principal minister, it is not clear whether the explosions come under the falls of roof, &c., so that there may be more than one, but he stated to me in a letter that the number was so small as not to be worth separating.

444. *Mr. Fitzroy.*] In your opinion, does that arise from greater precautions with respect to fire-damp, or from the absence of fire-damp itself?—From the absence of fire-damp. The precautions in Prussia, with regard to ventilation, are very slight indeed; the majority of the mines are carried on by natural ventilation.

445. *Chairman.*] Is there anything in the Prussian system which you can recommend this Committee to adopt, as preferable to the system which is adopted in England?—Nothing except the fencing of the pits, which I have alluded to. In other respects, I think we are very far in advance of them.

446. With regard to the system of Prussian inspection; can you state the system of inspection in Prussia?—There is one inspector-general, who resides in Berlin; four principal directors; 12 local directors; about 35 burgmasters; and a large number of officers who are called sworn miners. This staff is recruited from a class who at 18 years of age work a year in the mines; they then go to college for three years, which is succeeded by another three years work in surveying, &c., in the mines; and then, at about 26 years of age, on passing the several examinations, they are eligible for the lowest offices, or they may go into other occupations; they may rise and become directors; but it is necessary to pass another examination before they can do so. In Prussia, also, the inspectors are not solely engaged in looking after the safety of the mines and the welfare of the workmen. An important part of their duty consists in looking after the per-centage payable to their Governments, and in verifying the plans.

447. Are the inspectors generally a well educated and scientific class of men?—Yes; their previous education ensures that.

448. *Mr. Locke.*] With that staff, the Government are the owners of the mines?—They stand in a similar position to a lessor in this country.

449. They lease the mine?—They do not exactly lease it; the minerals are at the disposition of the Government.

450. Will you state in what relation the Government stand to the proprietors of the mines?—The law of Belgium recognises the right of proprietors of minerals, and in Prussia also, in certain cases.

451. Subject

451. Subject to any payment?—In Belgium about $2\frac{1}{2}d.$ per acre is in all cases paid to the proprietor of the minerals. In Prussia, the Government receives 5 per cent. of the profits from one portion of the kingdom, and 5 per cent. of the produce from another portion of the kingdom. There are properties in Prussia which belong to private individuals; and, in these cases, the mines are subject to Government inspection; but the Government receive no portion of the profits. Very few mines of this description belong to private individuals, compared with those where the profits are at the disposition of the Government.

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452. The great bulk of the mines are held in that way by the Government?—In Belgium they are all at the disposition of the Government, and they receive $2\frac{1}{2}$ per cent. of the profits. Surface damages are in all cases paid to the proprietor of the surface, and in some cases he is paid double damage.

453. *Chairman.*] Did you visit also any mines in France?—Yes.

454. Did you visit mines in the Valenciennes district?—Yes.

455. How did you find the mines in those districts carried on?—The mines are worked very well; the seams are thin and the accidents very few. During the five years ending 1851, there were only 49 deaths in an average of 9,375 persons employed, being an average of $9\frac{9}{10}$ deaths per annum, which is $1\frac{9}{100}$ lives per annum per 1,000 persons employed.

456. Are they fiery?—They are not fiery.

457. Did you visit the large coal fields at St. Etienne and Rive de Gier?—Yes.

458. Did you find the mines in those districts also well carried on?—With regard to the working of a thick coal by the system of long work, I think it is an admirable system; but, in other respects, such as the winding arrangement and the ventilation, it is very rough.

459. Is the loss of life very great?—Very great; in 1852, the total number of persons employed at the coal mines in this basin, the Loire basin, was 6,703, of whom 4,780 were employed under ground. The loss of life during the year was 42, being at the rate of $6\frac{26}{100}$ lives per 1,000 persons employed; 22 of the lives were by falls of roof; 19 by shaft accidents, and one by gunpowder. The quantity of coal raised in this basin during this year, 1852, was 1,534,588 English tons; the loss of life was therefore at the rate of one life per 36,538 tons of coal raised.

460. Do you think there is anything in the system of working mines in France, which this Committee ought to recommend as an improvement in working mines in England?—I think the long work system of working thick coal at St. Etienne might be introduced into Staffordshire in the working of the thick coal.

461. *Mr. Child.*] South Staffordshire?—Yes.

462. *Chairman.*] Is there any particular system of inspection in France?—Yes; they have a system similar to that which is adopted in Belgium and Prussia.

463. The Government having an interest?—The Government having five per cent. of the profits.

464. *Mr. Locke.*] Is there any other place in France, besides St. Etienne, where thick seams of coal are worked?—Yes; in the South of France there are several.

465. Do they work in the same manner in those places as they do at St. Etienne?—Not always; it is worked different ways at St. Etienne.

466. Can you state the reason why they do not work in the improved mode which is adopted at St. Etienne?—The other way is considered an improved mode also. I have prepared a drawing of this mode of working, and Mr. Mackworth has prepared a drawing of the other system of working.

467. Can you form an individual opinion as to which is the best?—I prefer the system of long work which is adopted at St. Etienne.

468. Can you give the Committee any reason why the French authorities have not insisted on one uniform plan of working similar coal?—No.

469. *Mr. H. Vivian.*] Would not the peculiar character of the seam of coal regulate the mode in which it was desirable to work it; that is to say, is there not a soft part in every coal which it is always desirable to work?—One portion of this seam which I examined was 65 feet thick, and there was no holeing in it; there were solid partings here and there an inch in thickness, but nothing which could be called a soft holeing.

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470. In the case of the Staffordshire thick coal, it is desirable to work certain portions first, owing to the easy nature of the cutting?—There is nothing in the Staffordshire thick coal, so far as the holeing goes, to render it desirable to continue the old system.

471. Then, in your judgment, that system is applicable to Staffordshire thick coal?—I think it is.

472. Mr. Locke.] Do you think the system which is adopted at St. Etienne is applicable also to other parts of France where thick coal is worked?—I think it is.

473. Do you think it would be an advantage if this system were adopted there?—I think it would.

Jovis, 16^o die Junii, 1853.

MEMBERS PRESENT:

Mr. Hutchins.
Mr. Hussey Vivian.
Mr. Mostyn.
Mr. Stephenson.
Mr. Fitzroy.
Mr. Baird.

Mr. Locke.
Mr. Cayley.
Mr. Cobbett.
Mr. Farrer.
Mr. Henry Austin Bruce.

EDWARD J. HUTCHINS, Esq., IN THE CHAIR.

Herbert Francis Mackworth, Esq., called in; and Examined.

H. F. Mackworth,
Esq.

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474. Chairman.] YOU are a Government Inspector of Mines?—I am.

475. How long have you held the appointment?—About 18 months.

476. You were examined before the Committee of 1852?—Yes.

477. You were at that time government inspector of the south-western district?—Yes; and I hold the same district at the present time.

478. In the month of May did you receive instructions by letter that you would be called before this Committee?—I did.

479. Is the paper now handed to you the letter which you received (*handing a paper to the witness*)?—Yes. [*The witness delivered in the same.*]

480. Have you got a tabular statement of the accidents which occurred in the coal mines of Great Britain in the years 1851 and 1852?—I have. [*The witness delivered in the same.*] Taking the number of lives lost in the coal mines of my district in 1851 and 1852, I find that there is a considerable diminution in accidents in shafts; accidents in shafts, and accidents from explosions of fire-damp, being those on which inspection would naturally have the most effect. In accidents from explosions there is a considerable increase in the number of deaths, owing to 65 lives being lost by one explosion at Middle Dyffryn.

481. When did that explosion take place?—On the 10th May 1852. The considerable increase in the number of deaths from “miscellaneous” accidents, is owing to irruption of water at the Gwendreath Colliery, by which 26 lives were lost, and this accident occurred on the same day; an accident of the kind had not occurred in the district for a long time previously. I find in the total number of accidents in Great Britain, there is a considerable diminution of the deaths in shafts in the year 1852, as compared with the year 1851, and also in the number of deaths from explosions of fire-damp.

482. How do you account for the decrease in the number of shaft accidents?—I think that, to some extent, it must be due to the inspection, because during this time there has been a considerable increase in the quantity of coal produced; and if you take the falls of roof (a class of accident upon which we are not able to produce so much effect), and the increased deaths which have occurred from that cause, I think the diminution of those accidents upon which the inspection can have most effect will appear in a more decided light.

483. Mr. Fitzroy.] How many different collieries did you inspect in the year 1852,

1852, when, as you state, there was a great decrease in the number of shaft accidents?—I inspected from 90 to 100 different collieries, as near as I remember, and to some of these I went several times.

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484. *Chairman.*] During that period, has there been an increase in the production of coal?—A considerable increase.

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485. Can you state the difference of production?—As near as I am able to form an opinion, the increase may be taken at five per cent.

486. Then of course a greater number of workmen were employed to raise that quantity of coal?—Yes.

487. Can you give the Committee any idea of the number of extra men who were employed during that period?—You may take the ratio of increase at five per cent, and there is a diminution of six per cent. in accidents from explosions and in shafts.

488. You attribute a good deal of the result to the present system of inspection?—I think it is due to it.

489. *Mr. Locke.*] Are you aware that any orders have been issued by the inspectors, which justify that conclusion?—I judge from the improvement that I have seen in a great many collieries, where I have made suggestions which have been carried out.

490. Is there any order in existence which was issued by an inspector, in reference to accidents in the shafts themselves?—We have not the power to give an order.

491. Have you seen any defects in any of the collieries that you have visited, with reference to the shafts?—A great many.

492. Will you name one?—The Soundwell Colliery.

493. *Chairman.*] Where is that?—Near Bristol.

494. In that colliery what did you find objectionable?—I found the ropes in a bad state; parts of the pits insecure, not properly walled, and I found the men descending in tubs without any cover.

495. *Mr. Fitzroy.*] Had there been many shaft accidents in that colliery, before you visited it, and made these discoveries?—There had not been any shaft accidents during the 12 months previously to the time that I was appointed an inspector, and up to the time of my inspection.

496. *Mr. Locke.*] Will you mention any other case in which there has been an accident in shafts, where you have made a suggestion, which has been attended with the benefit which you say you think has arisen from inspection?—I can enumerate many cases: at the Dowlais Colliery, the cage, in ascending, struck against the side of the shaft, and the chain guides were removed, so as to allow it to run clear, and the part of the shaft which was narrowest and got out of shape was rewalled.

497. Were those alterations made by the agents of the collieries themselves, or from your suggestion?—They were made by the agents of the collieries upon my suggestion.

498. To whom did you make the suggestion?—To the manager.

499. Of the Dowlais Company?—Yes.

500. Do you recollect his name?—Mr. Evans.

501. Can you give the number of accidents in that particular mine, during the preceding year, and during the last years?—There had not been any fatal accident there before, during the time of the inspection.

502. Has there been any accident since?—No.

503. *Mr. Fitzroy.*] You state that there has been a great diminution of shaft accidents, owing to the inspection of the Government inspectors: will you give one case where shaft accidents did occur, in which, owing to your suggestions, they have been put an end to?—The two cases I have mentioned I think apply to that, as near as any that I can mention.

504. *Mr. Locke.*] Can you mention any other case?—In numberless instances I have pointed out defects in shafts.

505. *Chairman.*] Can you state to the Committee any case where an accident has happened, and you have gone to the mine and suggested some improvement which has been followed out, and where, in consequence of that improvement, no further accidents have happened?—That is the case in the two collieries I have mentioned.

506. You were understood to state, that in the case of the Dowlais Company, no accident had happened before?—An accident happened at the Dowlais Colliery.

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Colliery: I examined the colliery at the time of the accident, and made the suggestion which I have described.

507. *Mr. Fitzroy.*] Can you mention any collieries in which you have found the shaft arrangements deficient, and where, in consequence of your suggestion, an alteration has been made in those arrangements, and loss of life has been checked?—I do not recollect, at the present moment, any shaft in my district, where there have been two accidents during the two years.

508. You were understood to state that the number of shaft accidents was very materially decreased, and that you attributed that decrease to Government inspection. To what period do you refer as abounding in accidents, which have been diminished by Government inspection?—I should state, in explanation of my meaning, that the number of lives which have been lost in England, from accidents which occurred from men descending by the ropes, is from four to five in 10,000 persons per year; consequently you will see that the probability is, that an accident might not again happen in the same shaft for many years, on the average. It is very seldom that the shaft is in such a state that accident after accident occurs in it. The inspection has improved some of the more dangerous.

509. *Mr. Stephenson.*] How long have you been an inspector?—A year and a half.

510. Would your experience in that time justify you in drawing any general conclusion with regard to these accidents and the benefit of inspection?—I judge of it in this way; that I have found many shafts in a dangerous state; I pointed it out, and the proprietors have either remedied them or promised to remedy them.

511. *Mr. Fitzroy.*] With what period are you comparing the year 1852, when you say that there was a great decrease in the year 1852 in the number of shaft accidents?—With the year 1851; and at that time the inspection was in existence; but I was only inspector during one month at the end of 1851.

512. *Chairman.*] In your visits round the mines, do you meet with any opposition from coal owners in carrying out your suggestions?—I have not experienced any difficulty in visiting the collieries; and they or the managers have almost invariably promised to carry out my suggestions.

513. Have you found a general willingness to meet your views as much as possible?—Yes.

514. *Mr. Locke.*] How long had you been connected with the management of mines before your appointment as an inspector?—Two years.

515. Where were you employed?—In South Wales.

516. Can you name the colliery?—Mr. Powell's collieries.

517. *Mr. Cayley.*] You have alluded to the loss of life, from explosion, in the Middle Dyffryn Colliery; was that the Aberdare case?—Yes.

518. Since 1845, how many deaths have occurred from explosions in that mine?—I think about 78.

519. How is it ventilated?—The Middle Dyffryn Colliery has a furnace and steam jet to produce the ventilation.

520. How was it ventilated during the time of these explosions?—The furnace was at work; the explosions occurred from the gas igniting the furnace.

521. *Mr. H. Vivian.*] To what do you attribute the great loss of life from explosions in the Middle Dyffryn Colliery?—To the bratticed shaft, and the number of doors and weak points in the colliery.

522. Were there upwards of 20 main doors in the Middle Dyffryn Colliery?—If you include the cross headings, there were.

523. Were all those doors destroyed by the explosion?—Yes, there were that number destroyed.

524. The result of that was, that the distant workings were entirely cut off from any supply of fresh air?—The miners at the bottom of the shaft were cut off from the current of air; it went down one side of the brattice, and returned up the other, passing through the aperture caused by the explosion. With regard to the Middle Dyffryn accident, an important point, which has not been given in evidence before, is the precise manner in which the accident occurred. There was a great discharge of gas, which came off about 300 yards from the furnace. On coming to a point 100 yards from the furnace, there was a regulator, with an aperture about two feet square at the bottom; so that the discharge of light gas, sweeping along the top of the air-way, met this obstruction,

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struction, accumulated stratum after stratum (if I may so explain it), and 10,000 cubic feet of air per minute were pressing behind; and when the lower level of this light gas came down to the aperture, hardly anything, naturally, but pure or highly explosive gas would be forced through that aperture—that gas, immediately rising up, would fill the whole of the heading beyond. At a distance of 30 yards only from the front of the furnace, it met the rather larger quantity of air coming from the ventilation of the rest of the mine, and there was not sufficient interval for these to mix, and the stratum of gas reached the surface of the fire.

525. Mr. Cayley.] And the furnace was the cause of the explosion?—Yes; it occurred under very peculiar circumstances.

526. There was no dumb-drift?—No.

527. Mr. Baird.] Was the aperture through which the air passed altered?—It was removed.

528. Mr. Locke.] When did that accident happen?—On the 10th of May last year.

529. Were you a Government inspector at the time?—Yes.

530. Had you been a Government inspector before that period?—I had.

531. Chairman.] When you gave your evidence on the 9th of June 1852, you put in a statement with regard to the accident?—Yes.

532. The evidence which you have now given is in addition to the statement which you gave at that time?—Yes.

533. Mr. Cayley.] Did you point out or advise them before the accident of the imperfect state of the ventilation?—My predecessor had pointed out, upon a previous explosion which occurred there, that it was dangerous to work with anything but safety-lamps in the colliery.

534. Chairman.] Who was your predecessor?—Mr. Kenyon Blackwell.

535. Do you agree with him in that recommendation?—Perfectly.

536. Mr. Locke.] Would the use of locked safety-lamps in that colliery have prevented that particular accident?—The expression Mr. Blackwell made use of was, that they were not to use naked lights. At the time Mr. Blackwell inspected the colliery, they were using candles, and a lamp in the up-cast shaft, for the purpose of ventilation; at the time the previous accident occurred; he then told them they must not use naked lights in the colliery.

537. Mr. Stephenson.] The question has reference to the last explosion which took place?—Yes.

538. Would the adoption of Mr. Blackwell's recommendation have tended in any way to have prevented the accident?—I think if the recommendation of Mr. Blackwell, that naked lights should not be used, had been followed strictly, the accident would have been prevented.

539. The accident took place at the furnace, and not at the lamp?—Yes; the question is, whether a furnace is a naked light or not.

540. Mr. Locke.] Did you or Mr. Blackwell ever give any order or make any suggestion against the use of the furnace in that mine before the accident?—No. At the time Mr. Blackwell inspected it, the furnace was not used.

541. During the time of your inspection, were they using the furnace?—Yes.

542. Did you ever object to it?—I had not inspected the colliery; the accident occurred about four or five months after I had been appointed inspector, and I had not been into that colliery.

543. Mr. Cayley.] Is it the fact, that before one of the explosions there was a great fall of the barometer?—There was a fall in the barometer on the morning of the explosion.

544. Would not that tend to allow of the escape of the fire-damp from the goaf?—I do not think, taking the appearance of the orifice through which the gas escaped, the thickness of the measures it had burst through, that the barometer had any effect in producing that accident.

545. As a general rule, is it not the fact that a fall in the barometer would indicate the necessity for greater vigilance on the part of the persons having charge of the ventilation?—Theoretically, the fall of the barometer would have an effect in making the gas, if there was an accumulation in the mine, approach more nearly to the working parts.

546. If there was a barometer kept at the bottom of either shaft, and there was a great fall in the barometer in the down-cast, would it not be an indication of danger?—A slight fall in the barometer, at the bottom of the up-cast shaft, might indicate an increase in ventilation, or an increase of fire-damp at the edges of goaves.

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547. Mr. *Fitzroy*.] Was this mine supposed to be peculiarly fiery?—There was not a large constant discharge of fire-damp; its peculiar and very great danger arose from the irregularity of the discharges; a seam of coal several yards above gives off gas from time to time, and I consider it one of the most dangerous class of collieries.

548. It is one of the most dangerous in your district?—Yes.

549. Do you select, for more careful inspection, those mines which are supposed to be more dangerous than others?—As near as I can determine.

550. Which of the mines in your district had you reason to imagine to be more dangerous than that in which this explosion took place?—I think it was about as dangerous as any.

551. How many months had you been appointed a Government inspector before this took place?—Four or five months.

552. Had you visited many mines during that time?—Yes.

553. Is it your custom to select those mines which are most dangerous for your more careful inspection?—Yes.

554. Then how came you to overlook this mine, which you have described as one of the most dangerous, if not the most dangerous in your district?—Because when the previous explosion occurred, my predecessor (Mr. Blackwell) made a very strong report upon the danger of the mine, and the necessity of avoiding the use of naked lights, which was confirmed by the verdict of the jury; and I considered that, under those circumstances, pursuing the course which I have mentioned, this mine did not run so great a chance of accident as other fiery mines in the district.

555. *Chairman*.] With regard to naked lights, you have alluded to Mr. Blackwell's official report, in which he condemned the use of all naked lights; from your present explanation of the way in which the accident occurred in the Middle Dyffryn pits, whether naked lights were used, or whether safety-lamps were used, the accident might still have occurred?—I consider that a furnace is a naked light, and that Mr. Blackwell's caution extended to that; there is a difference of opinion, I admit, amongst engineers on that point.

556. How would you obviate the recurrence of such an accident?—By a dumb drift, or by some other means of ventilation than the furnace.

557. There was no dumb drift in this mine at all?—No.

558. All the foul and pure air came over the furnace?—Yes.

559. Mr. *Locke*.] You consider a furnace to be a naked light?—Yes.

560. Have you made any suggestion against the use of the furnace in any other colliery since that accident?—I have given several cautions.

561. Have you given any suggestion against the use of it?—Yes.

562. Will you name the collieries?—Cwmamman, Tillerrey, Risca and others.

563. Any others?—I do not recollect them at the present moment, but I know I have given them to others.

564. Do you consider the use of the furnace in those two mines a dangerous means of producing ventilation?—Yes, if unprotected.

565. *Chairman*.] You mean the furnace without a dumb drift?—Yes.

566. Mr. *Locke*.] In those two mines were dumb drifts applied, or not?—No.

567. With the use of the dumb drift, does your objection to the use of the furnace entirely cease?—Not entirely; with the use of the dumb drift, and with proper precautions, I think it is perfectly safe.

568. Mr. *Cayley*.] Reverting to the ultimate cause of the accident (which was the oozing of the gas out of the fissures of the walls), rather than to the proximate cause (which was the ignition of the fire-damp at the furnace), supposing a barometer had been kept outside the mine, and a great fall in the barometer had been observed, would not that have been an indication of danger?—My opinion is formed upon a list of the great accidents in the north of England, which was given by Mr. Thomas John Taylor, before the Committee of 1849, in which he showed that as many accidents occurred with a rising barometer as with a falling barometer; if I were the overman of a colliery I would consider it a caution, because there is theoretically an increased danger; and I have understood that some persons have observed gases come more out of the goaves on a fall of the barometer. A far more serious danger, and one requiring constant attention, is the falling off in the amount of ventilation, arising from the change of temperature of the downcast shaft, or the neglect or want of skill of the flueman.

569. *Chairman*.] But whether the barometer stands high or low, should there

there not be, at all times, sufficient ventilation to prevent danger of any kind?—Undoubtedly. The cause of the numerous fire-damp accidents in this country is, that the margin between safety and explosion is so exceedingly small—hardly more than one-fiftieth.

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570. Mr. Cayley.] Your opinion is, that the safety of the mine depends upon increasing the amount of ventilation?—That is one of the precautions. I consider the distribution of the air to be far more important..

571. An increase of the quantity of air properly distributed?—Yes.

572. Chairman.] Mr. Blackwell, in his official report, condemned the use of brattices and all naked lights. Were his recommendations attended to?—They were not, in any shape.

573. Do you believe this accident occurred in consequence of those recommendations not being attended to?—If his recommendations had been attended to, in respect of the brattice, the accident would have been attended with a comparatively small loss of life.

574. Mr. Fitzroy.] Were you aware before the accident took place, that his instructions had not been followed?—I was not.

575. You agreed with him in opinion as to the necessity of those precautions?—I did.

576. If you had had an opportunity of inspecting that mine, and had been aware that his instructions had not been followed, would you have again urged upon the proprietor the adoption of his suggestions?—Certainly.

577. Do you think that the adoption of those suggestions would probably have been attended with a great saving of life, if not an entire avoidance of the accident?—I have not a doubt of it.

578. Chairman.] Is that colliery at work at present?—Yes.

579. Have those suggestions been adopted since the accident?—They have. The colliery is worked with safety lamps, and the ventilation is caused by a furnace (the air in the mine passing by a dumb drift), and by the assistance of steam jets, near the top of the pit. I believe, within the last few days, the mode of ventilation has been changed, and that one of Struve's ventilators has been substituted.

580. Was there not sufficient air obtained by the furnace?—No; there was not a sufficient quantity of air.

581. Is it a bratticed shaft?—Yes; and one object of putting up the ventilator was to take the currents of air through separate shafts; to take the down-cast air down the present winding shaft, and inside the brattice, where the up-cast air has hitherto ascended, and to exhaust the up-cast air by the pumping pit.

582. Then, in point of fact, it is one pit having pumps on one side of it, and winding apparatus on the other, with a brattice between?—There is a large shaft, which is divided by a brattice; on one side they wind, and the air goes down into the mine; on the other side, when the furnace and dumb-drift are in action, the up-cast air comes up.

583. Mr. Cayley.] On the other side of the brattice?—Yes.

584. There is only one shaft?—There is another shaft which was not made use of; at the present moment, I believe this, which is the pumping-pit, is made the up-cast shaft.

585. Mr. Locke.] Which is the pumping-pit?—It is a second shaft, which is now put into communication with the ventilator, and the air descends on both sides of the brattice of the first shaft, which hitherto has divided the up-cast from the down-cast air.

586. Can you state what is the relative area of the up-cast shaft, as employed at present, and the portion of the first shaft, which was bratticed off at the time of the accident?—In the former case, the area of the up-cast part of the shaft was 82 square feet, and the present up-cast shaft has a diameter of nine feet six, and an area of 70 square feet.

587-8. In your investigations, did you find, at the time the accident occurred, that the instructions respecting the use of naked lights in the pit had been attended to, or that naked lights or safety-lamps were used?—They were using naked lights at the time the accident happened.

589. Mr. Stephenson.] In spite of the instructions they had received from the inspector?—Yes.

590. Mr. Cayley.] Was that fact brought out at the coroner's inquest?—Clearly.

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591. Did that wilful neglect cause any additional penalty to be levied?—There was a verdict of accidental death.

592. Under the circumstances, do you consider that was a satisfactory verdict?—There were several colliery engineers there, who were not examined on oath, but whose opinions were taken; and with the exception of one person, who had been consulted about the continuation of the use of naked lights, they all stated that safety-lamps ought to have been used.

593. Mr. *Locke*.] Will you state whether, at that investigation, the explanation you have given in reference to the stopping and the use of the aperture, was brought before the jury?—It was not. I visited the colliery several times afterwards; and it was not until the colliery was again in working order, that I received the explanation about the stopping. It was blown out at the time I went through it.

594. As I understand your former answer, you are of opinion that that accident arose from the fact of an accumulation of gas, owing to the aperture being placed at the lower part of the stopping, upon which that accumulation rushed on to the furnace, and exploded. Is that the opinion which you have formed with reference to the cause of that accident?—Yes; that is the opinion I now hold; 70 yards of the heading became filled with gas, so that the explosion took place at the furnace. It is just possible that the gas might have gone over the furnace without exploding, if the aperture had not been in that position.

595. If that aperture had been at the top of the stopping, instead of the bottom, are you of opinion that the gas would have passed over the furnace without an explosion?—I think that the explosion would have occurred, if the aperture had been wholly at the top. The aperture ought to have extended up on one side. If the aperture had been at the top, the nearly pure gas would have gone through, nearly in the same way.

596. Without accumulation?—Without quite so much accumulation.

597. What effect do you attribute to the accumulation of the gas before it reached the furnace, instead of allowing it to pass, as it was generated in the goaf, over the furnace?—The accumulation brought the gas down to the level of the fire as it passed over.

598. *Chairman*.] If there had been a dumb drift, which would have taken that quantity of foul air at a sufficient distance above the furnace, in your opinion would the accident have taken place?—I do not think there would have been a chance of the accident occurring.

599. Mr. *Stephenson*.] Then, in point of fact, the accident arose from an improper application of the furnace?—Yes.

600. And it does not form, in your mind, any objection to the furnace system of ventilation?—Not as long as the furnace is used with the dumb drift.

601. Mr. *Coyley*.] You have stated that the safety of the mine depends very much upon the ventilation; how often can you visit the mines in your district?—It would take me four or five years to go round them once.

602. What test can you have between each visit of the state of the ventilation in your absence?—No test whatever.

603. Can you suggest no means of ascertaining what amount of ventilation there has been during your absence?—I cannot suggest any test which I could rely upon.

604. Then you consider that an inspector must remain in entire ignorance of the state of the ventilation during his absence?—Yes.

605. If inspection is to be of any use, do you consider that there are a sufficient number of inspectors?—I seldom give notice before going to inspect a colliery; and that is a certain check, although it does not amount to a test. I am now pretty well acquainted with the most dangerous collieries in my district, and to those I direct most attention. I require assistants to carry out the inspection effectually.

606. If you hear of a dangerous pit, and upon visiting that pit you find there is anything deficient, do you make recommendations?—Yes.

607. After making those recommendations, do you repeat your visit at some sudden and uncertain time, in order to see whether your recommendations are carried out?—Occasionally I do.

608. Do you consider the anemometer to be of no use?—I test the ventilation in every colliery by it, where there is a current of air sufficient to move the anemometer with the instrument; but there are many cases where the current of ventilation is not sufficient to give any indication on the anemometer.

609. If

609. If the current of air was insufficient to move the anemometer, would it be sufficient to dilute the gas, or would it be healthy for the miner?—It would not. H. F. Mackworth,
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610. Then if the current was not great enough to affect the anemometer, that would be an indication that the ventilation was insufficient?—Yes; I have always represented it as being very insufficient. 16 June 1853.

611. Have you any reason to believe that an anemometer could not be made to be self-registering; so that during your absence there might be a register of the amount daily?—I believe such an instrument has been made. I have not seen it in action; but I could hardly depend on the indication of the anemometer, because the air-ways are either altered, or may be altered from time to time, so as to affect very materially the results indicated by it.

612. If the owner of a mine, or the overlooker of a mine, wished to deceive an inspector, he would split the air in the galleries, so as to create a greater current past the anemometer?—It might be done.

613. But if it was the interest of the working miner that there should be a sufficient amount of ventilation, and a handsome penalty was leviable upon the owner for such a transaction, do you think the owner would dare to resort to such a proceeding?—I think he might without the miner's giving information.

614. *Chairman.*] Do you think there are not means by which the manager of a mine could deceive an inspector, provided the anemometer were in the most perfect state that ingenuity could invent?—There are means.

615. *Mr. Locke.*] You would not be disposed to rely entirely upon an instrument of that kind?—No.

616. That is, yourself, as an inspector?—I should not rely upon it.

617. I presume you would not be an advocate for the introduction of an instrument which might, at all events, weaken the vigilance of the overlooker of the mine, on the part of the owner?—No, if that were the effect.

618. *Chairman.*] Is it not often the case that the overlooker will deceive the owner himself?—Yes.

619. If you had an overlooker who was not an honest man, is it not possible that, contrary to the express order and wish of the owner, he might endeavour to deceive the inspector?—Yes.

620. If he did endeavour to deceive the inspector would there be any possibility of preventing him?—In some respects he might deceive the inspector.

621. *Mr. Cayley.*] Has not the working collier himself a strong interest in the safety of the mine?—Yes, but I believe colliers are bad judges of ventilation.

622. Is it or not the fact, that the working collier himself has a strong interest in the efficient ventilation of the mine?—Yes, but he is seldom sufficiently attentive to it.

623. Supposing it were understood that a self-registering anemometer was intended to be the test of the state of the ventilation during the absence of the inspector, if the working colliers saw that any tricks were played with that anemometer, in creating an artificial increase of current past the anemometer with a view of deceiving the inspector, would it not be the interest of the working colliers, or of some of them, to give intimation of such a circumstance?—I can only judge of that by the fact, that in much more important cases, where the safety of the mine is concerned, the working colliers do not come forward and give us any information.

624. If there was a punishment on such a transaction, and the working collier had a large reward for giving information, would not that be the probable protection for the use of and a test as an anemometer?—I think that not one in a hundred of the working colliers would understand anything about it; and I think that even a large reward would not induce them to give information to inspectors.

625. Then, at the present moment, you have no indication of the state of the ventilation during your absence?—None.

626. Would not you rather have an instrument which gave you some indication of the ventilation than have no means of ascertaining the state of the ventilation during your absence?—I here would be some advantage in having an instrument of that sort; I should be glad to see some instrument of the kind, because it would show me that some attention, at least, was paid to the amount of ventilation in a colliery, which, I regret to say, is not often the case.

627. *Mr. Stephenson.*] The volume of air is by no means a criterion of its perfect utility?—The point in which the collieries in England are most deficient

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is in the distribution of the air; and there might be a large amount of air at the bottom of a shaft, which would give a false indication of security.

628. Mr. *Locke*.] What would be the use of an instrument of the kind that has been alluded to?—I do not think there would be much use in an instrument of the kind.

629. Mr. *Cayley*.] If there were not a sufficient amount of air going into the mine, what would be the use of any method of distribution?—It is important to get a considerable quantity of air into a mine, because then it can be distributed comparatively easy.

630. The fact being, that the first essential of ventilation is to get a sufficient amount of air, and that the next is to distribute it properly through the various workings of the mine?—The first step is to get the air, and the next is to distribute it.

631. Mr. *H. Vivian*.] Do you find that the ventilation in each particular mine in your district varies materially, from visit to visit?—As much as one-fifth in some instances.

632. May not that depend on the state of the thermometer and barometer, and upon accidental causes?—I think the difference of the temperature of the atmosphere between the morning and the middle of the day, when there often occurs a considerable variation, will produce an alteration of one-sixth in the amount of ventilation in collieries, if it is not provided for.

633. Mr. *Locke*.] You mean the volume of air passing?—Yes.

634. Mr. *H. Vivian*.] Practically speaking, has not every colliery in your district a nearly constant quantity of air passing through it?—In those collieries which I have inspected a second time, I have found generally that the volume has been considerably increased; the one-fifth of which I have spoken was a deficiency occurring under occasional circumstances. A large deficiency sometimes occurs from the clinkers on the furnace, or want of skill in the flue-man.

635. Is it not largely to the interest of the proprietor of a mine to have his colliery well ventilated?—Undoubtedly; I do not think there is a more important point, with regard to the economical and proper working of a colliery.

636. Are you aware of the expense which falls upon the proprietor of a coal mine, when an accident does occur?—The expense is enormous; it is several thousand pounds in the more serious explosions.

637. Then, is it not immensely to his advantage to do everything in his power to avoid accidents?—To his real and true advantage, I believe it is.

638. Do you conceive that working miners generally know anything of the ventilation of a colliery?—Nothing; they generally object, when there is any increase in the ventilation; but in instances where the ventilation has been largely increased, and they have had considerable experience of its benefits, they have stated that they could do one-fourth more work in the course of the day.

639. A working miner is in the habit of going down his pit and straight to his stall?—Yes.

640. He neither turns to the right nor to the left?—No.

641. He is not aware of anything that goes on in the working of an extensive colliery?—No.

642. Consequently, he cannot be at all a judge of the general state of the ventilation in the colliery?—He has only a local knowledge.

643. Would it be possible, by any mechanical means, to measure the distribution of the air in a colliery, the splits being numerous?—You can measure each split separately.

644. Do those splits constantly vary?—According to the requirements of each district, the split is increased or diminished in amount.

645. So that, during your absence, it might be absolutely necessary to cause more air to pass into one portion of the colliery, and less into another portion?—Yes.

646. If by placing anemometers in the various splits, you compelled, to a certain extent, the proprietor of a coal mine to pass a certain quantity of air in certain directions at all times, might not that really endanger the proper distribution of air in the colliery?—Yes; he would be changing it from time to time; if he kept it the same, it might occur that a portion of the colliery had not a sufficiency of air for the safety of the men.

647. Would he not be obliged at all times to explain why he had changed the ventilation of his colliery?—Yes, if that was the regulation.

648. Might

648. Might that occur from week to week, from day to day, and from hour to hour?—Yes. H. F. Mackworth,
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649. *Chairman.*] The anemometer being an instrument simply for measuring the velocity of the air?—Yes.

650. *Mr. Cayley.*] With the sectional area of the gallery it shows the amount of air which passes?—If you multiply the velocity by the area of the gallery it gives the cubical amount of air that passes.

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651. *Chairman.*] You were understood to state, that if any appliance were made to contract the area, the velocity of the anemometer would be increased, inasmuch as a certain quantity of air would travel through a smaller space at an increased rate?—Yes.

652. Is it not, therefore, always in the power of the overman of the mine to deceive the inspector, if he chooses so to do?—Yes. The velocity which is indicated by the anemometer is to be multiplied by the area of the point at which the anemometer is placed; if this point were contracted by a plank or anything else being alongside of it, and that was removed before the inspector came, the inspector would not know what was the correct area to be employed; and consequently the anemometer would give a very incorrect indication of the quantity of air.

653. *Mr. Stephenson.*] Suppose a bord eight yards wide is being driven, and it is a very foul one, you take the air up to the face of the work by a brattice; is not that the mode of doing it?—Yes.

654. Supposing that you place in the in-gate an anemometer, and ascertain that there is a large quantity of air going up, is not the safety of that bord entirely dependent upon how near the brattice is carried to the face of the work?—The air returns by the shortest course, round the end of the brattice; and if the brattice is not carried sufficiently far on, a body of gas may be left there without its mixing with the air.

655. And the bord would become dangerous?—Yes.

656. Therefore the volume of air going up the bord is no criterion of the safety of that bord, unless the brattice is carried sufficiently near the face to sweep the face of all gas?—No.

657. Therefore it depends rather on the care with which the workmen really carry on the brattice towards the face?—Yes; I consider this distribution of air to be a most important consideration in every fiery colliery.

658. Would the velocity or the volume of the air, without other detailed knowledge, give you any means of judging of the proper distribution of the ventilation of the mine?—No.

659. *Mr. Cayley.*] The extent of the brattice is no test without a proper quantity of air?—The first point to determine is the quantity of air that is required, and next, the proximity to which it must come to the face.

660. Do you think that in every part of a mine there should be a certain minimum amount of air for the safety and health of the miners?—In every fire-damp mine, the minimum quantity of air required for the safety of the mine is different, and it varies in different parts of the same mine.

661. Varying how many feet per second?—From 200 cubic feet per minute to 600 feet per minute, per man.

662. *Mr. Stephenson.*] Does not that depend upon the extent of the workings of the mine?—It ought never to be less than 200 cubic feet per minute, per man, under any circumstances, in a mine containing fire-damp.

663. *Mr. H. Vivian.*] You are now speaking of the air brought to the workmen, and not of the air sweeping the goaves?—I am taking the whole quantity of air which comes into the mine.

664. *Chairman.*] Unless you have a sufficient quantity of ventilation going down the mine, and distributed over all parts of the mine, the ventilation is defective?—Yes; there must be an active current everywhere.

665. You must have a sufficient quantity to fill the whole mine, and to sweep it from danger?—Yes.

666. *Mr. Locke.*] Whatever may be the quantity of air which you may force down a mine and throw out of it, unless it is properly distributed, is it of any use?—No; that is the great point.

667. *Mr. H. Vivian.*] And no instrument can test the distribution of the air?—No one instrument. The water-gauge affords some indication of the distribution.

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668. Mr. Cayley.] Would not an anemometer be a test, if placed in the drift, whether the air goes or does not go through it?—Unless you put an anemometer in every working point, you cannot tell that the air is thoroughly distributed.

669. Mr. Locke.] Are you of opinion that an anemometer could give a certain indication of the proper distribution of air throughout the entire mine?—One anemometer certainly could not.

670. Keeping in mind the question which has been put to you in reference to the extension of brattices, will you state whether an anemometer, or any number of anemometers, would indicate with certainty that the air had been thoroughly and perfectly distributed throughout the mine?—If you were to place an anemometer at the end of every heading, such as Mr. Stephenson has described, in every place where a man works, and multiply the number, it would give you an indication of the quantity of air that was passing; but it would be no criterion whether that quantity of air would be sufficient to dilute the gas to the extent required by safety.

671. Would it at all times secure the sweeping of the face, so as to make the face where the workman is engaged perfectly safe?—No; I do not think the placing of these anemometers would secure that, and it would be impossible to carry it out in practice.

672. Mr. Cayley.] You state that it would be a test of the quantity going into any part of a mine, but not of the purity of the air passing?—Yes; if you take the simple case Mr. Stephenson has put at the end of a heading; if you put it at the extreme end it would tell you the quantity of air that was passing.

673. But not the purity?—No; the proper quantity of air would depend upon the discharge of gas which there might be, from time to time, at the end of that heading.

674. The greater the amount of air which was passing, the greater probability there would be that the deleterious gas would be diluted?—Certainly.

675. Chairman.] And always providing that the anemometer is not tampered with?—Yes. I think it is a plan that could not be practically carried out.

676. Mr. Locke.] Supposing the anemometer to be placed at the end of the brattice, and a constant supply of air to be passing through that brattice, would not the increase of the working, by every foot the miner went, increase his danger, notwithstanding the quantity of air remained the same?—If the anemometer was close to the end of the brattice, and the brattice was not lengthened as the heading advanced, the danger to the workmen would be increasing, whilst the indications of the instrument remained the same.

677. Mr. Cayley.] You have now no test whatever of the amount of air going into a mine?—Not during my absence.

678. When you go there, how do you test its ventilation?—I try the quantity of air passing in each split by an anemometer, and I judge by a candle whether that quantity is sufficiently carried round the mine where the men work.

679. Mr. H. Vivian.] You do not find, practically, that they vary from visit to visit?—In almost all cases I have found it considerably increased.

680. Chairman.] Will you furnish the Committee with a tabular statement of the number of accidents which have happened in Hainault, and state the number of workmen and the quantity of coal raised, and the average number killed and wounded in 10 years?—Yes. This is a Table of the number of accidents which have occurred in the coal mines in Hainault in 1849, in 1850, in 1851, and 1852. [*The Witness delivered in the same.*]

Vide Appendix.

681. Is the greatest excess of deaths in England, France, or Belgium?—The average is taken in 1851 and 1852 in Great Britain, over 460,000 persons employed; in Belgium, from 1846 to 1850 (as given in the last-published Returns), the number of workmen upon which the average is taken is 256,760; the number of workmen on which the averages are taken in Westphalia is 73,275. The deaths from falls of roofs in Great Britain were 14.4 in 10,000 persons; the average is taken on 10,000 persons employed for one year. In Westphalia there were 10 persons; in Belgium 9.4 persons killed from the above cause. The deaths from explosions of fire-damp in Great Britain, 12.4; in Westphalia, 1; in Belgium, 5.4; accidents in shafts of all kinds in Great Britain, 9.0; Westphalia, 4.0. In Belgium they are divided under breakage of ropes and chains, 3.2—ladders, 0.8; other accidents in shafts, 3.6, making a total of 7.6 from accidents in shafts in Belgium. In Great Britain the miscellaneous accidents

accidents amounted to 6·1; in Westphalia, 1·0; in Belgium, from blastings, 0·6; from inundations, 0·2; miscellaneous, 5·0; the sum total of all being, 41·9 deaths in England; 28·2 in Belgium; and 16·0 in Westphalia, out of 10,000 persons employed one year.

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682. Then it appears, by your comparative statement, that the excess of deaths is more in England?—Considerably more in England.

683. Can you account for the cause of the great excess of deaths from explosions, falls of roofs, and other causes, in England?—The difference arises, I think, from the very perfect system of management in Belgium. Mines are, first of all, laid out under the supervision of very competent men; there is a sufficient number of men appointed in the colliery, by the proprietor, to insure its safety; and there are frequent inspections made by the Government engineer, to see that the regulations are carried out.

684. As to falls in shafts, is not the relative proportion very much in favour of Belgium?—They are a great deal more than in Westphalia, and rather more than in Belgium.

685. How do you account for that?—That arises from the use of ladders being compulsory in Belgium, for the men to descend to the shafts; and in many cases, they are obliged to ascend also by the ladders.

686. Do not a great many men fall down shafts in England, from the pits being exposed without any fence round them?—Yes, it is a disgrace to the country.

687. In your opinion, would it be proper to enact a law to prevent pits being left in an exposed state?—I think it is a most important point for legislation.

688. Are there not cages adopted in some parts of England, by which no accident can occur when a pit is at work?—When guides and cages are employed, the accidents in shafts are much fewer.

689. Are there not coverings on the tops of the pits adopted in some parts of England, to prevent men walking into the pit, when the pit is in motion?—Yes; or the top of the pit should be fenced off, with the exception of the place where the coal is taken in or out; and the top of the pit may be entirely protected, without inconvenience.

690. Mr. H. Vivian.] Would it not be more destructive to life, if men were compelled to ascend by ladders in this country?—In the deep pits, it would be more injurious.

691. Chairman.] You state that mines are better laid out in Belgium, and that the Government inspectors are more efficient and have more power to carry their regulations into effect. Will you describe to the Committee the number of the inspectors, and their power, in Belgium?—There are two mining districts in Belgium; the district of Mons and the district of Liege; an engineer-in-chief resides at each of these districts; and the remaining staff are six engineers of the first and second class, eight sub-engineers, and 30 aspirants.

692. Will you describe the duties of the engineer-in-chief?—The engineer-in-chief receives the reports of the aspirants, investigates all important cases, and communicates directly with the Director-general at Brussels, and with the Minister of Public Works.

693. What are the duties of the Director-general?—He is in constant communication with the Minister of Public Works; and he exercises a surveillance over the whole of the staff, who are dispersed in different parts of the country.

694. Under him are there three inspectors-general?—No, only one, and two engineers-in-chief. The three districts have been lately made into two; one has been suppressed.

695. One of the three engineers has been suppressed?—Yes.

696. How many sub-inspectors are there?—There are six engineers of the first and second class, eight sub-engineers, and 30 aspirants.

697. Were there at any time 40?—That number would probably include another class employed in the public works.

698. Then the number you have given is for the collieries, and all other mines and manufactories?—For mines, quarries, foundries, and stationary steam engines.

699. Will you describe to the Committee the duties of the eight sub-inspectors?—They are sub-engineers. The engineers of the first and second class are under the orders of the engineer-in-chief; he gives them the charge of a portion of a district. The eight sub-engineers are distributed in the same

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way, sometimes having an independent charge under an engineer-in-chief, and sometimes under one of the engineers of the first and second class. The other aspirants are under the direction of those who are in superior offices. The aspirants are those who more particularly inspect the collieries. The sub-engineers are called in, or they come of their own accord, when there is anything very important.

700. Mr. Fitzroy.] What are the powers of the aspirants?—The aspirant engineers in their visits direct their attention to that which concerns the conducting of the works, the preservation of the mines, the safety of the workmen, the means of lighting, ventilation, support of the roof, use of gunpowder, protection from water, and the safety of the surface. They verify the plans of the progress of the works; they certify the regular keeping of the registers of progress, and examine into the control of the workmen, their registers, &c. They watch over the execution of the laws of steam engines; they inquire by *procès verbal* into accidents, and all contraventions of the laws and rules; they obtain all the necessary elements for fixing the proportionate dues, and collect all the documents for detailed statistics of mines, quarries, foundries, and steam engines. They assist in drawing up the preliminary information in case of a dispute between the proprietors, in verifying plans of the surface, and demands for concessions of mines, and the plans for establishing or removing foundries.

701. Chairman.] Do the mines in Belgium belong to the Government?—By the French law of 1791, modified in 1810, which they have adopted, the mines are the property of the Government.

702. Your account of the duties of the aspirants seems to do away with the use of overlookers; are there overlookers besides?—Yes; in the same proportion as in England. Each aspirant inspects 30 or 40 mines.

703. Have they the power of stopping mines or of giving directions, or what sort of directions have they the power of giving; how far, in point of fact, does their power go, and where does it cease?—There is a very excellent collection of rules for collieries, which are part of the laws of Belgium. Each province had distinct regulations made by its own Council, with the assistance of the engineers; and these were altered into a general law. Before this law was adopted a Council was formed, which was composed partly of colliery managers, and partly of Government engineers, and, having been agreed on by them, it was passed as a law. It is so well drawn up, and the precautions are so plainly stated, and are so applicable to our English mines, that, if you will allow me, I will put it in. [*The Witness delivered in the same.*]

Vide Appendix.

704. Can you state up to what point their power goes, and where it ceases?—They interfere as little as they can with the working of the mine. Their principal duty is to see that these regulations are strictly adhered to. In an extreme case, if they find that a mine is exceedingly dangerous, as they informed me, they have the power to order the men out. I have looked carefully over the laws, and I do not find that very distinctly mentioned. The clause which bears most upon it is this: "When an engineer, in visiting an *exploitation*, shall perceive an imminent cause of danger, he shall give, on his own responsibility, all the necessary directions to the local authorities, in order that it may be provided for on the spot, according to the arrangement which he judges to be convenient; he shall, without delay, inform the prefect of everything." I may explain, that the way in which he is able to order the men out, is because any danger must be a contravention of those rules which are distinctly laid down.

705. Has he the power of stopping the mine?—He can order the men out of the part that is dangerous, at least such is the practical working of the law.

706. If the men are ordered out, is it not virtually stopping the mine?—It is the practical working of the law; I am not prepared to say, that there is anything which will apply more nearly to it than this; but at Mons and at Liege, I was told distinctly that they had the power to order the men out.

707. Are there any penalties leviable on proprietors who refuse or neglect to obey the orders of the aspirants?—If any fatal accident occurs, the proprietor of the mine is fined, and to that is attached imprisonment. The fine for a breach of the regulations is under 8 l., and a week's imprisonment. That applies to the workmen as well as to the masters.

708. Mr. Stephenson.] Although the workmen may know nothing of the art of ventilation?—There are rules for the workmen, as well as for the masters.

709. Chairman.]

709. *Chairman.*] In point of fact, it is their duty to see that a regular system of regulation is carried out in the mines?—Yes.

710. Independent of those duties, have the aspirants anything to do with the collection of the revenues of the Government?—Yes; a royalty of 2½ per cent. on the profits is paid to the Government; and the aspirants, and the other engineers, have to determine what those dues amount to in each mine.

711. If, therefore, a mine were not properly worked, the aspirant would complain that they were not worked in a satisfactory manner, and that they were not yielding as much profit as they would produce if they were worked in a better way?—He returns the actual profit, as near as he can ascertain it, which the owner has made during the preceding year; and upon that amount 2½ per cent is charged. He cannot prescribe the mode of work.

712. You were understood to state that the mines were better laid out in Belgium than they are in England?—I think they are. With regard to the distribution of air, which is an important point, they form a marked contrast to the mines in England; and although there is not so large a quantity of gas probably in Belgium as there is in England, on the average, and the quantity of air is a good deal less than in some of our well-managed mines, yet the perfect distribution of air, and the thorough discipline and management, prevents so large a proportion of accidents arising from explosions.

713. Comparing the management of mines in Belgium with the management of mines in England, are you prepared to offer any suggestions for the improvement of our system?—I think that the best managed collieries in England are often nearly as well managed as collieries can be managed; but the distribution of air is, I believe, very generally neglected. I know that the opinion of many eminent viewers is, that they should have a current of air of a certain velocity, from three to five lineal feet per second; but I believe there is hardly a mine in the country where that is carried throughout the working faces, as far as my own observation has gone.

714. Are the mines in Belgium as fiery as the mines in England?—The seams in Belgium lie very peculiarly; they are exceedingly steep and turned over several times; the discharges of gas are rather unequal; more gas is found in strata which have been interrupted by faults; and, therefore, in some points, they are more dangerous than the average of the English collieries. And it is possible they may contain a good deal more gas than I was able to see; for the works being, by law, always carried on in a descending direction, the gas filters out from the coal, and immediately passes off. The great principle of the ventilation of mines in Belgium is that of ascensional ventilation, and throughout the Continent the greatest stress is laid on that point. By keeping all the air courses in a mine gradually inclined upwards to the up-cast shaft, even a blower of gas which comes off finds its own way to the surface.

715. Taking the average of the English mines and the average of the Belgian mines, you think the Belgian mines are as dangerous and as fiery as those in England?—I think there is not more gas in the Belgian mines, on an average, as far as I could see; but still it was difficult to form an opinion, in consequence of the coal being worked in such manner, as to get rid of the gas before it was perceptible.

716. Are there any mines in Belgium of as fiery and dangerous a nature as the most fiery mines in England?—The most fiery mines in England are more fiery than any coal mines in France, Belgium or Prussia.

717. According to your experience, do you find that mines are better managed in England, where the danger is greater, or in districts where there is not so much fire-damp to contend with?—Where there is a great deal of fire-damp, they are generally better managed.

718. Taking a comparison between Northumberland and Durham, where the mines are managed on the best principle, do you find they are as well managed in Belgium as they are in England?—I think there are no mines in England which, as regards discipline, surpass the Belgian mines.

719. That is, in police discipline?—Yes. I am speaking not of the control of the Government engineers, but of the discipline of the persons employed by the proprietors of the collieries. I believe it is not surpassed even by the best managed English mines.

720. Can you state with regard to what department of the management of the best regulated English mines in England the discipline is better in Belgium,

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and where you think that improvement could be effected?—The first point is, that each workman in a colliery has what is called a *livret*, which is a register of his character from the day of his birth, and a certificate from each employer he has been with; and without having that book he cannot be employed in a mine. The consequence is, that an engineer knows the character of the men whom he employs in fiery workings. The next point is, that a book is kept at the colliery, in which the names of the men are entered (for the inspection of the engineers), who are responsible for any important duties of the colliery. A number of supervisors are appointed, whose duty is to go through the mine several times during the working hours, inspect the state of the lamps, the conduct of the men, and the state of the mine. If any dangerous circumstances arise they are obliged immediately to report them to the Government engineer, so that in addition to the ordinary manager of the colliery, the highest engineering talent they have is immediately brought to bear in the solution of any difficulty, and introducing more safety by removing the cause of danger in a mine.

721. Do you consider that sub-engineers or aspirants are a superior class of men to the class of men who are called head viewers in the north of England?—The aspirants are the most highly-educated men in Belgium. Only the head student in each year of the first Mathematical College in Belgium is admitted into the mining service. In France it is the same.

722. At what age are they admitted?—Before they can enter the mining school at Liege they are examined in the higher mathematics (spherical trigonometry, geometry of three dimensions, integral and differential calculus), elements of mechanics, and descriptive geometry; they remain at the school three years, and they have to pass five strict examinations before they can become aspirants.

723. Mr. Stephenson.] At what age do they enter the school?—They must be at least 18, and remain until they are 21 years of age before they become aspirants. They undergo another examination before they become sub-engineers.

724. Mr. H. Vivian.] During the time they are at school, do they visit the collieries in the neighbourhood of Liege?—Yes.

725. Mr. Locke.] Have they any official position until they become aspirant engineers?—No.

726. Do they obtain that official position at the age of 21?—That is the minimum age; they are about 23 years of age on the average, when they enter the service.

727. Chairman.] Comparing the management of mines in Belgium and France, your opinion is, that even in the best regulated mines in England some improvements might be effected?—I will not go so far as that; I have stated that the best managed mines in England do not surpass the mines in Belgium.

728. In ordinary managed mines in Belgium, the system is infinitely superior to the system in England?—Yes, the superiority is remarkable.

729. Do you attribute that superiority solely to the system of inspection?—I attribute it, primarily, to that admirable code of regulations, which must be admitted by every experienced colliery manager to be very important; and next, to the manner in which the engineers see that those regulations are carried out.

730. Is it your opinion that such a system of laws could be enforced in England?—Not at all to the same extent.

731. You stated, in your evidence in 1852, that there were about 400 collieries in your district, and that you could not visit them more than once in every four or five years?—Yes.

732. What improvements can you suggest in the inspection of mines in this country, not for the purpose of making it as rigid as in Belgium, but in order to make it as effectual as the circumstances of England will allow?—I think there ought to be, in the first place, a certain number of the most important regulations to form the law; because that practically removes the responsibility from the inspector which might otherwise attach, if he had the power to order those things only when he found them deficient. In order to carry out these regulations, I think there might be an increase in the inspection, with very satisfactory results.

733. Mr. Fitzroy.] By an increase of inspection, do you mean an increase in the number of inspectors?—I think there ought to be a second class of inspectors; I do not think it is desirable to decrease the extent of the districts, because

because it is very important to have a variety of mines to compare, and to see the application of rules and improvements; and, besides, the system would be better organised; but I think that something of the same system which is adopted in Belgium (and I am not disposed to recommend any particular course) might be adopted with success in this country.

734. *Chairman.*] Do you think the system in Belgium tends in any way to take out of the hands of coalowners the proper responsibility which ought to devolve upon them?—No, quite the contrary.

735. Is it your opinion that any step which would take out of the hands of the coalowner the proper responsibility which should devolve upon him, would be injurious?—Undoubtedly.

736. *Mr. Fitzroy.*] Do you think that even if the powers of the inspectors were not increased, an increase in the number of inspectors would alone tend to promote greater safety in the mine?—I think so.

737. Supposing no alterations were made in the powers of inspectors, do you imagine that the establishment of such a class of men as you propose, subordinate to the inspectors, would tend to increase the safety of the mines?—I have no doubt that an increase in the number of the inspectors would diminish the number of accidents.

738. Even supposing their powers not to be extended?—Yes.

739. *Chairman.*] You stated, in a former part of your evidence, that every suggestion you had made had been willingly carried out by the coal owners and the overlookers?—I said that they generally promised to carry out the suggestions, and that in some instances I had found them carried out.

740. Do you think they would pay the same attention to an inferior class of men as they would pay to the inspector himself?—No; they would not pay so much attention, unless there were a code of regulations.

741. Taking that fact into consideration, do not you think that, instead of having an inferior class of men, subordinate to the present inspectors, it would be better to increase the number of inspectors and to give them higher salaries?—I think that the sub-inspectors might report to the superior inspector in important cases; but it would require a great deal of consideration, the class of men whom it would be safe to intrust with the position of sub-inspectors.

742. *Mr. Fitzroy.*] You are of opinion that it would not be desirable to diminish the area of the district of an inspector?—Yes.

743. That is, on the ground of the variety which exists in the mines, which it is important for him to have under his eye, that he may be enabled to adapt his regulations to each?—Yes; in collieries there are constant improvements going on, and by having large districts he will be able to communicate those improvements from one point to another; and experience gained in this way would be valuable.

744. Do you think it is desirable that the districts should be of such an area as to admit of the visits of an inspector only once in four or five years?—I think that the visits ought to be more frequent than once in four or five years.

745. You have stated that it would be impossible for you to go over your district and inspect each mine in less than three or four years?—Yes; I think the number of inspectors should be increased in some way, after the system which is pursued in Belgium, so as to allow of inspection once a year.

746. You think it is desirable that an inspector should visit each mine in his district once a year?—On an average.

747. The inspector himself?—Yes, or the sub-inspector.

748. Do you think it would be satisfactory, that the inspection of the mines should chiefly rest on the new class of men, whom you propose to establish?—Yes, but it is essential that they should be highly educated men.

749. Do you think it would be sufficient for the public safety, if the inspection was principally made by them, and the reports only made to the inspectors?—Yes, if you had a proper class of men.

750. Are you in a position to propose to the Committee any extension of the powers of the inspectors, at the same time that you propose to establish this new class of men?—I am not prepared to make any proposal of that kind; I think it would be much more satisfactory to have simple regulations which were generally applicable; for by giving increased powers to the inspectors, to some extent, you might remove the responsibility of the proprietors of the mines.

751. *Mr. Locke.*] Would you make those regulations universal, or would you

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limit them to particular districts?—They ought to be so simple, as to be generally applicable to collieries.

752. Do you think that a code of regulations could be adopted, which might be applied universally throughout this country?—Yes.

753. Do you think that you could yourself draw up a code of regulations for that purpose, which would include all classes of collieries?—Yes; I think there is no difficulty in it. I should extract some of the printed rules of the Newcastle collieries.

754. Mr. *Cobbett*.] Perhaps you have framed something of the kind?—No.

755. Mr. *Fitzroy*.] Is it your opinion, that the majority of the accidents which now occur arise from the neglect or contravention of regulations which have been laid down for the management of collieries?—There have been no regulations laid down; I do not exactly understand the question.

756. Is it your opinion, that the majority of accidents which now takes place in English collieries, arise from the neglect or disobedience of regulations which have been laid down with respect to their management?—I think that the majority of them occur from the neglect of regulations which are laid down in well-managed collieries as essential for safety.

757. By the proprietors themselves?—Yes, or by the managers.

758. Not by the Government inspectors?—The Government inspectors have laid down no regulations.

759. In what way will the safety of a colliery be increased by the presence of the class of men whom you propose to establish, if they are to lay down no regulations for its management?—There would be the same influence exerted as there is now; when an inspector visits a mine, he will point out the dangers and defects which exist in it; and if an accident occurs, by stating this at the inquest there will be a greater degree of responsibility thrown on the proprietor of the mine, or the persons employed in it.

760. Then the only additional safety to the public would arise from more frequent inspection?—I have recommended a simple code of laws, as well as an increased number of inspectors; it would materially assist the decisions of coroners' juries.

761. Would you propose to delegate to these sub-inspectors the same authority during the time of their inspection as you now yourself enjoy, with regard to pointing out dangers and so on?—Yes.

762. Do you think you would be able to secure the services of a class of men of sufficient engineering and general scientific acquirements to enable them to perform these duties satisfactorily, on the scale of salary which probably you would propose if they were to be subordinate to the present inspectors?—No, I do not think we should.

763. Do you think that the services of men of sufficient acquirements could be obtained upon the terms which would probably be offered to them as sub-inspectors?—I do not think they could be found permanently at the present salary of an inspector; they ought to be a class who would be promoted, and there ought to be always an opportunity of rising; I think that would tend to get their services, and to keep their services when obtained.

764. Do you propose that they should perfect their education in a manner to fit themselves for the duties of inspectors, by the experience which they would obtain in the mines?—Yes, after a thorough scientific education.

765. You do not propose to find men who are already fully acquainted with the working of mines, and of great scientific acquirements, to commence this career?—I do not think you will find them; and I do not think you will be able keep them, if they were appointed. The department must be increased very gradually.

766. Do you think it would be a satisfactory arrangement for the public to take men at a very reduced salary to undertake these duties nominally, but really in order to go through a course of study to fit them for the situation of inspectors afterwards?—I know that no other class of men would be so likely to remain in the service, as men who have been selected in the same way that they select the engineers of mines in Belgium.

767. Do you think it would be a beneficial arrangement for the public?—I think it would be the best arrangement. There would be less danger than in having inspectors of the other class that has been proposed, who would be wanting in tact and gentlemanly conduct.

768. Mr.

768. Mr. *Locke*.] Are the persons who now have the management of collieries in your district intelligent or otherwise?—I think that, on the average, the overmen are not very intelligent.

769. Do you extend that answer to the general managers, as well as to what are called overmen or wastemen?—In my district they are generally overmen. Where there are engineers employed, they are very superior men.

770. Are there any superior men employed in that district as in the north of England; viewers of considerable note?—Yes; there are some viewers employed.

771. But you think that the class of persons who have the daily superintendence of the mines are not persons of a very considerable amount of intelligence?—No; there is a great deficiency of information among the overmen on many important points of safety.

772. Is it your opinion that they are not well calculated to conduct the underground operations of the mines?—Generally speaking, I think they are wanting in every essential information for that purpose, especially with regard to ventilation.

773. You have stated that you are able to arrange a code of regulations which would be universally applicable to all mines. Would you in that code stipulate any fixed quantity of air for the supply of a mine or not?—No.

774. Would you stipulate for any fixed velocity of air through the mine?—Not further than this: that speaking simply of non-fiery collieries, I think there ought to be artificial means of ventilation, and that the current of air in every part of the mine should be just perceptible by the ordinary test of the candle.

775. Then would your code admit of two or three different classes of mines, namely, those which were fiery and those which were non-fiery?—There would be some rules which would not apply to non-fiery collieries at all, and there would be some rules introduced specially for them.

776. Do not you think there might be a difficulty, in case a jury were inquiring into the cause of death, in ascertaining whether a colliery should be designated fiery, or non-fiery, or moderately fiery?—If a jury were investigating a death by explosion, there would be no doubt in their minds that it was a fiery colliery; and unless they were investigating such a case, they would not go into the matter.

777. Would you consider that every colliery in which an accident might arise of any kind, was really what you would call a fiery colliery, and designate it as such, as distinguished from other collieries which had not much fire in them?—Yes; I can hardly conceive it possible that the presence of fire-damp should not be recognised in a colliery long before any accident occurred from it.

778. In whatever degree, therefore, that air should exist in volume in the mine, you would designate it, and apply your rules and regulations to it, as if it were a fiery mine to any extent?—The rules would be so simple, that they would apply to all mines in which there was fire-damp.

779. Do you think that those simple rules would be entirely efficacious in preventing an accident in any mine?—They would reduce the number of accidents.

780. If rules were laid down with reference to a very fiery mine, would the same rules, in your opinion, be proper rules to apply to a mine which was not so fiery, but was subject to a moderate amount of foul air?—Some of the rules would certainly apply to both. It is difficult to speak generally. In order to make the case more clear, I will take a special case. My own opinion is, after long consideration and inquiry, that the use of locked safety-lamps should be compulsory in every colliery where there is any fire-damp at all; that is an important rule, which, I think, ought to be generally applied.

781. *Chairman*.] Do you mean that the rules which you suggest are so general, that they might be applied to any mine, whether it was fiery or otherwise?—Not having framed the rules, I am not prepared to say there should not be some which would be specially applicable; but there are two or three of that simple kind that they would apply generally. I have given one as regards a non-fiery colliery.

782. Whether a mine is fiery or not fiery, looking at the health of the men, do you think it would, or would not be proper for the Legislature to forbid any colliery being worked at all without artificial appliances?—I think it is most desirable that artificial ventilation should be made compulsory. I believe that

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more injury is caused to life and health by the want of ventilation in non-fiery collieries, than by all the accidents by explosions.

783. *Mr. H. Vivian.*] Are there any collieries in your district which are ventilated by natural ventilation, with a sufficient current of air passing through them?—In the depth of winter, in many well laid out collieries, where there was no fire-damp, you could have a sufficient current of air by natural ventilation. I am giving you the most favourable circumstances. In an extreme case, you may get a sufficient current of air by natural ventilation.

784. *Mr. Locke.*] You have stated, that you think a better mode of distributing air in a mine is pursued in Belgium than in England. Will you explain to the Committee the difference which you have observed between the mode which is adopted for distributing air in mines in Belgium, as compared with that which you have seen in this country?—By law, in Belgium, when the air has once descended into the mine, it must always ascend; the air must never re-descend without the express permission of the Government engineer; a permission which is very seldom granted. The next point is, that the gobbing, as will be seen by those laws which I have put in, is very carefully attended to; the whole space between the air-ways is filled up, and it has, by law, to be carried on to within a very short distance of the face, so that the air is carried along the bottom level, until it reaches the working face; it passes right up the working face; it is kept close to it by the gob, and the gas which escapes is swept off along the return air-ways, without obstruction to make it accumulate.

785. Can you state the distance to which they are obliged to carry the gob to the face, by the Belgian regulations?—The distance is not specifically mentioned; it varies in different seams, but it is generally carried from four to ten feet from the face.

786. There is no regulation as to the distance to which it shall be carried?—No.

787. *Mr. H. Vivian.*] Can you state the thickness of the largest seam of coal in Belgium, where that rule applies?—About four feet.

788. *Mr. Locke.*] Are there not thicker seams of coal than four feet in Belgium?—No; I think that is the thickest seam.

789. *Mr. H. Vivian.*] Do you conceive that such a principle can be carried out in larger seams of coal?—The same principle; that is, filling the stopping well up is applicable everywhere.

790. But not the gob?—They work in long work in Belgium.

791. You work with stall and pillar?—Yes; and the stoppings are generally very much neglected.

792. *Mr. Locke.*] Are the mines in England generally inclined or flat?—Generally flat, some are highly inclined.

793. Would the principle which you say is so beneficial be applicable to a mine which is less inclined, or to a mine which lies flat?—The ascensional ventilation cannot be carried out in some of the English mines throughout; there is one point in flat-lying seams, where the air would have to descend if the up-cast shaft is not altogether to the rise, but it is a dangerous practice.

794. Then you have contemplated cases, where in England it would be impossible to carry out that principle which is adopted in Belgium?—I think the safety could be attained with great care, and the arrangement of the air courses.

795. Then it would not be one of your regulations which you would propose similar to that which is now adopted in Belgium?—No; I should not make it so exclusive a law as in Belgium.

796. Then that advantage which you say you have observed in Belgium, is not one of the advantages which you think would be universally applicable in this country?—No; I should not think it would be as universally applicable in this country as it is in Belgium.

797. Are you prepared to state to the Committee, from your knowledge of the management of mines in your district, that one cause of defective ventilation is a defective distribution of air?—Yes; it is one of the most common causes. To be set in comparison with the gobbing which is made use of in Belgium (carrying the air to the face), I should mention that there is, generally speaking, in English collieries an enormous leakage. A quantity of air comes down the shaft which does not penetrate to the working face.

798. *Mr. H. Vivian.*] Through stoppings?—Yes, besides doors and brattices.

799. *Mr.*

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799. Mr. *Locke*.] What is the distance between the gob and the face of the workings which is usually adopted in long wall work in the districts which you superintend?—The gob walls are not ordinarily sufficient to carry the air sufficiently along the face of work. I have frequently found neglect in that point.

800. Can you state, in feet or yards, of what that neglect consists?—I find it is very commonly the rule, under those circumstances, not to carry forward the gob, or the brattice, as the case may be, until there is some indication of fire-damp in the lamp.

801. Then you think that until they see danger they do not make themselves secure?—Until there is $3\frac{1}{2}$ per cent. of fire-damp in the air of the mine, they do not adopt the precaution of carrying forward the gob walls.

802. Mr. *H. Vivian*.] Do you consider the system of gobbing applicable to a larger vein than a four feet vein?—In thick veins you would build gob walls to carry your air forward.

803. I assume gobbing to apply to long wall work?—Yes.

804. You may define a gob as that which is mechanically done?—Yes.

805. While a goaf falls entirely?—Yes.

806. The gob will apply altogether to long wall work?—Not altogether.

807. Is long wall work applicable to a larger vein than a four feet vein?—Yes.

808. Is it applicable to a five feet vein?—It is more favourable in thin seams; but you may work a very thick seam by it, under favourable circumstances.

809. Must it not also depend, in a great measure, on the roof?—Somewhat.

810. If the roof will not fall readily, you can scarcely work long wall work?—It is more difficult. You may have a modification of long wall work.

811. You must work the coal first by stall and pillar, and then by long wall work?—Yes; that is a convenient way. There are two great divisions in long wall working, namely, working from the shaft and to the shaft. When you cannot work from the shaft you can almost invariably work to the shaft.

812. Is it not the fact, that it would be impossible to stow large veins?—It is sometimes impossible.

813. Those veins you would work by stall and pillar work?—No; I think in all veins you could build gob walls of some kind. I can imagine a case where you would have to leave a pillar of coal in order to carry the air in.

814. *Chairman*.] Would you recommend the Legislature of this country to enforce either the system of long wall work or stall and pillar work?—No.

815. If that were done in Belgium it would be because the Government, having a certain per-centage on the profits of the mine, might think it a more advantageous mode of working, and therefore they would themselves, in order to secure their own profits, recommend it; but in England, the system being different, each proprietor working a mine must be left to work his mine according to the system which he deems most profitable?—It would be impossible to say that a proprietor should work his coal in this or that manner. In Belgium it is not done.

816. Mr. *Locke*.] Are you prepared to recommend gobbing on any fixed rule to be carried on?—I should recommend that the stoppings, and everything which conducts the air to the face of work, should be made perfectly tight, so as to carry a sufficient quantity of air into the working faces.

817. Would you be prepared to say that the gobbing should be carried up to within a certain distance of the face?—No; I should not be prepared to say that; I should not recommend the adoption of gobbing as one of my rules at all.

818. With reference to the improved distribution of air, which you state exists in Belgium, are you prepared by any rule to enforce that system in England?—I should not concern myself at all with the air that came down the shaft; if there was any regulation, it should be that a certain rate of current, which I explained by saying it would indicate on the flame of the candle, should be maintained in the working parts of a colliery where there was no fire-damp at all.

819. Can you measure the velocity in feet?—It is 30 lineal feet per minute, half a foot per second.

820. Ought the velocity to be increased according to the amount of foul air which was met with in a mine?—Yes.

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821. That of course would render it very difficult to lay down any general rule, which would be applicable universally throughout this country, where there are so many different classes of mines?—I think you may arrive at a rule in a very simple way, namely, to say that there shall be a sufficient quantity of air to prevent any indication of fire-damp on a safety-lamp.

822. You do not mean to measure it by any fixed quantity, but that there shall always be a sufficient quantity of air to prevent fire-damp being shown either by a naked candle or by a lamp?—By the most delicate tests that we have, that fire-damp shall never be visible in the working face.

823. Whatever quantity of air might be necessary for that purpose, without fixing it in your rule, you would render it imperative upon any person who owned a mine to have that quantity supplied?—I am not prepared to say that.

824. I want to ascertain if we can get into some fixed regulation?—There is no doubt they ought to have that quantity.

825. Then, if they ought to have it, are you prepared to recommend this Committee to enforce it?—There are some peculiar circumstances in which it might be impossible to have that quantity; and there might be some exceptions, such as are provided for in Belgium, where the engineer may allow the air to descend. I cannot give a decided answer off-hand.

826. Then, in point of fact, you would not recommend a system of rules without making exceptions to them?—There might be an exception. It requires consideration.

827. Mr. Stephenson.] With regard to inspection, are there not a great number of circumstances almost daily occurring in an extensive colliery, which alter the relation between the supply of air and the demand for it, supposing the demand to be regulated by the principle you now lay down, that the safety-lamp is not to show more than a given indication of gas at the face of the working?—I think, that as a rule, there ought never to be the slightest indication of gas in the face of the work.

828. Are there not every day, in an extensive mine, various casualties which involve a great disparity between the supply of and the demand for air?—A variation to the amount, as I have explained, of one-fifth or one-sixth.

829. It is in evidence before all the Committees which have sat on this subject, that the discharge of fire-damp from coal is exceedingly irregular, and can only be detected by the men who are constantly in the pit, and that occurs almost every day. In order to make the mine safe at different times of the same day, do you not want a different supply of air to keep the ventilation in a good state?—Yes.

830. With such an inspection as you give to collieries, on your visits once in two or three years, what kind of regulation could you apply?—There is a point which it is necessary for me to explain in order to answer that question; that is, to point out that when you begin to see a halo, or indication of fire-damp on the flame of a naked light, there is already $3\frac{1}{2}$ per cent. of gas, according to Sir Humphrey Davy's experiments, and that when there is seven per cent. the gas explodes. That $3\frac{1}{2}$ per cent. under the most favourable circumstances, such as when a man is engaged in examining it, and it is almost pure carburetted hydrogen, is a very small margin indeed to interpose between safety and explosion; and every manager who wishes to put his colliery into a proper state, ought to increase that margin by doubling the amount of ventilation. If I was managing a colliery, upon seeing such an indication, I should double the amount of ventilation, so that I should make the chance of seeing any indication of fire-damp from a blower, or extra discharge of fire-damp, exceedingly improbable. With the safety-lamp the margin is only 2 per cent.; the true cause of the numerous explosions.

831. That is the act of the manager of the mine at the moment when he sees the casualty occurring?—No; he ought to have his colliery worked with so large a margin of safety, that even supposing there was a considerable alteration in the discharge of gas, it should give no visible indication by the rough test we now have.

832. Do you think an occasional inspection by yourself, or any other Government inspection, once a year, or once in two or three years, would meet a casualty of the kind I have alluded to?—No; and that is the reason why I think that simple rules of that sort would materially assist the inspection.

833. Does not the safety of a large colliery essentially depend upon the vigilance

vigilance of the manager?—A good deal; but still if such regulations were enforced, many collieries, which I am not perhaps able to visit, would pay attention to so distinct a law, and it would everywhere have a constant degree of operation, even although I was not able to visit the colliery more than once in several years.

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834. Supposing the quantity of gas was never to be allowed to exceed $3\frac{1}{2}$ per cent., when it does exceed it, how are you to know whether a manager has really taken those pains which are necessary for diluting it, or keeping it at that amount of dilution. If he neglects it, supposing that the quantity of gas is very large, and is liberated in one day, scarcely any power he could bring into play would maintain that dilution; how could you blame that man?—I should be able to get a good deal of evidence from the colliers, as to the indications of gas which they had previously seen; and besides this, to guard against any idea that the colliery might be rendered insecure, I think it is indispensable there should be a locked safety-lamp.

835. I want to ascertain how the occasional inspection of mines would essentially operate to reduce the number of accidents?—As I have stated before, the collieries are worked at present in a very dangerous manner; they are worked generally so as just to see the halo on the flame. I think that the quantity of air in those collieries should be doubled, and then it could very seldom occur that so extensive a blower would come off as to make the halo visible.

836. Do not you think that, before a man is allowed to undertake the management of a coal mine, he should be called upon to undergo an examination which should really test his ability?—I think it is a matter of great importance that the manager should go through an examination of that kind, if it were only a simple one, in order that he should know the principles of ventilation, of which many of them in my district are ignorant; but still, from what I have stated before of the improvements which are often carried out on the recommendations which I made to the managers, I think that inspection does and must do much good.

837. I am not disposed to question the utility altogether of inspection; but I rather put that question to ascertain your opinion as to the mode of investigation into the qualifications of the party to whose management a mine is submitted. Would not that be a more direct mode of remedying the evil we are now considering, or would it not be a very admirable auxiliary?—I do not think it would be possible to do it universally.

838. Mr. Cayley.] You think that inspectors may suddenly visit a mine, and keep the manager of the mine in proper order?—Yes. I would much rather you would take evidence as to what inspection has done; I think there are engineers coming who can tell you whether an amendment in ventilation and other things in collieries has taken place.

839. Do you think that no mine should be worked in which it would not be ordinarily safe to introduce a naked light?—I think that any mine can be worked, however great the discharge of fire-damp; for I am perfectly sure that, with the ventilating powers we possess, it could be adequately ventilated.

840. You think that however fiery a mine is, there exists a possibility of a sufficient ventilating power?—Undoubtedly.

841. The recommendations that you have given seem to imply rather the means of knowing how an accident has happened after it has happened, than the means of prevention before it takes place: is not that so?—No. In working a colliery you must have some test of the amount of discharge of fire-damp.

842. You have stated that a certain amount of ventilation is necessary?—I only spoke of where there is no fire-damp at all. I think that the air should be in motion in every working part of a colliery.

843. And you are not willing to give any particular amount?—Not less than 30 lineal feet per minute.

844. That is only half a foot per second?—Yes; where there is no fire-damp.

845. Are there many mines in which there is no fire-damp?—I should think two-thirds of the mines in my own district have no fire-damp in them.

846. But where there is an average amount of fire-damp, what is the current which you would recommend?—Where there is any fire-damp there should never be less than 200 cubic feet, per man, per minute.

847. What rate of current would produce that in an ordinary sized mine?—Supposing you had 300 men, that would be 60,000 cubic feet per minute.

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848. What

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848. What rate of current?—Where there is a tendency to fire-damp in a working face, the current of air ought to be travelling at something like three lineal feet in a second.

849. Would you not, in all such cases, establish a minimum, which should be essential to safety?—That is a very difficult point to determine. I should mention, that taking it roughly at so much per man, is not an accurate measure of the quantity of air which is wanted in a colliery. It is a unit of measure which is most generally applicable, and accordingly I put in that form, making the quantity of air depend on the number of men.

850. What should be the supply, per minute, to each man?—There should be from 200 to 600 cubic feet, per man, per minute, or even more than that.

851. Could you not establish that test?—I think it would be exceedingly difficult to define what the limit is, consistent with safety in a colliery, where there is very little fire-damp.

852. I want to ascertain something a little more definite than that it is a test of danger, when the flame begins to lengthen, which appears to me to be the result of the answers you have given in the latter part of your examination?—If in a working face you find a slight indication on the flame of the lamp.

853. Who finds?—The manager of the colliery.

854. The manager is not there?—The fireman informs the manager; the manager is the person to decide what quantity of air ought to go through the colliery. The manager will measure the quantity of air which is then going through the colliery, and he ought to have, at least, double that quantity of air.

855. If he could double that quantity of air, would the air be sufficiently foul to lengthen the flame?—I take the quantity of air at which I just see the halo, and I think the quantity ought to be doubled.

856. When the state of the atmosphere is such as to produce only that halo, you think that the quantity of the air should be doubled?—Yes; to interpose a sufficiently wide margin, in the same way that you make a boiler three times as strong as to resist the pressure which it has ordinarily to bear.

857. Do you think that amount would be sufficient in case of any sudden outburst of gas?—Outbursts of gas might occur which would overcome that in some cases. But such large discharges hardly ever occur in any mine.

858. Supposing there was a mine where these occasional outbursts did take place, would you recommend an additional amount of air?—Wherever a mine is subject to occasional outbursts of gas there ought to be a much larger ratio of air than where the discharge is perfectly uniform.

859. What would be the amount that you would recommend?—Somewhere between 200 and 600 cubic feet per man, per minute.

860. The test you had arrived at was, that when there was a halo round the flame you would recommend double the amount of air to the atmosphere producing it?—Yes; even this halo is often disregarded, or submitted only to the roughest observations.

861. Supposing it is a mine which is liable to these explosions, would you treble or quadruple the amount of air?—That would depend upon the amount of discharged gas. I have given in all cases a minimum in my evidence.

862. In case of an explosion taking place, have you any means of ascertaining the cause of the explosion?—Supposing that such a rule, as it is imagined I might recommend, was carried out, it would be more difficult to say that the overman or the manager was to blame where a colliery was subject to occasional discharges.

863. You would endeavour to get information at the coroner's inquest of what had been the amount of ventilation?—Yes.

864. How would you propose to obtain that knowledge?—I should inquire from the colliers, and firemen more particularly, how often they had seen a halo on their lamps, and in what parts of the mine, and what was about the amount of discharge of gas which had taken place.

865. Is not the fireman generally the offending party?—There are several firemen; I understand you to ask how I should ascertain how far the manager was to blame. We are speaking now of the quantity of air which is going through the colliery, and the manager is the judge of that, in the first instance. If he has not sent a sufficient quantity through the mine, and an explosion happens,

happens, I take evidence as to whether he has done his duty or not, from the firemen or from the colliers, and any other information I can obtain.

866. You have no means of obtaining information or of testing the mine except from the very parties who appear to have neglected their duty?—An explosion could not occur in a mine where all parties were to blame, because their duties are divided in different parts of the mine; and, besides, the collier is not responsible for the amount of air.

867. You have stated, with regard to the anemometer (as is perfectly well known), that where you are lengthening the workings you must extend the brattice, and so alter the place of the anemometer; so that the anemometer must be movable. In your opinion, would not a self-registering anemometer, at the bottom of the down-cast and at the bottom of the up-cast, be a test of the amount of air entering the mine?—It would measure the velocity of the air which passed it.

868. And that, multiplied by the area, would give the amount?—It would then measure the quantity of air which passed.

869. Although a self-registering anemometer at the bottom of the up-cast and at the bottom of the down-cast would be no test of distribution, yet it would be a test of the amount of air entering the mine to be distributed?—Yes, provided it was not tampered with.

870. Would it be so likely to be tampered with, or tampered with in the same way as has been suggested, at the bottom of the down-cast or at the bottom of the up-cast, as it would be in the galleries?—Yes; I do not think there would be more difficulty in tampering with it there.

871. Do you think it would be no additional means of testing the ventilation during your absence?—I should be very glad if such a thing were practicable; but I do not think you would get the managers of collieries to adopt it, or get such a machine to work a month without cleaning.

872. All the other means that you have suggested appear to be very much on the principle of locking the stable door after the horse is gone?—I lock the safety-lamp before the explosion happens.

873. *Chairman.*] You have stated, in one part of your evidence, that there are cases in which you would enforce the compulsory use of the safety-lamp?—Yes.

874. You have stated, with regard to inspectors, that the only mode you have of improving the inspection of mines, would be to appoint an inferior class of men, to be called sub-inspectors?—Yes, but to be promoted as vacancies occur.

875. You can suggest no other mode of improving the system of inspection in this country?—It ought to be combined with a code of regulations, which they should see enforced.

876. You stated that you could frame such a code of regulations; can you, by the next sitting of the Committee, prepare a code of regulations which you think would be applicable to the case, and submit them to the Committee?—I can easily give you the heads.

877. Perhaps you will be kind enough to do so?—Yes.

878. You have heard Mr. Dickinson's evidence as to the mode of ventilation which is adopted in Belgium?—Yes.

879. Is there any part of Mr. Dickinson's evidence with which you disagree?—I do not agree with him as regards mechanical ventilation; I do not think he has seen the results of the experiments. Comparing the effective work with the consumption of coal, it will bear comparison with the best furnace ventilation in the north of England.

*H. F. Blackworth,
Esq.*

16 June 1853.

Martis, 21^o die Junii, 1853.

MEMBERS PRESENT.

Mr. Hutchins.
Mr. Stephenson.
Mr. Fitzroy.
Mr. Baird.
Mr. Locke.

Mr. Cayley.
Mr. Cobbett.
Mr. Farrer.
Mr. Henry Austin Bruce.

EDWARD J. HUTCHINS, Esq., IN THE CHAIR.

Herbert Francis Mackworth, Esq., called in; and further Examined.

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880. Mr. *H. A. Bruce.*] IN your former examination, at Question 517, you are asked by Mr. Cayley, "You have alluded to the loss of life from explosion, in the Middle Dyffryn Colliery; was that the Aberdare case?—Yes." Then the next question is, "Since 1845, how many deaths have occurred from explosions in that mine?—I think about 165." Upon reconsideration, do you believe that to be inaccurate?—I intended to say 65 deaths from the last explosion in Middle Dyffryn Colliery; there was a previous explosion, which occurred before I had charge of the district.

881. Do you know how many were killed by that explosion?—Thirteen.

882. *Chairman.*] To what did that number, 165, refer?—I intended it to be 65; it is put down 165 by mistake.

883. Mr. *H. A. Bruce.*] With respect to that accident at the Middle Dyffryn Colliery, in your former examination, at Question 573, you were asked, "Do you believe this accident occurred in consequence of those recommendations not being attended to?" that is, the recommendations of Mr. Blackwell; and your answer is, "If his recommendations had been attended to in respect of the brattice, the accident would have been attended with a comparatively small loss of life?" Are we to gather from your evidence that you attribute the accident to the gas having come in contact with the furnace?—Yes.

884. That being the case, the whole question resolves itself into this: whether the furnace was or was not to be considered a naked light?—Yes; I have given that as my opinion, but I have stated that there is a difference of opinion among mining engineers.

885. Did Mr. Blackwell, in his report, call special attention to the furnace, apart from the naked lights?—No, he did not; the furnace was not in at the time the previous accident occurred.

886. How was it ventilated?—It was ventilated by a lamp.

887. Mr. *Stephenson.*] A large coal lamp?—Yes.

888. Which was, in fact, a furnace, not of a large character?—Of the same kind; it produced ventilation in the same way, but was indisputably a naked light. I think I ought to mention that the opinion of the overman of the colliery is, that the gas was exploded by a workman entering a part of the mine where the gas was passing with a naked light, which would be clearly a violation of Mr. Blackwell's recommendation, and that of the jury in December 1850.

Joseph Dickinson, Esq., called in; and further Examined.

J. Dickinson, Esq.

889. *Chairman.*] WERE you present in the Committee-room when Mr. Mackworth gave his evidence on Friday last relative to the inspection in Belgium?—I was.

890. Were you also present when he stated what measures he thought ought to be adopted to make the inspection of England perfect?—I was.

891. Do

891. Do you agree with that statement? Mr. Mackworth stated that he did not wish to increase the number of inspectors, but that he wished to have a number of sub-inspectors to act under the inspectors, who should be men of some scientific acquirements as well as practical knowledge; and they should be distributed over England; that there should be a sufficient number, so that they could periodically visit the mines and report to the inspectors. Do you think that would be a proper way of improving the inspection which now exists?—I agree with Mr. Mackworth that the appointment of sub-inspectors would relieve the inspector of the most laborious part of his duties, but I think that the appointment of sub-inspectors would be very strongly opposed by the colliery owners, especially in my district, where they have expressed themselves to me as being very much opposed to such appointments. I could give you the names of some of the largest proprietors in Lancashire: Messrs. Knowles are probably the largest colliery proprietors in England. They raise about 2,400 tons per day at the whole of their collieries. They are decidedly opposed to the appointment of any class of men lower than the present standing of inspectors.

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892. Did they state their reasons why they object to these sub-inspectors?—They have different reasons; one of which is, that if a lower class of men were appointed, rising engineers, who wished to obtain a knowledge of the district, might accept the appointments, and merely hold them for a time until they became possessed of a knowledge of the collieries and the neighbourhood, and then might retire into private practice as mining engineers; that was one objection.

893. Did those gentlemen at the same time complain of the insufficiency of the present inspection?—No, I have not heard any such complaints.

894. From this evidence in 1852, it is notorious that the present number of inspectors are too little; you stated, as well as Mr. Mackworth, that each inspector had about 400 collieries under his own superintendence, and that it was impossible to go round and visit those more than once in four or five years; now, if you think that appointing sub-inspectors is not the proper way of improving this inspection, what plan would you suggest in order to make the present mode of inspection perfect?—I think, if I recollect rightly, I qualified that recommendation in 1852, by stating, that if it was intended that each of the collieries should be inspected, a very considerable increase in the numbers of the inspectors was imperatively necessary; to make a thorough inspection of all the collieries in this country, such as would be adequate to insure a sufficient control over the management of them, would require a corps as large as the present staff of colliery managers. Even at the present time, under the present arrangements, the manager of the largest colliery in my district, Mr. Peace, of the Haigh colliery, belonging to the Earl of Crawford and Balcarres, publicly stated at an inquest, that his duties as manager of that colliery were so numerous that into some of the pits, where there was not imminent danger, he was only enabled to visit such pits once a year. If the manager of a large colliery can only visit the pits where he thinks there is not imminent danger once a year, it would require a force of inspectors quite as large as the present colliery managers, which I apprehend will never be appointed. I may state that the working of the Act appears to me to have a moral effect, as well as a coercive effect; that improvement introduced into one colliery, at the suggestion of an inspector, is not the less likely to be introduced into a neighbouring colliery, if done apparently at the instigation of the manager of the colliery.

895. Do we gather from your answer that you consider that the present number of inspectors is sufficient?—I think a very moderate increase in the present number would be quite sufficient for all the requirements of this country. If the colliery managers were held responsible for the management of their collieries, and if certain fundamental rules, such as I have stated in answer to Question 744, were laid down for the management of collieries, and an accident happening when those rules have been neglected, if punishment were awarded in those cases, I think that the present staff, or a very small addition to it, would be quite sufficient to carry out what is required.

896. Then you think that, instead of increasing the number of inspectors, that the better plan would be to increase their power?—I do.

897. Will you state in what respect you think their power ought to be increased.

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increased. In your evidence of 1852 you say in some cases the powers are deficient, and you have not the power of suspending operations; you can refer to your own evidence on that point in Question 1848 in the year 1852?—In my evidence of Monday last I have given a list of rules and regulations which, I think, might be laid down as fundamental rules for the management of every colliery in the country. In addition to these there are one or two points in which I think the present Act for the inspection of coal mines might be amended. The first point is, that I think iron-stone mines should be included in the Act. They are very intimately connected with the coal mines; so much so that the air which is used for the ventilation of the colliery is sometimes used for the ventilation of the iron mine.

898. But suppose iron mines were included in the Act, would not that increase the duties of the inspector and give him greater labour?—It would.

899. Would not that be a reason why more inspectors should be appointed?—I think if these rules, which I have named, were laid down, that a very small addition to the number of the inspectors would be all that would be required.

900. Can you state what would be sufficient to embrace a proper inspection, and to include iron mines?—I am not prepared, without consideration, to make such a statement.

901. What is the next thing you would suggest?—Where great danger evidently exists, and the proprietor refuses to resort to the most approved means of increasing its safety, I think the inspector should have the power to order the working of the mine to cease, until such time as its condition be improved, or an arbitration shall have been held on the case; one of the arbitrators to be the inspector himself, and the other to be appointed by the colliery owner; an umpire to be appointed in the usual way, or, failing to agree, an umpire to be appointed by the Secretary of State. I should enforce that by a penalty of 10*l.* per day, or not exceeding 20*l.*

902. Of course, giving the colliery proprietor reasonable time to effect those improvements before these penalties were to come into force?—In the imminent cases; I am speaking now of a case where imminent danger exists, such as the mine being carried on in an explosive state throughout, where the men ought to be ordered at once out of the mine. Such cases are very rare, and in the whole course of my inspection I think I have only met with three cases which I considered imminent; in two of them I succeeded in stopping the mine merely by my representations; in the other case the proprietor went on, and said he would risk it.

903. Not materially increasing the number of inspectors, each inspector having such number of collieries to look after as he at present has, such cases might exist in a great many collieries, and be in existence for a very considerable time before the inspector could find it out; is that not so?—They might; we use the best endeavours we can to get information of such cases, and when we obtain it we at once direct our attention to it.

904. What means have you of procuring this information?—I get such information from a variety of sources, which I should prefer not particularising.

905. Do the men ever give you information, or persons appointed by the workmen?—Very seldom. I rather object to receiving information from the workmen direct, as it might interfere with the good feeling which should exist between master and man; I generally prefer having it through their representative.

906. The question applied to their representative, or anybody appointed by them?—I have from their representatives received information of one or two very bad cases, in that way.

907. And then you immediately go and visit the mine?—I do.

908. Having visited the mine on their representations, have you generally found their representations to be correct or not?—In some cases they were, and in some other cases they were not.

909. Mr. *Baird.*] In the event of the men being turned out of the mine, in a mine of imminent danger, have you considered how the men are to get employed afterwards during that time?—In a large concern you have no difficulty in transferring a few men from one pit to another; considering the great number of pits you have yourself at work you would find no difficulty.

910. Suppose there is only one pit?—I will give a case, where a short time ago, I was enabled to stop the mine. It was a colliery close to Manchester.

On

On visiting it, I found the shaft in a very bad state; there were loose stones and loose bricks almost the whole way down it. I pointed this out to the underlooker who went down with me, and I asked if he was not afraid to go down such a shaft; he said no, he was not. On coming out, I informed the proprietor what I had seen; I said it was not fit to send a dog down. He said, "What must I do?" I said, "I should recommend your stopping the pit at once, and walling it throughout, and putting in guides." "But," he said, "they are working now night and day; the only time we can have for repairing is the hour at dinner time, and during that time the underlooker goes down to fettle it." I said, "That will do nothing, for the shaft is in such a radically bad state, that it requires a thorough repair." He said, "I cannot, without consulting my partners." I said, "I do not wish to press you beyond what you have the power to do. I will give you till Saturday to consider what you will do; and if you do not by that time determine to have it thoroughly repaired, I shall serve you with formal notice in the matter." On Saturday morning I received a letter from him, informing me that, on considering the matter over with his partners, they had determined to stop the pit and repair it thoroughly. What they would do with the men I cannot tell; they had another pit, and probably they would put them into that. At all events, a dangerous circumstance like that would not justify the pit being carried on, although they had no place to put the men.

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911. *Chairman.*] Provided they had no place to put the men in, do you think it would be better to order them out, although they might lose a day or two's wages, than to run the risk of sacrificing their lives with the pit in a dangerous state?—No doubt it would; indeed, with proper care no pit should get into such a state. If the pit I have alluded to had been properly repaired, as it ought to have been long before I visited it, it would never have gone into such a dilapidated state.

912. State what other powers you require that the inspectors should have given to them, to enable them satisfactorily to perform the duties that they are called on to perform?—I should ask for no extra powers excepting what I have named.

913. That is, the power to stop the pit?—Yes, and under the reservation which I have named. But with respect to plans, the Act should be more stringent than it is at present. The inspector has the power to order proper plans to be made when he finds them wanting; but I have met with cases in my district where plans have been entirely wanting, and on pointing this out to the proprietor he has undertaken to get them made, which was all the assurance the inspector could demand. But on going back to these collieries about a year after, I have found that plans have not been made, although there was an undertaking that they should be. I stated that we had the power to order plans to be made; but I apprehend that if the inspector ordered plans to be made, he would be responsible for the payment of the bill for them, in the event of the owner of the colliery failing to pay for them. The plans are not, in many cases, kept up in accordance with the Act, therefore, I think that the penalty should attach in every case where the plans are found not kept in accordance with the Act, and that no time should be afterwards allowed to the colliery owners to get the plans made. After the passing of the Act, I should allow six months for proper plans to be made in all cases, and after that time I should enforce a penalty of 1*l.* per day in every case where they were not found to be in accordance with the Act, until such time as they were made so.

914. Have you not the power to demand the inspection of the plans?—Yes, we have that power under the present Act.

915. Do you often do so?—Yes.

916. In what character of collieries do you find the plans are wanting?—There was one of the largest collieries in North Staffordshire, belonging to Mr. Sparrow, a very large iron master; he had no plan of it. In another case, in Lancashire, only very recently, I found one proprietor of mountain mines, some small outlying mines, where there were no plans of 11 collieries. In another case, in the Bristol field, when I had the charge of that district, I found several cases about Bristol where there were no plans; they all undertook to get plans made, but, about 16 months afterwards, it was proved that one of them had

J. Dickinson, Esq. done nothing whatever in the matter, and he had holed into some old working and drowned some men, in consequence of the absence of plans.

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917. There being a large stock of water in those old workings which they were not aware of?—They might or not be aware of it; Mr. Mackworth was the inspector for the district when the accident happened.

918. There was a large stock of water there which they struck without taking proper precaution, and by so doing a number of lives were sacrificed?—Yes. In the whole of the Cheadle district, also, in North Staffordshire, I think I only found one colliery where there were plans.

919. Are those large or small collieries?—They were small collieries, but large tracks of coal had been worked away; and there was no record at all of the old workings. I was informed that three of the lessors had plans of their own property, but they formed a very small portion of the district.

920. *Mr. R. Stephenson.*] Generally speaking, you found plans wanting in smaller collieries; did you find them more frequently wanting in small than large?—More frequently in small out-lying collieries. There is a large colliery in North Wales, the Coed Talon and Leeswood Colliery, where I found the plan of one seam was wanting, and the manager undertook to get a proper plan made; but on re-visiting the colliery about a year afterwards, I found he had done nothing whatever in the matter.

921. *Chairman.*] Then we are to take your answer as being that you find in your districts that there is such a deficiency of plans as would suggest to you that an Act of Parliament should be passed, requiring plans in all cases to be made of collieries, and to be enforced by penalties?—That is my opinion.

922. Or immediate stoppage?—Any adequate penalty.

923. Suppose you went into a large colliery where a very large number of men were employed, and you found no plans made of that colliery; if you were at once to order the plans to be made, it would take three or four months to complete these plans in a satisfactory manner; would you on that have ordered the colliery to be stopped?—No. I think the penalty of 1 *l.* per day till the Act was complied with would be quite sufficient; but some provision ought to be made to meet cases where the colliery was nearly done, when it might suit the purpose of the colliery proprietor better to pay the penalty than to be at the expense of making plans.

924. But that would not obviate such an accident as you have just described to the Committee, as to the stock of water, if no plan existed, and that stock remained in the colliery; by proceeding, and making the plans at once, they could not get at this stock of water to see where it was, and they might not be aware of its being in existence; therefore these plans would only show the exact state of the workings which were open to view?—I think the colliery owners had the knowledge of these workings; but as Mr. Mackworth was the inspector for the district at the time of the accident, he will be able to give you details. Admitting that they could not have got any plan of these old workings, to go on without plans is only perpetuating the mischief; and as colliery workings become more extensive, you will have an increase in the number of accidents by inundation, and perhaps by explosion of fiedamp or suffocation, consequent upon holing into old workings.

925. Now, in this case that you have described to us, were the owners of the colliery or overmen not aware that water was in some part of the mine?—I believe they were.

926. Are there not some means of preventing such accidents as these independent of plans; for instance, is it not possible to keep what they call boring rods at a certain distance before them, so keeping pillars between the water and the working; so that if ordinary care is taken the water never could break into the mine and drown the men?—If you have not got plans, boring is the only precaution you can resort to. But to show how easily an accident may occur in a colliery when it is expected that boring is going on, I will quote a case which happened in my district in Cheshire not very long ago. On visiting this colliery, and seeing everything with regard to the ventilation, I put a question to the assistant underlooker (the underlooker himself was from home) as to whether he had any water to tap; he said, "Yes, we are about to tap some water now in the top of our rise workings." "Are you keeping proper bore holes in advance?" "Yes," he said, "we are keeping one." "Are you

you not keeping three," I said; "you ought to have one in the middle and two on each side?" He said, "We have only got one." I said, "We will go and see it." He said, "You may rely on its being all right." I said, "I have met with so many cases where boring is neglected, that we will see in what state we find the boring in this case." The mine was a very steep one, dipping at an angle of 45; and on climbing up to the top, I found the man had no bore hole whatever, and that he had just driven through a fault and upthrow of about three or four feet, which was a likely place for the old working, to have been stopped at, and he had no bore hole there at all. The proprietor was in the pit with me, and I asked him what he thought of it, and what he considered I must think of the management of the colliery. He said, he could only assure me that he was paying for boring, and that his underlooker being from home his assistant did not appear to be looking properly to the matter, and the men were receiving wages for boring which they were not doing.

927. *Mr. Locke.*] Were there any plans of the mine which you have just been alluding to?—In that case they had plans.

928. Were you able, then, to suggest some further bore holes to be made as a matter of precaution?—I had nothing to add to the suggestion I had made that there should be two bore holes, one on each side, in addition to the one going on in the centre of the drift.

929. You said you thought it desirable to be in possession of the plans, in order to judge better of what accumulation of water might take place?—I did.

930. In all cases the plan of a mine is of very great importance, to enable persons to judge where water might not accumulate?—I think it is most important; no one can carry on a mine properly without the assistance of a plan, and every one could carry it on better if he had the plan of the workings to guide him.

931. And would be able to judge of the safety and security of the mine, if he had a plan of what had been done in previous years?—That is my opinion.

932. *Chairman.*] Without plans it would be impossible for any owner of a colliery to know whether he was confining himself to his own limits or not; he might work over his own boundary; if he had no plans he could not tell whether he was in his own ground or not?—There are cases of that kind, although they are very rare; they generally dial it, and peg it out upon the surface. The pegs are soon pulled up; and when two or more seams are being worked in the same field, the complication is increased.

933. *Mr. Locke.*] Are you aware of a law with reference to one person abstracting or taking the coal of another; is it not penal?—It is felony.

934. In order to enable parties to avoid those penalties, the plan of the colliery would be almost an essential thing?—Yes; it is surprising what a number of cases we meet where encroachments have been made on other properties.

935. *Mr. H. A. Bruce.*] Have you ever heard of a man being tried for felony for encroaching on his neighbour's coal?—Yes; there was a colliery owner in Lancashire, who was tried and sentenced to transportation for seven years. I believe he was not sent out of the country.

936. *Chairman.*] Are you aware under what Act he was tried?—I cannot state the Act, but I have no doubt of the fact. I am not sure whether he was sent out of the country; but if he was he has returned, and has a colliery, which I was through very recently.

937. *Mr. Stephenson.*] There must have been something peculiar in this case which made the thing felony?—I think it is felony if the encroachment has been made wilfully.

938. *Mr. Baird.*] Was it a case of letting off water?—I do not think it was a case of letting off water; if I am correctly informed as to the case, he worked under Wigan Churchyard.

939. *Chairman.*] (To *Mr. Lancaster.*) Is *Mr. Dickinson* substantially correct?—I heard the case tried, and the colliery owner was sentenced to transportation for seven years.

940. *Mr. Locke.*] Were there any peculiar circumstances connected with that case?—I believe he had been under 21 different properties, and got coal from them without paying.

941. *Mr. Cayley.*] It was made out that he had not been accidentally trespassing, but knowingly stealing coal?—He had been stealing; and I happened to make the remark when he spoke to me afterwards, before he was tried,

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“How could you do such a thing?” and he said, “I did not think I was stealing; I intended to pay for it at some time.”

942. *Chairman.*] (To Mr. *Dickinson.*) You have stated the two points you would insist on as to the mode of inspection, the giving the inspector the power of stopping the mine in cases of extreme danger, and to enforce proper penalties; is there any other point to which you wish to call the attention of the Committee?—There is another; the present Act for the inspection of coal mines refers only to persons employed in or about collieries, and does not apply to the public. A colliery which is worked out, or which is standing, may have many of the shafts belonging to it unfenced, and in a very dangerous state, so far as the public are concerned, and also so far as the workmen of other collieries are concerned, who have to pass over that colliery to get to their work. Cases of that kind are common enough in Staffordshire; and the inspector is not authorised under the present Act to interfere in such a case, he has no more power than another person.

943. You would give the inspector power to order these pits to be properly fenced round, that the public should be protected from accident, and also give him the power of enforcing a penalty if his orders were not provided for?—Yes, the fencing of the pits is one of the regulations which I have laid down in the code which I think ought to be carried out in every case; and I think that in cases of that kind the Act ought to apply to the public, as well as to the persons employed in and about a colliery.

944. Mr. *Locke.*] Would you limit that to pits only, or extend it to stone quarries and various other things that exist, equally dangerous in all parts of the country?—It would be desirable to extend it to pits of all descriptions; as we were speaking now of coal mines only, I have limited it to that.

945. Suppose a limit were given to coal mines, do you see why the coal pit should be fenced off, and other things, such as stone quarries, should not be fenced off?—I think they should all be fenced. If you have seen the Staffordshire pits, you will know that there are many footpaths passing close to an open pit without any fencing about it, and every person who tumbles into these old pits is not known. There was one case, when I had the charge of the Staffordshire district, of a skeleton being pulled out of a pit, and there was great uncertainty as to whose remains it was.

946. *Chairman.*] Pits are much more dangerous than quarries?—Pits are much more dangerous.

947. Grass could grow over a pit so that a man could not see what it was?—Yes; unfenced pits are the greatest evils in Denbighshire; I succeeded in getting 84 pits filled up or fenced in one colliery alone.

948. When accidents occur, the proprietor of the mine, by the present Act of Parliament, is obliged to send notice of that accident to the Secretary of State?—Yes; every life which is lost must be so reported within 24 hours after the occurrence of the death.

949. Then the Secretary of State communicates with the inspector of the district?—That is the way in which we receive information of it.

950. Would it be an improvement or not if the notice were sent direct to the inspector, at the same time as the one was sent to the Secretary of State?—It would save time if such an arrangement were come to, and would add very little trouble to the colliery proprietors. It is very desirable it should be done.

951. Would the time thus saved be of material importance?—In some cases it would; it would enable us to attend some inquests, which now there is not time to attend.

952. Mr. *Locke.*] Give a case where you have not been able to attend an inquest, in consequence of the delay arising from the transmission of orders from the Secretary of State?—In one instance the coroner administered a lecture on my absence, and also attributed neglect to the Government in not having sent down an inspector, when that inquest was being held, before it was possible for me to have received notice of the accident; and the inquest was finished before I received any notice whatever of it.

953. Mr. *Fitzroy.*] Is not the inquest usually adjourned, for the purpose of your attendance, if you are not present at the first commencement of it?—As a general rule it is; but if 48 hours have elapsed, the coroner is not bound to adjourn it, and in some cases he does not.

954. Mr.

954. *Mr. Locke.*] In a case of so much importance, is it not desirable that it should be adjourned?—It is very desirable it should. *J. Dickinson, Esq.*

955. Do you not think that would be a better mode of eliciting the truth, giving sufficient time for the inquiry, rather than it should be hurriedly proceeded with; and that instructions should be sent directly from the owner of the pit to the inspector?—It very often is a very great advantage to the inspector to be early at the scene of the accident, as he is able to see the circumstances exactly as they were at the time of the accident; whereas, if two or three days elapse (which do elapse under the present system) the circumstances under which the accident happened may have been very much altered.

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956. That is one of the circumstances which would justify you in giving that recommendation, whatever other inconveniences there may be, in the order not passing through the Secretary of State's Office?—It is; but I would still have a notice to pass through the Secretary of State's Office, in the usual way.

957. *Chairman.*] Can you conceive any inconvenience from adopting such a plan?—Not any; indeed in some cases it is done now.

958. You, in conjunction with Mr. Dunn, Mr. Mackworth, and Mr. Wynne, made some experiments with reference to the steam-jet and furnace power, at Seaton Delaval Colliery?—I did.

959. When was that?—On the 15th and 16th December last.

960. Did you go in consequence of any order by the Secretary of State?—No, we had no order from the Secretary of State; but Mr. Wood was at that time making some very extensive experiments at Hetton and Killingworth; those experiments which he undertook to make in his evidence of 1852; and we went down with the view of seeing them, and also with a view of seeing the experiments which Mr. Forster also undertook to make at South Hetton, as a check upon Mr. Wood's; and being in the neighbourhood, we were naturally anxious to see Seaton Delaval, which had been put forward in two Parliamentary Committees as the chef-d'œuvre of steam-jet ventilation.

961. Mr. Forster is the manager of Seaton Delaval?—The manager and viewer.

962. Did you apprise Mr. Forster of your intention of going there?—We did. Mr. Dunn wished us to write a general letter; we said, "You are the inspector of the district, and the letter had better go in your name." The letter was accordingly sent, requesting permission to visit Seaton Delaval and South Hetton. We were informed in reply that the arrangements at South Hetton were not completed; and it was stated that as there was such a prejudice against the steam-jet, Mr. Forster would very much prefer if we would postpone our visit to Seaton Delaval Colliery until he was able to accompany us himself, being laid up at the time from an accident.

963. Did you in consequence postpone your visit?—We discussed his answer over; and we thought as we were all then present, and it would not be convenient for us all to meet there again without very great loss of time, and as in these northern collieries there is always an intelligent resident viewer as well as a principal viewer, and as we went there without any bias whatever, but simply with the intention of testing the facts with respect to the ventilation, therefore we wrote a second letter to him.

964. When you visited Seaton Delaval Mr. Forster was not present?—No.

965. You were accompanied by the resident viewer?—Yes, and also by the overman, and also the predecessor of either Mr. Forster or Mr. Lamb.

966. Did you make any experiments on the ventilation of the steam-jet?—We did.

967. State the results of those experiments?—This is the report which we made on it.

968. *Mr. Fitzroy.*] Was this the first experiment you had ever been present at of the steam-jet?—No, it was not; I had been present at other experiments of the steam-jet in other collieries.

969. *Mr. Cayley.*] Where had you seen it?—At the Wardley pits, in the Worsley Colliery, in Lancashire, where 90 steam-jets were tried first at five yards from the top, and afterwards lower down. I had also seen it in operation at the Duffryn Colliery, and at other places; I think the first application I had ever seen of it was at the Dowlais Colliery.

970. *Chairman.*] At Seaton Delaval it was applied in a superior manner, and in an improved manner to the others you had seen?—It was.

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971. State to the Committee the result of your experiments?—I may state this: that the Seaton Delaval application of the steam-jet is not one of the best I have seen; I think the jets, as recently applied by Mr. Darlington, at Ingham Hall, are done in a superior manner to Seaton Delaval.

972. Have you in your hand the report of those experiments?—This is the report of the Seaton Delaval experiments.

973. Which way was the steam-jet applied at Seaton Delaval?—It is all set forth in the report.

974. Mr. Locke.] What was the depth of the main shaft at Seaton Delaval?—The colliery is ventilated by four down-cast shafts and one up-cast shaft, each eight feet in diameter, and 212 yards in depth.

975. What is the average distance from the four down-cast shafts to the up-cast shaft?—They are all in a group together.

976. Chairman.] How many splits of air are there?—Three main splits.

977. Mr. Locke.] What is the distance that the air has to travel underground from the down-cast shaft to the up-cast?—The longest split is seven thousand six hundred and fifty yards.

978. I should still like to know what the distance was between the two shafts; you have given us the course of the air; what is the absolute distance between the two shafts?—We did not measure it, but I should think about 100 yards.

979. Chairman.] What is the ventilating power at Seaton Delaval?—Four boiler-fires, 33 steam-jets, and the discharged steam from an underground engine, and a gas apparatus, of which five retorts are kept at work, all placed near the bottom of the up-cast shaft.

980. In addition to the steam-jet, these boiler fires tend to the rarefaction of the air in the shaft?—No doubt of it.

981. Describe the operation of the steam-jet?—I think it acts partly by propulsion, and partly by rarefaction.

982. Where is the steam-jet placed at Seaton Delaval?—Close to the bottom of the up-cast pit.

983. Mr. H. A. Bruce.] There are a great number of steam-jets; are they all in the same place?—They are placed on radial arms.

984. All at the bottom of the pit?—All at the bottom of the pit.

985. Mr. Locke.] When you said, placed at the bottom of the pit, how far from the floor of the mine, or from the roof of the mine?—It may be about 20 feet above the roof. I did not measure that, but I should suppose about 20 feet.

986. Chairman.] In the pit?—Yes.

987. State to the Committee the experiments that you made, and the greatest velocity of air you obtained?—I may state that we took our measurements twice. Finding those of the first day differ so very materially from those which had been put forward by Mr. Forster and others, we determined to repeat them the following day. We did so, and with numerous checks. We measured the air twice in the up-cast pit, both which measurements correspond very nearly together. We also measured the air twice over in the different splits, and all these different measurements agreed very closely together. The following is an abstract: "Total air going into the workings, with the 33 steam-jets, 4 boiler fires, and gas apparatus at work: temperature of up-cast, 130°; temperature of down-cast, 42°; difference of temperature between down-cast and up-cast, 88°. Water-gauge, $1\frac{51}{100}$ inches. Barometer, 28½ inches; 33,626 cubic feet of air per minute.—Total air going into the workings without the jets; temperature of the up-cast shaft 120°; temperature of down-cast, 45°; difference of temperature of up-cast and down-cast, 75°; 29,999 cubic feet of air per minute.—Increase by jets and an increase of 13° of temperature between the up-cast and down-cast on the 16th of December, 3,627 cubic feet of air per minute.—Increase by jets on the 15th of December, 3,474 cubic feet of air per minute.—Increase of water gauge by jets and temperature 16th of December, $1\frac{51}{100}$ — $1\frac{21}{100}$ = $\frac{30}{100}$ inch. Amount of air obtained per lb. of coals consumed by the boiler fires and gas apparatus, 1,372 cubic feet."

988. At what part of the up-cast was the temperature measured?—At 30 yards.

989. Mr. Stephenson.] From the surface?—Yes.

990. Did you not take the temperature down at the bottom also?—We did not;

not; we could not well get it; in the middle of the shaft is the proper place to take the temperature. You cannot do that without a registering thermometer; and they are all so liable to get out of order, that we preferred taking it near the top.

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991. Have you based any calculation of the quantity of air that would be discharged by the up-cast on that data?—We have not.

992. You have made no use of them, but merely as the records of the fact?—Merely as a comparison of temperatures; all the temperatures being taken at the same depth in the shaft.

993. *Chairman.*] Is that the report that you have in your hand?—It is.

[*The Witness delivered in the following Report:*]

THE colliery is ventilated by four down-cast shafts and one up-cast shaft, each eight feet in diameter and 212 yards in depth.

There are three main splits of air.

The engine plane split is 7,650 yards in length; average of smallest area, 80 square feet, at one point, through a whin dyke, the area being 45 feet. It is subdivided at the furthest part of the course, and before reaching a fall of roof, which had taken place about the 22d of November, and which was examined at the time of the experiments, and found to offer no appreciable obstruction to the free passage of air: a result which also appears by the measurement of air on the 11th of December, as taken by the master wasteman, and entered in the colliery book, which shows a partial increase.

The Victoria split is 4,400 yards in length; average area, 80 square feet, and it passes through regulators.

The boiler-fires split is 100 yards in length, and passes through a regulator 2½ square feet area.

The ventilating power consists of four boiler fires, 33 steam-jets, the discharged steam from an engine, and a gas apparatus, of which five retorts are kept at work, all placed near the bottom of the up-cast shaft.

Two of the boilers are each 25 feet long, six feet diameter, spherical ends, wheel flues; the other two are each 32 feet long by five feet diameter, spherical ends; fire surface, five feet by four feet, wheel flues.

The boiler bottoms are about four feet above the fire-bars.

The four boilers are connected, and work an underground engine of 27-inch cylinder and five feet stroke; nominal power, of 60 horses.

Two drifts of 80 square feet area discharge the products of combustion and the return air into the shaft, in one of which is the exhaust-pipe, seven inches in diameter.

When the engine is not at work, the boiler-fires split is partially closed, and the fires slacked. The jets are at work night and day.

The stated consumption of fuel for the four boiler-fires and five gas retorts is at the rate of 42 tubs of 7½ cwt. each per day; pressure of steam, 35 lbs. per square inch. Besides the engineer, one man and two boys are employed at the boiler-fires in the day, and one man at night. There are 33 steam-jets, without tubes or cylinders, placed in eight radial arms, four in each arm, and one in the centre; they are ⅜ inch in diameter, and 205 yards from the top of the shaft.

ABSTRACT of the Amount of Ventilation as taken from the Colliery Book.

	Engine Plane.	Victoria.	Engines.	TOTAL.
1851:	<i>Cubic Feet.</i>	<i>Cubic Feet.</i>	<i>Cubic Feet.</i>	<i>Cubic Feet.</i>
25 November - -	38,571	15,428	18,000	71,999
30 November - -	38,571	16,615	18,000	73,186
1852:				
15 April - - -	44,274	7,290	18,000	69,564
29 June - - -	45,818	9,317	18,000	73,135
30 October - -	45,818	12,480	19,636	77,934
11 December - -	45,818	14,400	20,000	80,218

The fourth boiler has been at work for about five weeks.

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FIRST EXPERIMENT, 16th of December.

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Present, Messrs. Dund, Dickinson, Mackworth, Wynne (inspectors); Lamb, resident viewer; Robinson, master wasteman; and overmen, &c.; with steam-jets, four boiler fires, and five retorts at work.

AMOUNT of Ventilation taken in the Three Splits, with Three Anemometers, simultaneously.

	Velocity, per Minute, in Feet.	Area, in Feet.	Cubic Feet of Air per Minute.
Engine Plane Split - - - -	196	72	14,112
Victoria - ditto - - - -	150	54	8,100
TOTAL Air going into the Workings - -			22,212

The above measurements corrected for the friction of the anemometers :

	Velocity.	Friction, in Feet.	Area.	Cubic Feet of Air per Minute.
Engine Plane Split - - - -	(196 + 38)		72	16,848
Victoria - ditto - - - -	(150 + 98)		54	13,392
TOTAL Air going into the workings - -				30,240

	Velocity.	Area, in Feet.	
Boiler Fires Split - - - -	3,721	2 $\frac{1}{2}$	8,682
TOTAL Air going through the Shafts - -			38,922

Water-gauge in drift, 880 yards long ; between bottom of up-cast and down-cast shafts, $1 \frac{50}{100}$ inches.

SECOND EXPERIMENT, 15th of December, without the Steam-jets.

The Jets were shut off at 12 h. 49 m. Experiment at 2 P. M. Correcting as before for the friction of the anemometers.

	Velocity.	Friction.	Area.	Cubic Feet of Air per Minute.
Engine Plane Split - - - -	(172 + 34)		72	14,832
Victoria - ditto - - - -	(125 + 98)		54	11,934
TOTAL Air going into the Workings - -				26,766
Boiler Fires Split - - - -	(116 + 95)		58	12,238
TOTAL Air going through the Shafts - -				39,004
				Cubic Feet of Air per Minute.
TOTAL Air going through the Workings } with the Steam-jets at work - - }				30,240
TOTAL Air going through the Workings } without the Jets - - - }				26,766
INCREASE by the Jets - - -				3,474

Water-gauge

Water-gauge at 2 h. 0 m., $1\frac{7}{100}$ inches; increase of water-gauge by the jets, $1\frac{50}{100}$ — $1\frac{36}{100}$ = $\frac{14}{100}$ inch. J. Dickinson, Esq.

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Temperature of down-cast air, 47°.

Mean temperature of the air in the mine, where the experiments were taken, 55°.

Simpiesometer, $29\frac{78}{100}$ inches.

The thermometer in the up-cast fell down the shaft before any observations were taken.

16th of December.—Present, the same persons as on the 15th.

FIRST EXPERIMENT.

Air measured with one anemometer in the up-cast shaft, at 10 yards from the top.

Velocity, $1,008\frac{1}{2}$ feet per minute, $\times 50\frac{1}{2}$ square feet area, = 50,669 cubic feet per minute.

Barometer at $28\frac{1}{2}$ inches.

Temperature of downcast air	- - - - -	42°	
Ditto - of up-cast shaft, at 30 yards below the top	- - - - -		130°
Average temperature of the air in the mine when the experiments were taken			50°
Difference of temperature	- - - - -		80°

Allowing $\frac{1}{180}$ for expansion of air, for a degree of heat at 32° gives $130^\circ - 32^\circ = 98^\circ$, and $50^\circ - 32^\circ = 18^\circ$; then $480 + 98^\circ: 480 + 18^\circ = 50,669$ cubic feet: 43,656 cubic feet.

43,656 cubic feet is the volume of air in the mine, at a temperature of 50°, obtained from the measurement in the up-cast shaft, no allowance being made for the friction of the anemometer.

SECOND EXPERIMENT, 16th of December.

With steam-jets, 4 boiler fires, and 5 gas retorts at work.

Taken simultaneously in the 3 splits, with 3 anemometers, at 12 h. 30 m., p. m., and corrected, as before, for the friction of the anemometers.

	Velocity.	Feet, Friction.			
Engine Plane Split	-	-	(297 + 5)	×	67 = 20,234
Victoria ditto	-	-	(150 + 98)	×	54 = 13,392
TOTAL Air going into the Workings			-	-	33,626
Boiler fires split, 207 × 58, taken by the colliery anemometer,					
which shows too high a velocity for air					
	-	-	-	-	12,006
TOTAL Air going through the Shafts			-	-	45,632
Temperature of up-cast	-	-	-	-	130°
Ditto - of downcast	-	-	-	-	42°
Difference					88°

Water-gauge, $1\frac{41}{100}$ inch, at 12 h. 30 m. p. m.

	Cubic Feet.
Total air, in 3 splits, as above, at 50°	45,632
Air in up-cast, corrected to 50°, as per preceding experiment	43,656
Difference between this measurement and the preceding one	1,976

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THIRD EXPERIMENT, 16th of December.

With steam jets, 4 boiler fires, and 5 gas retorts at work.
Measurements taken by the agents of the colliery, in the presence of the inspectors, with powder smoke, on walled headings, 60 feet long, at 3 p. m.

	Feet, per Minute.	Area in Feet.	Cubic Feet.
Engine Plane Split - - - -	400	× 67	= 26,800
Victoria ditto - - - -	257	× 52	= 13,364
TOTAL Air going into the Workings - -			40,164

Measurements taken at the same time with the anemometer gave—

	Velocity.	Friction in Feet.		
Engine Plane Split - - -	(390 + 5)	× 67	=	26,465
Victoria - ditto - - -	(245 + 5)	× 52	=	13,000
TOTAL Air going into the Workings - - -				39,465

The trial by powder smoke gave therefore a higher result by 699 cubic feet per minute. The measurements by powder smoke were taken at separate times, and the boiler-fires split did not admit of being measured with powder smoke. It is evident that at the times these measurements were taken the air was distributed in a different manner. The measurements afford, however, a means of calculating the ventilation which would have been indicated by powder smoke if it had been applied at the several splits simultaneously.

	Amount of Air by Anemometer.	Amount of Air by Powder Smoke.	Amount by Anemometers. Simultaneous Observation.	Amount of Air which would have been shown by Powder Smoke, had the splits been mea- sured simultaneously.
Engine Plane - - -	26,465	: 26,800	:: 20,234	: 20,490
Victoria - - -	13,000	: 13,364	:: 13,392	: 13,766
TOTAL Air going into the Workings, if taken simultaneously by powder smoke - - -				34,256 { Cubic Feet.
Boiler Fire Split, adding } the first two ratios - }	39,465	: 40,164	= 12,006	: 12,210
TOTAL Air passing through the shafts, if taken simultaneously by powder smoke - - -				46,466 { Cubic Feet.

FOURTH EXPERIMENT, 16th of December.

Without the steam-jets. The jets were stopped at 4h. 30m. p.m., the opening for the split to the boiler fires being nearly closed, the engine stopped working, and the boiler fires checked. The measurements were taken simultaneously with three anemometers at 6h. 30m. p.m., corrected for the friction of the anemometers as before.

	Velocity.	Friction, Feet.	Area in Feet.	Cubic Feet per Minute.
Engine Plane Split - - -	(261 + 5)	× 67	=	17,822
Victoria - ditto - - -	(128½ + 97)	× 54	=	12,177
TOTAL Air going into the Workings - - -				29,999
Boiler fires split - - -	-	51 × 58	=	2,958
TOTAL Air passing through the Shafts - - -				32,957
Water-gauge, 1 ³¹ / ₁₀₀ inches.				
Temperature of Up-cast Shaft - - -	-	-	-	120°
Ditto - - Downcast - - -	-	-	-	45°
Difference - - -				75°

COALS USED.

Quantity stated by the resident viewer at 35 tubs in 24 hours for 3 boilers and the gas retorts, the coke from the retorts being used in the boiler fires, and one-fifth more for the fourth boiler, viz., 42 tubs :

42 tubs each 7½ cwt. = 35,280 lbs. per 24 hours, or 24½ lbs. per minute.

With the Jets on, Cubic Feet of Air passing through the Shafts per Minute.	Lbs. of Coals.	
45,632	24½	= 1,862 cubic feet of air per lb. of coals.

With the Jets on, Cubic Feet of Air going into the Workings per Minute.	Lbs. of Coals.	
33,626	24½	= 1,372 cubic feet of air per lb. of coals.

But as the consumption of coals is much above the average when the jets are on, and the engine working, the actual economy of ventilation is much below this.

Allowing 300 cubic feet of air as the quantity usually employed for the combustion of 1 lb. of coals, 24½ lbs. × 300 cubic feet = 7,350 cubic feet, the quantity taken from the boiler fires split to feed the fires. It is evident that in the last experiment made without the jets that the boiler fires, with a split of only 2,958 cubic feet of air must have been very low.

Assuming each boiler at 30-horse power, 3,400 cubic feet of steam must have been given off per minute at atmospheric pressure.

In conclusion, we beg to present the following summary of the ventilation of the Seaton Delaval Colliery :

	Cubic Feet of Air per Minute.
Total air going into the workings with the 33 steam jets, 4 boiler fires, and gas apparatus at work. Temperature of up-cast, 130°; temperature of down-cast, 42°; difference of temperature between down-cast and up-cast, 88°. Water gauge, 1 ⁴¹ / ₁₀₀ inches. Barometer, 28½ inches	33,626
Total air going into the workings without the jets; temperature of the up-cast shaft, 120°; temperature of down-cast, 45°; difference of temperature of up-cast and down-cast, 75°	29,999
Increase by jets and an increase of 13° of temperature between the up-cast and down-cast on the 16th of December	3,627
Increase by jets on the 15th of December	3,474
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Increase of water gauge by jets and temperature 16th of December, 1 ⁴¹ / ₁₀₀ — 1 ²⁴ / ₁₀₀ = ¹⁷ / ₁₀₀ inch.	
Amount of air obtained per lb. of coals consumed by the boiler fires and gas apparatus	1,372

994. Mr. Locke.] What was the amount of air passing through the mine?—33,626 cubic feet per minute.

995. Chairman.] Under what circumstances?—That was with the jets, with the boiler fires, and the gas apparatus at work.

996. Mr. Locke.] At what temperature was air admitted into the down-cast shafts?—At 42 degrees.

997. And you have not the temperature of the air as it passed over the jets, but you have it within 30 yards of the top of the pit?—It was there 130 degrees.

998. Where did you measure the current of air, in order to ascertain that quantity?—In the workings. I measured the large intake as the air was going into the mine, about half a mile from the shaft.

999. What do you mean by the large intake?—The principal split of air before it is distributed. We took the temperature of the different splits as measured.

1000. In this mine-way you would have the combined quantities of the four down-cast shafts?—Yes; four down-casts.

1001. All concentrated in that mine drift-way?—Yes; but there were other

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two splits, in addition to this one, all of which received a portion of the air from those down-cast pits.

1002. This way you speak of was not the only one?—No, it was not the only one; it was the main split.

1003. You took the velocity in that air-way and in the other air-ways coming from the four down-cast pits?—Yes.

1004. Was there any material variation in the temperature of the air in that distance?—There was no material variation.

1005. Did you take the temperature there when you took the velocity?—Yes; we took the temperatures there also.

1006. You took the temperature, from which you made your calculation, at the spot?—Yes.

1007. Shall we find in that report the mean of all these three drift-ways, and the velocities from which you deduced the quantity of air passing through the mine?—Yes; all these particulars are given, and the friction of the anemometers is also shown.

1008. How do they work the mine at Seaton Delaval, is it pillar and stall, or long work?—It is pillar and stall; the ordinary work of the north of England.

1009. Are there many stoppings or traps in that mine; in 7,000 yards, for instance?—There are a large number of stoppings.

1010. Is it one of those pits where you will find, on an average, that there is as much friction and resistance to the passage of air as in ordinary cases?—Yes; I should consider it an ordinary sample.

1011. *Mr. Stephenson.*] Of the pillar and stall?—Yes.

1012. Is there more friction in the pillar and stall way of working, than in the long way of working?—Yes; I stated that fully at the commencement of my evidence; I am now speaking of pillar and stall collieries.

1013. *Mr. Locke.*] In drawing a comparison with any other system of ventilation, it should be borne in mind that the friction and resistance, being the matter to be overcome, is the question to be taken into consideration in estimating the value of the means employed?—No doubt of it.

1014. *Chairman.*] How did you ascertain the exact value of the steam-jet in your experiments, because in your report you seem to have had the steam-jet, four boiler fires, and five retorts at work at the same time?—We next stopped the jets to ascertain what amount there was without them.

1015. *Mr. Locke.*] Before you leave the jets, what was the elasticity of the steam as applied to the jets during the operation; during the time you were measuring the quantity of air, what was the pressure on the valve?—These are all set forth fully in the report; 35 lbs. to the inch.

1016. Was all the steam passing off into the steam-jets that was generated in those four boilers?—The four boilers were used to work the under-ground engine.

1017. Were the four boilers connected simply with the steam-jet, or was the steam from them used for any other purpose?—It was used for working an under-ground engine also.

1018. Could you give any notion as to what quantity of the steam was abstracted from the boilers for the use of the engine, and that which passed off to the jet?—I have not gone into the question to separate it.

1019. *Chairman.*] The discharged steam from the engine passes up the pit?—The discharged steam did; it was discharged into the returned air drift, and went up the pit with the returned air.

1020. *Mr. Locke.*] Was there any steam passing into jets other than that coming from the engine?—The jets were fed from the boilers direct.

1021. As well as from the issues of steam coming from the engine?—The jets were not at all fed by the steam from the engine.

1022. Have you made any dissection of the quantity of air that has passed up, to see what was due to the steam-jet, and what was due to other causes, namely, furnaces, and the issuing of steam from the engine?—In the second day's experiments the increase with the jets and 13° of temperature was 3,627 cubic feet per minute. On the former day the increase was 3,474 cubic feet, but in consequence of the thermometer being dropped down the pit the temperature was not ascertained.

1023. *Mr.*

1023. Mr. *Stephenson*.] Under the same circumstances?—The measurements were taken under the same circumstances. *J. Dickinson, Esq.*

1024. *Chairman*.] Did you try any experiment of putting out the retorts, stopping the engine, and applying only the boilers to supply the steam-jet?—We did not; it would have been impossible to have worked the steam-jet without having the fire under the boilers. *21 June 1853.*

1025. Having the fires under the boilers and stopping the engine, and putting out the gas retorts?—We did not.

1026. Mr. *Locke*.] In point of fact, so far as a simple steam-jet is concerned, you did not try that experiment?—We did not try that experiment.

1027. *Chairman*.] Do you not think, having all these powers at work, this engine pumping steam up the up-cast shaft, the rarefaction of the air caused by the boiler fires and the retorts would not create a certain current of air, that would prevent the power of the steam-jet in aid of it being fairly tested?—The first quantity of air we ascertained, is the quantity of air with the steam-jet and these united powers at work; the second quantity is with these united powers at work, without the steam-jet; and the difference between the two is the increase which is due to the steam-jet.

1028. Mr. *Locke*.] From your figures, what was that?—In one case it was 3,627 cubic feet, and in the other 3,474 cubic feet, per minute.

1029. Upon an aggregate of upwards of 30,000?—Yes.

1030. You make the deduction from that experiment, that the jets were, in the proportion to the others, as 1 to 10 in ventilating power?—That was about the increase that the jets gave to the ventilation; but there was a material difference in the temperature of the up-cast also, which in itself might account for a considerable proportion of the increase.

1031. Might not that have arisen from the steam-jets themselves?—Partly from the steam-jets, and partly from a larger supply of fresh air being sent to the boiler fires when the jets were in work, which caused a more perfect combustion of the fuel, and raised the temperature of the up-cast shaft.

1032. When there was a large quantity of air passing to the furnace fires, was it in consequence of the steam-jet?—Partly in consequence of the steam-jets, and partly in consequence of more steam being required when the engine was at work. With the engine standing, it was necessary to shut the dampers.

1033. Do you know any other cause for raising the temperature in the up-cast shaft excepting the use of the steam-jets in the experiments you tried?—Yes; I think, in addition to the temperature which would be obtained from the steam coming out of the jets, that there would be a larger quantity of air passing through the boiler fires, which would have the effect of creating a more perfect combustion of coal, and of increasing the temperature of the up-cast shaft.

1034. You do not think that that increased quantity of air passing through the fires was due to the abstraction of steam by the use of the jet?—Not to that alone.

1035. Was it to any part?—Yes.

1036. Was it to a chief part, or to a small part, in your opinion?—I should not like to venture an opinion as to what proportion, I think it partly due to both.

1037. Mr. *Stephenson*.] When you have no steam-jet working, you shut the dampers of the boilers, do you not?—Yes; the dampers or the slide that regulates the supply of air to the boiler was closed, or partly so, when a large supply of steam was not required.

1038. When you put on the steam-jet you then had an increase of ventilation as a consequence?—Yes.

1039. But, in order to put on the steam-jet, you must consume two or three times the quantity of fuel under the boiler that you were consuming previously to putting the steam-jet on?—No doubt, with more air to the boiler fires, the consumption of coal is going on more rapidly and more perfectly.

1040. The increase of ventilation that took place when you put the steam-jet on, was the joint effort of the steam-jet, plus the coal consumed under the boilers?—Yes; and also the more perfect combustion of the coal, which is most important. In the Seaton Delaval up-cast the cloud of black smoke that rolls out of the top is only half consumed.

1041. In your report, the increase of ventilation which took place when the
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steam-jet was turned on, would not be really the true representation of the increase due to the steam-jet?—No, it was due to the steam-jet, and to the increased temperature of 13 degrees.

1042. And to the large additional consumption of fuel under the boiler?—Yes.

1043. Therefore it was a joint effort; the increased size of the furnaces and the steam-jet?—Yes; it was due to the steam-jet, and also to an increased consumption of coal, and also to a more perfect combustion of coal.

1044. That would still leave the effect of the steam-jet less than apparently the report?—Yes.

1045. Did you measure the quantity of fuel that was being consumed under the boilers with the steam-jet at work, and without the steam-jet being at work?—We did not measure it.

1046. *Mr. Baird.*] You say you got 3,400 feet of additional current by the steam-jet, do you think any of that was carried by the propelling power of the steam, or was it entirely owing to the increased temperature of the up-shaft?—I think some of it was due to propulsion.

1047. Even so far down as that?—Yes.

1048. What portion?—I should not like to venture to separate those quantities; I should prefer not giving an opinion on it. The amount is so small as to be scarcely worth separating.

1049. *Mr. Locke.*] Have you formed any opinion as to what quantity of air would have passed up that shaft if you had employed the four boilers and the steam-jets only?—There are only the gas retorts in addition.

1050. And occasionally the steam-engine?—Yes; occasionally the discharged steam from the steam-engine. I think that, with one of these boiler fires, and a liberal supply of fresh air to it, and no steam whatever, I would undertake to send as much air up the pit as is now going by the entire powers that were at work.

1051. You were understood to have formed this opinion, that you could by means of those boilers, and by the rarefaction of the air passing from them, send more air up that pit than is now being sent up by those means, even with the additional use of the steam-jets?—I think I could; with those four boiler fires, and with a more liberal supply of fresh air to the boiler fires, I would materially increase the temperature in the up-cast pit, and draw more air through the workings.

1052. That you say, notwithstanding the experiments you have made, which show an increase of 10 per cent. by the use of the jets in the shaft?—Yes; but I should not recommend doing that with boiler fires, because by sending so much air to the fires you would burn your grates and boilers out.

1053. You think the proper mode of doing it would be to use the steam-jet as an auxiliary?—No; the proper way would be to put one eight-foot furnace at the bottom of the up-cast shaft, which would give more air than the whole of the powers now at work. I think one eight-foot furnace, properly constructed at the bottom of the up-cast shaft, would give more air than the whole of the powers now at work, and with a very much smaller consumption of fuel.

1054. *Mr. Stephenson.*] How far is the steam-engine from the bottom of the shaft?—It is not very far.

1055. Is it 50 yards?—Perhaps 50 yards.

1056. Then the steam is delivered from the engine after having performed its duties there, and does not come into the shaft?—It comes into the drift, and then into the shaft.

1057. Therefore, there is no additional power obtained from the exhausted steam of the engine?—I do not think there is much, if any additional power obtained from the exhausted steam of the engine, because in the split of air which I measured several times when the engine was running, and several times when it was standing, there was scarcely a perceptible difference in the quantities.

1058. *Chairman.*] Is there no additional velocity due to the waste steam from the engine?—Very little. There is a long train of about 100 waggons, which might retard or assist the current much more than the discharged steam.

1059. *Mr. Locke.*] In your report it is stated that there was a pressure of steam of 35 lbs. to the inch, at the boiler; during the time these experiments were made, was the engine at work or not?—Yes, the engine was at work; it

was

was at work at intervals, and standing at intervals; but it made no material difference in the quantities of air circulating through the different splits. *J. Dickinson, Esq.*

1060. Did it make any material difference in the pressure of the steam itself, and the boilers, as applied to the jets?—I think not, with four large boilers at work. *21 June 1873.*

1061. Would the same quantity of steam be passing to the jets whether the engine was at work or not?—I should think the four boiler fires are adequate to the jets and the engine.

1062. And therefore you give it as your opinion that the pressure on the valve would be the same, and the elastic force of the jet would be the same, whether the engine was at work or not?—Yes; I think there would not be any material difference with such a supply of boiler power, and considering that the supply of air to the boiler fires was regulated to the quantity of steam required.

1063. *Mr. Cayley.*] Is it your opinion that high pressure steam would produce a power proportionate to the height compression, or elastic force of the steam?—In the experiments which I have made with steam-jets, it appears to me, the higher the pressure of the steam the greater the amount of propulsion obtained by it.

1064. You have stated, in this case at Seaton Delaval, there was only a pressure of 35 pounds to the inch?—Yes; all these things are stated in the report.

1065. Could you not have used a greater pressure if it was necessary?—I do not know whether we could or not. It was not stated to me whether it could be done or not; we took the usual pressure.

1066. Are not cylinders often worked with 100 pounds pressure to the inch?—We made our experiments under the ordinary circumstances in which the colliery was worked; we asked for no alteration; and I am not aware that any was made.

1067. In what way did the men connected with the mine assist you in your experiments?—There was one of the under-managers with each of us at the different splits where we took the measurements.

1068. Were they cognisant of all the instruments you used, and the mode in which you tested those experiments?—No, they were not; but we explained the use of them to them. They had an anemometer at the colliery, but did not know how to use it. They were not in the habit of measuring the air with the anemometer. I believe the air had never been measured before by the anemometer; it had always been measured by powder smoke, which is a very rough way, and liable to lead to very erroneous conclusions.

1069. *Mr. Forster*, last year, in his evidence, stated that he preferred the powder smoke to the anemometer?—I think he did; but the master-wasteman, *Mr. Robinson*, informed us during these experiments that he had been in the habit of taking all the measurements formerly. He also stated that he had supplied those measurements to *Mr. Mather* and *Dr. Fife*, when they visited the colliery.

1070. At what time of day did you make the experiments?—The hours are stated in the report, and all the measurements were taken simultaneously; therefore if one split had an increase of air, the other might have a decrease.

1071. When did you test these; did you make your experiments in the morning and your calculations in the evening?—We each of us measured one split, and made our own calculations in the morning, and in the evening we put all the calculations together into one total.

1072. Did you compare the materials on which you formed your conclusions before the men connected with the mine, before you drew your conclusions?—What materials?

1073. Whatever you formed your opinion on; the results of your experiments, the facts?—The underlookers and the resident agents were not with us at the time we made up the total result; but we furnished each of them with the quantities of the respective splits, as they were measured, and they had an opportunity of putting them together, and forming a total. *Mr. Lamb*, the resident viewer, was with me in the split which I was measuring, and he was taking down the quantities at the same time as I was taking them down myself.

1074. Did he assent to the truth of the facts you assumed, that the measurement was correct?—He did; and he also informed me that he had never before measured the Seaton Delaval air himself.

1075. You stated that you had two calculations; the calculations you made
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in the evening of the first day were not satisfactory, and you made some calculations on the second day?—In making out the total of the air going through the workings, it fell so far short of the total quantity of air which had been represented as passing through the Seaton Delaval Colliery, that we thought it better to repeat the experiments than to have the slightest doubt hanging over the question.

1076. Are we to understand that you repeated both the experiments and the calculations on the second day?—We did; and in addition to repeating the experiment a second time, we measured the total quantities of air at two different times in the up-cast shaft, both of which measurements agreed very closely with each other; and on deducting from those quantities the amount due to increased temperature, the amount agreed very closely with the quantities obtained from the measurements of the different splits.

1077. Then the result of your investigation is an opinion that the steam-jet can only operate as a power to the extent of 3,600 cubic feet per minute?—That is, the steam-jet with the additional temperature of the up-cast shaft, caused by the increased combustion of coal and the more perfect combustion.

1078. Do you attribute to the steam-jet a ventilating power only of 3,600 out of the 30,000?—I do not attribute that much to it.

1079. Is it your opinion that the steam-jet, as a ventilating power, is incapable of producing a greater increase of ventilation than that?—I think I have a series of experiments here which show that the steam-jet, with a more perfect combustion under the boiler fires, is capable of being better applied than it is at Seaton Delaval.

1080. Then the evidence that you wish to give is rather against the mode of the application of the steam-jet at Seaton Delaval Pit as to its power as a ventilator?—No; although I have a series of experiments with better results to put in, none of the experiments lead me to the conclusion that the steam-jet is so efficacious or so economical as the furnace.

1081. *Chairman.*] Did you ever make any experiments with the steam-jet alone, aided only by the caloric caused by the boilers which were necessary to generate the steam for the steam-jets?—With the boilers on the surface.

1082. Or below; the steam-jet and the apparatus connected with the steam-jet?—I have.

1083. Have you got the results of those?—I have; I may state that in taking these experiments, I had the assistance of Mr. Wynne, and the pits were standing during the time we made them, and we had every facility afforded to us by Mr. Darlington, the manager.

1084. *Mr. Cayley.*] What would the additional 13 degrees of temperature produce?—I have stated that I am not prepared to separate these quantities.

1085. How does furnace ventilation operate?—By rarefaction.

1086. What is your test of that rarefaction?—The thermometer in the up-cast pit; perfect combustion has also a great deal to do with the efficient working of the furnaces.

1087. What is the best gauge of the ventilating power?—The water-gauge is the test which is commonly used.

1088. What is the greatest extent of the variation of the water-gauge that you have ever known by the furnaces?—I have never seen, myself, two inches exceeded.

1089. You have stated that with the steam-jet, at the Seaton Delaval experiments, there was only the effect of about $1\frac{1}{2}$ inch produced?—With the jets at work, the water-gauge was $1\frac{51}{100}$, and without the jets, and the other matters to which I have alluded, the water-gauge had fallen to $1\frac{21}{100}$, which was a decrease of $\frac{30}{100}$ of an inch.

1090. Is it your opinion that the steam-jet is incapable of producing a greater effect on the water-gauge than $1\frac{1}{2}$ or 2 inches?—It appears that, if the water-gauge is taken very close to the steam-jets, that it has a most extraordinary effect on the water-gauge; but if taken at some distance from it, it has comparatively a very trifling effect.

1091. Do you remember seeing the experiments in the Polytechnic last year with the steam-jet?—Yes.

1092. And its effect on the water-gauge?—I do; that is one of the cases where the water-gauge was tried close to the jet, and in which the steam appears to have a peculiar effect.

1093. What

1093. What effect had that upon the water-gauge?—A very high water-gauge. *J. Dickinson, Esq.*

1094. To the extent of how many feet?—I do not recollect.

1095. Do you not recollect to the extent of 15 feet?—I cannot say; it was very high. There is a very peculiar power about the steam-jet when confined in a cylinder; it seems to concentrate the whole of its force into a particular point, and by that peculiarity and the power, it is able to counteract a very large increase of temperature, if the jet be applied through a small hole against this difference of temperature. I have seen it in a pit where the tops of both shafts have been closed, and only an opening of about a foot or 18 inches square at the top of each pit and the pipe inserted into those holes; one steam-jet blowing down the down-cast and one exhausting the up-cast; and acting in the pipes or cylinders. These two jets, and indeed one of them, proved sufficient to counteract a difference of temperature between the up-cast and down-cast of 103°, and propelled the current in the opposite direction. The quantity of air that was driven against this large balance of temperature was certainly very small, but it was perceptible, so that by concentrating its power the jet appears capable of counteracting temperature. It is like the steam-engine; if you reduce the speed, and work on the second motion, you may lift a greater weight than you could do with a more powerful engine applied on the first motion.

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1096. What has temperature to do with the steam-jet when it is acting only as a propeller?—If it were shown that it acts only as a propeller it would have nothing to do with it; but in my opinion it acts both by propulsion and rarefaction; in this long series of experiments which I will put in, you will see that increased quantities of air have been accompanied by increased temperature in the up-cast shaft.

1097. Is it your opinion that if the steam-jet applies very great propelling power near to the jets, that power will not be communicated to the air next to it, and so onwards up the up-cast?—It is natural to suppose it would; but the air being so elastic, it does not appear to bear it out in practice.

1098. How long after the jets ceased, did you measure the quantity of air which was produced from what you describe as other causes than the steam-jets?—We found that in a very few minutes we got the maximum increase or decrease that takes place. There is no material increase or decrease in the quantity of air circulating through the working after a few minutes have transpired.

1099. No material alteration?—No material alteration; about 10 minutes seems quite sufficient to get the benefit of the full power. In the experiments I have made, I have allowed it to go on for a long time, and have observed that, after about a quarter of an hour, or at the utmost half an hour, there is no material increase or decrease. In this series of experiments, I have put in the exact time the experiments were taken.

1100. *Mr. H. A. Bruce.*] Did you consider the ventilation sufficient in that pit at the rate of about 33,000 feet a minute?—I was not the inspector of that district, therefore I gave no opinion; but considering the large quantity of coal raised, and the number of men at work, I think it must be too small.

1101. Was it susceptible of increase with those fires which they had?—I think a more liberal supply of fresh air to the boiler fires would have given an increase to the quantity of air circulating through the workings, but that is not the mode which I should have recommended for getting an increase. I should have preferred a furnace at the bottom of the up-cast pit.

1102. *Chairman.*] Were the air-ways sufficient to take through them an increased quantity of air?—Yes; if the air-ways were as large as stated by Mr. Forster, they were sufficiently large to take an increased quantity of air; and considering that the drag, as ascertained by the water-gauge, was only about an inch and a half, I think the air-ways must have been capable of allowing a larger quantity of air to be drawn through.

1103. *Mr. Stephenson.*] You have spoken of some experiments you made with the water-gauge when the steam-jet was at work?—Yes.

1104. You also stated that the water-gauge stood at different heights, dependent upon its proximity to the steam-jet or being some distance from it?—The distance at which it is placed appears to make a very important difference with regard to the water-gauge, and in steam-jet experiments I place no reliance on the water-gauge.

1105. Therefore the water-gauge, as applied to the power of ventilation with the

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the steam-jet, is no criterion at all?—So far as my experiments have gone, they have led me to that conclusion.

1106. But you think the water-gauge is a fair criterion of the ventilating power of a shaft when heated by a furnace?—It seems a more certain criterion when heated by a furnace, but I am not quite clear whether the water-gauge is an accurate indication even for rarefaction alone.

1107. You preferred the anemometer rather than depend on the theoretical calculation of the water-gauge?—Yes.

1108. *Chairman.*] Did you make any other experiments in conjunction with any other inspector, with respect to the ventilation by steam-jet?—I have, at Ince Hall; Mr. Wynne assisted me throughout.

1109. Will you put in the result of those experiments?—Yes; I have two series of experiments made at the cannel coal pits of the Ince Hall Coal and Cannel Company:—“First, with regard to the experiments at the cannel pits. The ordinary ventilating arrangements consist of a furnace six feet across the bars; also two boiler fires, and the discharged steam from an underground engine. The boilers are each 40 feet long by 5 feet diameter, spherical ends; and together with the furnace are placed in the seam at the bottom of the up-cast shaft. There are three shafts about 200 yards deep; two being down-casts, the conjoint area of which is about 140 feet, and one up-cast 71 feet area. The air is coursed round the workings in three main splits of about 6,000, 6,000, and 3,000 yards in length. In addition to this ordinary ventilating power, the steam-jet was added in September 1852. It consisted of 14 jets, each $\frac{3}{8}$ inch diameter, striking into cylinders six feet long by one foot diameter, and placed 15 inches in front of the jets; and it was with this arrangement my first experiments were made on the 2d of December 1852. The jets have since been increased by the addition of four jets each $\frac{5}{16}$ inch diameter, as shown on the Sketch. The experiments on the 13th of January 1853 were made with this latter arrangement.

Vide annexed Sketch.

Ventilation of the Cannel Pits, Ince Hall Colliery. First Series of Experiments, with Boiler Fires, Steam-Jets, and Furnace, 2d of December 1852.	Temperature of Up-cast Shaft, eight yards from Top.	Temperature of Down-cast.	Water-gauge in Inches.	Cubic Feet of Air passed through the Workings per Minute.	Fresh Air to Boiler Fires.	Total Air passed through the Shafts.
1st. With two boiler fires, and steam blowing off at 50-lbs. pressure. Boilers each 40 feet long by five feet diameter -	115°	48°	$\frac{9}{16}$	25,991	2,701	28,692
2nd. With 14 steam-jets each $\frac{3}{8}$ inch diameter, in addition to the boiler fires, and steam blowing off at 50-lbs., as in No. 1 -	106°	48°	$1\frac{1}{16}$	33,031	2,553	35,584
Increase with the 14 jets at work - - - -	-	-	-	8,040	—	—
3rd. With a six feet furnace and the boiler fires, and steam blowing off as in No. 1, but without the jets - - -	191°	45°	2	45,114	2,590	47,704
Increase by furnace - - -	-	-	-	19,123	—	—
4th. With the furnace and 14 steam-jets, and the boiler fires, and steam blowing off at 50lbs. - - - -	145°	45°	-	37,876	2,590	40,466

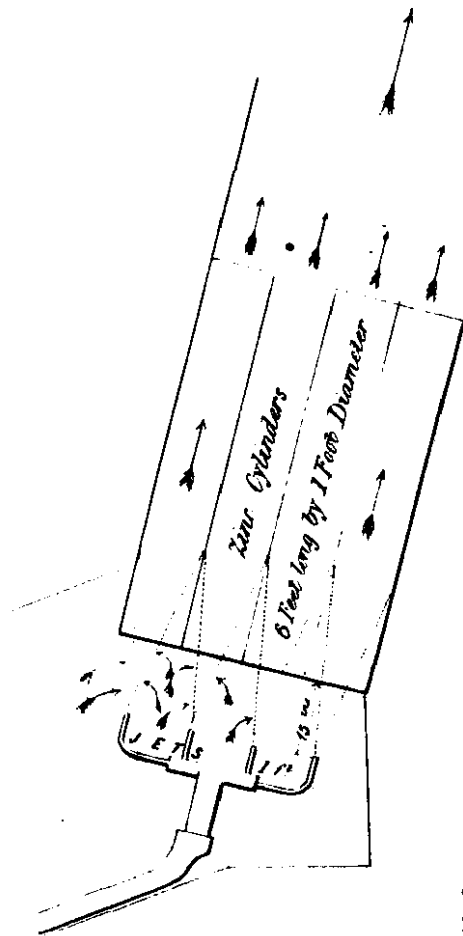
“In these experiments the united power of the furnace, steam-jets, and boiler fires, produced less effect than the furnace alone, the two powers seeming to baffle each other. This led to a series of experiments by which it was ascertained that by feeding the boiler fires with an abundant supply of fresh air, and with fresh air only, this anomaly could be obviated, and the powers of the jets and furnace worked harmoniously together.

On

[To face page 76.]

Sketch of the Steam Jet Apparatus as applied
at the Cannel Pits, Ince Hall, Wigan.

Scale 3 Feet to an Inch



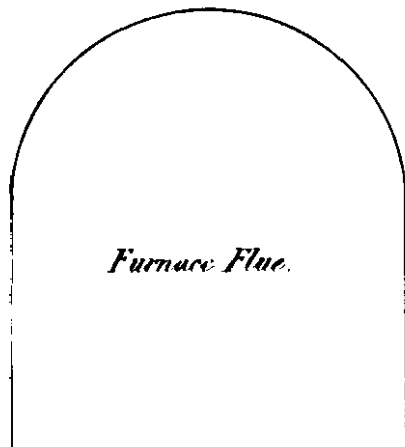
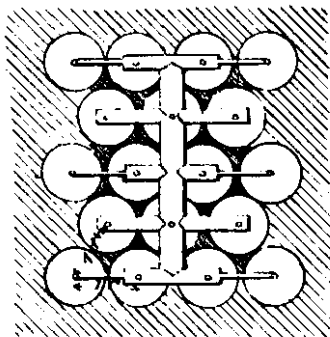
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UPCAST SHAFT.



Flue
for
Boiler
Fires.

Plan of the Jets
and Cylinders



Furnace Flue.

14 of the Jets are $\frac{3}{4}$ Inch diameter
+ D' — D' — D' — D' —

Jets One Foot apart Cylinders
One Foot Diameter, and the
interspaces between the Cylinders
are all made close.

Joseph Dickinson
Inspector of Coal Mines
1853

SELECT COMMITTEE ON ACCIDENTS IN COAL MINES. 77

“On the 13th of January 1853, some improvement having been made in the air-ways, and the number of jets increased to 18, as shown on the annexed Sketch, the experiments were resumed with the following result :—

J. Dickinson, Esq.

21 June 1853.

Ventilation of the Cannel Pits, Ince Hall Colliery. Second Series of Experiments with Boiler Fires, and 18 Steam-Jets. 13th January 1853.	Temperature of Up-cast, eight yards from Top.	Temperature of Down-cast.	Difference of Temperature between Up-cast and Down-cast.	Cubic Feet of Air passed through the Workings per Minute.	Fresh Air to Boiler Fires.	Total Cubic feet of Air passed through Shafts per Minute.
1st. With boiler fires low, and no steam blowing off, taken at 12 a.m. This measurement was taken by anemometers in the down-cast shaft; the others were taken in the workings -	102°	40°	56°	25,703	1,400	27,103
2d. With good fires under the boilers, and the steam blowing off at the valves at 55 lbs. At 1 h. 30 m. p.m. - - -	112°	43°	69°	41,041	34,000	75,041
Increase by 13 degrees of temperature, and the steam blowing off at 55 lbs. -	-	-	-	15,338	—	—
3d. With 18 steam-jets as per sketch, in addition to the boiler fires, and the steam blowing off at 60 lbs. At 2 h. 30 m. p.m.	130°	44°	86°	50,872	36,000	86,872
Increase by the jets and 5 lbs. higher pressure of steam, and 17 degrees of increased temperature as compared with No. 2 experiment - - -	-	-	-	9,831	—	—
4th. Same as No. 3, but with less fresh air sent to boiler fires. At 3 p.m. - - -	128°	45°	83°	50,794	28,400	79,194
Increase by the jets, and 14 degrees of increased temperature as compared with No. 2. - - -	-	-	-	9,753	—	—
5th. Same as No. 4, but with still less fresh air supplied to boiler fires. At 3.30 p.m. - -	121°	44°	77°	41,138	15,200	56,338
Increase by the jets, &c. and eight degrees of increased temperature, as compared with No. 2. - - -	-	-	-	97	—	—

“On completing No. 5 experiment, at 3. 30 p. m., when the temperature of the up-cast was 121°, the boiler fires were slacked, and in a quarter of an hour the furnace was lighted, and at 3 h. 50 m. the temperature of the up-cast had fallen to 110°. The heat of the furnace then began to act, in addition to the boiler fires, and at 4 h. 30 m. the temperature was 178°. The boiler fires then began to get very low, and at 5 h. the temperature had declined to 174°, and at 5 h. 30 m., when the boiler fires, with the exception of a shovel full of fire which was reserved on the charging plate for relighting them, were entirely out, the temperature of the up-cast had further declined to 160°. From that time the furnace rapidly rose to its full power, and at 6 h. the temperature had increased to 180°, which was its maximum height. The furnace experiments were commenced at 5 h. 15 m., as follows :

MINUTES OF EVIDENCE TAKEN BEFORE THE

Ventilation of the Cannel Pits, Ince Hall Colliery. Second Series of Experiments: The Furnace. 13th January 1853— <i>continued.</i>	Temperature of Up-cast.	Temperature of Down-cast.	Difference of Temperature between Up-cast and Down-cast Shafts	Cubic Feet of Air passed through the Workings per Minute.	Cubic Feet of Fresh Air to Furnace, and through Boiler Grates.	Total Cubic Feet of Air passed through the Shafts.
6th. With one furnace, six feet across the bars, the boiler fires being out; and allowing a large scale of fresh air, viz., 44,200 cubic feet, to pass through the boiler grates as a dumb drift, at 5. 15 p. m. - - - -	174°	42°	132°	48,811	44,200	92,511
Increase by furnace with 76° of additional temperature, as compared with No. 1 experiment - - - -	- - - -	- - - -	- - - -	22,608	—	—
7th. With furnace as in No. 6, but with the doors open to allow the furnace also to draw fresh air, at 5. 35 p. m. - -	160°	42"	118°	40,466	48,080	88,546
Increase, with 62° additional temperature, as compared with No. 1 - - - -	- - - -	- - - -	- - - -	14,768	—	—
8th. Same as No. 6, but with only 15,600 feet of fresh air admitted through boiler drifts, at 6 p. m. - - - -	180°	42°	138°	46,781	15,600	62,381
Increase, with 82° additional temperature - - - -	- - - -	- - - -	- - - -	21,078	—	—
9th. Same as No. 7, but with only 30,600 feet of fresh air admitted to furnace, and through the boiler drifts, at 6. 10 - - - -	- - - -	Not taken -	- - - -	44,534	30,600	75,134
10th. Same as No. 6, but with all the air passing through the workings in the way the fur- nace is ordinarily worked, at 6. 30 p. m. - - - -	180°	43°	137°	51,466	—	—
Increase, with 81° of ad- ditional temperature, as compared with No. 1. -	- - - -	- - - -	- - - -	25,768	—	—

“ At 6. 45 p. m. the boilers were re-lighted, when the increase of temperature was soon sensibly felt at the top of the up-cast, and the thermometer by which the temperature was being taken burst; another thermometer was substituted, and it also burst; one of the thermometers indicated up to 220°, and the other to 235°; the temperature of the up-cast would therefore appear to have been above 235°, when the following experiments with the united powers of the furnace, boiler fires, and steam-jets were taken :—

Ventilation of the Cannel Pits, Ince Hall Colliery. Second Series of Experiments, Furnace, Boiler Fires, and Steam-Jets. 13 January 1853— <i>continued.</i>	Cubic Feet of Air passed through the Workings per Minute.	Cubic Feet of Fresh Air to Boiler Fires.	Total Cubic Feet of Air passed through the Shaft.
12th. With furnace, two boiler fires, 18 steam-jets, and steam blowing off at 60 lbs. per square inch; at 7. 15 p.m.	61,746	33,930	95,676
13th. Same as No. 12, but with less fresh air admitted to the boiler fires; at 7. 45 p.m. - - - -	58,762	21,600	80,362

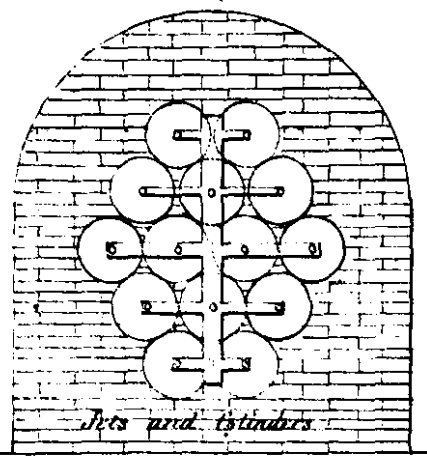
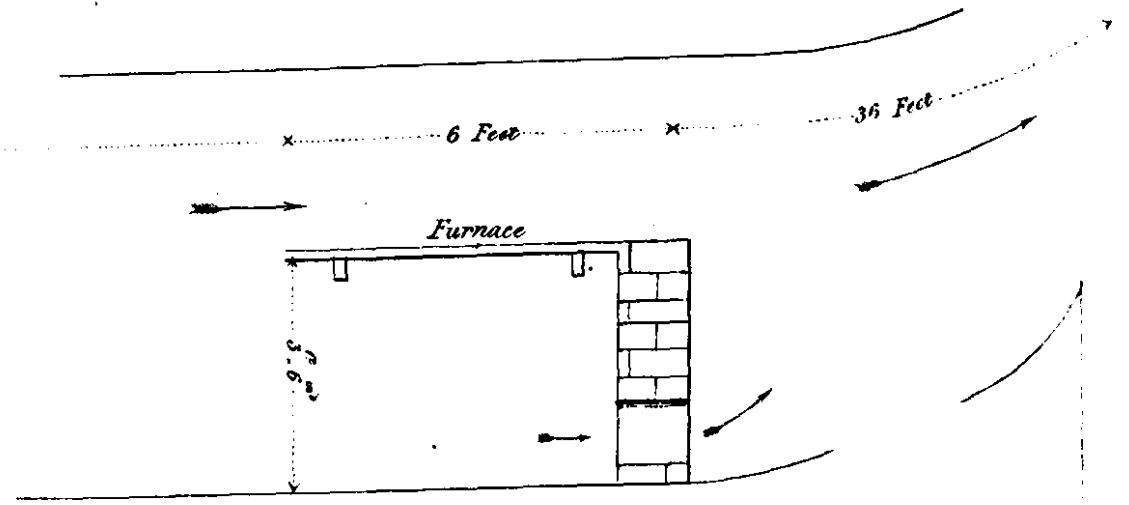
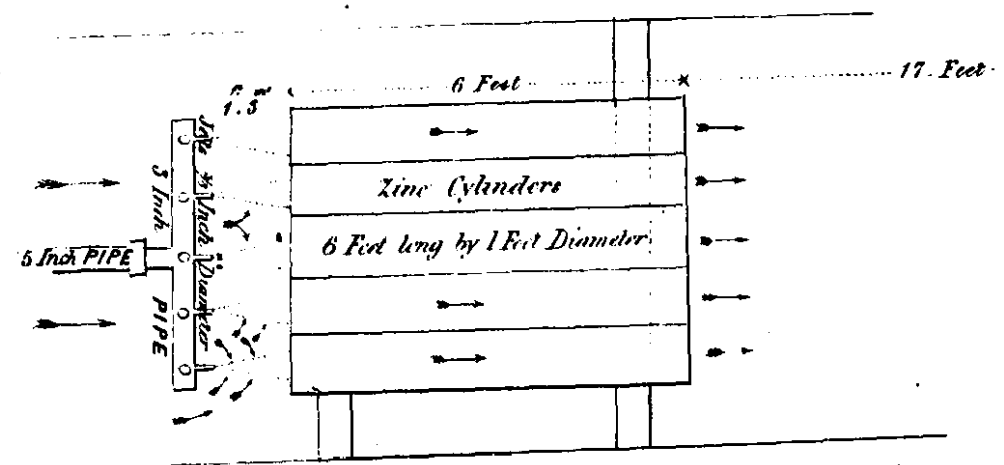
ABSTRACT

Upcast Shaft 10 Feet Diameter

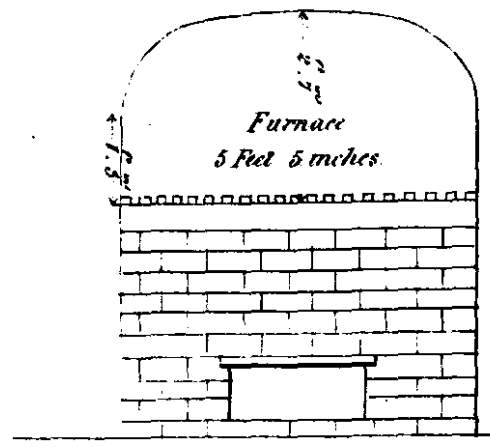
17th Nov. 1853

Sketch of the Steam Jet Apparatus and New Furnace, as applied at the Pemberton Pits, Ince Hall, Wigan.

Scale 3 Feet to an Inch.



At present only 10 of the Jets are in use.



Joseph Dickinson
Inspector of Coal Mines
1853

J. Dickinson, Esq.

ABSTRACT of EXPERIMENTS at the CANNEL PITS, INCE HALL COLLIERY, 13 January 1853.

21 June 1853.

	Cubic Feet per Minute.
Maximum effect produced with one furnace, 6 feet across the bars, as in No. 10 experiment; total air passed through the workings -	51,466
Maximum effect produced with 18 steam-jets, 2 boiler fires, and the steam blowing off at 60 lbs.; boilers, each 40 feet long by 5 feet diameter; total air passed through the workings, as in No. 3 experiment - - - - -	50,872
Difference in favour of one 6-feet furnace, as compared with 2 boiler fires, 18 steam-jets, and steam blowing off at the valves at 60 lbs., the boilers each 40 feet long by 5 feet diameter - - - - -	594
Maximum effect produced by the united powers of the furnace and 2 boiler fires, 18 steam-jets, and steam blowing off at 60 lbs; total air passed through the workings - - - - -	61,746

The barometer at 8 a.m., was 29.10 inches.

Ditto - 10. 20 p.m., was 29.20. inches.

“ In the experiments at the Cannel Pits it will be observed that a liberal supply of fresh air to the boiler fires had the effect of materially increasing the temperature of the up-cast, and that the current of air passed through the workings was greatest when the largest amount of fresh air was supplied to the boiler fires. With 36,000 cubic feet of fresh air per minute the difference of temperature between the up-cast and the down-cast was 86°, and the amount of air passed through the workings 50,872 cubic feet per minute. With 28,400 feet of fresh air the difference of temperature was 83°, and the amount of air passed through the workings 50,794; and with the still smaller amount of 15,200 feet of fresh air the difference of temperature was reduced to 77°, and the amount of air through the workings to 41,138 cubic feet.

“ The greatest velocity attained in the up-cast shaft with the furnace alone, and without allowing for expansion by rarefaction, was 1,303 feet per minute. With the addition of the expansion due to an increase of temperature from 62°, at about which the air was measured to 174°, the temperature of the up-cast, the actual velocity attained was 1,590 feet per minute; or, in other words, 1,590 cubic feet per minute was passed through each square foot of the up-cast shaft.

“ STEAM-JET and FURNACE VENTILATION, at the Pemberton Pits, Ince Hall Colliery, near Wigan.

“ In these pits, two seams of coal are worked with a pair of shafts, one seam lies at 214, and the other at 187 yards from the surface; the shafts are each 10 feet diameter, one being the up-cast and the other the downcast. The ordinary ventilating power consists of two boiler fires, placed in the lower seam, called the Pemberton five-foot seam, and a small furnace, together with an arrangement of 10 steam-jets (as shown on Sketch) placed in the upper or Pemberton four-foot seam, the jets being fed with steam from the boilers in the lower seam. The jets were added in September last, and they are only intended to be used when the furnace is out, or at nights when the engine is not at work; the boilers are each 20 feet long, by five feet diameter, with direct or flash flues underneath. There are three main splits of air in the four-foot seam, two of the splits being about 2,000 yards each, and the other about 1,000 yards in length; in the five-foot seam there are also three main splits, of the respective lengths of about 2,000, 1,000, and 600 yards. The first series of experiments was made on the 9th December 1852; the second series on the 20th January 1853, some improvements having in the mean time been made in the arrangements:—

Vide annexed Sketch.

MINUTES OF EVIDENCE TAKEN BEFORE THE

Pemberton Pits, Luce Hall Colliery. First Series of Experiments, with Boiler Fires, Steam-Jets and Furnace. 9 December 1852.	Temperature of Up-cast Shaft, Eight Yards from Surface.	Temperature of Down-cast.	Difference between Temperature of Up-cast and and Down-cast.	Cubic Feet of Air passed through Five Feet Workings per Minute.	Cubic Feet of Air passed through Four Feet Workings per Minute.	Total Cubic Feet of Air per Minute passed through both Workings.
1st. With two boiler fires, and the steam blowing off at 50 lbs.; average of two experiments -	135°	46°	89°	13,380	17,100	30,480
2d. With nine of the steam-jets at work, in addition to the boiler fires, and the steam blowing off at 50 lbs.; average of two experiments - - -	148°	48°	100°	20,700	18,540	39,240
Increase by the nine jets, and by an increase of 11 degrees of temperature -	- - -	- - -	- - -	7,320	1,440	8,760
3d. With furnace five feet across the bars, in addition to boiler fires, and steam blowing off, but without the jets; average of two experiments - - -	190°	44°	146°	17,625	20,160	37,785
Increase by the furnace -	- - -	- - -	- - -	4,245	3,060	7,305

“ In these experiments, a large scale of fresh air which was not measured was passed through the engine house, in the four-foot seam. The arrangements of the pit did not admit of more than about 12,000 cubic feet of air per minute being passed through the furnace.

Pemberton Pits, Luce Hall Colliery. Second Series of Experiments, with Boiler Fires, Steam-Jets, and Furnace. 20 January 1853.	Temperature of Up-cast.	Temperature of Down-cast.	Difference of Temperature between Up-cast and Down-cast.	Air passed through Five Feet Workings, per Minute.	Air passed through Four Feet Workings per Minute.	Total Cubic Feet of Air passed through both Workings, per Minute.
1st. With the two boiler fires low, and no steam blowing off	122°	50°	72°	12,990	20,472	33,462
2d. With good fires under boilers, and steam blowing off at the safety-valves, at 50 lbs. -	150°	50°	100°	17,760	24,840	42,600
Increase by the steam blow- ing off, and 28 degrees of temperature - - -	- - -	- - -	- - -	4,770	4,368	9,138
3d. With 10 steam-jets in addi- tion to the boiler fires, and the steam blowing off at 50 lbs. -	151°	49°	102°	21,015	23,400	44,415
Increase by the propulsive force of the steam, and two degrees of tempera- ture - - -	- - -	- - -	- - -	3,255	{ decrease 1,440 }	1,815
4th. With 10 jets, as in No. 3, but with air-splits differently arranged - - -	160°	49°	111°	22,800	not taken.	
Increase by the propulsive force of the jets, and 11 degrees of temperature, as compared with No. 2 -	- - -	- - -	- - -	5,040	not taken.	
5th. With 10 jets, as in No. 3. and 4 experiments, but with in- creased area for the air in the 4 feet to pass into the shaft -	152°	48°	104°	21,960	24,840	46,800
Increase by the propulsive force of the jets, and four degrees of temperature, as compared with No. 2 -	- - -	- - -	- - -	4,200	equal -	4,200

On the completion of the above experiments at 2 h. 10 m., the boiler fires were slacked. The steam had been got down, and the jets stopped at 2 h. 40 m. At 2 h. 50 m. the furnace, which, since the first series of experiments in December, had been increased to 5 ft. 5 in. across the bars, was lighted. It should be stated, that in consequence of the proximity of the furnace to the shaft, in which were wooden guides, it was found unsafe to drive the furnace hard, and only a small quantity of air was consequently passed through it. At 6 p.m. the following experiment was taken :

J. Dickinson, Esq.
21 June 1853.

Pemberton Pits, Ince Hall Colliery. Second Series of Experiments, with Boiler Fires, Steam-Jets, and Furnace. 20 January 1853.	Temperature of Up-cast.	Temperature of Down-cast.	Difference of Temperatures between Up-cast and Down-cast.	Air passed through Five Feet Workings, per Minute.	Air passed through Four Feet Workings, per Minute.	Total Cubic Feet of Air passed through both Workings, per Minute.
6th. With 5 ft. 5 in. furnace, small fire, the boiler fires being entirely out - - - - As compared with No. 2 experiment, the difference between the temperatures of the up-cast and down- cast, is in each case 100°, and the amount of air ob- tained almost identically the same.	143°	43°	100°	17,670	24,960	42,630
7th. With the furnace, as in No. 6, but with less air passed through the furnace - - - - The barometer, during these experiments, was at 29.20 at 8 a. m., and at 29.45 at 11 p. m.	143°	41°	102°	17,010	24,360	41,370

“It appears that throughout these Ince Hall experiments, both with the furnace, boiler fires, and steam, increased temperature in the up-cast has been followed very closely by an increased amount of air. There appears, however, to be a small amount gained by propulsion. The largest increase on the application of the jets, as in No. 3 experiment in the second series at the Cannel Pits was 9,831 cubic feet per minute; this was due to an increased temperature between the up-cast and down-cast of 17 degrees, and, to some extent, to propulsion also. That some amount is due to propulsion is however perhaps more apparent in a comparison of Nos. 2 and 6 with Nos. 3 and 5 in the second series of experiments at the Pemberton Pits. In No. 2, the boiler fires, with steam blowing off at the valves at 50 lbs. per square inch, but not propulsively applied, gave 42,600 cubic feet of air per minute; and No. 6, with a like difference of 100° of temperature, with the furnace, gave 42,630 cubic feet, being a difference in the two experiments of only 30 feet. Comparing these results, which, with the exception of the lighter gravity of the steam, are due exclusively to temperature, with Nos. 3 and 5 experiments, with the steam applied propulsively through the jets, it will be seen that an increase of only two degrees of additional temperature in the one case gave an increase of 1,785 cubic feet of air per minute, and of 4° in the other gave an increase of 4,179 cubic feet per minute; being a ratio of increase in the quantity of air obtained at the rate of about 1,000 cubic feet for one degree of temperature, which exceeds the ratio due to temperature alone as compared with the other experiments. No. 3 experiment, with two boiler fires, steam and steam blowing off at the valves, with a temperature of 102°, gave 44,415 cubic feet, whilst No. 7, with the same temperature, by the furnace, produced 41,370 cubic feet, leaving a balance of 3,045 cubic feet due to propulsion, which is the utmost amount assignable to propulsion in these experiments, a comparison with No. 6 and other experiments giving a less amount.

“The quantity of coals used in the boiler fires at the Pemberton Pits is stated at 4 tons 16 cwt. per 24 hours, which, at the rate of 46,800 cubic feet of air

J. Dickinson, Esq.

27 June 1853.

air per minute, as obtained by the jets and boiler fires, gives 6,268 cubic feet of air per lb. of coals.

“The furnace at the Pemberton Pits is a new one, 5 feet 5 inches across the bars, and the quantity of coals which it consumes had not been ascertained when I made these experiments; but it stands on the site of an old furnace which was 5 feet across the bars, and as it stands within 12 yards of the shaft in which are wooden guides, which are liable to catch fire, the furnace could not be safely driven hard; the consumption of coals therefore would probably be much the same as in the old one. This amount is stated at two tons per 24 hours, but allowing 10 cwt. extra as an ample margin for the slight increase in the size of the furnace, say 50 cwt. per 24 hours. This, at the rate of 42,630 cubic feet of air per minute, as in No. 6 experiment, gives 10,962 cubic feet of air per lb. of coals as the result of furnace ventilation.

“In the Cannel Pits the quantity of coals used in the boiler-fires is stated at 6 cwt. per hour, or 7 tons 4 cwt. per 24 hours, to keep the steam at 50 lbs. pressure per square inch, which is the usual pressure. The second series of experiments which gave the best results were taken with a pressure of 60 lbs., to obtain which the consumption of coals would be increased in a proportion. As this increase was not ascertained, the balance may be thrown to the favour of the jets, and the coal estimated as for 50 lbs. pressure, which gives 4,542 cubic feet of air passed through the workings per lb. of coals consumed in the boiler-fires. The furnace is stated to consume about 6 tons per 24 hours, which gives 5,514 cubic feet of air per lb. of coals. The united powers of the furnace, boiler-fires, and steam-jets gives 3,007 cubic feet of air per lb. of coals.”

1110. In that case was the same proportion of fresh air blowing over the boiler fires?—The quantity of fresh air sent over the boiler fires had a material effect in increasing and diminishing the quantity of air through the workings; but this amount which I have stated as being due to the steam-jets is the maximum effect of all the experiments.

1111. *Mr. Stephenson.*] Did you compare the consumption of fuel in that small furnace as compared with that consumed with the two boilers?—The quantity used by the boiler fires in the Cannel Pits is stated as six hundred weight per hour, or seven tons four hundred weight in 24 hours, to keep the steam at 50 pounds pressure per square inch, which is the usual pressure.

1112. Have you given the consumption of coal per hour upon the furnace, or the boilers?—Upon the boilers.

1113. What is the consumption per hour upon the furnace?—I should also explain that the quantity of coal stated for the boiler fires is to keep the steam at 50 lbs. pressure, but the experiments with the jets were taken with the steam at 60 lbs. pressure.

1114. Give that 50 lbs. then?—The coal estimated as for 50 lbs. pressure, gives 4,542 cubic feet of air passed through the workings per pound of coals consumed in the boiler fires. The furnace is stated to consume about 6 tons per 24 hours, which gives 5,514 cubic feet of air per pound of coals; the united powers of the furnace, boiler fires, and steam-jets, gave 3,007 cubic feet of air per pound of coals.

1115. You say the united power of the furnace, the steam-jet, and the boilers; had you ever them united?—Yes, we tried all the powers together.

1116. Had you not the consumption per hour, of fuel, under the boilers for driving the steam-jet only?—I have not. The pressure was raised to 60 lbs. at Mr. Darlington's request, and the consumption of coals was not taken; the quantity given is for working the boilers at the ordinary pressure, 50 lbs.

1117. You have given me the consumption of the furnace alone at seven tons a day?—That is for the boilers' fires, 7 tons 4 cwt.

1118. How much does the single furnace consume, the open furnace?—About six tons.

1119. They are about equal; that is not a very great disparity?—Taking the quantity, the two boiler fires and steam-jets give 4,542 cubic feet of air per pound of coals. The single furnace gave 5,514; and the united power of the furnace and the boiler fires, and the steam-jets, gave 3,007 cubic feet per pound of coals.

1120. You do not appear to me now to have separated the effect of the steam-

steam-jet from other influences, because you have stopped the steam-jet, and compared it with the furnaces; but you omit to take away the effect due upon the ventilation from the steam-boiler furnaces, because when the steam-jet is at work the steam-boiler furnaces are assisting in the ventilation?—The boiler fires are in addition.

J. Dickinson, Esq.

21 June 1853.

1121. Is the effect that you state to be produced by the steam-jet alone, really, in point of fact, the effect of the steam-jet plus the coal consumed under the steam-boilers?—Yes; and with the exception of the first day's experiments at the Cannel pits, when anomalous results were obtained, every increase of air has been simultaneous with increased temperature.

1122. Does the heated air which passes through the steam-boiler furnaces go into the up-cast shaft or not?—It does.

1123. Let us suppose for a moment the steam-jet could be taken out of the shaft, and put into some other place where it would have no influence on the ventilation, what effect would the furnaces under the boiler have in producing ventilation; consuming as much fuel as they do, would they not nearly produce as much as a simple furnace of six foot square?—Yes, they would produce nearly the same result as we have obtained by the steam-jets with these fires, the only difference would be a trifling amount by propulsion.

1124. *Chairman.*] Did you ever try the steam-jet, worked with the boilers being on the surface, the steam carried down to the bottom of the pit, and the jet at the bottom of the pit?—Yes; I have seen different applications in that way. In one instance I saw it so applied at the Bentgrange Colliery, at Oldham, where the effects upon the ventilation were trifling indeed; and at the time this jet was at work the whole of the pit continued in an explosive state.

1125. *Mr. Stephenson.*] The ventilating power was small?—Very small; it is a case that I have alluded to in my report to the Secretary of State.

1126. *Chairman.*] Then, taking the whole of these experiments into consideration, your opinion appears to be that the mechanical power of the steam-jet, without any rarefaction whatever, is a very small aid in ventilating a pit?—Yes, that is my opinion; I was formerly disposed to attribute more power to propulsion, but I now believe it to be very small.

1127. *Mr. Cayley.*] According to the evidence you have given, you consider the steam-jet is a retardation rather than an assistance to ventilation?—No, that is not my opinion; I think that some amount of power is due to propulsion, but that the amount is small.

1128. The furnace, you stated, consumed six tons of coal per day?—Yes.

1129. That gives 50,000 cubic feet of air per minute?—It gave 51,466 cubic feet of air per minute.

1130. And the boilers use seven tons per day?—Six hundred weight per hour, that is 7 tons 4 cwt., to work the boilers at 50 lbs. pressure; with the boilers at 60 lbs. pressure the maximum effect produced with 18 steam-jets, two boiler fires, and the steam blowing off at the valves was 50,872 cubic feet of air per minute.

1131. Is it your opinion that the same quantity of coal would give more ventilation burned in a furnace than under a boiler?—It is my opinion.

1132. Is it your opinion, then, that the furnace alone gives the greater power of ventilation, and is greater than the same quantity of fire plus the steam jet?—Yes; I think the furnace more economical; the combustion is much more perfect in the furnace than it is under the boiler fires, that is, in a properly constructed furnace; and there is no dense cloud of black smoke rolling up the pit; the heat is not taken up by the water and flues, and the upcast is easier raised to a high temperature.

1133. Then you consider the steam-jet to be a retardation to the ventilation?—No; I think the same amount of coal applied through the furnace would give you a greater amount of air than that quantity of coal burnt under the boiler fires, however the steam generated in these boilers might be applied.

1134. Is not that a question very much of the depth of the mine?—I am speaking now of experiments made under similar circumstances in the same pit.

1135. The deeper the pit, in point of fact, the more economical does the furnace system of ventilation become?—No doubt of it.

1136. Do you think the furnaces would equally apply to shallow as to deep pits?—The furnace is not so peculiarly applicable to shallow pits as to deep ones.

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1137. Was Mr. Darlington with you when you made your experiments?—He was, and took all the figures down.

1138. Was he satisfied with the propriety of your mode of carrying on the experiments?—Yes; he made no objection to it.

1139. Was he satisfied with the results you came to, that they were correct?—I cannot say whether he was satisfied or not; we took the measurements with the utmost fairness; there was no partiality to either one side or the other; my sole object was to develop the utmost resources of the jet and the furnaces, and I believe Mr. Darlington was actuated by the same desire; the underlooker of the pit was also there.

1140. *Chairman.*] With regard to the steam-jet, although your opinion is that the furnace is infinitely superior as a ventilator to the steam-jet, can you, or not, conceive circumstances in which the steam-jet may be useful, in cases of mines being on fire; we have evidence in 1852 that the steam-jet was there applied to force carbonic acid gas down into the mine to put the fire out; do you conceive the steam-jet may be made useful in a case of that kind?—I think we know it to be very useful in cases of that kind. The case which I have given (question 1095), as an illustration of the peculiar power of the jet, had reference to one of these experiments of Mr. Gurney's, where he was forcing the choke-damp into the mine. It was this choke-damp, although it had undergone the cooling process, which had heated the down-cast shaft to 103 degrees above the temperature of the up-cast; and yet the jet was able, by acting through a confined tube, to resist that balance of temperature. I do not know any other power that could have been applied so well adapted to an experiment of that kind. But for the transmission of large quantities of air through coal mines, it does not appear to be sufficiently powerful unless applied in conjunction with temperature.

1141. *Mr. Locke.*] Was that application of the jet in any way similar to the application to the mine in Seaton Delaval?—No; that was a peculiar application, applied for the purpose of forcing choke-damp into the mine, with a view to extinguishing the fire that was in the same.

1142. I want to know whether the use of the tube was applicable solely for the purpose of forcing choke-damp, or might it not be employed, as in the case of Seaton Delaval, if necessary?—A series of cylinders might be applied at Seaton Delaval; and I think, by a series of cylinders, that is, one cylinder to each jet, the propulsive power would be increased to some extent. In those experiments which I have put in, all the jets were acting through cylinders.

1143. *Chairman.*] In explosions very often, or generally, are more lives lost by the after-damp than by the actual explosions themselves; is that so?—It varies. In my district the greater proportion of lives have been lost by burns and violence; and few by suffocation.

1144. Where it is so, do you think that the steam-jet could be successfully applied from the top of the pit to force down atmospheric air to combine with the choke-damp, so as to prevent the men from losing their lives?—Any power that you can apply readily is the best in cases of that kind. Perhaps, if a steam-jet were kept in reserve at the top of the pit, it might be an addition in such circumstances.

1145. In that case, the furnace at the bottom of the up-cast shaft would be totally ineffective?—The furnace is sometimes blown to pieces by the explosion.

1146. Therefore, although you give us your opinion that the steam-jet is not so good a ventilator as the furnace, still you think it would be advantageous, in pits where a great quantity of fire-damp existed, to have in reserve a steam-jet at the top of the pit, which could always be ready if cases of that kind should occur in the pit?—Although I am not an advocate for the steam-jet, or mechanical appliances in preference to the furnace for ventilating coal mines, there are circumstances under which economy should not be considered; for instance, with a very shallow up-cast, or where large bodies of gas have to be moved, in newly tapping a very fiery seam, where the gas is given off so rapidly that you cannot put the furnaces into it; in cases of this description, mechanical appliances are and may be resorted to successfully.

1147. The steam-jet might always be put at the top of the pit, with scarcely any expense to the coal proprietor, inasmuch as there is always an engine at the top of the pit, and the steam from its boilers could be turned into the steam-jet

jet at any time when it was needed; is that so?—Yes; the expense would not be very great. J. Dickinson, Esq.

1148. Mr. Locke.] Do you consider that that would be the best mode of applying the steam-jet?—No, I do not; I think if you applied it at the top of a pit, without enclosing it into a tube, its effect would be very trifling indeed. 21 June 1853.

1149. Chairman.] Whatever your opinion may be as to the ventilating power either of the furnace or the steam-jet, unless the capacity and size of the air-ways is attended to, either of those powers may be very much deteriorated?—It is impossible to transmit a large amount of air through a colliery unless you have spacious air-ways.

1150. Then the actual forcing or throwing a current of air into the pit would have no effect at all, unless great and proper attention was paid to the size of the air-ways?—It is a most important point to have spacious air-ways; in fact, the ventilating power may be said to be almost useless if you have not proper space for the air to be passed through.

1151. Is it your opinion that the goaf should be cleared of foul air or not?—It is very desirable that it should be thoroughly cleared. I have stated, in a former part of my evidence, that where the goaf is foul, if there is any insurmountable difficulty in the way of thoroughly ventilating it, I think it is better not to attempt to do it.

1152. Can you give the Committee any idea of the areas of air-ways you would require? It would depend on a certain number of men working in the pit: how much air would you require for each man working in the pit?—It depends very much on the quantity of gas you have to contend with in the mine.

1153. Supposing the air-ways were sufficiently large, and supposing there was a sufficiently ventilating power in the pit, would there not then be very considerable skill required in order to force that air to every part of the pit, so as to give each workman his necessary proportion of air?—Yes, there is very great skill required. There is nothing in which the judgment of a colliery manager is more shown than in the proper distribution of air.

1154. Do you find that properly attended to in your district?—In the best managed collieries it is; in the majority of cases it is not.

1155. The air is not split?—Both in the splitting and in the proper distribution of the air to the different parts of the workings it might be improved.

1156. The consequence is, that the air passes from one part of the workings to the other, and of course the last man who breathes it, breathes air very considerably loaded with foul air, with carbonic and other deleterious gases?—He does, and what is more frequently neglected is the leakage through the stoppings; many of the stoppings, instead of being built with bricks or stone and mortar, are built with rubbish, which subsides and leaves an opening at the top, and air leaks over that; and it is not unusual to find a large quantity of air going down the down-cast and up the up-cast, but by leakage at doors and stoppings, only a very small portion of it reaches the extremities of the workings, where it is most required.

1157. Can you state what quantity of air is necessary for the supply of each man?—In the ventilation of a fiery mine, I look more to what will thoroughly ventilate the mine than to the requirement of the men per man; because what is sufficient for the thorough ventilation of a fiery mine is always more than adequate for health.

1158. But in cases where men are breathing deleterious gases, or a body of gas breathed by other men, do you not conceive that would be very injurious to their health?—No doubt it would.

1159. Mr. Locke.] That does not often arise in collieries, air that is already respired; have you found in mines that any deaths arising from respired air have occurred?—Yes, a few deaths have taken place from such causes, but the amount of sudden deaths from that cause is trifling compared with the injury it causes to health. I have a table here of the ventilation of a number of collieries in my district, and the amount of air in some of these is so small that it would not support a single lighted candle in the mine; it was necessary to have two or three candles put together to maintain a light; others are very large; in the smallest cases there was no ventilating power applied.

[The Witness handed in the following Table:]

DATE.	NAME OF COLLIERY.	VENTILATING POWER.	Water Gauge in Inches.	Total Cubic Feet of Air passing through the Workings.	Number of Cubic Feet of Air obtained per lb. of Coal Consumed.
1852:					
12 July	South Mostyn, Flintshire	-- Furnace on surface; air-way impassable.	-	665	—
	Ditto, 24th January 1858	Large fan; airway improved	-	5,170	1,956
13 "	Mostyn New Pits, Flintshire	Temporary furnace	-	5,580	—
29 "	Coleshill - - - ditto	Small furnace	-	2,640	—
30 "	Bath - - - - ditto	None; air-way impassable	-	44	—
4 August	Norley Hall, Lancashire	Draft furnace	-	25,600	—
12 "	Laffak - - ditto	Large furnace on surface	-	17,500	—
21 "	Westminster, Denbighshire	Struve's air-pump	-	23,608	5,238
31 "	Blackley Hurst, Lancashire, Seneley Green Pit.	Furnace	-	8,652	7,418
2 September	Blackley-hurst, Lancashire, Little Delf Pits.	ditto	-	4,763	10,206
9 "	Bredbury Black Mine, Cheshire	-- Underground boiler; fire and steam.	-	4,266	2,576
17 "	Ince Hall Cannel Pits, Lancashire.	-- Two boiler fires and steam, and 6 feet furnace.	2	35,329	2,809
2 Dec.	Ditto - - - ditto	ditto - ditto, air-ways improved	2	47,704	—
7 "	Ditto - - - ditto	Two boilers and jets	1 $\frac{1}{10}$	35,584	—
1853:					
13 January	Ditto - - - ditto	-- Six feet furnace only; air-ways further improved.	-	51,466	5,514
13 "	Ditto - - - ditto	Two boilers, fires, and jets	-	50,872	4,542
13 "	Ditto - - - ditto	Furnace, 2 boiler fires, and jets	-	61,746	3,007
1852:					
8 October	Stoneclough, Lancashire, Pad-dock Pit.	Fire grate	-	8,600	18,000
9 "	Ditto - - Starkie Pit	Two ditto	-	13,360	13,213
9 "	Clifton, Lancashire, Manor Pit	Furnace	-	18,900	12,150
12 "	Glodwick, Lancashire, 250 yards deep.	None	-	6,360	—
20 "	Bank, Lancashire (A. Gibbon's 2 feet air pit).	ditto	-	1,000	—
20 "	New Water-gate, Lancashire, two pipes 2 feet area.	ditto	-	560	—
23 "	Worsley, Lancashire, Sanderson's Pits.	Furnace	-	2,835	6,156
29 "	Kirkless Hall, Lancashire, Arley Pits.	Two small furnaces	$\frac{8}{10}$	59,145	38,021
7 November	Haigh, Lancashire, Bridge Pits	Temporary furnace	-	24,335	17,380
1853:					
April	Ditto - - - ditto	Large furnace	-	60,000	—
1852:					
3 November	Ditto - - - Patcheroff Pits	Two furnaces	-	18,891	—
12 "	Winstanley, Lancashire, 4 feet mine.	Small furnace	-	5,400	17,357
24 "	Broadfield, Lancashire, through a pipe 1 $\frac{3}{4}$ feet area.	-- Pipe inserted into engine chimney, into which the steam was discharged.	-	850	—
9 October	Ince Hall Pemberton Pits	Two boiler fires and steam jets	-	39,240	—
9 "	Ditto - - - ditto	Five feet furnace	-	37,785	—
1853:					
20 January	Ditto - - - ditto	Two boiler fires and steam jets	-	46,800	6,268
20 "	Ditto - - - ditto	5 ft. 5 in. furnace	-	42,630	10,962
	Orrel, Lancashire	-- Eight feet furnace and one boiler fire.	-	47,200	—

1160. *Chairman.*] In such cases as we have been alluding to, in bad collieries, or collieries where there is no gas, men breathe worse air than in what you call fiery mines?—Yes, very much so; the fiery mines are generally much more healthy than the choke-damp mines. J. Dickinson, Esq.
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1161. The reason of that is, that it is necessary to split the air, so as to throw a large proportion of air through the mine, so as to clear the mine of foul air?—Yes, better ventilation is the cause of it.

1162. Do you think that any stated quantity of air to be given to a man could be enforced by legislation?—It would be very desirable if you could ensure all these mines being ventilated in some way, so, at all events, that the man should have a respirable atmosphere to breathe; whether that may be the best test or not, I am not prepared to offer an opinion; it is a very complicated question, and if enforced by law may lead to great hardships in some cases. In no case ought the men to be allowed to work, where there is not sufficient air to support a candle burning freely.

1163. *Mr. Bruce.*] That would be different in different places; either the Legislature would have to fix the minimum, or the inspectors would have to fix the minimum in each particular pit?—As a minimum, I would not go below the quantity which would freely support the combustion of an ordinary-sized candle.

1164. *Mr. Stephenson.*] If it ever reaches that point, or nearly that point, the men would not obtain light to work with?—They would not, and you would be surprised at the number of places where I hear, "This drift was holed in the dark; we had such a man who worked there; he is a capital fellow for such work."

1165. *Chairman.*] That is a system that ought not to be tolerated?—It ought not.

1166. Should not the inspector have the power to see that a proper proportion of fresh air is carried into the mine?—If any minimum amount could be fixed it would be very desirable to do so. In coal mines men generally receive higher wages for doing work of that kind.

1167. *Mr. Stephenson.*] Is it not inevitable that, when a man is holeing in the stall system, is it not necessary that he must work for some time in bad air; how is it possible to avoid that?—In the most fiery fire-damp mines, in Lancashire, it is necessary to have the air bratticed up to within two or three yards of the face of the works.

1168. Of the holeings?—Yes; I mean in the fast ends.

1169. Do you know many collieries worked where they have to brattice up the holeings to within two yards of the face?—In several of the new openings, in what is called the Arley or the Little Delf seam, it is necessary to brattice within two or three yards of the faces.

1170. In the stalls or the holeings?—In cases where the narrow work is driven to the extremities, and no stalls worked until the levels have reached their extremities; when the stalls are driven, and the pillars following after them towards the pit; in winning out these narrow levels it is necessary to brattice the air close up to the face, but after they have been driven for a time the gas pines off.

1171. *Chairman.*] These are peculiar cases, are they not; in ordinary cases, with proper attention, it is quite easy to split the air, and carry it to different parts of the workings; also to give each man his proper quota of fresh air?—Yes; these are cases that apply to the most fiery mines, which bear a small proportion to the moderately fiery and unfiery mines, where there is no difficulty in splitting the air and carrying on the ventilation.

1172. In addition to supplying the mine with fresh air, is it not easier to get the air through the mine with less power if it is properly split?—In a large colliery it is indispensably necessary to split the air.

1173. If it were not so split, it would have to travel through so many miles in the working; and the friction would be so great, and the drag of the mine would almost counteract the power of the furnaces altogether?—It would. It is very well understood by almost every manager of a large colliery; but many of the managers of small collieries, where the amount of air is small, prefer carrying the air round in one body, and they are very much prejudiced against splitting the air; but it is only among the managers who have not had the experience of a large colliery, and who do not know the difficulty of getting a large quantity of air through the workings.

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1174. When the air is properly split, the usual plan adopted is to turn the air by doors?—Yes; where you wish to carry the traffic across the ventilating doors are used. Crossings may be sometimes substituted.

1175. In case of explosion in one part of the mine, these doors are apt to be blown away, and the consequence is, the whole of the ventilation of the mine ceases?—Yes; it is so after a severe explosion.

1176. Do you think it would be well to have such stoppings as would be strong enough to resist the power of the severest explosions that take place in the mine?—Yes; all the principal stoppings which carry the air into the mine should be made as strong as possible, with the view of preventing their being blown down by the blast.

1177. Mr. Stephenson.] They are very often made with brick masonry. Yes, in the best-managed mines; but too often with rubbish.

1178. Chairman.] In the report of the Committee of 1852, it recommended that bore-holes should be sunk down from the surface into the goafs, so as to allow holes for the pent-up gas to escape; is it practicable to keep those bore-holes open?—Yes; I think it would be practicable to keep them open, but I do not think you would introduce it into practice; you would not get any colliery manager to do such a thing.

1179. Mr. Stephenson.] Did you ever see a bore-hole under such circumstances?—I have seen a bore-hole put down to ventilate the level.

1180. What did you get, air or water?—Both; but that was the whole of the ventilation in the mine; that was done as the up-cast pit.

1181. If a bore-hole was put down to the goaf with a view of taking away the hydrogen gas, would it not be a down-cast instantly; it would fail altogether in the object in view; it would be full of water, and there would be no current of fresh air coming in at the top?—It is highly probable, if you had a ventilating power applied at the up-cast, that the bore-hole would be a down-cast, not an up-cast.

1182. Mr. Cayley.] Suppose a steam-jet applied to the top of the bore?—I think you would make it an up-cast by putting the steam-jet to it.

1183. Mr. Stephenson.] Do you think that a hole put down into the goaf of a mine is at all likely to carry away one item of the foul air of the men; would you put a steam-jet into it, or not?—I think if you put a hole down the mine, if there is any ventilation going on, it would have the tendency to carry away some of the gas.

1184. In sinking coal mines, in nine times out of ten, or probably ninety-nine out of a hundred, they have water to contend with, have they not?—Very frequently.

1185. Therefore, in boring a small hole down into the goaf of a coal mine, would the sides of that hole not yield a very large quantity of water?—It probably might; but I have stated already that the objection to putting these bore-holes down would be so great in practice, that you would not get any colliery manager to adopt them.

1186. Mr. Cayley.] Is there any means whereby you know ventilation is going on during your absence, between your visits of inspection?—No; we have no means of knowing.

1187. Could you suggest any means whereby you might know what amount of ventilation had been going on in your absence?—With the great number of pits we have at work in this country, it would be impossible to keep such a control over the management of collieries as that, unless you have as many inspectors as you have got managers of collieries. The great point that should be looked to, in my opinion, is to get competent managers, and merely to have the inspectors to find out, if possible, where incompetent men are employed, and also to make very diligent inquiry into every cause of accident that has taken place; and with such a code of regulations as I have stated, I think very beneficial results might be produced.

1188. There is no instrument that would practically measure the amount of ventilation going on?—None. Byram's anemometer will measure about a fortnight, but it would take an inspector to each large colliery to read off the numerous measurements that would be necessary.

1189. Chairman.] Do you not think that it would be impossible for the overman of the pit, if he were so inclined, to contract the current where the anemometer is placed, so as to make the air rush past it with greater force, and so deceive

deceive the inspector, if he was to make a periodical visit of once a week?—It would be quite possible for the overlooker to do so. That is not the worst effect I am afraid it would have on the managers of the collieries; by shortening the currents, and not carrying the air to the extremities of the workings where it is most required, he would increase the quantity of air passing over the anemometer, therefore, unless you had such an endless number of anemometers, probably a hundred in a large colliery, so as to measure each of those currents in its subdivided form, the result would be very defective.

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1190. Supposing you had these hundred anemometers that you speak of, could not the overman deceive the inspector at each of those anemometers by contracting the current at each of these anemometers, and making it rush by them faster than the actual speed at which air travels through the mine?—He could, by placing a plank or any temporary material in the air-way, so as to contract it, deceive the inspector.

1191. *Chairman.*] However good or excellent the anemometer is, it has always that effect, that if it is in the hands of a man who would play tricks with it, the inspector could always be deceived?—He could; and besides that, it is necessary to have anemometers made so delicate, with a view of getting rid of friction, that I do not think that the anemometer in its present form, or in a form which would work with any reasonable amount of friction, would last above six months, if so long, if kept continually going.

1192. *Mr. Cayley.*] What is your principal objection, your scepticism as to the perfection of the instrument, or as to the power of preventing its being tampered with, supposing it to be perfect for its purpose?—My principal objection is neither of these two; my principal objection is, that it would induce, or have a tendency to induce, the colliery manager to shorten his currents, and consequently to reduce the quantity in the long splits, and to send a larger quantity of air over the anemometer, and not to take the air to the extremities of the workings, where it was most required.

1193. That would be one mode of tampering with the anemometer?—It would be tampering with the ventilation.

1194. Supposing you had an anemometer placed in a down-cast, or at the bottom of a down-cast, or in the air-way between the down-cast and the up-cast, and also, in addition to that, an anemometer at the extreme working, would not this be a test of the current, and of the amount of ventilation going on in the extreme working, as well as in the more direct air-way?—Before you get the air to the extremity of the works, it is generally subdivided into a certain number of large currents, and then again into a larger number of smaller currents. To ascertain what quantity of air is going to the extremities of the working it is necessary to have an innumerable number of anemometers.

1195. Would it not be some test of the circulation of the mine, supposing the instrument to be perfect for the purpose, of the amount of circulation going on at the extremity of the mine, if there was an anemometer placed there?—It is a test that I should not rely on. Indeed the current of air at the extremities of the collieries, where the air is so subdivided into so many small splits, the velocity is so slow that it would not move Byram's anemometer. Many of Byram's anemometers will not move under a velocity of 120 feet per minute; it is a very delicate one indeed that will move at 50 or 60, and that current is seldom obtained in the extremities of the workings; therefore your anemometer, in a drift that was sufficiently ventilated, you might remain stationary.

1196. Would that amount be sufficient for health; would there be a sufficient ventilation if the current did not move the anemometer?—In many cases it would, supposing the drift near the extremities of the working, 50 feet area, and you have a velocity of, say, 70 feet per minute; that would be 3,500 feet of air per minute for the ventilation of that working alone, which is very much more than is generally sent to each separate working at the extremity of a colliery.

1197. I thought you said that Byram's anemometer was a very delicate instrument?—I stated that it was necessary to have it made as delicate as possible, with a view to getting over friction; but with all this care which has been bestowed upon it, I know of no instrument where the friction is less than 50 feet per minute, and in some cases it is more than 120; that is, that it requires a current of more than 120 feet per minute before the instrument will begin to move.

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1198. Do you ever use the anemometer yourself?—I do.

1199. When you visit the mines?—Yes.

1200. If you trust yourself to an anemometer, when you are inspecting a mine, to know the actual ventilation, if there could be an anemometer devised which registered the amount of the current, why should not that tell its own tale on your next visit if it could not be tampered with?—For the reasons I have stated at such great length.

1201. A registering anemometer, in point of fact, is, in other words, the same instrument which you use to test the amount of ventilation when you visit a mine, with a registering apparatus attached, which denotes at your next visit the amount of ventilation going on in your absence?—Yes.

1202. Then if it could not be tampered with, why should it not speak the same truth in your absence as in your presence?—I think it could be tampered with; and if you make it register beyond a fortnight you would multiply the number of wheels to such an extent as to increase the friction considerably more.

1203. You are now expressing a doubt as to the anemometer doing the work which it professes to do?—That is only one doubt; but I have expressed my objection to such a system of check being kept over the managers, and the most important reason was not to any defect or any want of reliance upon the instrument, but that it would have a tendency to induce the manager to send a larger quantity of air through the short splits, and to diminish the quantity in the long ones, which would increase the total quantity as registered by the anemometer.

1204. Supposing there were scientific means devised by which those attempts to tamper with truth could be defeated, would your objection to some extent cease?—You might have a large amount of air going down the down-cast, and up the up-cast, and over your anemometer; but there might still be a number of places in your mine which would be quite sufficient to blow the whole mine up; therefore, as a practical man, I should place no reliance whatever on these records of the anemometer.

1205. You would prefer to have no test at all to having a test of a certain definite value?—I think if your test cannot be in having the managers to take an interest in ventilating the extreme points of the mines, you had better have no test at all; you would make it then their interest to neglect the points which require most attention, and by too much attention to matters of secondary importance you direct attention from the main point, and conduce to the very thing you are endeavouring to avoid.

1206. What is the objection to having one anemometer at the very extreme point of the working of the mine?—It would be merely a record of the air at that one place; that is, provided there were sufficient air to move it; but it would not be a record of the other places which are of equal importance, and which are very numerous.

1207. It would not be a record of the distribution of the air near the extreme workings?—No; and you might have a large quantity of air circulating along this drift where the anemometer was placed, but there might be a fast end going out of that drift up which no air was passing, and which might be sufficient to contain enough fire-damp to blow all the men up in the place.

1208. It would tend materially to the proper supply of air in all the extreme workings, if there was an ample supply of air at the very extreme working?—I think if you made it a colliery manager's interest to throw a large amount of air over his anemometer, you would, from the circumstances I have pointed out, tend to diminish the supply of air to the extreme points where it is most required. I do not think any practical man would place any reliance on such a test as your question appears to propose.

1209. *Mr. Baird.*] Do you consider the best test of a well-managed colliery to be the absence of accidents?—Not invariably; as a general rule, it is so; but a colliery under strict discipline may go on being very badly ventilated for some time, until at last the evil day comes, and there is an explosion. As a general rule, it is the very best test in the absence of inspection.

Jovis, 23^a die Junii, 1853.

MEMBERS PRESENT.

Mr. Hutchins.
Mr. Cayley.
Mr. Ingham.
Mr. Huesey Vivian.
Mr. H. A. Bruce.

Mr. Baird.
Mr. Fitzroy.
Mr. Locke.
Mr. Farrer.
Mr. Mostyn.

E. J. HUTCHINS, Esq., IN THE CHAIR.

Joseph Dickinson, Esq., called in ; and further Examined.

1210. *Chairman.*] YOU stated in your evidence that every old pit should be properly fenced off to prevent persons falling into it ; are there not nearly as many accidents occurring in winding persons up and down the pits?—Yes, a great number of accidents take place in winding people up and down pits. *J. Dickinson, Esq.*
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1211. From what cause do those accidents principally arise?—From a variety of causes ; in some cases from boys or men tumbling off the cage, or more frequently from the skip ; sometimes from a man incautiously putting his head out, and getting it crushed against the cross trees.

1212. Do accidents of that character arise from their own carelessness?—Where there are guides in the pit they generally arise from want of caution on the part of the men ; but in pits where there are no guides, and only a loose skip, the men are sometimes thrown off by the two skips coming in collision, by the ascending skip coming in collision with the descending one, and throwing the men off, or by its striking against the side, and throwing the men off.

1213. Do you think, therefore, it should be enforced by legislation that every pit should have guides to it?—As far as practicable to enforce it. There are some cases in Staffordshire and Denbighshire, where the portion of coal which has to be worked is so small, that there is not sufficient coal to be left for a proper shaft pillar ; indeed the whole portion of coal to be worked is only the size of an ordinary shaft pillar. In that case, you cannot prevent the shaft squeezing and bulging out of shape. Wooden conductors, under such circumstances might be displaced, and be unsafe for the cage to run upon ; but wire ropes might be applied to meet these cases, which would obviate the evil.

1214. As guides?—Yes.

1215. My question did not allude to wooden guides ; but to guides of any kind or sort ; your answer alluded to pits which were entirely without guides?—I think guides should be enjoined as far as possible ; I do not know of any case where they could not be introduced. The Staffordshire people make an objection to the introduction of guides, for the reason I have stated. I also know of a case in Staffordshire where the landlord of the property has objected to the introduction of guides, when the tenant has introduced them.

1216. What reason did the landlord assign for objecting to the introduction of guides?—He said the use of guides had a tendency to lead the colliers to break the coal smaller, to put it into the trains, and produce a larger proportion of small coal.

1217. *Mr. Farrer.*] Why should that be?—I think it is only a prejudice ; I see no reason for it whatever. The tub, in this case, where it has been introduced, carries about 30 hundred weight of coal, and there is ample space for putting in any ordinary lump of coal, such as one or two men could lift.

1218. *Chairman.*] In the case you have described just now, where the shaft has got into a dangerous condition, and such a condition that they could not use guides, do you think such a pit is safe for men to be wound up and down?

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—Very unsafe; they are called crooked pits, and they are not fit for men to be drawn up and down; it is only in the Staffordshire district and Denbighshire where such a thing is known.

1219. In your opinion, then, should not the pit be kept in such a condition at all times that men could be wound up and down with perfect safety by legislative enactment?—At the present moment there is no practical objection that occurs to me to prevent the use of guides being compulsory in every case where men are drawn up and down; in the sinking of pits it is seldom desirable to have guides; they are only used in working pits, except in very rare cases, where they are used in sinking deep pits.

1220. During the process of sinking?—I should certainly not make them compulsory in that case.

1221. *Mr. Farrer.*] Would the use of guides secure the men against accidental collision when the skips are one ascending and the other descending?—They would.

1222. *Mr. Baird.*] Would not a brattice have the same effect?—Certainly, not so good; it is possible to make a brattice in such a shape that it acts as a sort of guide for the skips; the addition of a rod on the brattice would be a very slight expense indeed.

1223. *Chairman.*] But the use of guides in pits would not necessarily render the pits so safe that the men would be free from danger from the falling of the sides of the pit?—Certainly not.

1224. Could you recommend any plan by which the pits could be rendered perfectly safe?—In the code of regulations I have put in, I have stated what precautions I would take for guarding against such accidents.

1225. Do you consider that casing the pit from the top to the bottom would be an effectual remedy against parts of the pit falling down and killing men in their descent?—It is an effectual remedy, and one that has been taken in my district in the best managed collieries. The manager of the largest colliery in the district was very strongly opposed to walling his pits throughout. After a number of recommendations, and a long correspondence with him on the subject, he has at last assured me that every new pit should be walled. He represents the largest colliery in Lancashire, where 1,500 men are employed.

1226. Would this increase the expense of sinking the mine?—It is a very trifling addition to the expense of sinking. I think in the long run it would be a saving; there is generally time lost in the repair of sides of shafts, and which has to be done at a busy time, when the use of the shaft cannot be spared for such a purpose.

1227. Does it not happen that accidents frequently occur by which men are killed by pieces of coal falling from one ascending bucket, while the men are descending in the empty one?—It does sometimes happen, and also by materials falling from the top of the pit.

1228. Do you think that the Legislature should interfere to prevent the men being let down the pit while the materials are coming up?—Yes; I think it is a regulation which would meet with the approval of the majority of experienced mining engineers in my district.

1229. Would that cause a very great hinderance in the pits where a very large amount of coal was brought up every day?—No, I do not see that it would.

1230. Could accidents be obviated by any apparatus that has yet been brought out, such as Fourdrinier's?—I have already stated my opinion to be, that I place much more reliance on having good tackle and good winding arrangements, than I do upon any arrangement for arresting the cage in the event of a breakage taking place. I think if we had all our pits fitted up with Fourdrinier's apparatus, or an apparatus which is an improvement of Fourdrinier's apparatus, by White and Grant, it would be better. If that apparatus were attached to every working pit in our country, we should have the ropes worked very much closer than they are now, and instead of a decrease of accidents, we should have a positive increase by the breakage of rope, and a new source of accident would be introduced in the complication of the apparatus.

1231. Is it not the duty of an inspector now to see that the machinery and apparatus connected with the pit are in proper order?—It is a part of his duty.

1232. In the course of your inspection, have you ever represented to the owner

owner of a colliery that any part of the machinery of his pit or ropes were in improper order?—Yes, I have, in several cases.

1233. In consequence of your representations, has he taken any means to obviate the danger that existed?—Yes; in a great number of cases; I could quote one which took place.

1234. Did you ever find any case of their non-compliance, or refusing to comply with your suggestions?—We have sometimes a difficulty in persuading them that we are correct in our views, but I have generally succeeded in the end.

1235. Provided they did not comply, and any accident was to take place, there would be no remedy at law against those parties so neglecting their duty?—If we had an opportunity of attending at the inquest we should attend, and state to the coroner and jury that we had pointed these dangers out to the colliery manager, and he did not appear to have taken the precautions which we stated to be necessary. We have not always an opportunity of attending at the inquests; many of the inquests are held before we hear of the accident.

1236. But in cases of that kind, would you feel it your duty, if possible, so to attend, and to represent to the coroner those facts which you have stated?—Yes.

1237. What time do you think ought to elapse under ordinary circumstances before the coroner's inquest sits over the body; in order to give you time to attend the inquest in all cases, what would be the average necessary time?—In answering that question we have to consider that the body cannot be kept above a certain time, and that the coroner and jury must assemble for the purpose of viewing it; 48 hours is the time allowed now, and I believe that could not be extended.

1238. Has not the coroner now the power to adjourn the inquest; could not he assemble the jury and view the body, and adjourn the inquest to a future day, when you could attend and give evidence as to the cause of the accident?—He has that power; but it gives rise to a great number of complaints on the part of the jurors, that they are obliged to meet twice and receive no pay for their services. The coroner in some districts is allowed double expenses for holding an adjourned inquest; in other cases he is only allowed the expenses of a single inquest. In the majority of cases the jurors receive no pay whatever.

1239. Do you consider that the law, as regards coroners' inquests in that respect, is not in a proper state?—I think it admits of improvements.

1240. Do you know the practice of Scotland with regard to accidental deaths in mines?—Yes.

1241. When an accident occurs, the owner of a mine is immediately obliged to write to the Lord Advocate, apprising him of the accident; he then sends to the inspector, desiring him to report on that accident to the procurator-fiscal?—Yes.

1242. And the procurator-fiscal, after receiving the report, lays it before the Crown counsel, who decides whether a prosecution shall take place or not; is that the state of the law?—Yes, that is an outline of it; the police also make their own inquiries with respect to the accident; they have a sort of secret system at work, and they ferret out information from sources which they know. This is also laid before the procurator-fiscal; and if on this evidence, which has been furnished by the police and others, if they think there is a case to prosecute, they prosecute. Having been a manager of a colliery in Scotland, I know what is the feeling of the managers on the subject. Fortunately, I never had a fatal accident during the time I was there, therefore I have not experienced it personally; but my own feeling on the subject is so strong, that I would rather manage a colliery for 100 *l.* a year less in England than in Scotland; the rather than have to undergo the excitement which the manager is placed under at the time the secret inquiry is taking place with regard to the accident.

1243. You say the police are the parties who make this secret inquiry?—It is part of their duty.

1244. What police do you allude to; is it the county police?—The constables of the district.

1245. Do you think that the system pursued in collieries in Scotland renders the owners and managers of collieries more careful?—I have no doubt it has that effect,

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effect, but I think it is carried to an extreme in Scotland; men become really nervous under it.

1246. Do you not think that improvements might be made in the law of Scotland and England, so as to assimilate them, and put them both on a better footing?—Yes, I do not know of any objection to it.

1247. *Mr. Ingham.*] Supposing an inquest is held before you have an opportunity of attending, and you are aware that in the colliery where the death had occurred you had previously given directions to have greater precautions used, would you think it your duty to communicate with the Home Office?—If I had served a colliery owner with a formal notice, I should consider it my duty to do so.

1248. Whether you had been at the inquest or not?—Yes; a case occurred in my district, where I had a colliery owner, not exactly under formal notice, but he had undertaken to carry out certain suggestions which I had made to him, which obviated the necessity of serving a formal notice on him. An explosion of fire-damp took place in the colliery afterwards, and immediately on receiving information of that accident, I posted off to the inquest. That was before I received any official information of the accident, but I found I was too late, for I met the coroner coming away. In that case I had a long interview with the manager, and told him it was my intention to bring it before the magistrates; but his promises of amendment were so strong that I did not do so.

1249. *Mr. Baird.*] Are you aware now that all the expenses in England, of prosecutions at the assizes, are defrayed by the Treasury and not by the county?—I am not aware of that.

1250. That being the case, would there be any difficulty in the proper authorities of the Government, if they thought it right, directing that a Crown prosecution should take place on your report, although the coroner's inquest had not returned a verdict justifying such a course?—I very much doubt whether the Home Office would have authorised a prosecution in the case. We generally find, where loss of life is brought in as manslaughter, and that is sent to the assizes, in nine cases out of ten the case is thrown out, by the judge stating that it is a case that falls within the proper degree of caution and culpable neglect. Two such cases of that kind have occurred in my district in this present year, but both were thrown out by the judge and jury upon that ground.

1251. *Mr. Ingham.*] Are you aware that in either of those cases there had been specific directions given by the inspector which had been neglected or contravened by the proprietor?—They were both cases which appeared to be combined with considerable neglect. I was present at both of the inquests. I had previously examined the colliery in one case; but they were neither of them cases that the inspector could have any control over. One was the case of an engineer drawing the cage up to the pulley; the other was the case of a collier not setting sufficient pit wood to support the roof of the workings, and sending his drawer under it to fill the coal.

1252. *Chairman.*] What was the coroner's verdict in the first case?—Manslaughter.

1253. *Mr. Ingham.*] Had you, before that, observed anything in the conduct of this engineer to make you think he was an improper person to be placed in a situation of trust?—I had not seen the engineer before.

1254. You had not at all represented to the proprietor of the mine that this particular man, in his employment, was unworthy of his situation?—I had never seen him before, and knew nothing of him; therefore I could not make such a representation.

1255. It is not such a case as I mentioned, where the act by which the party came to his death was committed by the owner, after directions to the contrary from the inspector?—It was a case which no Act could meet.

1256. That was a case in which it was the personal default of the engineer, and in no way attributable to any misconduct on the part of the proprietor?—It was, and he was severely reprimanded; the colliery proprietor stated at the inquest that the man had committed a breach of duty in having done so.

1257. Was that indictment preferred against the engineer or proprietors?—Against the engineer.

1258. *Chairman.*] And the bill was ignored?—I believe in both cases they were thrown out by the grand jury.

1259. *Mr.*

1259. Mr. Vivian.] You stated that you would recommend that men and materials should not be wound up together in the same pit?—Yes, I did. J. Dickinson, Esq.

1260. Does your objection apply to such pits as are not properly fitted with guides and cages?—It applies to all cases where there is a brattice partition between the two cages, and it also applies to the winding of the coal up any other pit than the one the men may be going down: In some districts it is common to have one engine to wind from three or four pits, so that if men were going down in one pit, you would have a loaded skip coming up the other pit. You would then have the maximum strain on the machinery when materials only were being raised, which those regulations which I have proposed would avoid. 23 June 1853.

1261. That might apply to that particular case, but such a case is not common in the coal trade?—No, it is only common in the Staffordshire district.

1262. Chairman.] The cases you would apply that to are only in ill-regulated collieries?—I should not make any exception in any case.

1263. Mr. Vivian.] Have you ever known accidents occur in properly fitted pits, from materials falling down while men were being wound up?—Yes; it is a very common cause of accident, and the regulation alluded to is a regulation at many pits at the present time. In my district it is a common regulation; you may not have it in South Wales, where the regulations are much more lax.

1264. I did not know that such a regulation existed in the northern pits?—In some it may not; it is much more common in Lancashire.

1265. Mr. Locke.] Does it not extensively prevail, both in the counties of Durham and Northumberland, that they do not wind up coals at the same time that men are ascending and descending where the shafts are not bratticed; is it not a general rule that men are not permitted to go up and down the shafts while they are pulling coals in pits that are not bratticed?—As a general rule, men do not go up and down against loaded tubs; and where I meet with it in practice, I always make a representation as to the danger attending it, and in no case have I not succeeded in receiving an assurance that it should not be continued for the future.

1266. Mr. Vivian.] Do you conceive the danger to arise from the unequal strain on the machinery, or the falling of the material?—Partly from the one and partly from the other; when the winding engines are very powerful and in good order, there is comparatively little if any danger from the breakage of machinery; but in the Staffordshire district, where heavy three-linked chains are used, and the machinery much weaker, there is very great danger.

1267. That I can easily conceive; but in collieries fitted up in the best style would it be desirable to apply such a regulation?—I think it would; it would inflict no hardships upon them, as the men all go down together in the morning. It does not apply to the coming up, where only two pits are used, as the empty tub would be coming down. It is only in the case where the pit is in full work during the day, that it could be considered a hardship, and at such times it is only overmen or the viewer who is going down.

1268. Chairman.] The falling of these materials does not depend on the excellence of the machinery of the pit; supposing the coal was improperly loaded by the collier, or supposing the collier had properly loaded the coal, and that the roads at the bottom of the pit were in bad order, and however excellent the machinery was in the pit, might not the coal be shaken out by the slightest movement, and fall on the heads of the men?—A piece of coal might fall from a tub that was not well filled.

1269. Mr. Locke.] I understand your objection to go even to the use of the men descending in the mines where there are two pits; where a loaded tub is coming up one of the pits, you object to the men descending in the other pit where there can be nothing to fall?—The only objection in that case is as concerns the machinery.

1270. In what respect do you consider the descent of the men, going down one shaft, whilst the loaded tub was coming up the other, as putting any more strain on that machinery than the ordinary balance of the first loading; and then unloading the skips going up and down those shafts?—I should think the weight of a man is an addition.

1271. Is the weight of a man larger than the weight of the tub coming up when

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when it is in the act of ascending?—The weight of the man is in addition to that of the full tub.

1272. Would not the weight of the man descending in that tub have the effect of balancing the two?—I think the engineer would have more control over his engine if the cages were empty.

1273. Do you see any extra strain on the machinery in the case put?—Do not you think that the weight of the descending man would rather tend to balance the two loads, and give the engineer a more perfect command over his engine, than if he had a training engine pulling at one tub?—Yes, I think the engine would be better balanced; but a weak engine would be more likely to break, having the additional weight of the man in addition to the weight of the coal.

1274. You think a weak engine would be more likely to break, having less work to do?—Having the addition of the man to the coal.

1275. I am supposing a descending man against an ascending tub; I wish you to answer that question?—Suppose the drum-shaft to be weak, and both drums fixed on one shaft, I cannot give any other opinion than the one I have given. I think there would be a greater strain on the drum-shaft.

1276. You think there is more strain on the drum-shaft by the man descending than if they were not descending?—Yes.

1277. And your objection, therefore, is to the use of two pits; to the permitting the men to descend the one, while the loaded tub is ascending the other?—Where there are only two pits, and good machinery, my objection to descending the other pit is very slight.

1278. Is that one of the cases that you would insist on absolutely prohibiting, or would you make that an exception to the rule?—If that was the only cause, I should not think it necessary to prohibit.

1279. Are you of opinion that that ought to be one of the exceptions to the rule?—I think it might be an exceptional case.

1280. What would you propose to do if you had to frame a code of regulations; would you propose a positive prohibition in a case like that?—I should make the regulations as simple as possible, and with a view to avoid exceptions I should include that in the rule.

1281. *Mr. Vivian.*] Then the rule would not apply to men ascending; only to men descending?—Only to men descending.

1282. *Mr. Mostyn.*] Would you recommend the attendance of the inspector on all coroners' inquests relating to those mines under his inspection?—Certainly not, unless you made the inspector the coroner. In this country the coroner's duty is to inquire into every case of sudden death; on the Continent they have no coroners, and it is part of the inspector's duty to inquire into every colliery accident.

1283. *Chairman.*] Do you find the workmen commit reckless acts, so as to endanger the safety of other men?—Sometimes.

1284. As the law exists at present, has the magistrate the power of inflicting fines upon those workmen who so transgress?—I have stated that on that point a difference of opinion appears to prevail among the magistrates; some consider that they have power, others consider that they have not.

1285. Do you think that the law should be made clear on that subject?—I think it is very important that it should be.

1286. In what district is it that these magistrates have refused?—*Mr. Vivian* stated that he knew of a case where they refused to convict.

1287. Where was that?—I think it would be in South Wales.

1288. Did they refuse to hear the case, or refuse to convict because they considered that they had no power to convict; that the Act of Parliament did not give them power?—I cannot state the particulars of those cases *Mr. Vivian* alluded to; but in my district, a few months ago, I received a letter from one of the colliery owners, telling me he had made application to the stipendiary magistrate for the district for the purpose of prosecuting a man for leaving an air-door open, by which a serious explosion might have taken place. It is a similar misdemeanor to opening a safety-lamp. The magistrate refused to act in the case. The colliery owner asked me what he should do under the circumstances. I undertook to see the magistrate, who assured me that, if any future application of the kind were made to him, he would give it his best attention,

attention, and that he would see what the law was upon the point. He was not aware of the Act. J. Dickinson, Esq.

1289. When workmen do commit these reckless acts, so as to endanger the lives of their fellow-workmen, and those acts are discovered by any of their fellow-workmen, do they usually inform the overlooker?—Such cases do take place sometimes, but they are very rare. 23 June 1853.

1290. Do you mean that cases of carelessness are very rare?—No; where one man informs against the other is very rare indeed.

1291. Do you think a workman would be more likely to screen a man?—Yes; as a general rule, they are more likely to hide each other's faults than bring them forward.

1292. Have you read the Report of the Committee of 1852 with regard to safety lamps?—I have.

1293. Do you agree in this portion of the Report: "Your Committee would now refer to some more incidental means of security against explosion; first, stating their concurrence in the opinion expressed, directly or indirectly, by the Committees of 1835 and 1849; and also with that so strongly expressed by the South Shields Committee, that where a proper degree of ventilation does not exist in a mine, the Davy lamp, or any modification of it, must be considered rather as a lure to danger than as a perfect security. Practically secure in a still atmosphere it may be considered; and in the hands of a cautious over-man an admirable instrument for exploring, or as an indicator of danger; but in a current, as admitted by the illustrious inventor himself, it is not a security; and in the hands of an ordinary workman, under circumstances of excitement, when danger is threatened, it is not improbably, far oftener than imagined, the very cause of the explosion which it was intended to prevent?"—I agree with that generally; but at the latter end, I think it is not so frequent as they suppose it to be; I think cases where explosions have taken place through the gauze of the safety-lamp are exceedingly rare, and only two cases have come to my knowledge where such accidents have taken place.

1294. Is it your opinion that in fiery mines the use of the safety-lamp should be enforced or not?—In some mines I think it should be used.

1295. However good the ventilation?—I think that is a point that might to some extent be left to the discretion of the manager. The difficulty is in drawing the line between a fiery mine and a very fiery one; what some persons would call a very fiery one another person would call a moderately fiery one.

1296. Would you give power to the inspector to determine when the safety lamp should be used, and when it should not be used?—Yes, I think the inspector might be entrusted with that power.

1297. What are the sort of safety-lamps now in ordinary use in this country?—The common Davy lamp is the lamp generally used. Two of the North of England managers give the preference to Mr. Clanny's lamp: Mr. George Elliott and Mr. Easton. The Stephenson lamp is also becoming now much more generally used than it was; it has the property of becoming extinguished immediately on an explosion taking place, which puts it out of the power of a workman to remain in an explosive atmosphere with a light.

1298. The Stephenson lamp has glass within the wire gauze?—It has, and is fed with air from the bottom.

1299. The Clanny lamp has glass at the bottom of the lamp quite unprotected?—It has.

1300. Is it safe to use a lamp with glass so unprotected?—It is not considered safe by nearly all our mining engineers in this country, but on the Continent they consider them perfectly safe; and they place every confidence in them, and I am not aware of any accident having taken place in consequence of the glass abroad, where they are very extensively used.

1301. The glass is made very thick, is it not?—It is generally made very thick, and well annealed.

1302. However thick it might be, if the glass was to get very hot, and a drop of water was to come on it, would it not have a tendency to break that glass?—Yes.

1303. If such an occurrence were to take place to a man, and the glass were

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so to break, it would cause an explosion in the mine?—That is one of the great objections that our engineers had to them.

1304. If the lamp was in an explosive atmosphere it would go out?—Most of the glass lamps have that property.

1305. The Clanny lamp has that property?—Yes, as a general rule, the Clanny will; but it is possible to keep up an explosion in the top of the tube of the Clanny.

1306. *Chairman.*] Would the Clanny burn in an atmosphere in which, if a naked light were used, it would explode?—No; as a general rule, it would go out.

1307. Have you seen the lamp invented by Mr. Henderson?—I have not.

1308. Have you seen Dr. Glover's?—I have that here.

1309. Do you approve of the principle of Dr. Glover's lamp?—It avoids the objection to the glass lamp so far as the breakage by water goes, inasmuch as the air passing down between the two glasses has the effect of keeping the outer glass quite cool.

1310. What kind of lamp gives the best light?—The Eloin lamp.

1311. Is one of the objections by the men to the use of safety-lamps the small quantity of light that lamp gives?—Yes, that is the objection to the Davy lamp.

1312. Is it not, therefore, material to have a safety-lamp in which could be combined the most perfect security and the greatest amount of light?—It is very desirable to have such a lamp.

1313. Have you seen Dr. Fyfe's lamp?—I have; I have not had an opportunity of making any experiments with it. I heard the Doctor deliver a lecture on it; it seems to me much the same as the Clanny, with the addition of a double gauze to the top of it instead of a single gauze.

1314. Have there been any improvements made in the safety-lamp since the report of the Committee in 1852?—I think Dr. Glover's lamp has been patented since that Committee, and Dr. Fyfe's lamp has also come out since that Committee.

1315. Is Dr. Fyfe's lamp here?—It is so nearly like the Clanny, that I did not think it necessary to bring it.

1316. Do you think the improvement made by Dr. Glover renders his lamp the most safe of any lamp hitherto invented, and combining with that quality the giving the greatest amount of light?—I do not think it is more safe than the Davy or the Stephenson.

1317. *Mr. Locke.*] What in your opinion, having reference to the object of the safety-lamp, namely, the security of the mines, is the best lamp according to your knowledge?—Considering all the circumstances with reference to lamps, I am disposed to give the preference to the Davy.

1318. The Davy stands first in your estimation?—Yes.

1319. Which do you think is the next best?—The Stephenson is a good lamp for the workmen.

1320. Do you think the Stephenson better than the Clanny?—So far as avoiding the glass goes, the Stephenson has the advantage.

1321. If you were called upon to order a lamp for a particular colliery, what lamp would you order?—I should leave it to the option of the manager of the colliery, for I believe with proper care they are all safe.

1322. Then the answer you have given with respect to the Davy, is that there is no material difference between that and any of the rest?—No, a very slight difference indeed; for testing fire-damp there is no lamp so good as the Davy.

1323. *Chairman.*] Why?—You can judge of the presence of gas so much more accurately by it, and also the quantity of gas.

1324. For the purpose of working in a fiery mine, where no naked lights are allowed to be used, to which lamp would you then give the preference?—I believe them all to be safe, but I think one of the lamps which becomes extinguished on coming into an explosive atmosphere best for the working men, but the Davy for the firemen.

1325. *Mr. Farrer.*] If you could render it impossible for the miner to open his

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his lamp, which would you prefer then as a locked lamp?—The best locked lamp is the recently registered lamp of Watson's, of Newcastle-on-Tyne. *J. Dickinson, Esq.*

1326. *Chairman.*] What is the principle of that lamp?—It has a very long key about two inches long, and you cannot open it with a nail. *23 June 1853.*

1327. Is it a common Davy lamp, with a key to it?—It is both the common Davy and the common Stephenson.

1328. With Watson's improved lock to it?—Yes, and also a different arrangement as to the opening of it.

1329. Your answer applies only to the lock?—Yes.

1330. *Mr. Furrer.*] Has the miner, when in the mine, at present, a key for opening the lamp?—Where locked lamps are used, the miner is supposed not to be in possession of a key.

1331. *Chairman.*] But your opinion decidedly is, that the inspector should at all times have power to order the use of safety-lamps in a fiery mine, if he should think proper so to do?—I think he might be entrusted with that power, and that power would come under the regulation I suggested, in one of the clauses of the Act, to the effect that the inspector should be entrusted with power, in cases where imminent danger existed; where the manager refused to adopt proper measures for increasing its safety, he should have the power to order the working of the mine to cease; that is, under the restrictions which I specified.

1332. Of course you think that attention to ventilation is a primary course to pursue, in order to make a mine safe?—It is.

1333. Therefore, whether the inspector orders a safety-lamp or not, he would not pay less attention to see that the ventilation of the mine was properly carried on?—Certainly not.

1334. You would not use the lamps in order to screen the colliery proprietor from having proper ventilation, but you would rather use the safety-lamps to increase the security with the proper ventilation?—Merely for the purpose of guarding against an emergency such as an outburst of gas, or a discharge of gas. No workings should be systematically carried on in an explosive atmosphere.

1335. Therefore, you agree with the report of the Committee of 1852, that the primary mode of rendering mines secure is attention to the best mode of ventilation?—I do.

1336. *Mr. Ingham.*] You gave your opinion as to the comparative merits of lamps with respect to their safety; now, as to their illuminating power, which lamp are you inclined to prefer?—The Eloin lamp gives the best light, but it is generally attended with the disadvantage of going out in a brisk current of air.

1337. Which do you prefer of the English lamps?—The glass lamps come next; all the glass lamps, without exception, are equal. There is the Glover lamp, and the Clanny lamp, and all the glass lamps.

1338. Which of the glass lamps combine the most safety with the most illuminating power?—The addition of the chimney to Dr. Glover's lamp, as in Musileer's lamp, appears to make it safer than an ordinary Clanny.

1339. Then, as a combination, you give the preference to the Glover lamp?—For certain purposes I would, but for other purposes I would not. If you are travelling in old wastes, and a little choke-damp happens to be coming off from the waste, the Glover lamp will go out when a Clanny lamp will burn, and when a Davy lamp will burn; so that, in a case of that kind, I should prefer a Clanny.

1340. But for ordinary working purposes, where the men were hewing, you would prefer the Glover?—I think I stated that I place all these glass lamps on a par; I make no distinction between one and the other.

1341. You were understood to say that there was more safety in the Glover as a glass lamp?—It has some advantages which some of the others have not. Clanny's has not the Museleer chimney, and has only a single glass.

1342. It is not added to the Clanny now; of the actual lamps in use which do you prefer?—For a workman, I think that the Glover has that additional safety which the Clanny has not.

1343. Are you aware of the Glover lamp being in actual use in any one of the collieries in the north?—No, I am not; it has only recently come out.

1344. Do you not know the fact that it is in use at Wingate Grange and

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Pelton?—I know that experiments have been made by Mr. Reid, the viewer at Pelton. I believe he is satisfied with the lamp, but I am not aware that he has introduced it for the use of the mine.

1345. Are you aware that it is not a more speculative lamp, but that practical men have given consideration to it?—Experiments have been made by practical men; I am not aware whether they have introduced it for their workmen or not; I believe it is not in use anywhere in my district.

1346. Mr. *Mostyn*.] Are you acquainted with Coed Talon, in Flintshire?—I am.

1347. Is it a well-managed colliery?—No, I do not think it is, it is very roughly managed; indeed, one of the roughest in my district.

1348. When did you visit it?—I have been there two or three times.

1349. Have you been there within the last twelve months?—I have; at the time when I went down into the workings one of the pits had a flat chain in it. Since that time, there has been nothing but single link chains at the colliery. I go into no colliery where there is a single link chain, unless I have urgent business to take me there; I do not think it is safe.

1350. Were any plans shown you?—Yes, plans of all the seams excepting one.

1351. In the course of your experience you have seldom seen a worse-conducted colliery, have you?—It is very rough.

1352. And highly dangerous, as compared with your general knowledge of collieries?—I have objected to the use of single link chains there, and I have pointed out the want of plans to Mr. Harrison, the manager. He undertook to get these plans made. On going back, as I stated previously, a year afterwards, although he had undertaken to have the plans made, he had not carried out that undertaking. I afterwards directed Mr. Oakley, the proprietor's attention to it. I received a letter from Mr. Oakley, informing me that he would see to it, and that it should be attended to.

1353. I understand that those instructions you gave to Mr. Harrison and Mr. Oakley, a year ago, have not been attended to?—Mr. Oakley has since promised me that he would attend to them himself, and see it was carried out. I hope he has attended to it, I have not been there since.

1354. Are you aware of the number of accidents that have taken place there?—There are a larger number than usual at that colliery, considering that it was in North Wales. The men of North Wales take great care of themselves, more than they do in other parts of my district. The mining in North Wales generally is very rough, and but for the great care the men take, the number of accidents would be very great; as it is, they are very few.

1355. Still, in the Coed Talon Colliery there have been more than the ordinary proportion of accidents?—Yes, I have taken that view of it but recently. I should not apply it. I think greater care has been exercised for some time past; and of late there has been no accident there. The last accident was by the breakage of a rope, which occurred under unfavourable circumstances.

1356. Is the Davy lamp used there generally?—No, there is not much fire-damp in the mine.

1357. Then are we to understand that the accidents which have taken place have not been in consequence of explosions, but general mismanagement of the working?—Chiefly by falling in of the roof, want of care in the timbering, and tumbling down pits, the winding arrangements being very rough indeed.

1358. *Chairman*.] Is it your opinion that any scheme could be adopted for the establishment of schools for the children of the workmen in collieries?—I think there might be such a system without inflicting any great hardship on the colliery proprietors. I believe several of the colliery proprietors have expressed themselves favourable to such a system.

1359. Do you think any system could be enforced by legislative enactment?—I think it might be; it is so in the case of the print-works; I think it might be applied to coal mines.

1360. How would you provide funds for such schools?—I think they might be made self-supporting, by deductions from the workmen's wages, as adopted with the Dowlas Colliery, with which you are conversant.

1361. That could only be done with the consent of the workmen themselves?—Yes.

1362. In almost every case, would the workman consent to a small deduction towards the establishment of schools for the education of his family?—No; I think in many cases they would object to it. There are some parts of my district where the men are very ignorant indeed; where they attach very little importance to education.

1363. Taking that as your opinion, that a great many would object, would it be wise in the Legislature to pass an enactment enforcing the establishment of schools at all collieries?—It would be very desirable if such a thing could be done; you could not get all the boys to go to school without there is such an enactment.

1364. But provided you had such an enactment, could you then force the boys to go to school?—They do it in the case of the print-works now.

1365. Will you describe the system?—I cannot give the details of the print-works system.

1366. Are you prepared to recommend any plan?—I am not.

1367. Mr. *Vivian*.] Would it be possible to prohibit the employment of any boy who could neither read nor write?—I think it would be very much opposed if such an Act were passed.

1368. Mr. *Farrer*.] Do you think it would be advisable?—I think it would not be advisable.

1369. *Chairman*.] In most of the collieries in your district, are there not funds provided for the relief of the workmen in case of sickness?—There are not in my district; there is scarcely a sick fund in connexion with any colliery; the men have benefit societies of their own.

1370. Mr. *H. A. Bruce*.] The men belong to clubs?—Many of them do.

1371. Almost universally?—Generally.

1372. Mr. *Farrer*.] Are you speaking throughout the country, or of your own district?—My own district.

1373. Mr. *Locke*.] Has it come to your knowledge, that the miners in all parts of the country belong to benefit societies or sick clubs?—As a general rule, the workmen throughout the country belong to one or more sick funds.

1374. Is it necessary or desirable that any legislative interference with the workmen, with reference to these establishments, should be made in addition to that which exists?—It is desirable that some provision should be made for the widows and orphans. I do not see how it could be done in the case of collieries alone, without having the colliery owner to pay the larger portion of poor rates than another employer in another trade. If any enactment is made with reference to coal mines, it should be general with respect to builders and railway contractors, and all classes of workmen.

1375. Are we to understand that, in your opinion, the benefit societies and sick clubs which exist at present are not sufficient to meet the case?—I do not think they are sufficient to meet the case.

1376. Do you know the extent to which they are carried?—I know they are very general.

1377. Do you know the extent of payment which the family would receive on the death of any member of it?—I do not know the utmost amount paid in such a case. I know in some cases, where a man belongs to several funds, during the time of sickness he is in receipt of more money than whilst he is at work.

1378. You know a case of that kind?—There are many such cases represented.

1379. Is that a desirable state of things?—Certainly not.

1380. Would you propose to remedy that defect in any way?—I have not considered the question sufficiently.

1381. You were understood to say that the present system was inefficient; to what extent do you consider it inefficient?—I have stated with respect to widows and children, it is very desirable that some provision should be made for them, and also in the case of an accident happening to a workman; but if such provision were made compulsory by law, the Act should apply to all trades, and not to coal mining only. Respectable workmen have a great objection to receiving parish relief.

1382. Do you know whether the present system of the benefit societies, as they now exist, does not meet those cases?—To a great extent it does.

1383. Are you prepared to say it is so far deficient that it is necessary to make any other enactment whatever; and if so, to what extent?—I think an
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enactment might be made upon the point, but that it should include all trades, and that coal-mining should be merely one of them all. To make an enactment for coal-miners alone would come into collision with the poor rates to a great extent. If any enactment should take place, it should apply to trades generally.

1384. Still you do not know to what extent those casualties are not met by the present system of benefit clubs and sick clubs?—I know in cases of accident, and in cases of death, that many of the relatives, and the sufferer himself, is sometimes left in a state of very great distress, and he is thrown on the parish or the sympathy of his friends.

1385. You also said you have known cases where persons have belonged to so many institutions of that kind that they have been in receipt of more wages than when at work?—Yes.

1386. Those two opinions being given to this Committee, what is the best mode of obviating those two extreme cases; are there not cases that lie within those two extremes?—No doubt, a very large number.

1387. Does not the general number of cases attending those institutions lie between those two extremes?—A great number; perhaps the majority.

1388. *Mr. Cayley.*] What are the payments to the benefit clubs in the colliery districts, as compared with the payments in agricultural districts; what higher premiums do they pay?—I can tell you what the payments are in the colliery districts. I do not know what they are in the agricultural districts; fourpence in the pound is a deduction which is sometimes made from workmen's wages at the collieries; that includes a penny halfpenny for doctor, a halfpenny for schools, and twopence for sick fund.

1389. Is that per week?—That is per pound of the workman's earnings.

1390. *Chairman.*] Then the doctor attends him while he is sick, and he pays to the doctor only when he is well and at work; is that so?—It is; and for that he is entitled to medical relief; in many cases the wife and family are not attended for that payment but in the best organised cases the wife and family, or any one dependent upon the man is attended.

1391. Where do the first cases exist?—I should think they are the majority.

1392. Where the man alone is attended, and the wife and family are not attended?—Yes, I think they form the majority.

1393. *Mr. Cayley.*] Taking the case of the support of a man after the age of 60, under the circumstances of the possibility of his being cut off before that time, the insurance for him would be very small; but supposing it affected his wife and the support of his children, is there any instance where benefit societies would have to contribute to the support of the wife and children that you remember the rate of contribution to?—I do not recollect a case of the kind to give you.

1394. In reference to the support of the widow and family after death, you do not recollect any case?—I do not; that is one of the cases where I say there is great suffering.

1395. The benefit societies do not extend to such cases?—No.

1396. *Mr. Baird.*] There is no annual payment after the decease of the husband?—No.

1397. *Mr. Cayley.*] Do you consider that it is material to the safety of the workmen working in various pits that the traps should be carefully attended to?—No doubt of it.

1398. Would that be as safely confided to the care of a boy as to the care of a man?—There is a difficulty in getting men to do such work as that; it is not thought to be men's work. Some viewers state they more frequently find an old man asleep, than they find a boy neglecting his duty.

1399. What is your own experience?—The cases where men are put to doors are so few that I can scarcely offer an opinion upon the question; I have, in a critical case, where there has been a very important door to keep, put a man to attend to it.

1400. Have you experience of an accident having been produced by the carelessness of the person to whom the care of a trap has been confided?—The recent explosion in the Arley Pits, at Ince Hall, was supposed to have arisen from the fact of a door having been left wide open, but there was no evidence to show that such was the case; and all the evidence that bore on the subject showed that the doors had been shut up to a very short period before the accident.

1401. *Mr.*

1401. *Mr. Locke.*] Are you prepared to recommend that boys should not be employed?—I am not prepared to make such a recommendation. I think unless you get boys into pits when young, you would never be able to keep up a proper staff of colliers. It is dirty laborious work, which no man of mature years would think of commencing.

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1402. *Chairman.*] In Scotland, it is constantly the practice for the widows and orphans of men who have been killed in collieries to bring actions against the owners of mines where the husbands or fathers have been killed by gross carelessness, and damages are constantly given by juries; do you think such a law would be applicable to England, and, in your opinion, should such a law be enacted?—I believe the same law does apply to England.

1403. *Mr. H. A. Bruce.*] Can you point out the superior facilities in Scotland for the widows and orphans of colliers killed by accident recovering damages from the owners or managers of collieries?—I am not aware that there are any peculiar facilities in that respect in Scotland. There is a procurator fiscal, but in a civil action I think the party would have to proceed himself. They proceed, I believe, under Lord Campbell's Act; and I know no other reason for our men here not entering such actions, but that they are not generally so well informed as to the law; and I think a better feeling exists between the master and the men. In the case of a serious accident there is generally some relief, and a subscription is got up, and the parties are relieved to some extent, which keeps up a good feeling. Then the children or relatives of the deceased might imagine that their interests would be affected to some extent, if proceedings were taken by them to recover damages against the colliery owner.

1404. *Mr. Fitzroy.*] Has any instance occurred of an action being brought against the colliery owner, or the manager of a mine?—I have heard of one at Wakefield, but I cannot give the particulars.

1405. *Mr. Ingham.*] Are your answers as to the provisions made for the families of the deceased confined to your present district, or are you speaking generally?—Generally.

1406. Is it not the practice in Northumberland and Durham, that the widow is permitted to have a free house and coal free for the rest of her life?—In some cases it is.

1407. Is not that the general practice?—I cannot say it is general.

1408. Do you know any colliery where it does not prevail that, when a man has lost his life by accident, the widow is not allowed to continue in his house and have her coals free during her life?—I cannot give you a case in Northumberland or Durham, but I can in other parts of the country.

1409. Do you know enough of the district to give an opinion upon the subject?—Yes, I know the district very well.

1410. Is it not, as far as you know, the universal practice?—I am not prepared to say whether it is universal or not.

1411. *Chairman.*] Could you give the Committee any estimate of the amount of expense that a colliery owner would be put to in cases of severe accidents or severe explosions?—They are very various.

1412. Are they not put to very great expense, in cases of serious accidents by explosions?—Almost invariably.

1413. Looking at that fact, is it not the interest of the coal owner to keep his mines in as good a state as he possibly can?—It is his interest to keep them in the best state possible, but they not unfrequently take a short-sighted view of the matter, and in endeavouring to economise and get the coal cheaply, proper precaution is not taken, and an accident takes place.

Herbert Francis Mackworth, Esq., called in; and further Examined.

1414. *Chairman.*] YOU have heard Mr. Dickinson describe the ventilation in Belgium?—I can describe to you the ventilation in several collieries there.

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1415. Perhaps you will do so?—The general system of ventilating collieries in Belgium is to allow the air to descend the winding-pit to the lowest part of the seams then in work. These seams are almost invariably highly inclined. The air on entering the seam is divided into two parts, which pass right and left; the currents pass to the extremity of the work up the face, and return again by the level which has served for extracting the coal in the working on

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the next higher level. The air is then conducted by a cross-measure drift, ordinarily into the shaft, which is used for the men to ascend and descend by ladders. As an example, in the Grand Bac Pit, near Liege, the air is split 10 times, each passing one face of work. The average length of the current in the mine is 2,200 yards; each division of the air averages 2,000 cubic feet per minute. The ventilation was carried on by a chimney 220 feet high, and nine feet in diameter, without any furnace. When the weather becomes warm in the spring a ventilator of Lesoinne's construction is set in motion, which produces a ventilation of 19,000 cubic feet of air at a water gauge of one half-inch.

1416. Under ordinary circumstances is there no artificial power?—During the winter months the ventilation is carried on by this chimney without artificial power.

1417. You heard Mr. Dickinson's evidence as to the mode of ventilation in Belgium being principally conducted by mechanical means?—Yes.

1418. Do you agree with him as to the one machine which he named being the best?—Fabrey's pneumatic wheels, that is the best ventilating machine they have in Belgium.

1419. Is that as good as Mr. Struve's machine?—It gives about the same economical result as the first machine of Mr. Struve, which was erected at the Eagle Bush Colliery, and which of course possesses many imperfections since remedied.

1420. Mechanical ventilation of that kind is not practised in England?—No, there is an unfounded prejudice existing against it, on account of its imagined liability of derangement, and possibly causing an explosion.

1421. Are you in favour of a mechanical ventilation, comparing it with the furnace and the steam-jet?—Ordinarily speaking, I recommend the adoption of a furnace in mines, principally on account of its convenience, and because it is in the majority of cases sufficiently effective in producing ventilation. But there are numerous collieries in my district which cannot have a sufficient amount of air passed through them by furnace ventilation; and in other instances on account of the condition of the shafts, the employment of furnace ventilation would be comparatively far more expensive.

1422. Have you seen anything in Belgium with respect to ventilation that is better than it is in England, that you would recommend to be adopted?—Many things.

1423. What are they?—There are a number of ventilating powers employed there, nearly every one of which possesses a peculiar merit, and I think the knowledge of the performance of these ventilators would be very useful in this country, because they might be adopted with advantage in many of the English collieries which now require such powers to ventilate them.

1424. State what they are?—Motte's pneumatic screw; Letoret's inclined vane fan; Lesoinne's windmill ventilator; Pasquet's spiral ventilator, Fabrey's pneumatic wheels, the cylinder and piston pumping engine constructed of wood; Lemielle's feathering fan, and others.

1425. Mr. Locke.] These are all the machines which you think are useful, and that you would recommend in this country?—There are certain cases in which one or other of them would be more applicable than the other.

1426. Chairman.] Are they all applicable to ventilation?—Yes, they are all applied to ventilation in Belgium, and the best are considered more certain, powerful, and economical than the furnace.

1427. Mr. Fitzroy.] In addition to the furnace, or alone?—Alone; the furnace is considered to be less economical, and is forbidden by law in fire-damp collieries, and even associated with dumb-drifts, is being abandoned in order to be replaced by ventilators. Some of the first engineers on the continent have devoted themselves to this subject; the opinion in Belgium is unanimous, and in a country where the slightest danger is carefully avoided, not the slightest fear is entertained of a ventilator breaking down or danger arising from it.

1428. Are some of these more applicable to some places than others, or are they generally applicable to the English mines?—Some are applicable to a large ventilation with a small drag, others to a smaller ventilation with a heavier drag.

1429. But all capable of being adopted in this country?—Yes.

1430. Can you recommend them all equally, or have you any preference for any particular system?—I have experiments on each which will point out their peculiarities.

1431. Chairman.]

1431. *Chairman.*] You will put in those experiments?—Yes.*

1432. *Mr. H. A. Bruce.*] Are any of those plans adopted in England?—Some modifications of them; there are several kinds of fans used, and Struve's ventilator is a great improvement on the plunging bell ventilator used in Belgium.

1433. *Mr. Locke.*] What do you mean by the same kind of ventilator used in Belgium?—Struve's ventilator is an airometer similar to the gas-meter, moving up and down in water; the form in Belgium is only single acting, the air is admitted underneath, and passes out underneath; whereas Struve's performs the same office above as well as below the airometer, by four sets of valves.

1434. *Chairman.*] You have a table of the experiments of the relative value of these machines?—I have.

1435. Put that in?—Yes.

1436. Looking at the whole question of ventilation, is it your opinion that ventilation is carried on better in England than in Belgium?—The amounts of ventilation are larger in the well-managed collieries in England than they are in Belgium, but the means by which the amount of ventilation is obtained in Belgium are, in some cases, better than in England.

1437. You do not agree with the Report of the Committee of 1852 with respect to mechanical powers generally?—No, I think mechanical ventilation is very much overlooked in this country, and I think it is one of the most economical powers there is; its economy and its effects have been well ascertained, and I think it ought to be introduced into many collieries.

1438. Do you think it preferable to the system of ventilation by rarefaction?—I am prepared to compare one of the best ventilated collieries in the north of England, in an economical point of view, with the first of Struve's ventilators which was erected.

1439. *Mr. H. A. Bruce.*] Can the same amount of ventilation be procured by the invention you have mentioned as by the system now practised in England?—Yes, I believe so, by one or other of the Belgian ventilators; and by Struve's ventilation, I believe, the largest amount of ventilation can be obtained that circulates through any colliery in England. I will give you a few details with respect to one of the largest collieries in the North of England ventilated by the furnace, to form an economical comparison between the ventilation of that and of the Eagle's Bush Colliery, where the first of Struve's ventilators was erected; the Tyne Main Colliery was lately experimented upon by Mr. Nicholas Wood in the most careful maner, and it is from his data that I give the economical position of the ventilation of the colliery.

1440. How is that ventilated, by furnaces?—Ventilated by two furnaces, each six feet four inches wide; the consumption of fuel was 16·76 pounds per minute.

1441. *Mr. Locke.*] Give us the quantity of air extracted?—The quantity of air was 101,876 cubic feet per minute at a water-gauge of 0·925 inches; the amount of horse-power expended in that ventilation was 14·88.

1442. *Chairman.*] You consider that a very good result?—Yes; each pound of coal consumed on the furnace therefore produced a useful effect of 0·88 horse-power.

1443. What was the depth of the shaft?—672 feet; 8 feet in diameter, and a portion of it 7½ feet in diameter.

1444. What is the cost?—I have taken the consumption of coal, 3,942 tons at 3s. a ton, which gives 591 l. 6s. per annum. Four firemen at 14s. a week, each would give 145 l. 12s.; maintenance 6 l.; total 742 l. 18s. The annual cost, therefore, per horse-power of effective ventilation was 50 l. The first cost of the two furnaces was about 350 l. The upcast shaft, 1,344 l.

1445. Does that include the sinking?—Yes; I have put it at the lowest estimate, for which any such shaft could be sunk, less than the real cost.

1446. A brick shaft?—Yes; and they had to pass through water, but I was desirous of putting it in the most favourable light, the total first cost was 1,694 l. The first cost, therefore, per horse-power of effective ventilation is 114 l. I might mention that the natural ventilation of the Tyne Main Colliery, before the furnaces were set to work, was 34,955 cubic feet per minute.

1447. Of natural ventilation?—Yes; but I give that entirely in to the effect of the furnaces, because there was no natural ventilation at the Eagle's Bush

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Colliery. The temperature of the external air being high, and the upcast shaft only 16 feet deep.

1448. Mr. *Locke*.] Was there any chimney producing that natural ventilation in this case?—The shaft was the chimney; that was the natural ventilation through the colliery. At the Eagle's Bush Colliery the ventilation is produced by two airometers, each of 113 square feet area. The speed of the airometers was 75 lineal feet per minute. The engine had a 2 feet 9 inch stroke, and 8 inch cylinder. The boiler 9 feet long, 4 feet diameter; cylindrical, round ends, and steam at a pressure of 40 pounds. The consumption of coal 93 pounds per hour. The amount of ventilation 16,950 cubic feet per minute.

1449. That is against the 101,000 before?—Yes; the water-gauge was 1.55 inches, the horse-power expended in effective ventilation was therefore 4.14, or 2.67 effective horse-power per pound of coals. That is the point to which I have brought the calculations to form the economical comparison. The result of Tyne Main Colliery was 0.88 horse-power to a pound of coals, and at Eagle's Bush Colliery it was 2.67.

1450. Mr. *H. A. Bruce*.] Three times as great?—Yes; the cost of airometers, masonry, and connexion with the mine was 300 *l.*; the cost of the boiler, engine, and engine-house was 200 *l.* The consumption of coal 310 tons, at 3*s.*, 46*l.* 10*s.* per annum. The wages of two boys 52*l.* Grease and oil 6*l.* 12*s.* I have taken interest on capital and repairs there at 10 per cent., 50 *l.* Total annual cost 155 *l.* 2*s.*

1451. Mr. *Locke*.] In the capital account you have no shaft sinking?—The shaft is only 16 feet deep, that is included in the cost of the connecting with the mine.

1452. What mine is this; is it the Eagle's Bush?—Yes; similar to many other collieries in South Wales, the coal is worked very near to the surface.

1453. *Chairman*.] You gave us the cost per horse-power in the first case; what is the cost in this case per horse-power?—£. 25 8*s.* is the annual cost of working per effective horse-power, and 120 *l.* 16*s.* is the first cost per effective horse-power.

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1454. You will put tables of these two experiments in?—Yes.

1455. Mr. *Vivian*.] In instituting this comparison, you included the cost of the shaft in one case, and not in the other?—The cost is included in both. At Eagle's Bush it is included in the connecting with the colliery.

1456. Assuming that you had to ventilate the Tyne Main Colliery by Struve's ventilator, would it not be necessary to expend the same sum in sinking a shaft?—I think that at the Tyne Main Colliery I might have made use of a pumping shaft for the ventilation, if I made use of Struve's areometer, and consequently should not have sunk another shaft.

1457. Mr. *Locke*.] Are you aware that at the Tyne Main the shaft was sunk purposely for ventilation?—I am not aware of that. If mechanical ventilation were adopted, it might be converted into a winding shaft.

1458. In instituting a comparison of this kind, where you are testing two machines, do you or not think it fair to consider the working-up shaft as an element fixed in both cases?—No; because where there is a deep, large and walled shaft disposable for ventilation, I think that the furnace is the best power to employ. Where there is no shaft so disposable, except a pumping shaft, then the mechanical ventilator is the best power to employ, and in that case it is not right to include the first cost of the shaft in the cost of the ventilator, as no additional shaft is required for ventilation.

1459. In this case you have instituted a comparison wherein you have made use of a pumping shaft in the one system, and you have charged to the other system the entire cost of the up-cast shaft?—Yes, in the first cost; because the expense is actually saved to the owner; the first cost is not so important as the annual cost.

1460. *Chairman*.] In your tour in Belgium, have you seen any ventilating machinery, or any process of ventilation, which would induce you to recommend to the Legislature by enactment to enforce any particular system?—I think that the ascending ventilation should not be made altogether compulsory in collieries in England, because there are many in which there would be great difficulty, and it might be impossible to produce it. But I think that air ought never to be allowed to descend a second time in a fire-damp colliery without the exercise of very great caution, and should only be permitted by the manager

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or the proprietor of the colliery by express directions, and under his personal inspection.

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1461. Looking at all these different modes of ventilation by mechanical power, and looking at the modes adopted in England, did you see anything so superior in Belgium, as would induce you to recommend to the Legislature by legislative enactment, to enforce any particular system adopted in Belgium?—No, I think the kind of ventilating power must be left entirely to the proprietor; these ventilating powers, one or the other of them, are amply sufficient to get a proper supply of air to any colliery.

1462. This pit at Eagle's Bush; it would have been possible to put up a furnace to ventilate there?—No; before this ventilator was erected, a culvert up the slope with a chimney on the top of the hill was erected at great expense, but without producing adequate ventilation.

1463. In your opinion, the ventilation by rarefaction does depend on the depth of the up-cast shaft?—Yes, it varies as the square root of the height of the heated column, and as the square root of the difference of temperature of the up-cast and down-cast column.

1464. *Mr. Cayley.*] Would you indicate, as far as you can, the particular conditions under which you think mechanical power is preferable to furnaces in ventilating mines?—The majority of the pits in Somersetshire and Gloucestershire are of so small a diameter, averaging four or five feet, and are so nearly filled by the tub when it ascends and descends, that I think it would be imprudent often to adopt furnace ventilation. That is a case in which the mechanical ventilation is particularly applicable. When the drag of a colliery is very considerable, when it amounts to half an inch of water for shallow mines, and above an inch for deep mines; when the workings are carried on by means of levels or an inclined drift, so that but a very short up-cast column could be obtained; when a pumping shaft is available for the up-cast air when a shaft would otherwise have to be sunk for the purpose of ventilation. In up-cast shafts, which are used for winding, and where a high temperature is an objection; also in shafts which are not walled, where the expense of repairs amounts not unfrequently to 7 l. or 10 l. per month.

1465. Would you say, generally speaking, that the machine was preferable in proportion to the shallowness of the mine and the amount of the drag?—Principally.

1466. How did you test the relative value of these several ventilators in Belgium?—By the amount of ventilation, and the drag of the colliery.

1467. How did you test the amount of ventilation?—By the anemometer.

1468. Did you test it at all in the up-cast by the water-gauge?—I take the water gauge as well as the amount of ventilation.

1469. What effect was ever produced on the water-gauge by these machines?—I think about three inches is the maximum I have given in my tables; four inches has been reached with Fabrey's.

1470. If these machines were to get out of order, would not the effect be that the ventilation would be practically stopped?—With some machines it would.

1471. In any machine, would not the effect be, that if the machine were to get out of order, there would be an immediate stoppage to the ventilation?—Some machines are so applied, that the ventilation would pass through to a certain extent. Others, such as Struve's areometer, would stop the ventilation altogether, unless the valves were removed, which can easily be arranged.

1472. What power was generally applied to these ventilators?—The amount of horse-power applied to the ventilators has hardly been carried beyond 12-horse power, that is generally sufficient to ventilate Belgian mines, which are small.

1473. Was steam the power used?—By means of a steam-engine.

1474. If the machine was to get out of order, the power would then become wholly deficient?—The ventilator would stop; at Mynyddbachyglô one engine works a large ventilator, winds and pumps, so that if it breaks down the whole works must stop.

1475. And the ventilation in the mine would cease?—It would.

1476. Is there not a certain amount of friction to be overcome in all these machines?—Yes, it varies in different machines.

1477. Is that a loss of power?—A very considerable loss of power.

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1478. If you could apply the whole power of the steam to the air to be moved without the friction of machinery, would not that be a more economical application of power than by machinery?—The application of the steam-jet directly to the air, to set it in motion, would be a much more expensive application of it than applying it by means of the steam-engine.

1479. In what way; is not the high-pressure jet applied to the atmosphere?—The steam-jet is applied directly to the air, but rotatory engines, where it is so applied, have been always notoriously failures.

1480. Is it not one of the first laws of motion, that a body in motion continues to move until it is stopped by means of some body stopping it?—Theoretically, it is.

1481. How is the steam stopped?—By the reaction on all sides, as well as the line of motion, by its own weight, by its condensation.

1482. Does not the steam-jet communicate the whole of its power to the atmosphere with which it comes in contact?—I imagine that it expends a greater portion of its power on the jet through which it passes, and in forming a partial vacuum above it.

1483. Would not the power be indicated by the tendency to vacuum which it produced?—No; the water-gauge will give you a certain indication of the amount of resistance to the force applied by the steam to the air, by the expansion in the air of the mine which this force and resistance, pulling against one another, cause.

1484. If the effect of the water-gauge amounted to 15 feet by the steam-jet, and the effect of the water-gauge by one of these machines which you say amounted to three inches, would not show a greater power applied to the atmosphere by the steam-jet?—I think there have been most serious mistakes made in stating that the water-gauge is an indication of power; water-gauge simply indicates a resistance; what I call power is resistance multiplied by velocity; another name for it is work.

1485. Mr. *Locke*.] Do you think it would be an advantage that the steam should pass directly to the paddles of a steam-boat, instead of going through the cylinder and having its force expended through machinery in order to produce a result, or do you not?—I think it would be an enormous squandering of power.

1486. If you passed the steam directly to the paddle?—Yes, there would be an enormous loss of power if you applied the steam-jet directly. In order to determine the power of a jet of steam or any other means of moving air, it is necessary to take into consideration both the resistance, as indicated by the water-gauge, and the velocity. Although you may obtain 15 feet possibly of water-gauge by a jet, the quantity of air that passes is little or nothing at all; and to put it in the strongest light, I believe, without any difficulty, I could suck up the same amount of water-gauge with my mouth. I believe that is precisely the same action which the steam exercises; water-gauge is no indication of power at all, without it is associated with velocity.

1487. Mr. *Cayley*.] You saw the experiment in the Polytechnic Institution last year; how do you account for the force which appeared to be applied there?—There was the force applied, but there was not the power developed.

1488. The water-gauge was affected to the extent of 15 feet?—Yes, I have understood that it was, the common pump will do 30 feet.

1489. If the water-gauge was affected to the extent of 15 feet close, or nearly close to the jet, can you assign any reason why a water-gauge, placed half way up the shaft, would not be equally affected, the conditions remaining the same?—It depends entirely on the air passing, it is impossible for me to form an idea of what the power produced was when those 15 feet of water were raised by the steam-jet, without knowing the quantity of air passed through by that steam. In practice the steam-jet falls much below the furnace, and far below other powers in the water-gauge it will produce, and the resistance it will overcome. I have given a table of the cost of getting up three inches of water-gauge with a steam-jet.

1490. Mr. *Locke*.] Are we to understand that the objection to the use of mechanical means was, that it was subject to derangement; if that machine got out of order the ventilation of the mine would be entirely stopped; now apply that to the destruction of a machine by explosion, would it be as easy to re-adjust or re-apply that fixed machinery for the purpose of ventilation, as it would be

be to fix the furnace?—Your question divides itself into two parts, which I will answer consecutively. I made particular inquiries in Belgium as to their experience of these machines, and they were surprised at the idea that there should be any danger connected with the use of them, either from their breaking down, or causing explosion when they did break down. One, which had been longest in use, was a wooden cylinder and piston ventilator, a kind most liable to derangement, at the pit Hainchamp's, which had been at work for 18 years without a break down. An explosion had occurred during that time without affecting the machine. Whenever a ventilating machine is employed, in order to use every possible precaution, I think that the air-way between the ventilator and the shaft may be covered with planks, so that an explosion would blow those out without affecting the ventilator, and in that case they could be replaced more rapidly, and brought to work much more safely than a furnace.

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1491. Mr. *Vivian*.] You would attach a description of safety-valve to the machine in case of explosion?—Yes.

1492. Have not the force of explosions been known to blow the whole shaft head off?—Yes.

1493. Mr. *Locke*.] In that case would your safety-valve be effectual?—Perfectly.

1494. Then with this precaution, in your judgment do you think that you would be perfectly secure from derangement by the adoption of these mechanical means, and that there would be no chance whatever of their being destroyed?—I speak simply on the information I received in Belgium, and the unanimous opinion there as to their superior safety.

1495. Supposing these mechanical means were employed in England, and liable to explosions such as we have here, do you think the application of such a machine to a mine would be perfectly secure against explosions if they arose?—I think they might be made perfectly safe. The precautions that I should adopt in a colliery where they were used in case a break down of a machine occurred, would be a strict rule that all the men should leave their work as soon as there was a stoppage in the air current. The use of a ventilator affords additional security for having a uniform current of air; for there are three very simple kinds of danger signals adapted to the ventilators in Belgium, which act through the medium of the water-gauge. As soon as the water-gauge falls a little, it sounds a whistle, and the engine-man is immediately aware that there is a slight diminution in the amount of ventilation. The water-gauge is a delicate test, because it varies as the square of the amount of ventilation.

1496. Mr. *Locke*.] Would it be difficult to apply it to furnace ventilation?—It would be necessary to have a boiler to the whistle.

1497. Would it be difficult to apply that for the purpose of giving warning?—No, it would be nearly as easy, putting out the cost of the steam-pipe, to apply it to a furnace as the ventilator.

1498. Mr. *Vivian*.] But a signal line passing from a water-gauge, placed under ground, up the shaft to a whistle on any boiler at the surface, would equally indicate the fall of the water-gauge?—In that case it would have to be observed by a man; whereas, in cases to which I have been alluding they would be self-acting.

1499. Mr. *Locke*.] In either case could it not be made self-acting?—Yes, by putting up a small boiler, or other means of sounding the whistle.

1500. It being as easy in one case as the other to apply the security which you suggest as one of the peculiar advantages of the mechanical means of ventilation, do you still attach as much importance to the mechanical means as you attached previously?—Yes, I think it is a safer appliance to the ventilator, because the water-gauge in this is very much greater than the water-gauge of the furnaces, and there is a great fall for a small diminution in the ventilation.

1501. Might not they be of the same size?—Yes; the water-gauge of the furnace and the ventilator might be the same.

1502. *Chairman*.] You stated in a former part of your evidence that the mines in Belgium were by no means so fiery as the most fiery mines in the north of England?—No, they are not so fiery as the most fiery mines in the north of England.

1503. In any mines in Belgium did you find the same amount of ventilation
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going through them as you found in some of the mines in the north of England, in Durham. Take the South Hetton, for instance?—No; the quantities of ventilation in the north of England in the larger collieries is three times as much as in the largest collieries in Belgium. The collieries in Belgium are not so large as those in England, owing very much to the direction in which the seams lie, being highly inclined. With strictly ascensional ventilation much smaller quantities of air are necessary for safety.

1504. To procure such an amount of ventilation as they have in some of the best managed collieries in the north of England, do you think any of these mechanical apparatus could be applied economically?—There is a mechanical apparatus (Struve's) now erected, and a portion of it (one airometer) is at work at the Middle Dyffryn Colliery in South Wales; and I believe when the air-ways are opened out to anything like the same extent in size as the air-ways of the collieries in the north of England, that it will produce a ventilation quite as large, and more economically.

1505. Can you state what is that apparatus?—There are two 20 feet diameter airometers of the same kind which I have described, and each stroke will produce a ventilation of 10,000 cubic feet.

1506. Is that Mr. Struve's apparatus?—Yes.

1507. Can you tell the Committee what horse-power steam-engine it takes to work those airometers?—The steam-engine at Eagle's Bush is about 8-horse power.

1508. What is this one at Dyffryn?—I have not seen it since it was put up; I think it is an 18-inch cylinder. Mr. Powell has gone to great expense to have his colliery ventilated in the best way.

1509. Is it your opinion that that machine will be worked more economically than the furnaces to produce the same amount of ventilation?—I think so.

1510. What is the depth of the mine?—The depth of the shaft is 165 yards; at present there is a furnace at the bottom, and a steam-jet on the surface; and I have no doubt of the economy being far greater than that of these motive powers, separately or combined.

1511. Mr. Cayley.] Is there not a point of depth at which the furnace becomes the most economical mode of ventilating?—There is a point, but I am not aware that it is yet attained by the deepest shaft we have in England.

1512. Chairman.] You have stated, that in your excursion through Belgium, you have found nothing which you can recommend to be adopted as an improvement in the working of the best regulated mines in England; with respect to the management, have you seen anything in Belgium that you can recommend as being a decided improvement on the best managed mines in England?—I think the discipline of the Belgian collieries is as nearly perfect as discipline can be.

1513. Has the number of deaths decreased in Belgium in the last 15 years?—Dividing the last 15 years into three periods of five, and taking the average number of deaths on 10,000 persons employed in the mines, in the first five years there were 208; in the second five years 170; in the third and last five years, up to 1850, 120.

1514. Have you seen experiments made on the steam-jet in Belgium?—I have an account of them.

1515. Mr. Ingham.] Were you present at the experiments?—No.

1516. Chairman.] From whom did you receive them?—From Mr. Glepin, who was appointed by a large colliery proprietor to compare the various known ventilating powers, with the view of introducing the most economical in his very extensive works at Grand Hornu; he is the engineer of those collieries.

1517. Mr. Locke.] Not a Government engineer?—No.

1518. A civil engineer?—Yes.

1519. Are his experiments published?—They are printed only for private circulation.

1520. Chairman.] Did you see anything in Belgium that you can recommend to be enforced by legislative enactment in England, further than what you have already stated to the Committee?—I think that it should be enacted that ventilation should be produced and conducted by perfectly safe and efficient means, and there are other recommendations which I am prepared to lay before you.

Edward

Edward Cayley, Esq., called in, and Examined.

1521. Mr. Cayley.] ARE you practically acquainted with coal mines?—No, I am not. *E. Cayley, Esq.*

1522. Have you given scientific attention to the question of ventilation?—To a certain extent. 23 June 1853.

1523. Have you ever been at any practical experiments in regard to the use of the steam-jet?—Yes; I have seen it applied practically in one case, particularly in putting out a fire.

1524. What was that case?—It was in Scotland.

1525. Upon what occasion?—It was at Alloa, about three years ago.

1526. What was that experiment?—It was the putting out of a fire in a coal-pit in Alloa, about three years ago.

1527. What was the size of the coal-field?—We had to fill about 25 acres with choke-damp.

1528. Was the mine on fire?—The mine was on fire at the time.

1529. How long had it been on fire?—It had been on fire about 30 years.

1530. Had they been able to extinguish the fire by any other means?—They had walled the fiery part of it round, and, in fact, there had been two or three walls made, so that the place was divided into three or four different compartments. They had been beaten over by the fire, but they had got it enclosed within a large mud wall inside. There was about 25 acres.

1531. But practically the fire remained smouldering?—In spite of the wall.

1532. Had the injection of carbonic acid gas the effect of extinguishing the fire?—Yes; it appeared to have extinguished the greater portion of it; but some doubt remains as to whether one portion was not still smouldering. At the east end it had been arched over, in consequence of some of the walls built in the first instance giving way. We could not get in to see.

1533. *Chairman.*] Can you state whether the fire is now out?—There is some doubt as to one corner of the pit. There is no doubt we extinguished the fire in the part we got the gas into; but there was some doubt as to whether some of the residue had been got at. We had no means of ascertaining.

1534. What was the depth of the pit?—I think it was something like 20 yards deep, it was very shallow.

1535. Mr. Cayley.] The jet was propelled down the pit and other workings; and did the carbonic acid gas come out at any place?—Yes; it passed down, and we found it coming out. We tested it with lights at a sort of level driven in at the crop. It rolled out there. When we had been blowing the gas in some hours, we found the carbonic acid gas passing out there sufficient to extinguish lights.

1536. The carbonic acid gas was injected by means of a steam-jet?—Yes.

1537. You have heard the evidence of the last witness on the subject of machine ventilation?—Yes.

1538. Do you consider that there is any loss of power in ventilation by a machine?—There is the loss of the friction, of course.

1539. In what respect does that argument not apply to the steam-jet?—I apprehend there is no loss of power on the steam-jet, for this reason; I believe it is the first law of motion, that a body in motion continues to move for ever, unless it is stopped by something to which it communicates its force. Now the steam in passing out at the jet is going with the full force which the steam is capable of exerting, therefore I apprehend that unless it was stopped by some body through which it passed, and against which it impinged, you would have a perpetual motion produced (not in the sense that it is sometimes used), but the thing would continue to move until it was stopped by some other body. Now that body is the atmospheric air, against which it strikes and through which it passes, and therefore it appears to me there is no loss. The steam-jet is not necessarily a steam-jet, but a jet of air answers the purpose exactly in the same way. That air or gaseous substance would continue to move for ever, unless and until it was stopped by some other substance, and whatever other substance stopped it, it must communicate its force to.

1540. Mr. Locke.] You are of opinion then, that the application of steam in an ordinary steam-engine, directly puffing against the paddle-wheel, would be more effectual than in its present application by machinery?—No, certainly not; there is no necessary connexion between the two positions. The difference

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is this, you obtain the full power of the steam or of the jet, whatever substance it is, in moving the air; but you cannot obtain the full power of the air in moving the machinery. It would be a misapplication rather than a loss of power. In this case, your object is to move air and not machinery. If your object is to move machinery, you would have a loss in applying it to air, from which it is impossible to obtain its full force.

1541. Do you take any account or attach any importance to the different degrees of density of the two substances used, water and air or steam?—Water you could scarcely use in the same way, although to a certain extent a fall of water does produce the same effect; but the colder the substance, the colder the air, if you are using the jet of air, I believe it has been found by experiments the greater the effect, but it is a very trifling difference. I conceive it to act entirely mechanically, and upon that ground, upon the first law of motion, that it would continue to move for ever unless it was stopped, and to the bodies that stop it it communicates the full energy of its force; that body is the air which you wish to accelerate. I am not practically acquainted with machinery sufficiently to give an opinion, not being a mechanic.

1542. *Mr. Ingham.*] You were present some time during the experiment at the colliery at Alloa?—Yes.

1543. How long?—I was there a fortnight or three weeks.

1544. *Mr. Cayley.*] In what way do you consider the steam-jet is the more powerful agent of ventilation than the furnace?—I consider it to be more powerful, inasmuch as you produce a greater vacuum; you obtain a greater force by it. I consider that it ought to be more economical, because I do not know that it is a necessary part, the burning coal under a boiler, that it is less perfectly burnt than in a furnace; I do not know that that is a necessary part of the arrangement of a boiler. Therefore, I apprehend you must under a boiler get the heat which is applied through the steam, so that you ought to get, if the steam was perfectly applied without loss, the heat of the coal plus the propulsion of the steam, therefore, theoretically I should imagine it ought to be more economical.

1545. Theoretically, do you believe there is a limit to the furnace power of ventilation?—There is a limit, because it is impossible to get beyond a certain heat; if you push your furnace too far, you get a pull of air down one of the sides of the pit, as you do in a smoky chimney occasionally.

1546. *Chairman.*] Would that be so if the air-ways were sufficiently large to bring sufficient air to fill the up-cast shaft?—No; then we should have plenty of ventilation, but if you have a throttle, it of course produces it. With the jet you cannot produce it.

1547. *Mr. Cayley.*] Is it the fact then, that the steam-jet operating not in the way supposed, but in the way you have described, is a much more powerful agent in ventilation than the furnace?—I conceive it more powerful in the way described, but I do not say it is an agent more universally available than the furnace. I think the furnace is a perfectly efficient agent in many cases, but I think the jet, in difficult cases, gives you a command of a much greater power; and, for particular instances, for clearing a mine of choke-damp after an explosion, is perhaps the only means you have.

1548. For these reasons you think the steam-jet, among the mechanical powers, if it may be so called, is a more economical agent than the machines you have heard described to-day?—Yes, I should be inclined to think so; and less liable to danger from explosion.

1549. Have you ever known machinery deranged by explosion?—I saw some at Nit's Hill Colliery; I was there a day or two after the explosion. All the head gear of the pit was blown to pieces. The jet is a very small arrangement of pipes, and if it was blown off it could be put up again in the course of half an hour, and small steam pipes would not be liable to be blown away. At Nit's Hill I saw all the head gearing blown to shivers.

1550. Were you at the Nit's Hill pit shortly after the explosion?—Yes.

1551. Did you hear what means of ventilation they had?—They trusted it to the winds of Heaven; there was no artificial system. They had not had the furnace in for three months; at least, so I was told at the time.

Lunæ, 27^a die Junii, 1853.

MEMBERS PRESENT.

Mr. Hutchins.	Mr. Stephenson.
Mr. Cumming Bruce.	Mr. Fitzroy.
Mr. Baird.	Mr. Locke.
Mr. Ingham.	Mr. Cayley.
Mr. Cobbett.	

EDWARD J. HUTCHINS, Esq., IN THE CHAIR.

Herbert Francis Mackworth, Esq., called in; and further Examined.

1552. *Chairman.*] YOU stated, at the last meeting of the Committee, that you would put in experiments of the different ventilators in Belgium?—Yes; I hand in a description of them (*the Witness delivered in the same*).*

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1553. Do you consider that bad ventilation is injurious to the health of the men, as well as uneconomical to the proprietors?—That subject is the most important which affects the workmen in mines and collieries. I believe it produces very great and quite unnecessary injury to the lives and the health of the men; miners are proverbially short-lived; and as they enter the works at an early age, it is at that time it produces the most serious effects, carrying off those of weak constitution, and only leaving the most hardy. In the summer time, as the temperature of the air increases, the ventilation in a mine stagnates; the men are sometimes, for days or weeks, unable to carry on the work, as candles will not burn. The oxygen in the air is quite as essential, or more essential, as support to life, than proper food. The condition of many mines may be easily imagined, by supposing a room containing a number of persons to be hermetically closed until the atmosphere was raised many degrees higher in temperature, and candles would scarcely burn. It is evident that the amount of work to be performed by the men must fall far short of that which would be executed if the supply of air was adequate for their health and vigour. In some mines, where the ventilation has been increased, the men have admitted that they are able to do one-fourth more work in the course of the day. According to an analysis of the air, in some mines in Cornwall, where four men were at work in a dead end, and the candles would hardly burn, the proportions of air were 85 per cent. of nitrogen, 14·7 per cent. of oxygen, and 0·3 per cent. of carbonic acid gas. The average of 18 samples of air gave 17·07 per cent. of oxygen, 82·85 per cent. of nitrogen, and 0·08 per cent. of carbon. When the amount of oxygen is reduced from 21 per cent. to 16 per cent. candles will hardly burn; and when it is reduced to below 14 per cent. it produces suffocation. This deficiency of oxygen, or, which is the same thing, excess of nitrogen, produces a pressure on the chest, a strange fatigue, and feebleness; the breathing becomes quick and heavy; the work is performed with great labour and thirst; and drowsiness, vertigo, and convulsions eventually succeed. The carbonic acid gas, which produces injurious effects on the men, and occasionally death, is an active poison; whereas nitrogen simply acts from the deficiency of the vital oxygen. When the amount of carbonic acid gas is above 10 per cent. it produces death. In consequence of these two deficiencies, in coal and other mines, pulmonary diseases, black phthisis, asthmas of various kinds, and a disease called *anemie*, are more or less prevalent. Dr. Barham, in his Report to Lord Ashley's Committee, states: "Hence it is that almost every miner in the deeper mines is at all times exposed to what he himself designates 'poor air,' by which he means air so impure as to affect him in a noxious way, distinctly perceived by him at the time. Of the less marked degrees of impurity he takes no account. Of the deficiency of oxygen, and the excess of carbonic acid, the presence of a sulphureous acid, or sulphuretted hydrogen, he is not aware; and of smoke, however dense, he seldom takes any notice." By Mr. Lanyon's Table the average age of 2,145 miners was 30 years and four

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* *Vide Appendix.*

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months; and of 1,033 labourers above ground the average duration of life was 40 years and four months.

1554. Those are ordinary labourers?—Yes; but from the miners leaving work when they are incapacitated from breathing this noxious atmosphere, and finding employment on the surface, he thinks that the shortening of life amounts to nearer 20 years than 10. In the Report of Lord Ashley's Committee it is stated that the average duration of life of old colliers in Pembroke-shire is 40 years; a surgeon at Narbeth, and another at Coleford, state that they rarely attain the age of 45 years. Mr. Franks says, in the same report, that labour in the collieries of Glamorgan, Pembroke, and Monmouth, is unwholesome, and productive of diseases which have a tendency either to shorten life, or reduce the number of years of successful labour. The diseases in South Wales and Somerset are principally chronic diseases of the respiratory organs, asthma and bronchitis. It would appear that coal in mines is in a state of decomposition; the gases which are found in different mines are an indication of the state of decomposition in which it is; the coal by the absorption of oxygen, forms carbonic acid gas, and this oxygen being taken away from the air, a double deterioration is produced, and a difference in the percentage of oxygen of only one-half the amount I have stated, under those circumstances would produce a similar effect. The fire-damp collieries have usually sufficient air for the health and vigour of the men. I find on a large average that a man does one-fifth more work in the fire-damp than in the choke-damp collieries. Dr. Hanot could distinguish the men working in each by the lividity of complexion arising from the want of oxygen, which acts as the colouring matter of the blood.

1555. Are you the engineer of the Standedge tunnel?—I was; during the time I was the engineer I had an opportunity of seeing the effects of impure air very strongly exemplified.

1556. Where is Standedge?—Between Manchester and Leeds. It is the longest railway tunnel hitherto made. I had occasion to spend nearly a fortnight uninterruptedly under ground, and myself experienced the effects.

1557. Will you state those effects?—Soon after the works were opened, a large proportion of the men, amounting sometimes to one-fourth, were laid up from illness; the average amount of medical and surgical cases were from 200 to 300 per quarter; the average was two-fifths surgical cases, and three-fifths medical cases; the principal ones were diarrhœa, fever of a low type, and inflammatory affections of the chest and windpipe; in some cases complete loss of voice, which remained for some time; the smoke from the boats which passed through the tunnel was productive of very much mischief, the expectoration in many instances being loaded with carbonaceous matter. The cases were more of an asthenic than of a sthenic form; the men who worked inside were pale, and did not possess strong restorative powers; the treatment generally was tonic; there was very little disease when the ventilation became good; the recoveries were tedious; but certainly the pure mountain air did wonders for the men, many cases recovering which, in a less pure temperature, would have died. I feel satisfied that noxious gases, and the want of ventilation, aggravated by the smoke from the boats, increased in a very considerable degree the disease amongst the workmen at the Standedge tunnel. This information is mainly obtained from the medical man, H. H. Broughton, Esq., M.D.

1558. Do you consider that natural ventilation is ever applicable to mines?—Only under extremely favourable circumstances. In the winter months, when there is a difference of temperature of 25 degrees at least, between the down-cast and the up-cast shaft, and the air-ways of the mine are large and laid out in the best manner, under those circumstances alone would the quantity of air be adequate for the men in a colliery where no explosive gases were present.

1559. Does the quantity of air depend on the number of splits and the area of the air-courses?—The division of the air into a number of currents, and the enlargement of the air-courses, is the best method of taking a large quantity of air through a mine; and when an air-course of the same length and area as the first one which there might be in a mine, is added for the purpose of ventilation, the amount of air is nearly doubled. It is called splitting the air, and is the same thing as making two channels for a river instead of one.

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1560. Is it the difference of pressure at the bottom of the shaft which causes ventilation, in your opinion?—It is not precisely correct to say that it is the height of the heated column of air which produces ventilation. It depends upon the relative weight of two columns of air, reaching from the highest limits of the atmosphere down to the bottoms of the down-cast and up-cast shafts, and the rise and fall of the air-ways in the mine. That which primarily produces ventilation by rarefaction, is the difference of pressure at the bottom of the up-cast shaft, and a point at the same level in the down-cast shaft. It may be best illustrated by taking a barometer to the top of the down-cast shaft, and then to the bottom of the down-cast shaft; it will be found that the difference of pressure at those two points is less than a calculation taking in the depth of the shaft and the temperature of the air would afford; the difference being very nearly the amount of expansion which the air has undergone in the down-cast shaft, from being dragged through it. As I pass round the mine, following the air current with the barometer, it is constantly falling, until near the bottom of the up-cast shaft, where it stands at the lowest point which it will reach in the mine; the difference between the point at which it stands, and the point at which it should stand by calculation, represents the amount of expansion or resistance which the air has undergone in being drawn through the mine.

1561. You have invented an air-pressure gauge?—Yes. In making the experiments which I have described, I made use of a barometer invented by Descartes, which has a scale six times as open as the ordinary barometer; that was not sufficiently delicate for the purpose, and I contrived an instrument something on the principle of the sympiesometer, but containing a thermometer in the air-vessel, which afforded me a scale fourteen times as open as that of the ordinary barometer. It is only eight inches high, and very portable.

1562. How would you measure the power of ventilation?—By ascertaining the total expansion which the air undergoes in being drawn through the mine, converting that into so many pounds of pressure per square foot, and multiplying it by the velocity at which the air moves.

1563. Is that an accurate mode, in your opinion, of measuring the power of ventilation?—That is the only accurate mode of measuring the effective ventilation in a colliery.

1564. What is the mode which has been hitherto adopted?—In measuring the economy of the ventilation of a colliery, it is generally stated that so many cubic feet of air have been passed through that colliery by the consumption of one pound of coals; whereas, the resistance, in many cases, is double what it is in others.

1565. Mr. Stephenson.] Do you consider that, in estimating the efficiency of any system of ventilation, you ought to take into account the amount of drag of the air?—I think it is equally important to take the drag into account with the amount of air which is passed through; otherwise it would be like estimating the economy of a steam-engine without knowing the pressure on the piston, or of a locomotive without the weight or resistance of a train.

1566. In comparing two systems of ventilation, would you not endeavour, in determining upon the best of the two, to make the experiment with the same amount of drag in each case?—Undoubtedly, if it were possible; but in order to compare the ventilation obtained under different circumstances of drag, those drags must be taken into account.

1567. Do you consider that some eminent viewers, who have compared the efficiency of the steam-jet with the furnace, have come to various results, in consequence of having neglected the amount of drag?—I believe this neglect is at the bottom of the serious errors which have been made respecting the steam-jet. In many other cases the drag has been taken into account, to a certain extent, although the economical result has been stated in the way which I have described. This I regret, as it is calculated to mislead the simply practical man, and shuts the door to a strict comparison of the merits of the various ventilating powers.

1568. If you compare two plans of ventilation in the same mine, under similar circumstances, not altering the air-courses at all, nor lengthening them, and consequently not affecting the drag, would the comparative merits, under those circumstances, not be ascertained fairly?—I think it would be a most favourable manner of comparing the two systems of ventilation, to work them

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under the same drag, and up to the same velocity; but fully to understand the merits and applicability of a ventilating power, it is necessary to vary the ventilation with the same drag, and vary the drag with the same ventilation.

1569. Have not many experiments been already made by eminent men in the coal trade, under such circumstances?—The experiments have, in many instances, been satisfactory.

1570. What do you mean by “satisfactory”?—They have afforded the means of comparing the two systems of ventilation correctly, by the great scale and elaborate care with which they were conducted.

1571. Therefore the experiments of that kind which have been made do not tend to any delusion?—No; they have been made, I feel convinced, with the most honourable desire to arrive at truth, and increase the safety of the mines.

1572. They give broad and approximately correct results?—Many of the results are so approximate as adequately, for ordinary purposes, to compare the furnace and steam-jet.

1573. *Chairman.* Do you agree with the Committee of 1852 as to the existence of a natural brattice?—In consequence of so much stress being laid in that report upon a matter which I had previously thought of no importance, I have directed my attention to discover the existence of a natural brattice; but although I have visited a large number of collieries I have not been able to find one. The ground on which the natural brattice was put forward does not at all exist in mines. The proportion between the diameter and the height of the shaft has not been taken into consideration. When the shaft or the tube become 100 times the height of its diameter, it appears on the face of it to be impossible that the air can descend at the sides when it is ascending at all rapidly in the middle. In point of fact, if the bottom of that column were closed, no fire would be able to burn.

1574. Supposing the air-ways are so large that the amount of air passing them would entirely fill the up-cast shaft, do you think it is possible that a natural brattice could exist?—I think that a natural brattice from such a cause as has been put forward is impossible, except when the velocity of the air is hardly, if at all, perceptible.

1575. Do you agree with the Report of the Committee of 1842, with respect to the existence of a furnace paradox?—I totally disagree with the conclusion which was come to upon that; and I think it is right to point out, that that conclusion was put forward by Mr. Hann and several other witnesses, in total misconception of the evidence which was given by Mr. Woodhouse in 1849. Mr. Woodhouse is made to state, that when the furnace is pushed beyond a certain point, the current of ventilation stops altogether. It is very clear upon a careful reading of Mr. Woodhouse's evidence, that he merely means that the power of increasing the ventilation stops; and the true explanation of that, which has not yet been given, is that the power required to ventilate a colliery increases at least as the cube of the amount of ventilation. It is easy to demonstrate this mathematically, but I have proved it on the furnace and mechanical ventilators by measuring the power and the quantity of coal consumed.

1576. You stated in your evidence, the last time you were examined, that you were inclined to prefer mechanical ventilation to any other system. Do you consider that it would be desirable for the Legislature to enforce any particular system of ventilation?—Under the majority of circumstances, I think the furnace is the most convenient, and possibly the most economical to use; but there are many cases in which mechanical ventilation is preferable and can alone be effectual. I think it must be left to the option of coalowners, with a proviso that there shall be sufficient quantity of air passing through the mine.

1577. Should the power of ventilation always be capable of being increased, to meet such an emergency as an escape of gas from a blower?—I think it is a point of great importance; and it appears to me, that in that point of view, mechanical ventilation offers superior advantages to any other system of ventilation. It has a more expansive action, accompanied by greater uniformity and safety, as I have before shown, and it is capable, in an emergency, of passing a much larger quantity of air than any other means. The speed of machines can be readily increased.

1578. Do you think that accumulations of gas should be removed while the men

men are in the mine?—I think that accumulations of gas should only be removed, and with the greatest care, when the colliers are out of the mine. They ought never to be allowed to occur, and every goaf should be thoroughly ventilated.

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1579. Have you any suggestion to make as to the capacity and size of the air-ways, and the best mode of carrying the air through the workings to the up-cast shaft?—I think that the working of a colliery ought to be divided into panels; that the air should enter by an unalterable intake air-course, enter the various panels without doors, and be coursed through the panels by doors and stoppings; that there should be only one inlet and one outlet formed by a regulator, constructed in the most solid manner, at the higher side of the panel, next to the return air-course, and so as to resist any explosion.

1580. In speaking of panels, do you mean the solid pillars of coal which are left to separate one part of the workings from another?—A square room of work, divided from the other rooms or panels by barriers of coal; so that if an explosion occurs, it is confined almost entirely to that panel. If all the doors and stoppings in the panel are blown down, a larger quantity of air passes through that panel than before the explosion, but by a straight course through it, and within a sufficient distance of the working face to allow the men to make their escape without being overcome by the after damp.

1581. Mr. Fitzroy.] Has that plan been introduced into any colliery?—Yes; into some collieries in England.

1582. Chairman.] Do you agree with the Committee of 1852, as to the utility of refuge stalls?—No; I think they could not be carried out practically. If an explosion occurred and injured them partly, as would probably be the case, they might become filled with suffocating gas.

1583. Where crossings are made, should not great care be taken that they are made of sufficient strength?—Crossings are very weak points in a mine; and in order to build them in the strongest manner, they ought either to be constructed of whole timbers crossed, resting on arching, and supporting an invert above; or they should be constructed of boiler plate, and supported by masonry.

1584. Mr. Stephenson.] Are they not usually constructed of strong brick-work now?—Many of them are constructed of brick-work in the manner which I have described.

1585. Chairman.] Do not you think that strict attention ought to be paid to the discipline of the mines, in all cases?—I think that is essential to the safety of every fire-damp colliery; and that the only mode to insure it is by the careful superintendence of the viewer, or of the proprietor himself.

1586. Do you think that education of the colliers and overmen would be the means of insuring better discipline?—I think that the education of both is of very great importance. No doubt the education of overmen is of the most importance. In the case of a collier, he becomes more careful and attentive; and by adopting a system of reward or promotion for education and intelligence, I think that the best system of discipline may be introduced into the mines. Of this, some of the best conducted mines in the north of England afford good examples. Education is an instrument of great power for good which position has placed in the hands of the master, if he will use it aright.

1587. Can you suggest to the Committee any means of improving the education of the colliers and the overmen?—In some of the larger collieries in my district the schools are well conducted; they are supported, to a certain extent, by the proprietors; and they reach a perfection which is almost as great as one can expect at first to attain. With regard to the education of the overmen, in some parts of the country they are of a much superior class than in other parts. Many of the Newcastle overmen, who manage collieries in my district, are well skilled and good men, and show how much may be done by introducing a system of education generally amongst that class. I am not prepared to recommend any specific system of education for the overmen. It is a wide field, requiring much consideration.

1588. Is practical mining taught in those schools to which you have alluded?—In the schools for the colliers, they learn usually reading, writing, and arithmetic. Some of the overmen read and educate themselves. There is no school and no book which will give them precisely the information they most want.

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1589. Do you agree with the Report of the Committee of 1852, as to the use of safety-lamps?—I have not met with any well substantiated case of an explosion having occurred from the use of the common Davy lamp; and I think that, with proper usage, it is a safe lamp; still, the glass lamp, by Mueseler (8,000 of which are employed in Belgium, and are much approved of), could be very advantageously introduced into the English collieries.

1590. You would not use the safety-lamp as the means of rendering less attention to ventilation necessary, but rather as an increased security in addition to good ventilation?—Undoubtedly. There is nothing contradictory in the two. The lamps should always be locked.

1591. Are there any circumstances in which you would recommend that the use of the safety-lamp in mines should be rendered compulsory by legislative enactment?—I think it ought to be compulsory in every fire-damp colliery. With the increased light and safety from the Mueseler lamp, no objection can hold its ground. Watson's method of locking is the best I have seen, as the men cannot pick it.

1592. Mr. Fitzroy.] Has any improvement lately been made in safety-lamps?—There is one by Dr. Glover, at Newcastle, which is a very safe and very ingenious lamp; but I am afraid that, on account of its weight and price, it is not very likely to be introduced into mines.

1593. Mr. Ingham.] What is the price?—Twelve shillings.

1594. Chairman.] Do you consider that is the best lamp which has hitherto been invented?—It is one of the most ingenious. I think the Davy is the best lamp for some purposes; and it is the one I always use myself. I have added a second gauze and glass chimney to it, which very much increases the light, prevents the men lighting their pipes, and renders it less affected by currents of air.

1595. Can you suggest to the Committee any precautions which should be enforced by the Legislature as to winding the men up the shafts, so as to prevent a great number of accidents by the breakage of ropes, chains, or any other part of the standing machinery; and also from the falls of coal, or any substance, on the heads of the workmen when they are being wound up the pit?—I think there should be a shaft indicator in every engine-house; that guides ought to be used in shafts; that shafts ought to be walled, and the shaft tops protected; that there should be a cover or bonnet for the men, in ascending and descending; that cages should be employed as far as possible; and that any imperfections in the machinery which might tend to endanger the men should be at once repaired. With regard to precautions against falls of roof, the system which is adopted in the north of England, of making the deputies set the props, tends to a considerable saving of life, and is almost universally employed on the Continent.

1596. You mean that if the men are allowed to set their own props they do not pay sufficient attention to putting up a sufficient number of props to ensure their own safety, and consequently lose their lives by their own carelessness?—Yes; and in addition, the props are more regularly supplied into the pit, the deputies are able to watch over the men, and see that they conduct themselves with a proper regard to safety in other respects.

1597. Do you agree with Mr. Dickinson in the evidence which he gave, that the inspectors should, under any circumstances, have the power to stop a mine?—I am not prepared to recommend that they should have that power individually.

1598. Do you agree with him as to the arbitration which he suggested?—I think that some plan of that sort would be very desirable.

1599. Do you agree with him as to the necessity of the Government inspector enforcing a regulation that proper plans of all collieries should be kept?—I think that it is essential. It is provided for in the present Act, but there are no means of carrying it out. A very serious accident occurred in my district a short time ago, in consequence of the inspector's cautions in two instances having been completely neglected. The plans have been subsequently made; and it is now from them perfectly clear, as I stated to the jury at the inquest, that if those plans had been in existence at that time, the accident would not have occurred.

1600. Mr. Fitzroy.] When you state that "there are no means of carrying it out," do you mean that there are no means of enforcing it?—Yes; I have taken the opinion of an eminent solicitor on the Act.

1601. Chairman.]

1601. *Chairman.*] Was that accident from an inundation?—Yes; I have the plan of the colliery here, if you wish to see it. *H. F. Mackworth,*
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1602. *Mr. Stephenson.*] Are the lamps generally, as regards cleaning, under the management of the miner himself, or are they under the management of an inspector to each colliery, whose duty is solely confined to seeing that the lamps are kept in good order?—It is only in the best managed mines that there is a person appointed to that very important post. 27 June 1853.

1603. Do you think it is important that there should be an inspector in all mines where lamps are used, to look after the lamps solely?—I think there should always be a lampman.

1604. Do not you think that the Davy lamp may occasionally be made insecure by unskilful or rude cleaning?—Yes; I find that where there is not a proper person to look after the lamps, they are often not cleaned more than once a week; and they get into a foul and dangerous state.

1605. May not the miner in brushing his lamp, or in cleaning it, increase the size of some of the meshes?—Yes.

1606. And by increasing the size of the meshes, may he render a lamp which was safe one day unsafe the next?—Yes, it is often done.

1607. *Mr. Locke.*] That objection would apply to any lamp, and it depends on the gauze?—Yes, more or less; most lamps, when they get out of order, become dangerous. The overman should have all suspicious lamps set aside, and shown to him.

1608. *Mr. Fitzroy.*] Have you found great practical inconvenience from the extent of your district?—It is quite impossible to inspect my district satisfactorily without an increased number of inspectors.

1609. You were understood to state that you have not been able to visit all the collieries within your district?—Not half of them.

1610. Do you think it would be possible to lay down any code of regulations which would meet the requirements of all the collieries within your district, or would it not be requisite almost to adopt particular regulations for each particular mine?—I think it could be effected in this way: I would recommend a simple code of regulations, generally applicable, to be carried out for the whole of England; one of those regulations should be, that at each mine there should be printed rules embracing those points of safety which were to be particularly attended to in the mine.

1611. Are not the particular circumstances of each mine so different from others that it is impossible to lay down satisfactorily any code of regulations for the government of the whole, when you have not an opportunity of visiting them and ascertaining their circumstances?—Without having visited them, I am so well aware of the general characteristics of coal mines, that I believe there are a dozen or 15 regulations which would apply to the whole of the collieries in England. I am able to speak, not only from my own information, which I think is quite sufficient for the purpose, but from conversations with the managers of other mines which I have not visited.

1612. Then, when you propose an increase in the number of inspectors, it is not with a view of making particular regulations for each particular mine, but simply for the purpose of enforcing the regulations, or of seeing that the regulations which are already made, are carried out?—Yes; it is with the object of seeing that the regulations are carried out which I propose; and also, even supposing these regulations are not carried out, of becoming acquainted with the general condition, as regards safety, of the whole of the mines in each district.

1613. Then would you propose greater facilities for enforcing the observance of those regulations by penalties?—Yes; I think there should be penalties attached to non-compliance with those regulations.

1614. Do you think it would be possible to obtain such information as to the enforcement of those regulations, as to enable a penalty to be enforced, in the event of an accident arising?—If it were considered that the penalty should be enforced, it would in all cases be necessary to make a visit specially, unless the evidence at the inquest sufficed.

1615. Would you be enabled, after the occurrence of an accident, satisfactorily to ascertain whether it had arisen from an infraction of the regulations, or not?—The coroner's inquest affords me that opportunity, provided I have time to attend the investigation.

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1616. You think that the coroner's jury would be enabled to test the fact, whether the accident had arisen from an infraction of regulations?—I think if I was present at the coroner's inquest, it would afford me the best opportunity I could have of examining into the circumstances of the accident, and of ascertaining whether it occurred from an infraction of the regulations.

1617. What penalty, pecuniary or personal, would you propose to affix for the breach of those regulations?—I think it should include both, at the option of the magistrate, or whoever had to inflict the penalty.

1618. What amount of additional inspection do you imagine would be necessary within your district, in order to guard against any accident from carelessness?—I do not think that any amount of inspection can prevent accidents, it will only prevent a certain proportion of the accidents. The comparison which I have given between the number of accidents in England and in other countries, affords an opportunity of judging of the extent; but I think if the average amount of inspection was such as to enable an inspector to visit a mine once a year, there would be a great diminution in the number of accidents.

1619. How many mines are you enabled to visit within your district every week?—Three or four.

1620. Do you think that the presence of an inspector once a year in a mine would be sufficient?—Yes, on the average; some mines he would not visit more than once in two years, others he would visit every six months, or more frequently if it were necessary.

1621. Would it not be necessary to have sub-inspectors, who were practically conversant with mines of all descriptions?—I think that an arrangement might be made to have persons of superior acquirements, who would very soon become sufficiently acquainted with the dangers of coal mines to be able to point out when a mine was safe, and when it was dangerous. I think that young men of the highest scientific education, such as the first pupil each year at the Museum of Economic Geology, should be gradually introduced into the corps.

1622. Do you think that a large proportion of the accidents which now occur in mines arise from recklessness, or from ignorance on the part of the proprietors?—There are but few accidents which arise directly from neglect or ignorance on the part of the proprietors; the manager of the mine is, I believe, in the majority of instances, more or less in fault when an accident occurs.

1633. Do you think that an improved system of education for the miners, or any means by which they might become acquainted with the result of carelessness on their part, would tend more to the security of the mine than an increased number of Government inspectors?—If the mines could be as well managed, and have as good managers as some of the best mines in the north of England, such a result might be arrived at; but I think it is impossible to have the managers so well educated. It would be at least 10 years before any perceptible effect would be produced in the safety of mines by the education of the managers. It would be uncertain whether men so educated would become managers of coal mines, and I believe that the most direct effect is produced by inspection, and that in the long run it is most effectual. By communicating information to the managers, visiting mines, and pointing out sources of additional information, I believe that a good deal of information of a most useful kind is given, accompanied with a certain pressure of responsibility, that they shall carry out the recommendations which are put before them. I do not, however, the less advocate such education.

1624. You were understood to state that a great proportion of the accidents arise from carelessness on the part of the managers. Supposing a heavy penalty were imposed upon the proprietor of a mine in cases of proved carelessness on the part of the managers, do not you believe that the enforcement of such a system would tend better to the security of life and the prevention of accidents than even an increased number of Government inspectors?—That is not the way in which I think it should be remedied; I believe it would not have great effect.

1625. You have not answered the question with respect to the number of inspectors who would be requisite in your district to put the whole system of mines upon a satisfactory footing?—I think that in my district there ought to be about five inspectors.

1626. Five in addition to yourself?—Yes.

1627. And

1627. And it is your opinion that the presence of the inspectors, on an average, once a year in a mine, would be as beneficial as the enforcement of greater precautions, by visiting the proprietor with a penalty, and consequently making it imperative on him to enforce greater regularity and care on the part of his manager?—I think that the adoption of such a system as you propose would induce the proprietor to look on that penalty as simply something to be added to the capital of the mine; and I think that the most effective system of diminishing the number of accidents, is to associate an increased inspection with the adoption of a code of regulations such as I have described.

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1628. Enforced by a penalty?—Yes; to enforce a penalty for an infraction of the rules, and not for the inefficiency of the manager, because an owner is not always able to judge of the competency of the manager whom he appoints to a mine.

1629. Mr. Cayley.] Do you see any objection to combining the two systems which have been suggested; that is to say, increasing the number of inspectors, and attaching penalties where great carelessness is proved?—In the regulations which I have thrown out, a portion of Mr. Fitzroy's proposal is embraced. I think there should be some kind of regulation that the manager should be a competent person to discharge his duties; and in case an accident occurred, the owner should show how far he had endeavoured to procure a suitable and efficient manager; but to say that the owner should be fined whenever an accident occurred from the carelessness of his manager, would not, I think, work practically, as the most difficult point after a colliery accident is to fix the responsibility.

1630. Mr. C. Bruce.] You would throw the responsibility very much on the manager?—Yes; it is to them almost alone that the dangerous condition of many collieries is attributable.

1631. Would you exempt the workmen?—By no means; the penalties to which I have referred should be levied upon workmen in cases where they had broken through the rules. The miners' regulations in each colliery which I have alluded to, would apply more particularly to them, and by being specially mentioned in such a code as I have alluded to, they would, to a certain extent, take the force of law and become, as it were, bye-laws in the mine.

1632. Mr. Fitzroy.] Do you think it would be desirable to make it imperative upon mine owners, to employ as managers only men who could undergo some examination as to their practical knowledge in the working of mines?—There is no doubt that course would be desirable; but I am not able to see how that could be carried out in this country at the present time; it is a point at which we may gradually arrive.

1633. Chairman.] How would you propose to arrive at that point?—There must, first of all, be the means of education before you can expect the men to be educated; there must be a certain time allowed for men to qualify themselves, and there should be persons appointed to examine them.

1634. Can you suggest any means for educating men in the manner you propose?—I am not prepared to suggest any means.

1635. Mr. Fitzroy.] What salary do the overmen receive?—A good overman gets 100 *l.* a year.

1636. Mr. Locke.] In your judgment, is it possible, for that amount of salary, to obtain a good practical man for the management of a colliery?—You may obtain a good overman for a colliery, but I think that all collieries ought to be superintended by viewers, according to the system which has been found so effectual in the north of England.

1637. Whom would you appoint to examine a new candidate as a manager of a colliery?—I am not prepared to answer the question, not having considered sufficiently minutely the best mode of educating the overmen.

1638. Whom would you appoint to examine whether a man was or not fit to be a viewer in your district, or in any other district in the kingdom?—I am not prepared to suggest any board of examination.

1639. Do you think that a Committee of Parliament would be fit to do it?—I think they should be well acquainted, scientifically and practically, with the working of coal mines. The best persons to make the test would be the persons who had to teach.

1640. Mr. Ingham.] Would the general body of inspectors form a good body for

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for the purpose?—Yes; if there was a sufficient number qualified by the highly scientific education I have mentioned, and long practical study.

1641. You have spoken of having the number of inspectors increased in the proportion of five to one; do you think that the united body of inspectors would form a good Board for the purpose of examining candidates for the situations of managers?—I think they would be quite competent eventually to do it, but I never contemplated submitting the viewers to an examination.

1642. Mr. C. Bruce.] Do you think that if certain qualifications were necessary for an overman, such an appointment might be left to competition?—I think that a great deal might be done in that way; I am not prepared to say that would be sufficient.

1643. You have stated that you could not suggest any machinery for the education of overmen which you would think it desirable to give, and therefore I asked whether you thought that by laying down a certain amount of qualification as requisite for employment in this situation, the natural competition for such employment would not induce a sufficient number of persons to qualify themselves for such situations?—I think that would be the best course to adopt at the present time, until more complete machinery could be carried out.

1644. Mr. Cayley.] The questions refer, not so much to the mode in which the education is obtained, as the test of the qualification; what body would you recommend for that purpose?—The body of inspectors seems to be the first that presents itself.

1645. Supposing it were necessary to bring the body of inspectors themselves under some central body, do you conceive that a Board of three gentlemen might be instituted, with the power of testing the qualifications of a candidate?—They are persons who would be able to test the scientific qualifications of an inspector; but I am not aware of any Board that would be able to test their practical qualifications.

1646. Supposing there is no such Board already existing, do you think it is impossible to institute such a Board?—Such a thing is possible; but I do not see how it can be carried out.

1647. Can you imagine no Board or Commission which could by possibility be instituted, which should have the capacity of judging whether an inspector was a proper appointment, or a viewer was a proper appointment, or an overman was a proper appointment?—I think there is a Board now which might be made use of for that purpose; that is the Board of Inspectors; they would be qualified to judge on any future appointments of inspectors, whether they were sufficiently well informed, or they would be able to judge of the qualifications of overmen and managers, if there were no other means of providing for it.

1648. Who should judge of the appointment of inspectors themselves?—The inspectors themselves.

1649. Then you would have them a self-elected body?—No; those who had already the acquirements, and who were well qualified for their office, would be the most competent persons to judge of the qualifications of any persons who were to be taken into that body. This is approving, not appointing.

1650. Have not the last inspectors been subject to some kind of examination?—I am not aware that they have.

1651. Has there not been a different mode of selecting the last one or two inspectors, as distinguished from the mode in which the others were appointed?—No; but I think a strict examination highly desirable.

1652. Mr. Fitzroy.] You would propose that competent parties should test the qualifications of the sub-inspectors whom you propose to appoint?—Yes, I think it is desirable; without the highest qualifications they will do more harm than good.

1653. Whatever body would have been competent to test the qualifications of the sub-inspectors, would be equally competent to test the qualifications of overmen, whose examination it was wished should be taken?—Undoubtedly.

1654. You have stated that you think all collieries should be inspected by viewers; do you propose that there should be viewers for so many collieries, or do you contemplate one viewer for each colliery?—The plan that I proposed is the one which has been found to work best, after very long experience in the north of England, both in economical and other points of view; that is, for one viewer

viewer to look after a number of collieries, according as his time allowed him to do it. *H. F. Mackworth,*
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1655. Then that viewer would exercise the same powers as the sub-inspectors whom you propose to appoint?—No; the viewer has a power to control everything in the colliery; he is employed by the proprietor. The sub-inspector would have no other power than to point out the regulations had not been carried out, or that other regulations for safety were desirable in a particular colliery. He would come but once a year; the viewer every week.

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1656. Would he be appointed by the coalowners themselves?—The viewers are appointed by the coalowners. I find great improvements in collieries when viewers are appointed; it is the wisest course a proprietor can take, and I am only surprised it is not more generally done.

1657. *Mr. Cayley.*] Would not a viewer stand in the capacity of the steward of an estate, and a sub-inspector in the position of an auditor of an estate?—No; the sub-inspector would have no right to interfere in the works. I do not propose that the sub-inspectors should have more virtual power than the present inspectors possess.

1658. *Chairman.*] You do not propose to make it incumbent upon a coalowner to adopt any particular plan for managing his own coal mines, but you would leave him to conduct them in the way he thought proper?—No; I would only recommend that course which I have suggested to many coalowners, as being the most economical means for themselves of managing a colliery; and it is being every day more and more adopted.

1659. *Mr. Fitzroy.*] Would you propose to give to anyone the power to stop a mine, under any circumstances?—After it had been decided, upon an arbitration, that a mine was unsafe, I think that a magistrate should have the power to stop the mine.

1660. *Chairman.*] Supposing that a mine were in a highly dangerous state, and you were to proceed to an arbitration, would it not be possible that an explosion might take place, and a great many lives be sacrificed during the progress of the arbitration?—I think that practically it would amount to the inspector stopping the mine; the first caution would be one of the strongest kind.

1661. *Mr. Cayley.*] Do you see any objection to that?—No other objection than that I am reluctant to take the responsibility out of the coalowners' hands.

1662. If a mine is extremely dangerous, according to your opinion, would not the responsibility be quite as heavy in allowing a number of men to be hurried into eternity?—I should try all that persuasion could do. My difficulty is, that it is possible for an inspector to go through a mine, and for circumstances to arise immediately after his inspection, such as leaving open a door, or the giving off or a blower of gas, which may cause an explosion; and then the question immediately would be, why did not the inspector stop the mine. I believe it is taking the responsibility out of the hands of the coalowner or manager, and putting it on the inspector, when the inspector has not the means of judging whether he is performing his duty with a full knowledge of all the facts.

1663. *Mr. Stephenson.*] Does not that imply, that inspection really will not tend to prevent accidents?—Quite the contrary. It will prevent a great many accidents, but I do not recommend it as preventing all, or nearly all; and I must point out once for all, that it is impossible for an inspector to ascertain every liability to accident in any mine which he visits, the manager himself cannot always do it; and no reasonable man would suppose that because an inspector had visited his mine, and found no fault, that his mine was perfectly safe.

1664. *Mr. C. Bruce.*] You stated that you would look principally to the managers for preventing accidents in mines; would you give to the inspectors any power of objecting to a particular manager continuing to hold a mine, from a want of fitness for his duties?—I do not think that an inspector should have the power of dismissing a manager.

1665. What power would you give the inspectors with regard to that?—The coalowners should employ competent managers; and the inspector would then point it out, if in his opinion that regulation was very glaringly not complied with.

1666. *Chairman.*] Who would be the judge of whether a manager was competent?

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petent or not?—The matter would be decided by some accident occurring, or by some act which proved it.

1667. Would not that be locking the stable after the horse was stolen, if you are only to decide upon the competency of a manager, after some serious accident has occurred?—It is a similar case to the other. I think the responsibility should rest on the coalowner. The manager would be responsible for the safety of the mine, and the coalowner would be responsible for the manager.

1668. Mr. C. Bruce.] In case of his failing to act under that responsibility, would you give any power to the inspector to enforce his so acting, by the discharge of a person who was considered by the inspector to be incompetent for his duties?—No.

1669. Chairman.] Do you think it would be better, in all cases, to leave it to the discretion of the coalowner, to employ men whom he thought were most competent, and would carry on the workings in the most satisfactory manner, leaving only to the inspectors the power of enforcing fines in particular cases, such as you have stated?—Yes, I think it is necessary to be very careful indeed, in not shifting the responsibility from the manager to the inspector, because the inspector is not in a position to judge fully.

1670. Mr. Cobbett.] You were understood to state, that you could frame 14 or 15 regulations which would be applicable to all the collieries in your district?—Yes.

1671. Did you not also say that you had prepared them?—Yes; I will read the more important of them. “1st. An artificial means of ventilation shall be employed at every coal mine, so as to produce a constant and active current of pure air throughout the working parts of the mine, as well as to dilute and render imperceptible all noxious gases. 2d. The ventilation shall be produced and conducted by perfectly safe and efficient means. 3rd. The descent of air, supposed to be more or less impregnated with fire-damp in a mine, being attended with great danger, it shall, as far as possible, be avoided, and can only be permitted by the express authority of the manager or proprietor; and when accompanied by constant vigilance and precautions against the dangerous accumulation of fire-damp. 4th. All dangerous or defective places shall be fenced off, or clearly indicated. 5th. Every accessible part of a coal mine shall be carefully examined, and its safety assured by a deputy or fireman, before the workmen are allowed to enter. 6th. Locked safety-lamps shall be exclusively employed in every coal mine, or part of a coal mine, where the presence of fire-damp or other explosive gases has been ascertained; they shall be opened only at such stations as may be determined on by the manager, and by men selected for that purpose. 7th. No blasting with gunpowder shall occur where safety-lamps are exclusively used, until the vicinity of the place has been ascertained to be free from fire-damp by deputies specially selected. No substance capable of emitting flame shall be employed to ignite the gunpowder. 8th. The safety of all and every part of a colliery, its works, ropes, machinery, shafts, &c., shall be entrusted to competent and specified persons, who shall exercise a vigilant supervision. 9th. The tops of and openings into all shafts, whether in work or abandoned, shall be made safe. 10th. When men descend any shaft by a tub, skip, or cage, they shall be protected by a bonnet or cover. 11th. Whenever an engine is employed to raise or lower men into a coal mine, an indicator, showing the position of the load, shall be placed conveniently in front of the engine-man. 12th. Two safety-valves of adequate area, with weights and levers marked to indicate the pressure of the steam, or an open feed-pipe shall be used for every boiler. 13th. A sufficiency of props shall be supplied wherever required in a coal mine, and the deputies shall satisfy themselves of the efficient setting, and of the safety of the roof. 14th. Printed rules, setting forth in detail the special precautions to be adopted in all respects of discipline and safety, whether herein generally described or not, shall be affixed and made known at each colliery. 15th. Fines, with or without imprisonment, should be inflicted by a magistrate for non-compliance with these rules; which should be doubled after the neglect had been pointed out by an inspector. 16th. Power should be given to carry out the 3d Clause of the Inspection Act, Vict. 13 and 14, chap. 100, respecting the making of plans, by a fine, increasing for every day which may be allowed to elapse after a reasonable period for their completion. 17th. Facility should be given to the families of those who are killed, to recover damages at the County Courts, under

under the Act 9 and 10 Vict., chap. 93, commonly called 'Lord Campbell's Act.' 18th. All pits should be walled, and guides, as far as possible, be adopted. 19th. All important defects in the ropes or machinery, which may increase the danger to the men using the pit, shall be immediately remedied. 20th. No persons shall be allowed to use the shaft or incline whilst a full tub or tram is ascending or descending; and the number of men, or boys, ascending or descending at one time, shall not exceed one-half the usual load of coals. 21st. Iron mines should be included in the Inspection Act, and the same regulations should be adopted as in coal mines, as far as they are applicable."

1672. Mr. *Cayley*.] When you state that you would not interfere at all with the practical management of a mine, what would you have an inspector do, in case your suggestions were carried out by legislation, if one of the vigilant supervisors, whom you have recommended, were not appointed by a coal proprietor?—In case it was an urgent matter which came before the attention of an inspector, it might be competent to him to take the case before a magistrate, and have it argued, and the penalty inflicted.

1673. Supposing your suggestions were carried out by legislation, would you not make them imperative?—Yes.

1674. Then the magistrate would merely have to decide whether the fine was leviabie?—It would be necessary to decide whether there was a sufficient person in that position or not.

1675. *Chairman*.] Would you not think it necessary to add to those rules, that in every case where safety-lamps are used they should be cleaned and examined daily by one single man, and if necessary, repaired by him?—Yes; I think it would be desirable.

1676. Mr. *Cayley*.] Would you add to that list of rules, supposing the mine was, in your opinion, in an extremely dangerous state, and such as to endanger human life, and the manager refused to adopt your suggestion as to improving the ventilation, that the inspector should have the power of stopping the working of the mine?—Not until after an arbitration. I should be able to enforce locked safety-lamps at once, and the remedy of most of the serious defects.

1677. Mr. *Ingham*.] You have mentioned that in the north of England, in some of the better managed mines which are under your inspection, the rule is to have a viewer of superior attainments, who has charge of several collieries?—Yes.

1678. Who is the officer next in authority to him; is it the overman, whom you have mentioned at a salary of 100 *l.* a year, or is there an intermediate officer between the overman and the chief viewer?—At the large collieries in the north of England, there is frequently an under-viewer.

1679. A local viewer?—A local viewer.

1680. Are you aware of any case of a colliery in the north of England being left in the charge of an overman, and with no person above him except the principal viewer, who has several other collieries under his superintendence?—Yes; there are many in that position; and some of the collieries in the north of England are without a viewer at all.

1681. And in the charge of an overman only?—Yes.

1682. Mr. *Cobbett*.] Is it not practicable to lock up the lamps, when the men take them down into the pits?—It is the common practice in some mines. It is practicable.

1683. And it is the practice abroad?—Yes; it is the law in Belgium.

1684. Is that one of your regulations?—Yes.

1685. *Chairman*.] And that the key should be kept by the man who has to clean the lamps every day?—Yes; that they should be locked and unlocked in special places appointed at the bottom. There must be two or three men who have keys.

1686. But no man, except those who were specially appointed, should have keys which would open the lamps?—No.

Martin Jude, called in; and Examined.

1687. *Chairman*.] YOU were examined before the Committee of the House of Lords in 1849?—Yes.

1688. You then stated that you had been 34 years engaged in working in collieries?—Yes.

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1689. Have you been working in collieries since your examination in 1849?

—No; I have not.

1690. What is your present occupation?—I am keeping an inn at Newcastle.

1691. You are the secretary of the Miners' Association?—Yes.

1692. Did you receive a circular which was sent down?—I did.

1693. In your opinion, from what you have heard from workmen, are the mines in a better condition in the Northumberland and Durham districts, as to ventilation, than they were in 1849?—I think they are not improved at all.

1694. Do you think there is no improvement in splitting the air?—The air-splitting was in operation at that time.

1695. Is it not carried out more extensively and with greater success now than it was in 1849?—Not that I am aware of.

1696. Have the sizes of air-ways been improved since 1849?—There has not been any increase in the area of the air-ways, as far as I know.

1697. Are the workmen anxious to recommend any particular mode of ventilation?—No; we wish to confine ourselves to this, that there shall be a sufficient quantity of air, the owners being responsible for that sufficient quantity.

1698. You are in constant communication with the working people of that district?—Yes.

1699. What are the particular grievances that the working people complain of?—They complain very much of the five-quarter seam in the county of Durham, that the heavy gas is so much, that sometimes they are obliged to work where their candles will not burn, within several feet of the face.

1700. The heavy gas that you allude to being the choke-damp?—Yes.

1701. The reason of that is, that there is not sufficient ventilation in the mines?—There is in many cases a sufficient amount of air, if it were properly conducted, but there is a want of brattice to convey it to the working face; there is a want of doors and proper stoppings.

1702. How would you enforce the conveyance of air, in an efficient manner, up to the face of the workings?—Simply by inspection, I think.

1703. Do you think that an inspector should be empowered to order brattices to be carried up properly to the face, and that a sufficient quantity of air should be carried round the brattice, so that a man might breathe a sufficient quantity of pure air?—Yes.

1704. Can you state what quantity of air should be allotted to each man?—I cannot say.

1705. Have you ever seen the steam-jet in operation?—I have been down the Seaton Delaval pit lately, and have seen it in operation there.

1706. Did you find the ventilation in the Seaton Delaval pit better than in any other pits?—It is much superior to any pit I ever was in before.

1707. Have you ever been down the principal pits which are under the superintendence of Mr. Wood?—No; I never worked for Mr. Wood, except at Tyne Main Colliery, several years ago.

1708. Is Seaton Delaval Colliery under the superintendence of Mr. Forster?—It is.

1709. Do you attribute the better state of ventilation entirely to the steam-jet?—There was a larger amount of air, generally speaking, than ever I felt in a pit; and when I went through the workings I went into most parts of the workings where the return air came from; I found an entire absence of all gas, and the workmen working in a cool atmosphere.

1710. Is Seaton Delaval a very fiery pit?—The overman informed me that there were some places where gas was given off much more than in the part I was in, but additional means are employed to carry it off.

1711. In any part of Seaton Delaval pit, were the men working with safety-lamps?—They were working with safety-lamps in the broken or pillar working which I visited.

1712. Are the air-ways in Seaton Delaval pit larger than the air-ways in any other pits that you have been in?—A great deal larger.

1713. Do not you think that the size of the air-ways has something to do with the increase of the quantity of air passing through the workings?—I should think it would be so.

1714. *Mr. Cayley.*] You do not know what the state of the Seaton Delaval pit was before they commenced working with the steam-jet?—I have heard the

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the workmen state that previously to the steam-jet being put in operation, there was always the presence of gas at the edge of the goaves.

1715. *Mr. Ingham.*] You say that you have not worked under Mr. Wood in any colliery: what are the principal collieries you have visited where furnace ventilation was not carried on?—I worked in Walker Colliery a long time; but furnace ventilation was the only mode then employed.

1716. Have you visited any other collieries since you ceased to be a workman?—Not the interior.

1717. Have you seen the South Hetton Colliery?—No; not the workings.

1718. Have you not been recently at Seaham, and seen some collieries there?—I was at the colliery, but not down the pit.

1719. Supposing that some regulations were issued, to be observed in the mines, do you think that if the pitmen in the colliery saw that they had been broken, they would take the trouble of giving information, or that they would be indifferent to it?—If they knew it, they would take the trouble to give information.

1720. It has been stated, as a matter of opinion, that they are so careless about those things, that if there were regulations they would allow them to be broken without taking any notice?—It would not be carelessness on their part. It would be intimidation or fear that would produce that effect.

1721. If they knew there was a Government inspector coming round, whose duty it was to give encouragement to the making of honest complaints, do you think there would be backwardness on the part of the men in giving him materials to act upon?—I do not think there would.

1722. *Chairman.*] Do you think that on the size of the air-ways for the in-take and the return air depends the safety of the pit, more than anything? I think that is the principal thing.

1723. Do you think it is the opinion of persons in the neighbourhood of Northumberland, that the air-ways are sufficient to prevent explosions?—Not generally; they are very deficient.

1724. Do you think there should be distinct air-ways to convey leading currents of air, through which there should be no passing?—I think it should be essential not to have any air-way obstructed by the passage of corves and tubs.

1725. Do you think the goaves should be ventilated—As far as it is possible. I perceived that at Seaton Delaval it is so to a great extent.

1726. At Seaton Delaval is all the gas taken out of the goaves?—I cannot say that; but for the great distance I travelled I found none.

1727. You went into the goaves yourself?—Yes.

1728. You found the goaves free from gas?—Yes.

1729. And air circulating through the goaves?—Yes.

1730. *Mr. Fitzroy.*] Have you known any accident occur from carelessness in the use of the safety-lamp?—No.

1731. You have never known miners open their lamps in a fire-damp mine?—Not one.

1732. *Mr. Cayley.*] Do you remember an explosion taking place at Killingworth Colliery?—Yes.

1733. Do you know what was the cause of that explosion?—I cannot exactly say: but the general opinion of the workmen was that it was at the Davy lamp.

1734. Have the men worked with the Davy lamp since that explosion?—No; they refused, at that explosion, to work any longer with it, and Mr. Wood conceded their request to work with the Stephenson lamp.

1735. *Chairman.*] They do not work with naked lamps?—Not much; there are some naked lights worked with.

1736. Do the men generally prefer the Stephenson lamp to the Davy lamp?—At that colliery they generally do.

1737. *Mr. Cayley.*] You wrote to me for some copies of the Report of last Session?—Yes.

1738. What was the opinion of the colliers, generally speaking, upon that Report?—They highly approved of the recommendations in it, and were satisfied that if legislation commenced on that Report, it was all that they wanted.

1739. Has there been any excitement in the colliery districts, with regard to

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the furnaces, since that Report came out?—I think there has not been any great excitement.

1740. Do the furnaces burn any brighter, or produce any more ventilation, than they did before that Report?—There have been some attempts to improve them and to increase their power.

1741. *Mr. Fitzroy.*] Have those attempts failed?—Not all.

1742. Then the ventilation in the mines has been improved since last year?—In some particular collieries, but not generally.

1743. You were understood to state, that in your opinion there had been no improvement since you gave evidence before the Committee of the House of Lords in 1849?—No improvement in the principles of ventilation.

1744. *Mr. Stephenson.*] You have stated that generally the system of ventilation, in the north country mines, has not been improved since you gave evidence in 1849?—No.

1745. In some few cases you think there has been improvement?—Yes; I have learned that there have been great improvements at Great Hetton Colliery, by additional power being added.

1746. When you speak of additional power, do you mean by an enlarged furnace, or by the application of the steam-jet to aid the furnace?—By an enlarged furnace, an increased size of air-ways, and other necessary appendages.

1747. *Chairman.*] Are there more shafts?—No.

1748. *Mr. Cayley.*] Are there more furnaces?—There is more furnace-power.

1749. Does not Mr. Wood burn three furnaces?—So I understand.

1750. *Chairman.*] All the heat from those furnaces goes up the same shaft?—Yes.

1751. Is it your opinion that the present mode of sinking two shafts alongside each other is defective?—I think it is very defective.

1752. How would you propose to remedy it?—I should, at least, have two shafts sunk at the dip of the colliery, and one or two of equal area at the rise of the colliery.

1753. Would it not be sufficient to have one shaft, provided the one shaft had as great an area as the two?—There is always great danger in having a brattice in a shaft, and they would always require a brattice-shaft, if there was only one, until they got the whole pits sunk and ventilated.

1754. Would you propose that the shaft to the rise should be made useful for conveying coals up the pit?—No, simply as an air-shaft.

1755. If it be an up-cast shaft, why need it be bratticed?—The down-cast shaft is alluded to, at the dip.

1756. I was speaking of the up-cast?—One large shaft will do there.

1757. Provided the area of that shaft was as large as the two?—Yes.

1758. Therefore you would have one large shaft at the rise of the colliery, and you would have two shafts to wind the coals up and down the pit, which would serve as down cast shafts?—Yes.

1759. To what depths have the proprietors to sink in order to reach the coal, as an average, through the district to which you belong?—I think about 120 or 140 fathoms.

1760. Can you state the expense of sinking a shaft?—The physical labour of sinking a shaft is from 6*l.* to 8*l.* per fathom; or about 1*l.* per fathom per foot diameter of shaft.

1761. In some districts do you not suffer from a great in-rush of water?—Yes; that is an additional expense.

1762. Does not that make the sinking of a shaft very expensive?—Yes.

1763. Do you know Monkwearmouth Colliery, at Sunderland?—Yes.

1764. In such a colliery would it be possible to sink as many shafts as you allude to?—I may state, that at Seaton Delaval Colliery there are six shafts already sunk, so that there would be less expense in sinking three than in sinking six; in almost all the collieries there are three or four shafts sunk, but they are sunk at a certain place in the colliery, and the air has to travel all the distance round the colliery to return to the up-cast shaft.

1765. Can you give any idea of what number of acres should be worked by one shaft?—I could not say particularly; it might be 50 acres for one shaft.

1766. Do you think, taking the district to which you belong, that there are not enough shafts sunk in reference to the number of acres which are worked by

by each shaft?—I believe there are not so many shafts as there should be to ensure safe ventilation.

1767. Mr. *Ingham*.] You do not express a very decided opinion as to the area of acres which may be worked by one shaft?—No.

1768. Mr. *Stephenson*.] Why do you prefer two shafts being sunk, one at the dip and the other at the extreme rise of the royalty?—My chief reason is, that if an explosion takes place, instead of the air-stoppings being all blown out, and rendering the passages all blank, there will be a continuous stream of air going over the pit, not subject to any stoppings.

1769. But it would be only going from the lower shaft to the upper shaft?—It can be conducted through the whole of the workings, and then made to ascend the up-cast shaft.

1770. The parts of the mine which have to be ventilated by the air being split, if an explosion takes place, would equally be left in a stagnant state, whether you had the air going direct from the lower shaft to the upper shaft, or whether you had to bring it back to the lower shaft again?—There would be a certain portion of excavation liable to that.

1771. Supposing you have a drift direct from the lower shaft to the upper shaft, and the bords are worked away from each side of that drift, when an explosion takes place, will not the air ventilating through the mine be entirely confined to that single drift between the one shaft and the other?—No; it could be conveyed out of the drift to all the workings, in the same manner as it is now.

1772. I am supposing an explosion to take place, and blow down the stoppings, which is an assumption you made yourself; suppose the air is divided, in ventilating three or four sheths or bords, when the stopping is knocked down of course the air will go from the down-cast shaft to the up-cast shaft in the shortest possible way?—Yes.

1773. If it does go between the one shaft and the other in the shortest direction, will not the sheths of bords on each side of that air course be left in a perfectly stagnant condition?—Yes.

1774. Therefore there is no advantage derived from having the one shaft at a lower level, and the other shaft at a higher level, as regards the position of the works after an explosion has taken place?—There is no difference; but there is this advantage, that the workmen, if they are able to get out at all, having a continuous stream of air passing between the shafts, can reach that sooner than they can the bottom of the up-cast shaft, or the down-cast shaft.

1775. In a large royalty, extending perhaps over an area of two miles, have you ever known an instance, where you would recommend, as the manager of a colliery, the sinking of two shafts, and the working of a mine in that way?—I would recommend it, in the largest royalty.

1776. Take a large royalty with two shafts sunk down, and that they are a mile apart; how long would it take you to drive a double headway between these two shafts?—That would depend on the height of the seam and other contingencies. I should say six or 12 months.

1777. That is, half a mile each way?—Yes.

1778. Did you ever know a drift of that kind driven at that rate?—I have not known it, because it has never been put in practice.

1779. What do you think a good hewer ought to drive in a double headway per day?—Six feet for two men in one day.

1780. Half a mile at two yards a day, will be upwards of 12 months?—Several men can be employed in one day.

1781. *Chairman*.] Do you mean two yards in 24 hours?—One man six hours, and another man succeeding him for six hours again.

1782. How many yards could be driven in the 24 hours?—Seven or eight yards. All depends upon the nature of the seam of coal and the number of men employed. I wish also to state that I think that plan would be advantageous when they came to work the pillars, and more so than in the previous excavation of the workings, because in working the pillars back from the shaft they drive the air necessarily through the goaf.

1783. Mr. *Stephenson*.] You have stated that you walked through a goaf some time ago?—Yes.

1784. What colliery was that?—Seaton Delaval.

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1785. What was the extent of the goaf when you walked through it?—The goaf was several acres in extent, but I went in but a few yards.

1786. The seven or eight yards of goaf in which you walked might be affected by the air-courses adjoining it?—Just so.

1787. Would any air-course which you ever saw affect a goaf extending over eight or ten acres?—I think not under the present system.

1788. The goaf through which you walked through must have had a good roof?—A part of the roof had fallen.

1789. And the other admitted of your walking through it?—We climbed over the falls, and on to the top thereof.

1790. What were the means of guiding the air through that goaf?—They fetched it from the whole workings, right down to the up-cast shaft, through that edge of the goaf.

1791. Would not the ventilation of the goaf rather be accidental than scientific or practical?—I think there is a great deal of accident about it; but they bring the air down that way purposely, and carry off the gas as made.

1792. With a large goaf, do you think that anything like certainty can be obtained in ventilation?—Not a moral certainty.

1793. *Chairman.*] You have stated that when you went down Seaton Delaval mine, you did not go into the worst part of the workings, and that you were told there were worse parts than those parts which you visited; why did you not go into the other parts?—From the distance I had travelled, I felt so fatigued that I could not go further; I went several miles.

1794. Do you think you could form an accurate judgment of the ventilation of that pit unless you visited the parts which were said to be the worst ventilated?—Those other parts were better ventilated; but there was more danger in that part, and of course they put more brattices in, and paid more attention to it, than they did to the part which I visited.

1795. *Mr. Stephenson.*] You have stated that you thought that by a vigilant system of inspection you would get better air up to the face where the workmen were employed?—Yes.

1796. What kind of inspection would you propose to secure that?—A system of Government inspection, as at present laid down.

1797. How often would you have the Government inspector go down for the purpose of examining each bord and ascertaining whether the brattices are sufficiently extended towards the face?—I think that he should not be absent more than a month.

1798. Supposing that he was absent for a month, might not the men be suffering three weeks of that month from want of bratticing?—I should hope that monthly inspection would ensure safety.

1799. As the bords advance every day they require fresh bratticing to be put up, and the ventilation of any one bord depends to-day on the amount of bratticing put up this very morning?—Yes.

1800. Therefore what security would you have for having the brattice carried up within a certain distance on the face of the work, by a person coming there once a month?—In my opinion there would be a sufficient stock of brattices in every colliery in that way, whereas the reason they are not put up now is, that they have not a stock at the collieries, and they will not be at the expense of making that stock; but when that stock is made and kept up, they will make use of it.

1801. Have you been a hewer?—Yes.

1802. Have you never in your life had brattices lying in your bord when you felt uncomfortable in the face of your work, and did not take the trouble of putting up the brattice?—I would always take the trouble to put it up, if it was necessary.

1803. Do not you remember, that sometimes you did not take the trouble to put up the very material which had been supplied to you?—No, I have no remembrance of anything of that kind; I recollect very well being nearly killed by an explosion from the want of brattice; I came out about three or four minutes before the explosive point was arrived at, and complained to the deputy, and when more brattice was put in and a door set at the bord end, the whole of the gas was cleared away in two hours, which had accumulated in about half an hour from first perceiving it, to fill the seam two feet high from the floor, and 10 yards from the face.

1804. Did you ever hear workmen complain of having too much air?—They will sometimes complain of the air being driven too heavily upon them when the place is first holed.

1805. Mr. *Stephenson.*] Although in some mines the amount of bratticing may be scanty, would you say there was a deficiency of bratticing, generally speaking, in the Newcastle or Durham coal fields?—Yes; I think they are all deficient, from what I have learned from the colliers.

1806. Did you experience a deficiency yourself when you were a workman?—A great deal.

1807. *Chairman.*] If an accident occurs, independent of the unfortunate circumstance of a great number of lives being sacrificed, is not the coalowner put to great expense?—Yes.

1808. Do not you think it would be some inducement to the coalowner to find sufficient materials for carrying on the workings properly, and avoiding danger?—It ought to do so, but it is not done.

1809. You have stated that you have heard complaints of having too much air. Is the reason of that because the candles sweat?—Yes.

1810. Do not you think that if a safety-lamp could be invented, which was secure in itself, and gave as much light or more light than a candle, that would obviate the difficulty; and that the workman could work in a better current of air than he could with a naked light?—Yes; a lamp of that kind would effect the purpose.

1811. Have you seen no lamps of that kind at present?—Yes; I have seen one or two.

1812. What lamp have you seen which has effected that object?—Dr. Clanny's lamp.

1813. Have you seen Dr. Glover's lamp also?—I have not seen it lighted.

1814. Have you seen a lamp which has been invented by Mr. Henderson, a workman?—Yes.

1815. Is that a good lamp?—I think it is as good as Dr. Clanny's, because it removes one objection which was made at the Committee of 1849, that a drop of water falling on Dr. Clanny's lamp glass would break it.

1816. Is not the weight an objection both to that lamp and to the lamp invented by Dr. Clanny?—I asked several workmen if they preferred the Clanny lamp.

1817. Which lamp, in your opinion, do the workmen prefer?—As far as they have a choice of employing different lamps, they prefer the Clanny lamp to the Davy.

1818. Mr. *Cayley.*] Have you seen Dr. Fife's lamp?—Yes.

1819. What do you think of his lamp?—I think it is a very good lamp.

1820. Do you think it is superior to any of the others?—By having a talc surrounding the glass, it removes the objection of the drop of water.

1821. Is it made of a finer gauze?—I think it is not; I have not examined it closely.

1822. *Chairman.*] Taking every precaution which could possibly be used to secure full and efficient ventilation of a mine, do you think that circumstances may exist in which it would be necessary to enforce the imperative use of the safety-lamp?—Yes.

1823. You think that an inspector should be empowered by the Legislature to enforce the use of safety-lamps?—Yes; I think he should have the power, where he sees danger, of enforcing the use of the safety-lamp.

1824. And therefore you think, that in addition to good ventilation, the use of the safety-lamp should sometimes be enforced by legislation?—Yes.

1825. Mr. *Cayley.*] What you want in reality is, sufficient ventilation?—Quite so.

1826. How do the workmen test the amount of ventilation?—They have no means of testing it, except by feeling its want.

1827. In what way do they feel it?—They want air to breathe when they are working.

1828. That comes from the heavy gas?—Yes.

1829. But the heavy gas is not the gas which would explode?—No.

1830. How do they test the presence of fiery gas?—They generally have a notion of its presence, if it is strong, by the smell.

Martin Jude.

27 June 1853.

1831. They can smell the fiery gas?—Yes.

1832. Is not another test the lengthening of the flame of the lamp?—Yes; if they are employing a safety-lamp, or a candle, they can test it by that mode.

1833. Supposing the colliers found there was a large amount of gas constantly present when they were working, and that no steps were taken by the overmen or the viewers to diminish the quantity, do you think it would be desirable that the workmen should have some means of confidential communication with an inspector, so as to give him notice of the danger?—It is necessary that it should be so.

1834. How could you carry that out?—I believe it is not practicable to carry it out, inasmuch as the workmen feel alarmed by having their names exposed; and they hardly dare complain, lest they should lose their employment.

1835. *Chairman.*] Could not the workmen complain, through an authorised agent like yourself, and could not you, on receiving such a complaint, speak to the inspector, and by that means would it be known who was the man who had first made the complaint?—That has been done up to this time on frequent occasions.

1836. Has it been done with any good effect?—It has been done with very good effect at one colliery; but I will show you the way in which the employers attempted to learn the men's names who signed the document, and sent it to Sir George Grey, complaining of the colliery being in an unsafe state; six of the men's names were signed to it, and the master wished to find them out; he requested the inspector to give up the document, which he refused; to make sure work of it, he wrote this heading on a large sheet of paper, "We, the undersigned, are not the persons who sent our names to Sir George Grey complaining of the dangerous state of the colliery," and he asked every man, as he came in to get his money, to read it and sign it. It was only on account of the first men not being the actual parties, coming to prepare the others for it, that they went in and signed it, although they were actually the senders.

1837. Suppose the men had complained to you, and you had complained to the inspector, and the inspector in consequence of that complaint had gone to the colliery to observe whether it was in a dangerous state, how could the master of the colliery possibly know that any complaint had been sent to the inspector, unless the inspector had told him?—It depends on the confidence of the inspector.

1838. What is the general opinion of the workmen as to the verdicts of coroners' juries, when accidents occur in a mine?—They think them nearly a farce.

1839. Do they think that juries give wrong verdicts, or that the coroners do not perform their duties?—I believe their opinion is, that the coroners are anxious to do their duty, but that they have not competent jurymen.

1840. *Chairman.*] Do not you think it would be desirable that the Government inspectors, when they paid visits of inspection, should examine into the state of the lamps?—Yes.

1841. Do not you think that where safety-lamps are used, it should be imperative on the owner of a colliery to have one man always to clean the lamps, and if they are out of repair, to repair them?—I do.

1842. Do not you think that where safety-lamps are used, they should be locked?—Yes.

1843. Do you think the keys should never be entrusted to the workmen, but always to parties appointed by the overman of the mine, who should open the lamp when it was necessary?—Yes.

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 :

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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 -	25,590	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 - - - - -	0.06	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
<p>Note.—They are quite new, fitted up in the best manner, with horizontal cylinders and direct action.</p>										
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, 3 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 Baumont, 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.

Appendix, No. 3.

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	-	-

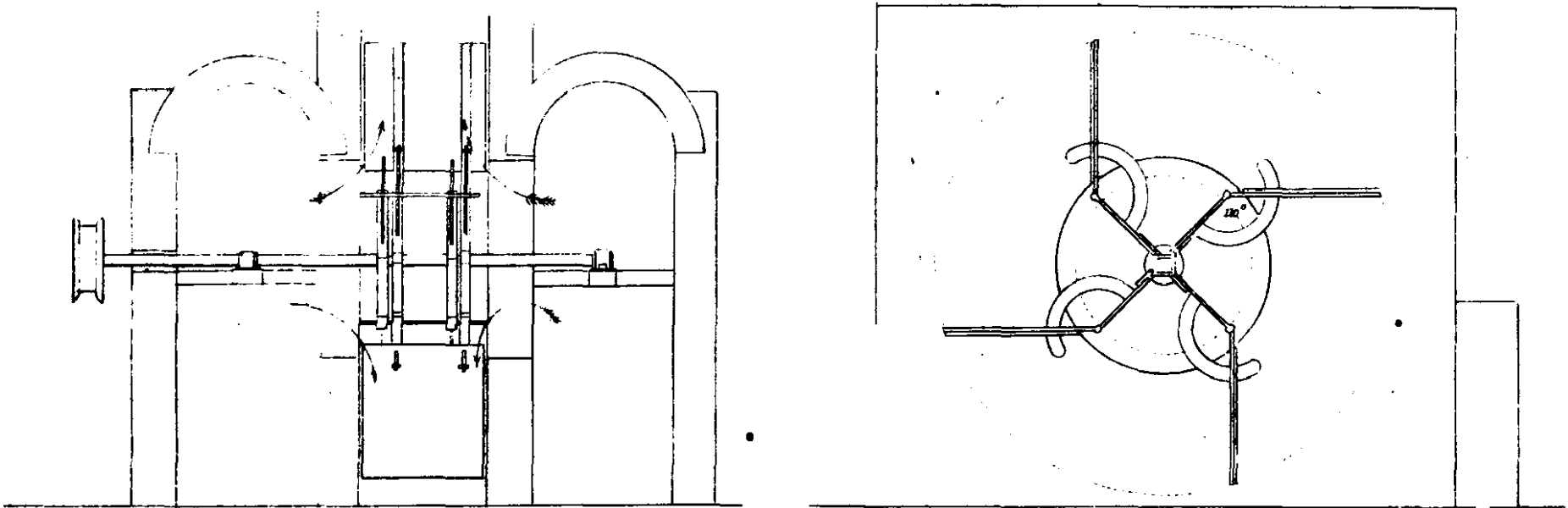
According to the experiments of Mr. Glépin.

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

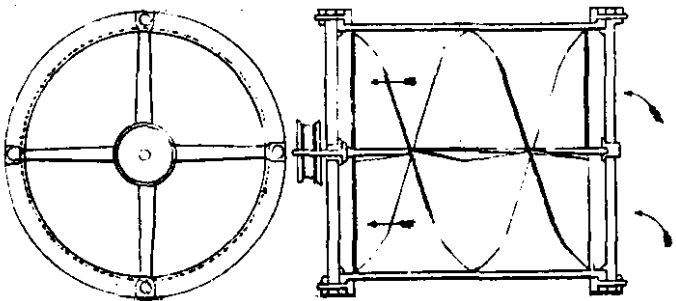
NAME OF APPARATUS.	Moving Power transmitted.	Moving Power Useful Effect.
Exhausting engines, reciprocating motion (Mairhaies)	100	25 to 40
Ventilator of Mr. Combes	100	27 to 29
Screw of Mr. Motte	100	20 to 24
Ventilator with straight vanes of M. Letoret	100	16 to 20
Ventilator of M. Pasquet	100	10 and 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.



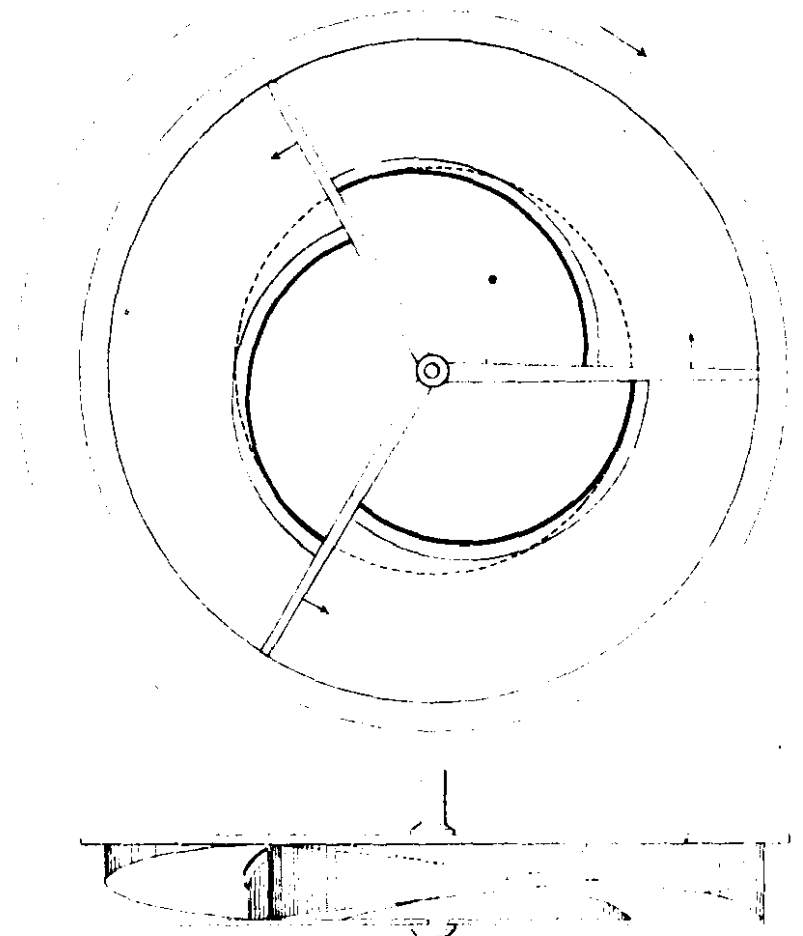
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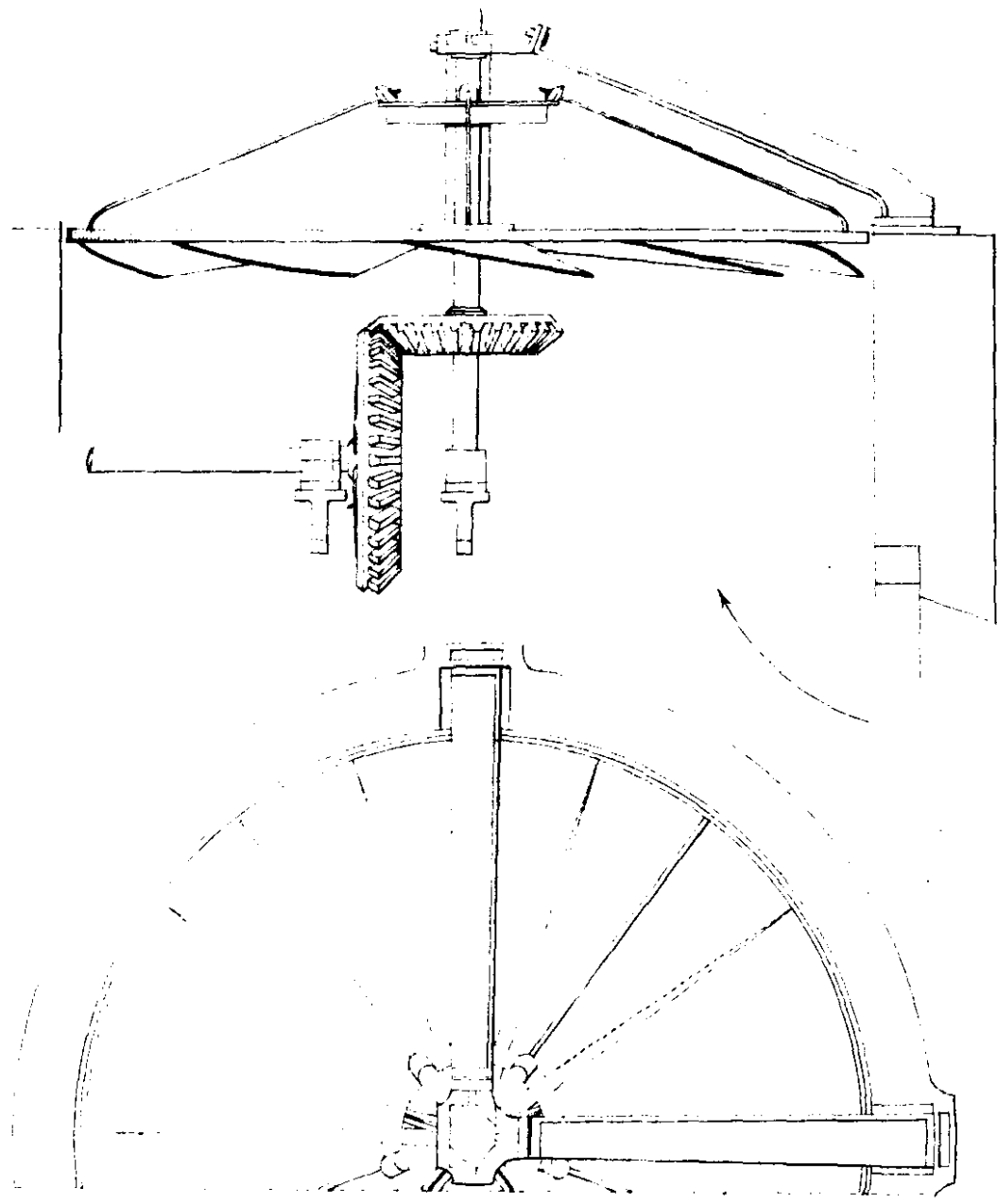
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Machine, &c.

Pasquet's Ventilator



Lescaupes Windmill Ventilator

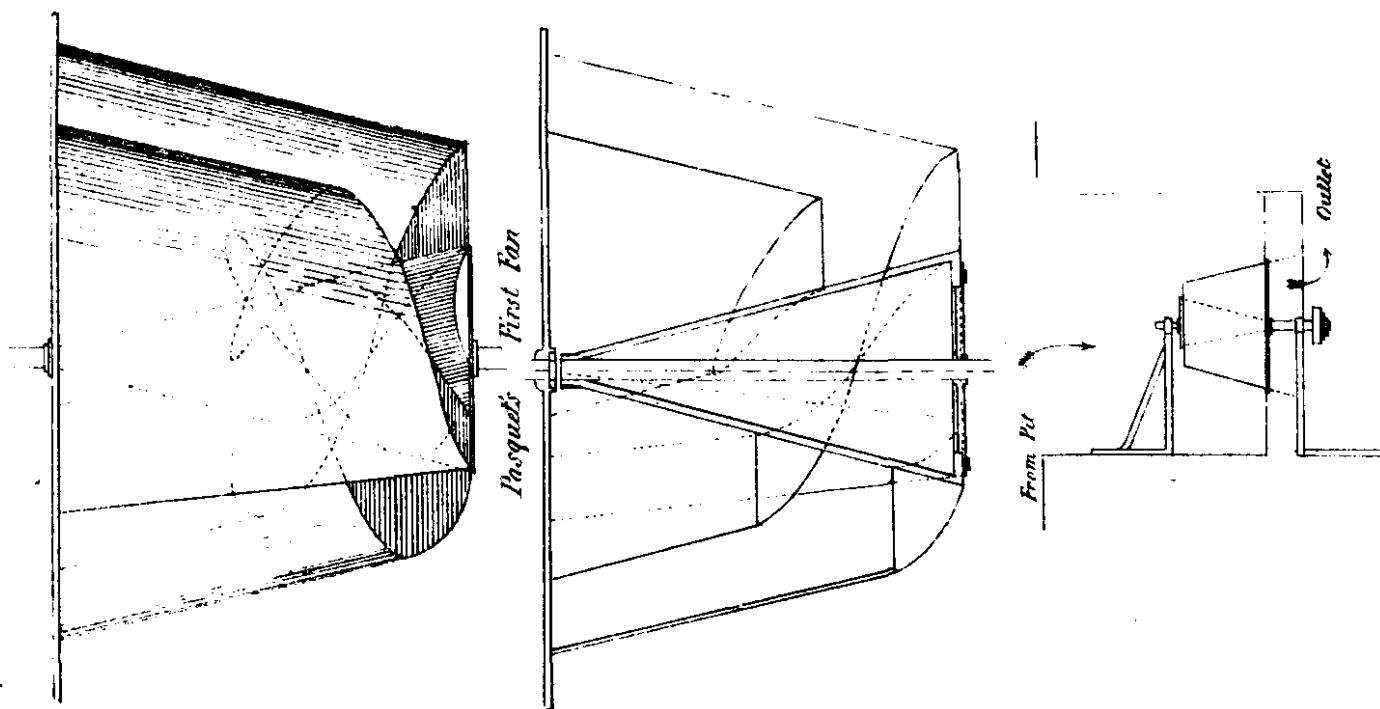
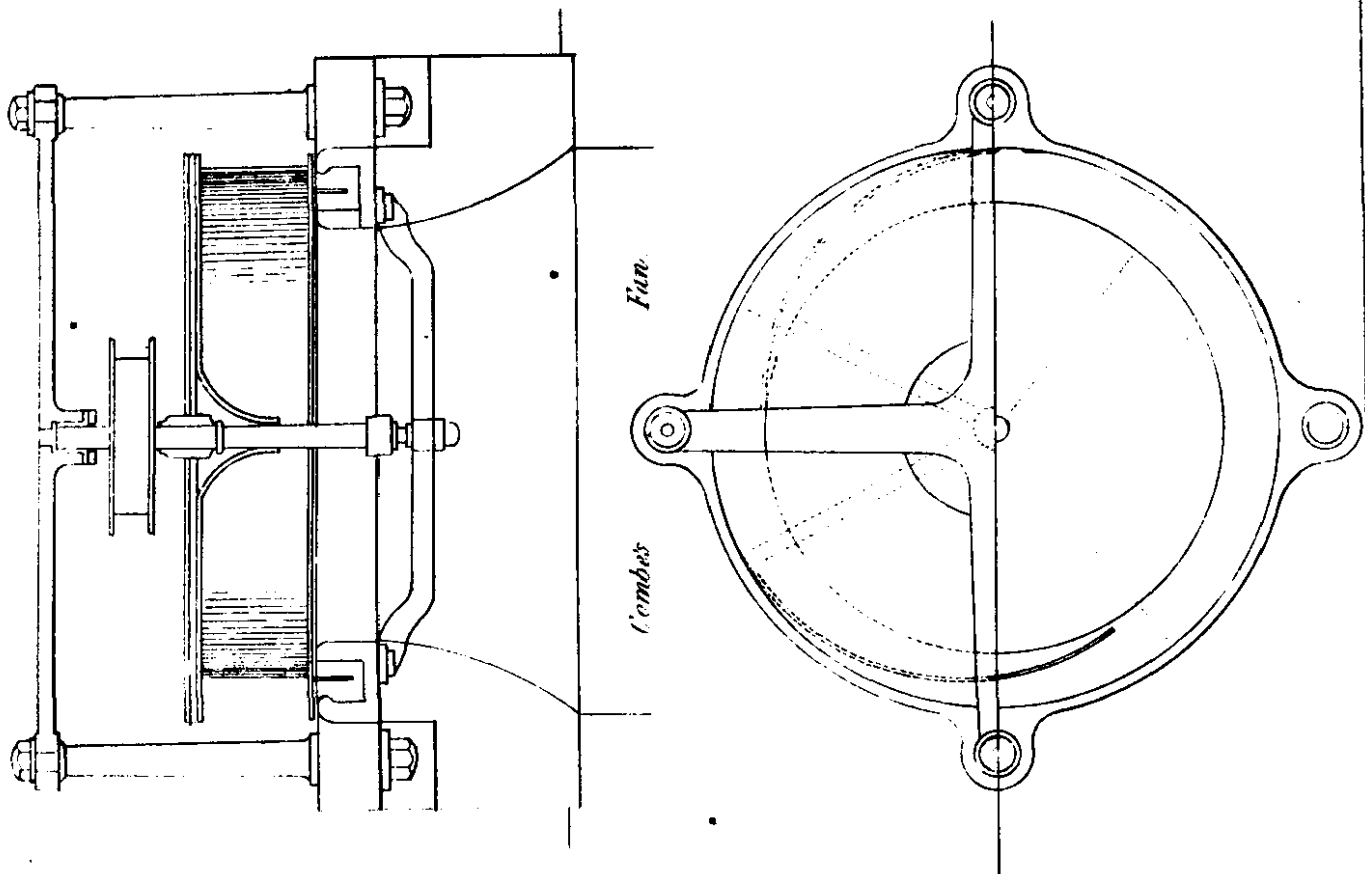


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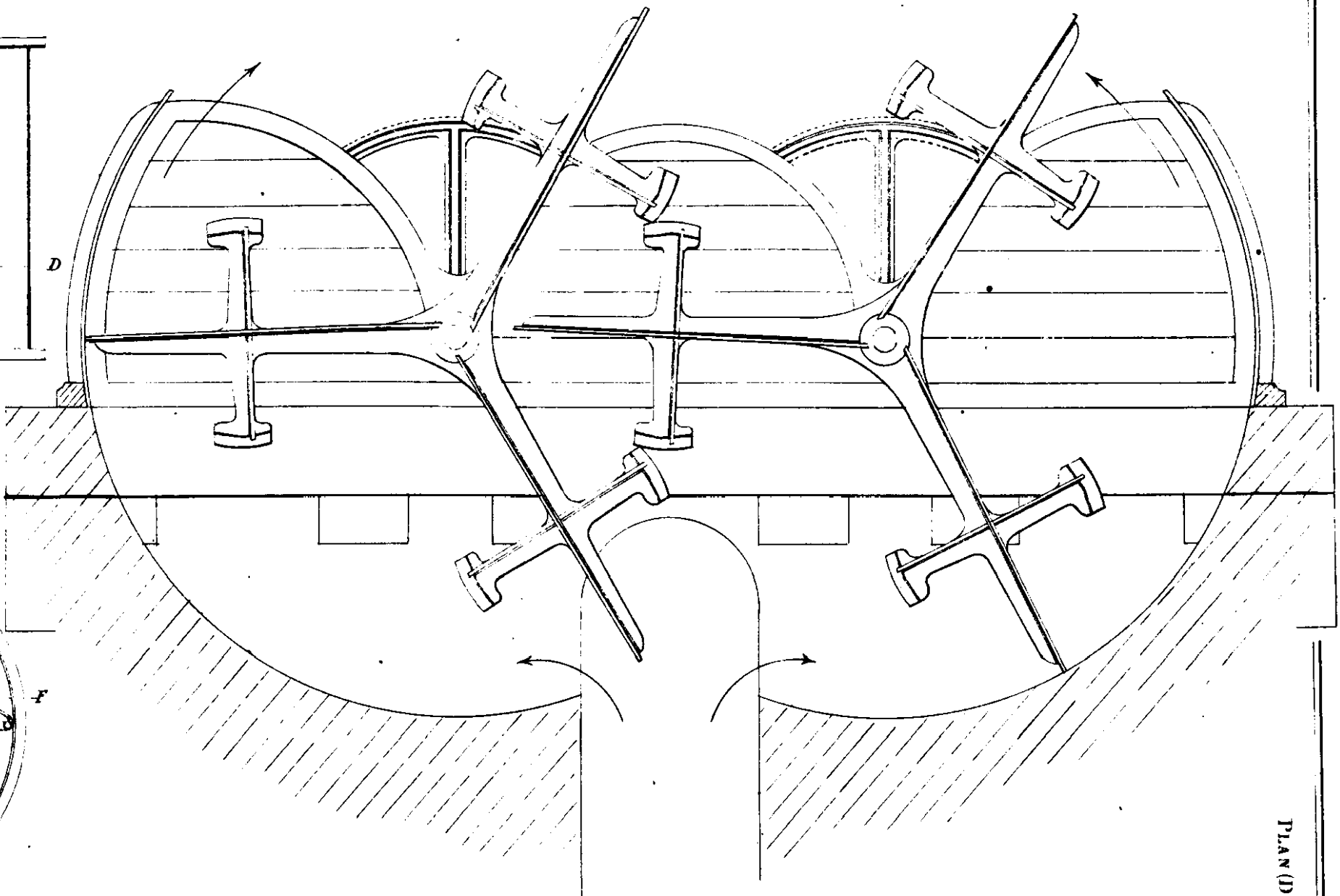
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Henry Hanward, Printer.

PLAN (C)

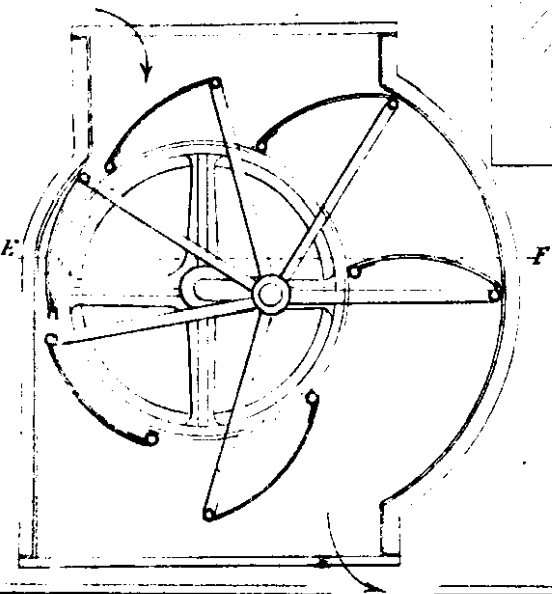
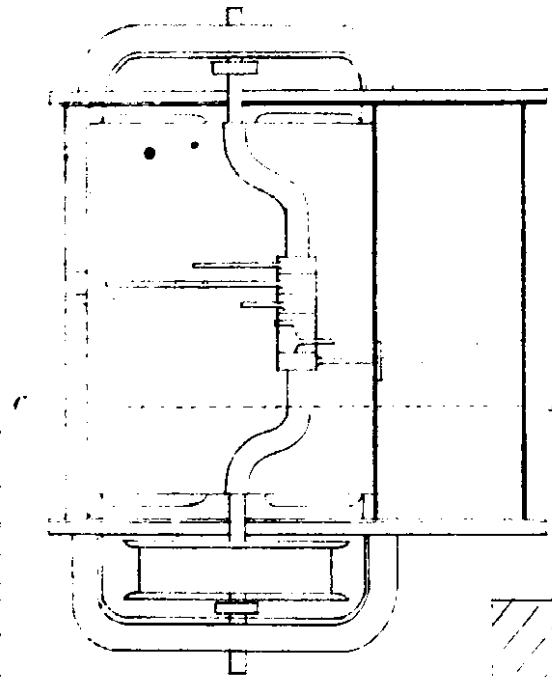


Fabry's Ventilator in Wood.



PLAN (D.)

Louette's Feathering Fan.

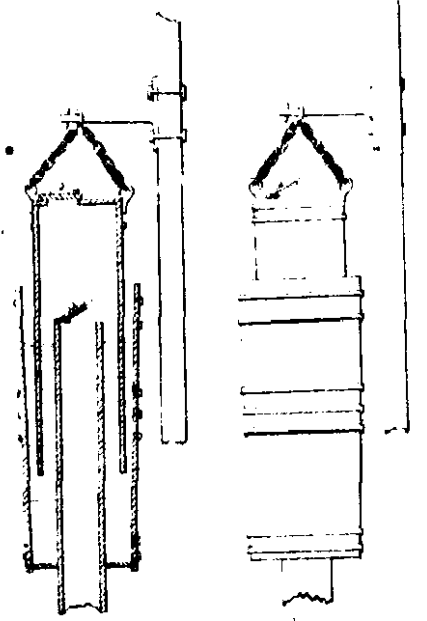
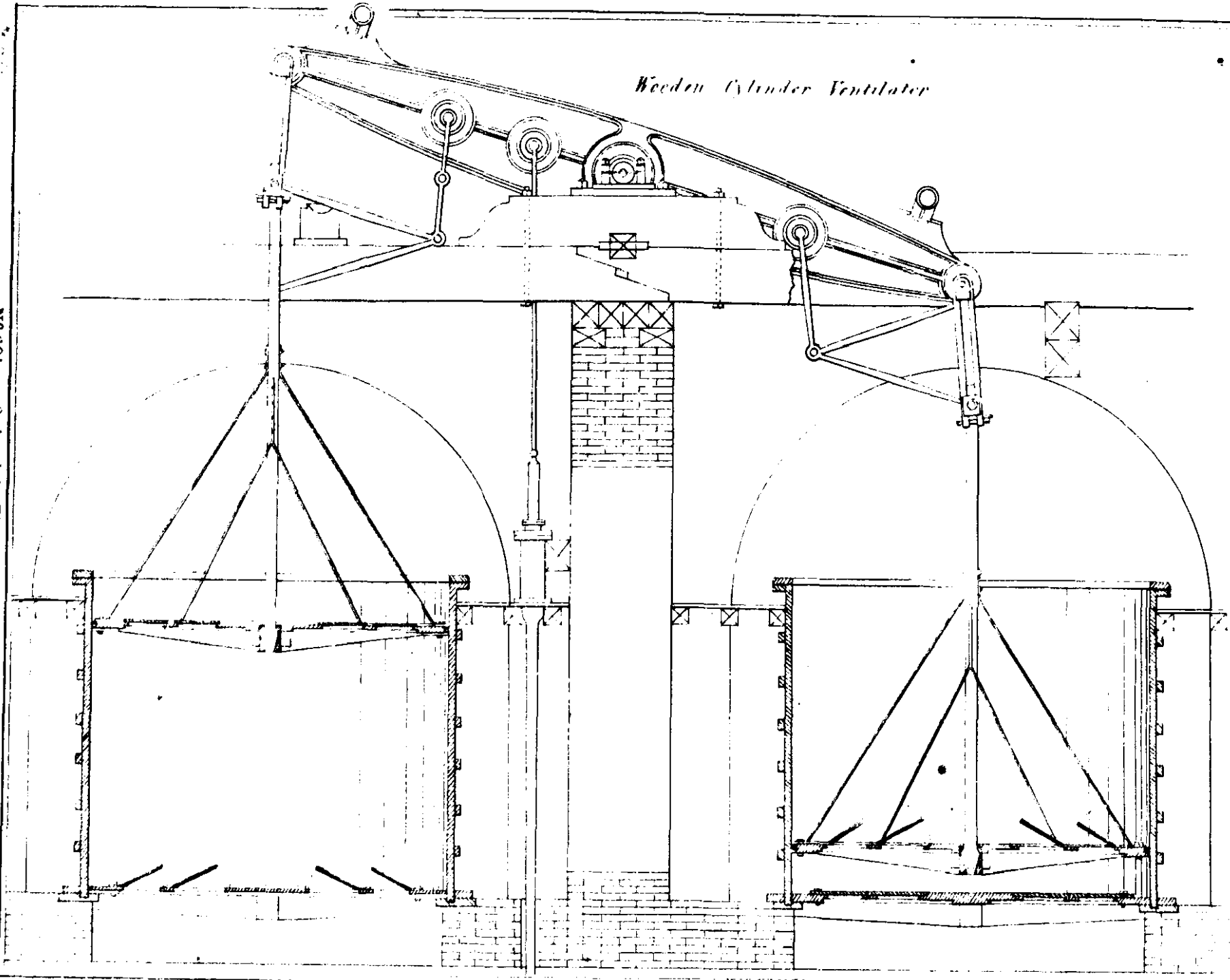


N^o 691.

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

Henry Woodcock, Printer.

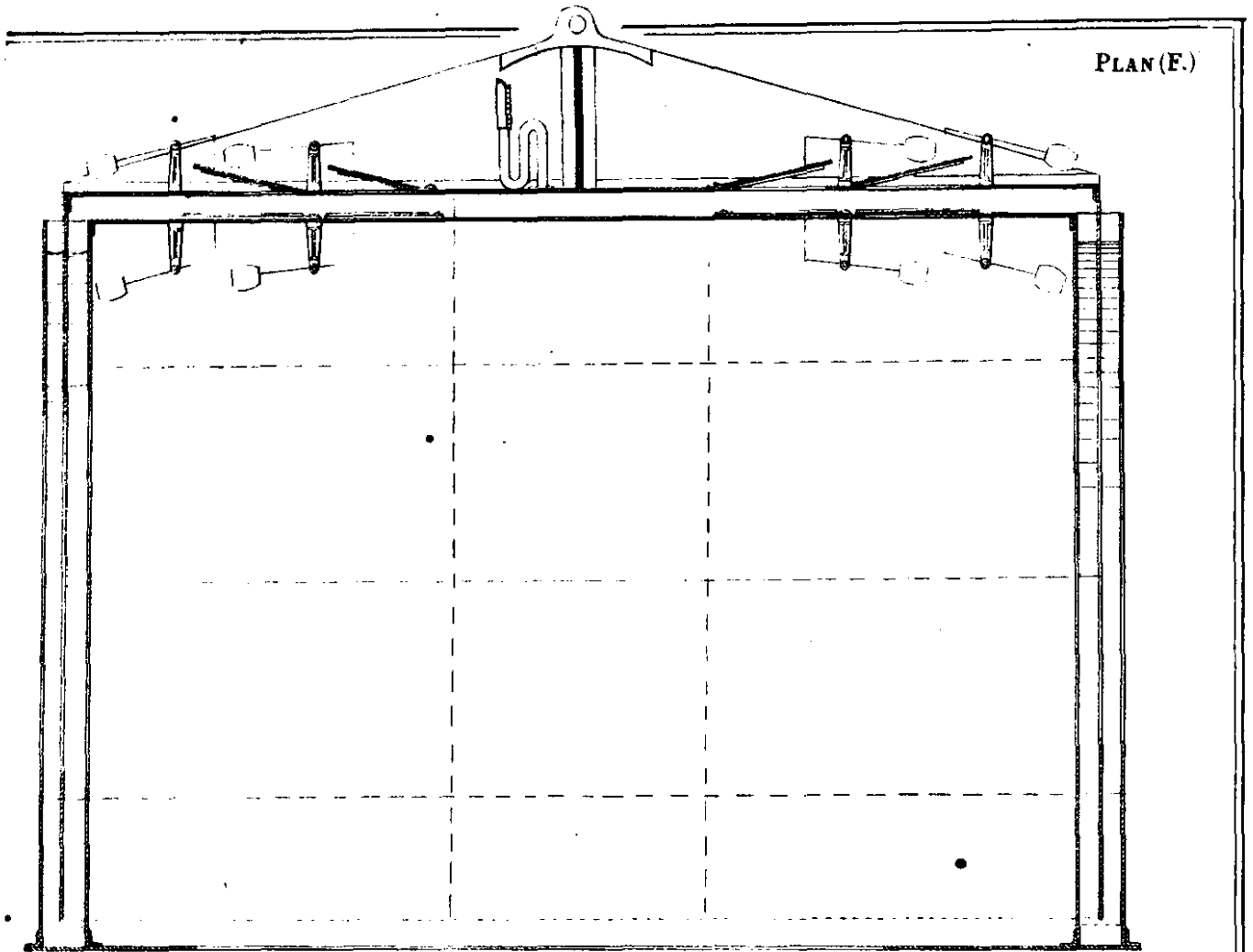
Wooden Cylinder Ventilator



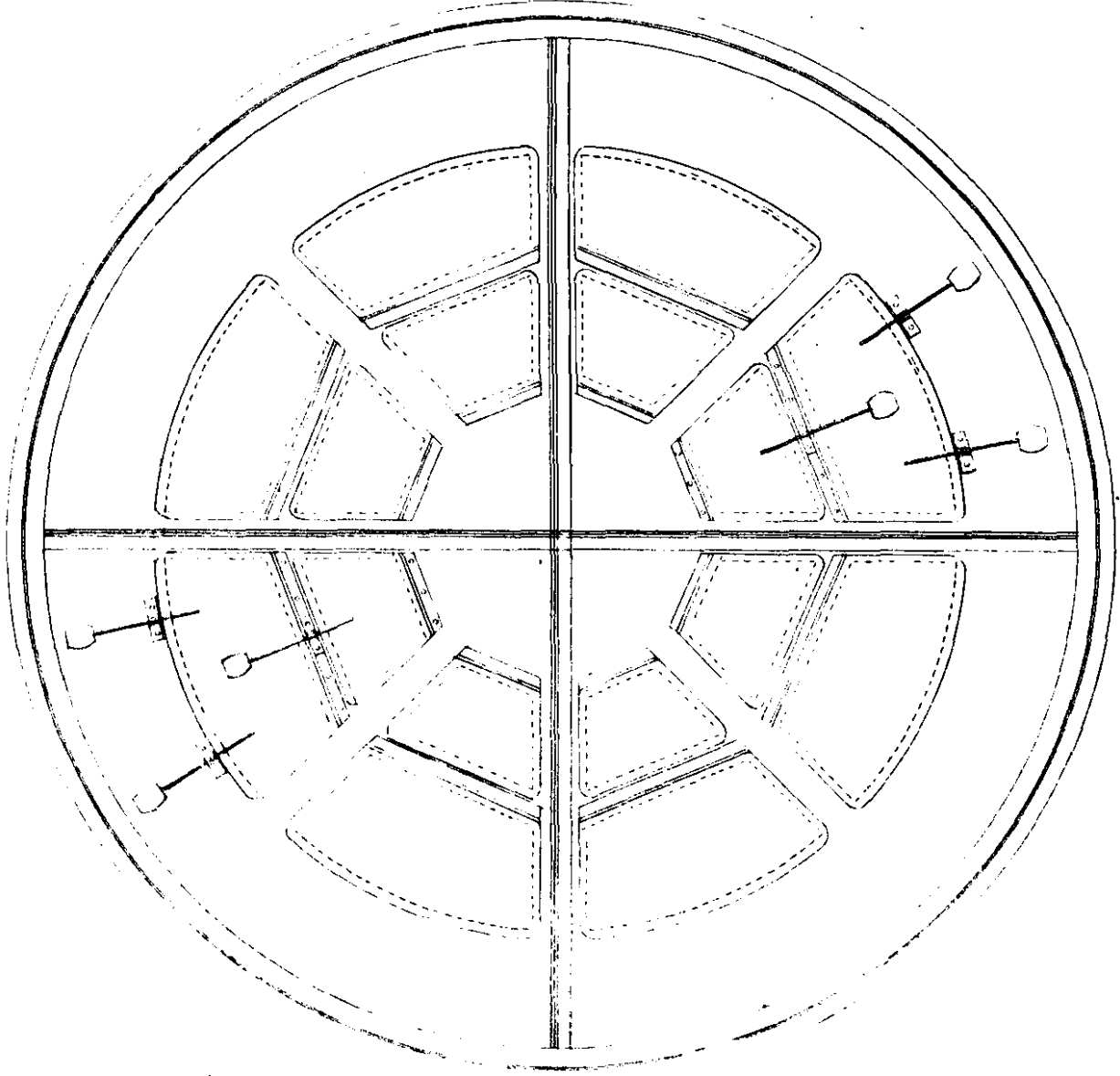
*Exhausting Bell or Duck Machine
used in the Hart's*

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

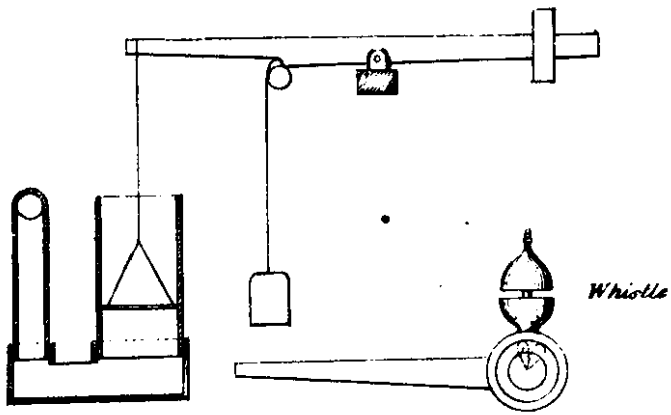
Henry Howard, Printer



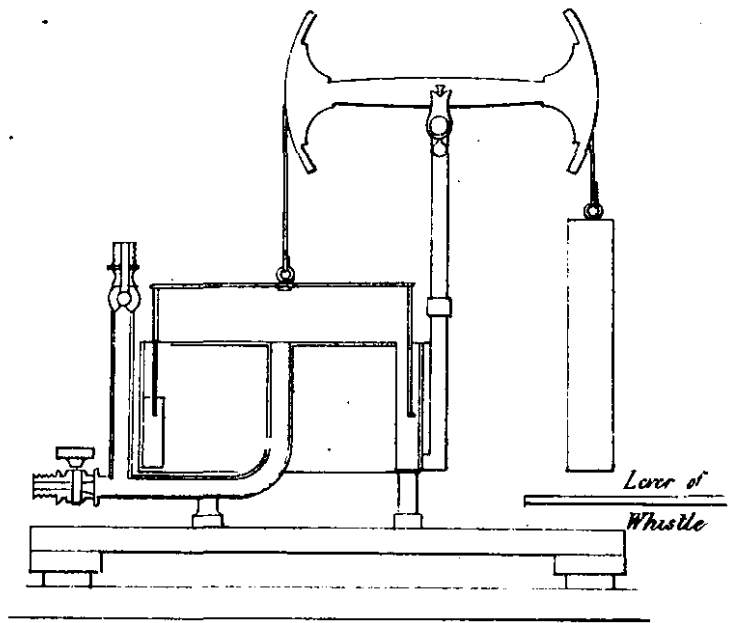
Plan and Section of Single Acting Airmeters.



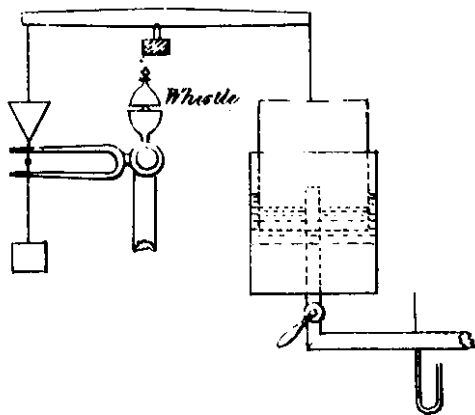
Ventilator Danger Signal.



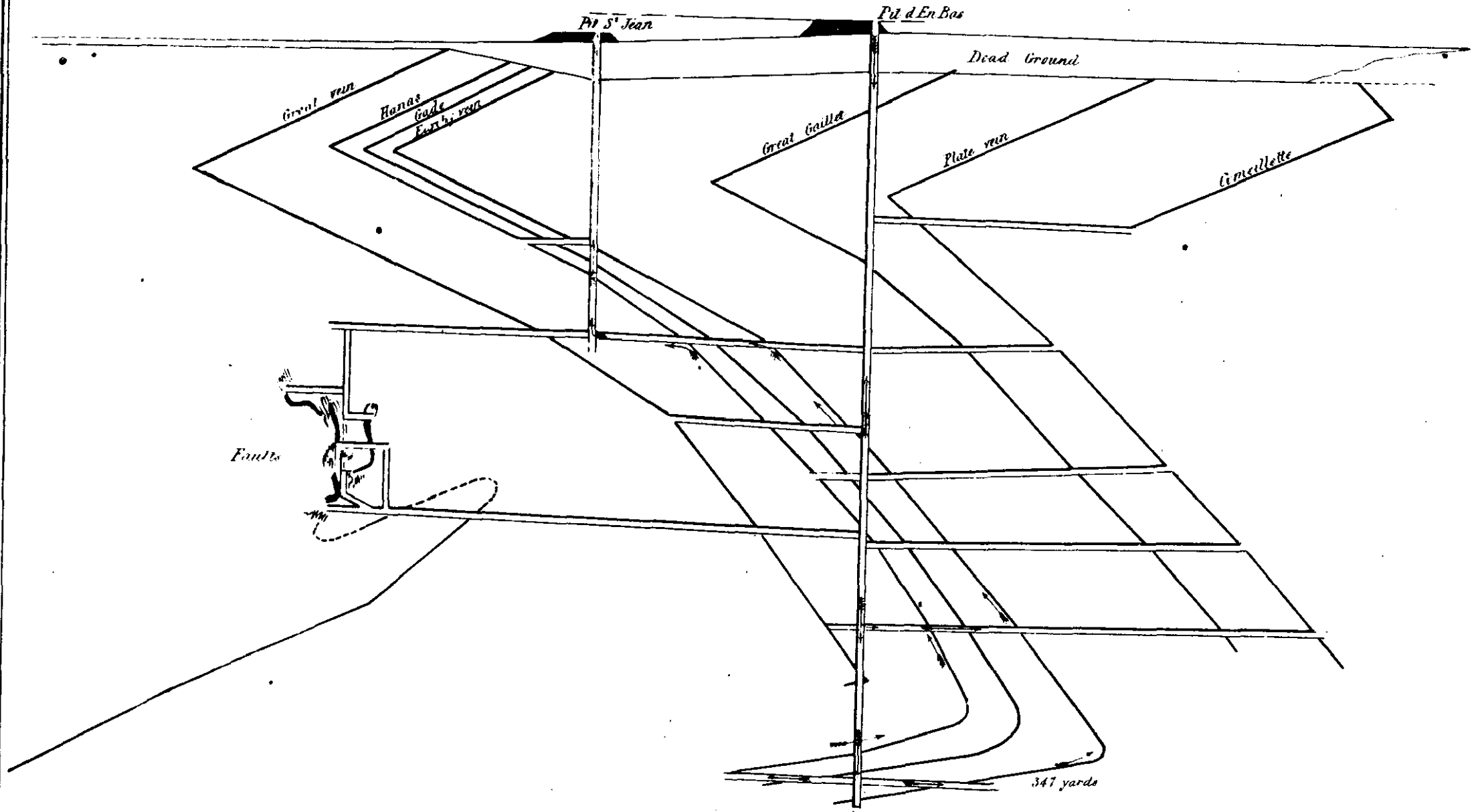
*Patent Ventilator's
Donger Signal.*



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

W. G. & Co. Lith.

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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