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DESCRIPTION

OF A

MODE OF OBTAINING

THE

PERFECT VENTILATION

OF

LAMP-BURNERS.

BY

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ABSTRACT OF THE PAPER, AND OF THE DISCUSSION UPON IT.

EXCERPT MINUTES OF PROCEEDINGS

OF THE

INSTITUTION OF CIVIL ENGINEERS.

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INSTITUTION OF CIVIL ENGINEERS.

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The PRESIDENT in the Chair.

No. 640. "Description of a Mode of obtaining the perfect Ventilation of Lamp-Burners." By James Faraday.

The paper commences by stating, that in consequence of the injury sustained by the books in the library of the Athenæum Club, and the complaints made by the members of the vitiated state of the air in the rooms, the attention of Professor Faraday was drawn to the subject, and that he suggested the trial of various plans for effecting the removal of the products of combustion, and for the ventilation of the lamp-burners. Ventilation of Lamp-Burners.

The author then assumes, that all substances used for the purpose of illumination, may be represented by oil and coal-gas; for although tallow and wax are also employed, yet as they cannot be burnt until they are rendered fluid like oil, they may, for all practical purposes, be classed with it.

Oil and gas both contain carbon and hydrogen, and it is by the combination of these elements, with the oxygen of the air, that light is evolved. The carbon produces carbonic acid, which is deleterious in its nature and oppressive in its action, in closed apartments, and the hydrogen produces water. A pound of oil contains about 0·12 of a pound of hydrogen, 0·78 of carbon, and 0·1 of oxygen; when burnt it produces 1·06 of water, and 2·86 of carbonic acid, and the oxygen it takes from the atmosphere is equal to that contained in 13·27 cubic feet of air. A pound of London coal-gas contains on an average 0·3 of hydrogen and 0·7 of carbon; it produces, when burnt, 2·7 of water and 2·56 of carbonic acid gas, and consumes 4·26 cubic feet of oxygen, which is equal to the quantity contained in 19·3 cubic feet of air.

A pint of oil, when burnt, produces a pint and a quarter of water, and a pound of gas, more than two and a-half pounds of water; the increase of weight being due to the absorption of oxygen from the atmosphere, one part of hydrogen taking eight parts (by weight) of oxygen to form water. A London Argand gas lamp, in a closed shop window, will produce in four hours, two pints and a half of water. A pound of oil also produces nearly three pounds of carbonic acid, and a pound of gas two and a-half pounds of carbonic acid. For every cubic foot of gas burnt, rather more than a cubic foot of carbonic acid is produced. As carbonic acid is a deadly poison, an atmosphere containing even one-tenth of it is fatal to animal life. The various accidents from lime and brick-kilns, brewers' vats, occasionally from the sinking of wells, and from the choke damp in coal mines, attest the danger contingent upon the presence of this substance. A man breathing in an atmosphere containing seven or eight parts of carbonic acid would suffer, not from any deficiency of oxygen, but from the deleterious action of the carbonic acid.

M. Leblanc has recently analyzed carefully the confined air of inhabited places, and concludes,* that the proportion of carbonic acid gas in such places may be regarded as measuring with sufficient exactness the insalubrity of the air; that in the proportion of 1 part to 100 of air, ventilation is indispensable for the prevention of injury to the health; that the proportion of carbonic acid gas should not exceed a five-hundredth part, though it may extend without inconvenience to a two-hundredth part. If a room twelve feet square and twelve feet high, with the doors, windows, and fire-place closed, has a gas lamp burning in it, consuming five cubic feet of gas per hour, the light will produce sufficient carbonic acid, in rather more than three hours, to be in the proportion of 1 part to 100 of air, and, as M. Leblanc states, when in such condition the air is decidedly injurious to health: and even in one hour and a-half it will produce that proportion of carbonic acid which he considers should never be exceeded.

The experiments which were made, led to a modification of the ordinary mode of ventilating by ascension, and finding that there was sufficient draught in the main part of the metal chimney to allow of a descending current over the lamp, the tube, instead of going directly upwards, was made to turn short over the edge of the glass, to descend to the arm or bracket, to pass along it, and then ascend at the central part of the chandelier, or against the wall, if applied to a single light. To this succeeded another form, which is very simple, and is in fact only a correct application of the principle of a descending draught to a lamp-burner.

The gas-light has its glass chimney as usual, but the glass-holder is so constructed as to sustain not merely the chimney, but an outer cylinder of glass larger and taller than the first; the glass-holder has an aperture in it, connected by a mouthpiece with a metal tube, which serves as a ventilating flue, and which, after passing horizontally to

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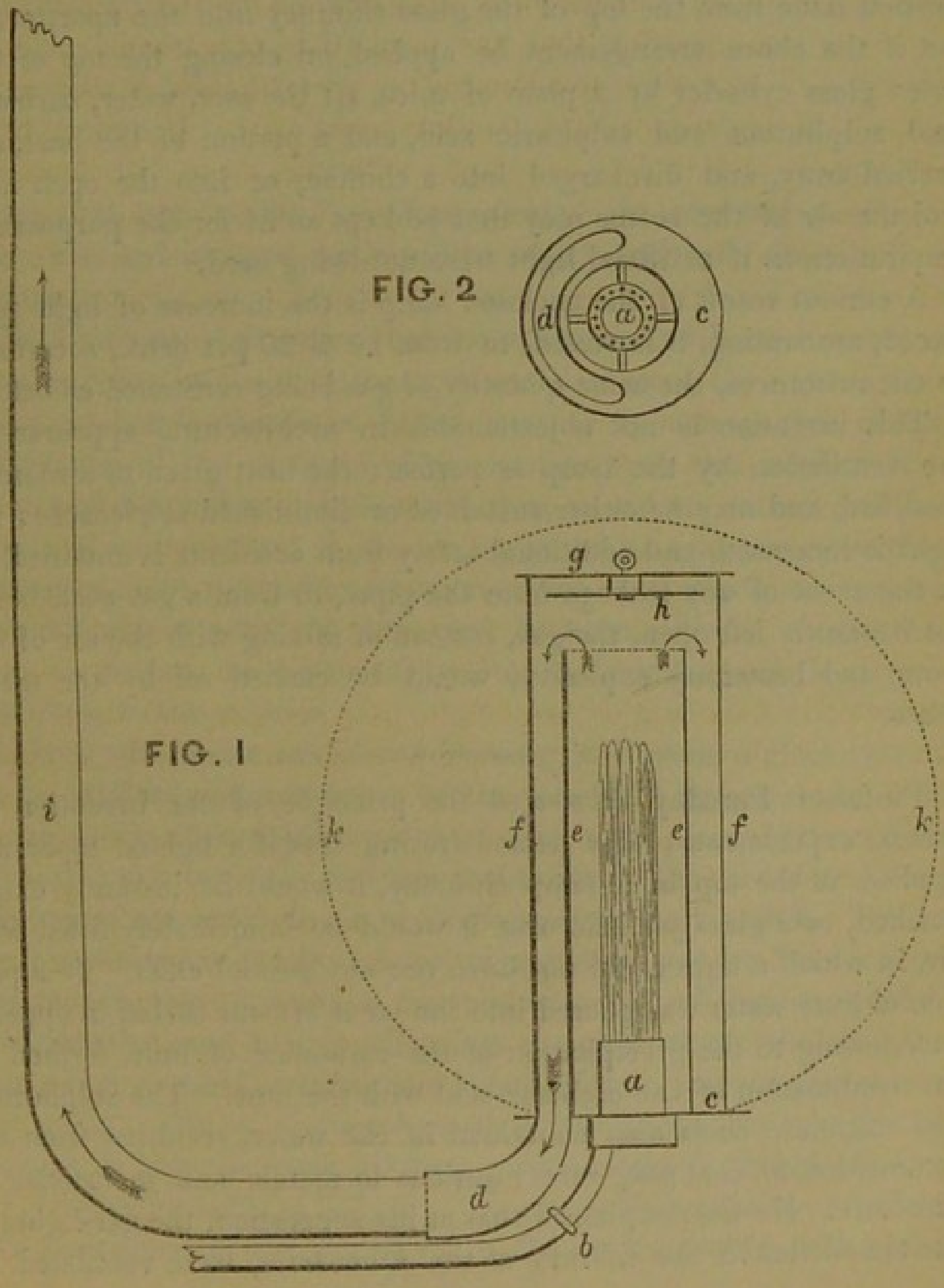
* "Collection de Mémoires relatifs à l'assainissement des ateliers, des édifices publics, et des habitations particulières," par J. P. J. D'Arcet, redigée par P. Grouvelle. Paris, 1843, p. 27.

the centre of the chandelier, there ascends to produce draught and carry off the burnt air.

Fig. 1.—*a*, is the burner; *b*, the gas-pipe leading to the burner; *c*, the glass-holder, with an aperture in it, opening into the mouth-piece *d*, which is attached to the metal chimney; *e*, the ordinary glass chimney; *f*, an outer cylinder of glass, closed at the top by a plate of mica, *g*; or, still better, by two plates of mica, one resting on the top of the glass, and the other one, *h*, dropping a short way into it. They are connected together by a metal screw and nut, which keeps them a little apart from each other; thus forming a stopper, which cannot be shaken off the glass chimney, but is easily lifted on and off



by the small metal ring or knob at the top; *i*, is the metallic tube chimney; *k*, a ground globe, which may be applied to the lamp, and which has no opening, except the hole at the bottom, where it rests on the glass-holder; but any other form, as a lotus glass or vase, may be substituted at pleasure.

Fig. 2, is a plan of the glass-holder, showing the burner *a* in the centre, perforated with jets, with openings round it to allow of a free admission of air to the flame—and the aperture, *d*, which opens into the mouthpiece connected with the metal chimney, *i*.

The burnt air and results of combustion, take the course indicated by the arrows, and are entirely carried away by the chimney.

With a lamp burning in the ordinary way, the products of combustion issue from the top of the glass chimney into the apartment; but if the above arrangement be applied, on closing the top of the outer glass cylinder by a plate of mica, all the soot, water, carbonic acid, sulphurous and sulphuric acid, and a portion of the heat, are carried away, and discharged into a chimney or into the open air; and the air in the rooms may thus be kept as fit for the purposes of respiration, as if artificial light were not being used.

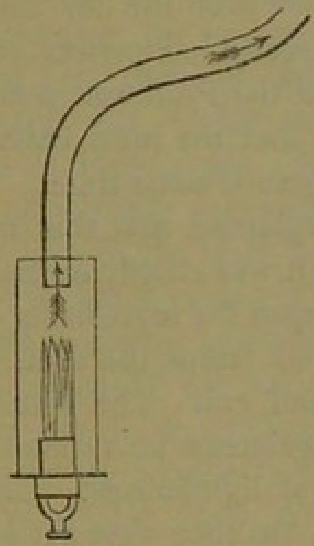
A curious result of the enclosed lamp is the increase of light produced, amounting, it is stated, to from 10 to 20 per cent., according to circumstances, the same quantity of gas being consumed as before.

This invention is not objectionable in architectural appearance; the ventilation by the lamp is perfect; the heat given to a room is modified, and may be either sustained or diminished at pleasure; the light is increased, and additional safety from accidents is obtained, as in the event of any leakage from the pipes, or from a gas-cock being inadvertently left open, the gas, instead of mixing with the air of the room and becoming explosive, would be carried off by the metal tubes.

'rofessor 'araday.

Professor Faraday illustrated the principle of the invention by several experiments; first demonstrating that if a lighted taper was applied to the top of a lamp chimney, it would be instantly extinguished, or a glass jar held over it would be immediately filled with air, in which a light could not burn nor any animal exist. If a portion of lime water was poured into the jar it became turbid in appearance, owing to the precipitation of the carbonate of lime, formed by the combination of the carbonic acid with the lime. The sulphurous and sulphuric acids also contained in the water, resulting from the combustion of coal gas, were injurious to metals and to articles of furniture. He then explained that at his suggestion, the gas-lights of the chandelier in the Library of the Athenæum, were ventilated by tubes dipping into the lamp glasses, Fig. 3, and conjoining at a short distance above into one central pipe, which carried away all the burnt air from the room.

Fig. 3.



This first application had demonstrated the correctness of the theory, and had induced modifications which had been described in the paper.

The Professor then stated that his attention had been directed to the subject also by the disadvantages attendant upon the want of ventilation in the lanthorns of Lighthouses, as in consequence of the condensation of the products of combustion upon the windows, the intensity of the lights was diminished to a serious extent, and the quantity of carbonic acid in the lanthorns was at times so great that the keepers could with difficulty enter them. This was illustrated by an experiment, showing the difference between allowing combustion to give its products to the air of a room, and carrying off those products freely to the exterior.

A short wax candle was placed burning on a plate, a glass jar put over it; and the upper aperture of the jar closed by a globular cork through which was passed a piece of glass tube, about half an inch in diameter and twelve or fourteen inches long: the tube descending to the top of the candle flame, and being placed just above it. Under these circumstances, plenty of air passed into the jar between its edges and the plate, and out by the tube, to supply all that was needed for combustion, and to keep the glass chamber clear: therefore, in that position it would burn for any length of time, and the jar remain quite bright. But on moving the cork a little, so that the tube should no longer be over the flame, all these results changed, though the air-ways remained exactly as before. The candle then gave the products of its combustion to the general air of the glass chamber, which immediately became dull, from the water deposited upon it, the air itself was deteriorated, the light grew dim, and in a few minutes it went out; but if that was prevented, by the tube being again placed over it, signs of recovery appeared, the light resumed its former brightness, and after a short time even the dew disappeared from the glass, demonstrating how indispensable a perfect ventilation was for lighthouses: on which subject the Professor promised a communication.

Mr. Bethell

Mr. Bethell remarked that the inner chimney appeared to become dim after the light had burned some time.

Professor Faraday.

Professor Faraday explained that this might arise from several causes; he apprehended it was chiefly occasioned by the action of the sulphur in the coal gas upon the ingredients of which the glass chimney was composed. In oil lamps the same effect was observed, but not so speedily as with coal gas. The Trinity House suffered much by it, and had made experiments on various qualities of glass for the chimneys of the lamps of lighthouses. Chimneys formed of mica would not be so affected, but they were not so transparent as glass.

Mr. Bethell

Mr. Bethell said that the Bude light, as now used in the House of Commons, was constructed somewhat on the same principle as had been described in the paper, except that the current was directly upward, which rendered the application of two chimneys unnecessary: perfect ventilation was obtained by it.

Professor Faraday.

Professor Faraday said that the Bude light, as proposed to the Trinity House, was an oil lamp, supplied with oxygen by an apparatus for generating it. In lighthouses, it was indispensable that the lamps should be so arranged that the lights should consume only a given quantity of oil, and retain an unvarying degree of brightness for a given time, which was now four hours, at the end of which time they were trimmed. It was found that with the Bude light, the quantity of oil consumed was greater, and the lamps required trimming in two hours, in consequence of the wicks charring; these circumstances rendered the system inapplicable to lighthouses. Subsequently, five of the Bude-light lamps had been referred to him by the House of Commons for experimental purposes, and his observations upon them were of the same nature.

Mr. Bethell

Mr. Bethell explained, that in Mr. Gurney's present "Atmospheric Gas-burner," the supply of oxygen alluded to by Professor Faraday was not used.

Mr Snow Harris.

Mr. Snow Harris inquired whether the action of carbonic acid, to which the term "poisonous" had been applied, was to be considered as positive or negative. How was it to be viewed in its connexion with the circulation of the blood and with the process of respiration?

Professor Faraday.

Professor Faraday replied, by quoting from the work of Dr. Marshall Hall,* that "It was first distinctly stated by Sir Humphrey Davy, that in inspiration and during the pulmonic circulation, the double function was performed of—1st, the absorption of oxygen, and 2nd, the exhalation of carbonic acid, by and from the circulating blood, a doctrine from which another doctrine flows, *viz.*, that, during the systematic circulation, the oxygen absorbed is continually undergoing the transition into carbonic acid." The general conclusion from his experiments was, " That respiration was a chemical process, the combination of phosoxygen (oxygen) with the venous blood, and the liberation of carbonic acid and aqueous gas from it." †

Professor Graham, in a note to Dr. Hall, says, " If an animal were to breathe atmospheric air to which carbonic acid were added, in proportion to this addition, the evolution of carbonic acid from the blood would, in my opinion, be impeded ; the passage of the carbonic acid outward, at all from the blood, depending upon the comparative absence of that gas from the air taken into the lungs."

In treating of " asphyxia," Dr. Hall says, " The absorption of oxygen, or the evolution of carbonic acid, or both, are impeded or interrupted in every case of asphyxia. From the want of oxygen the blood is deficient in stimulus ; by the presence of carbonic acid it is positively poisonous."

It appeared from the researches of physiologists, that the presence of a certain proportion of carbonic acid was necessary to stimulate the action of the heart, and regulate the circulation of the blood; that nature kept up the proper supply for this purpose, but that any excess was prejudicial.

Acting upon this principle, Dr. Payerne had brought forward a proposition for purifying the air in a diving-bell, so that without using

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* " The Gulstonian Lectures for 1842," pp. 8, 12, and 40.

† Mr. Edwards, in his work, " De l'influence des Agens Physiques sur la Vie," 1824, p. 465, observes, " L'oxigène qui disparait dans la respiration de l'air atmosphérique est absorbé en entier. Il est ensuite porté en tout ou en partie, dans le torrent de la circulation. Il estremplacé par une quantité plus ou moins semblable d'acide carbonique exhalé, qui provient en tout ou en partie, de celui qui est contenu dans la masse du sang. En outre, l'animal respirant de l'air atmosphérique, absorbe de l'azote ; cet azote est porté en tout ou en partie, dans la masse du sang. L'azote absorbé, est remplacé par une quantité plus ou moins équivalente d'azote exhalé, qui provient en tout ou en partie du sang.

" Voila quatre points fondamentaux :

1°. L'absorption de l'oxigène qui disparait ;
2°. L'exhalation de l'acide carbonique expiré ;
3°. L'absorption d'azote ;
4°. L'exhalation d'azote."

the air-pump the diver might remain under water for four hours, or even longer. This was, the professor believed, accomplished by ~~de-composing~~ the carbonic acid, ~~absorbing the carbon, and eliminating the oxygen~~, and not by generating oxygen, as had been generally imagined.

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