FARADAY
ON THE VENTILATION
OF
LAMP BURNERS.

FARADAY, M.
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James Faraday, whose paper is discussed, was Michael Faraday's nephew

DESCRIPTION

OF

A MODE OF OBTAINING

THE

PERFECT VENTILATION

OF

LAMP-BURNERS.

BY

JAMES FARADAY.

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

EXCERPT MINUTES OF PROCEEDINGS

OF THE

INSTITUTION OF CIVIL ENGINEERS.

LONDON:

1843.

INSTITUTION OF CIVIL ENGINEERS.

June 13, 1843.

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 aparments, 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

* "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.

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 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 mouthpiece *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

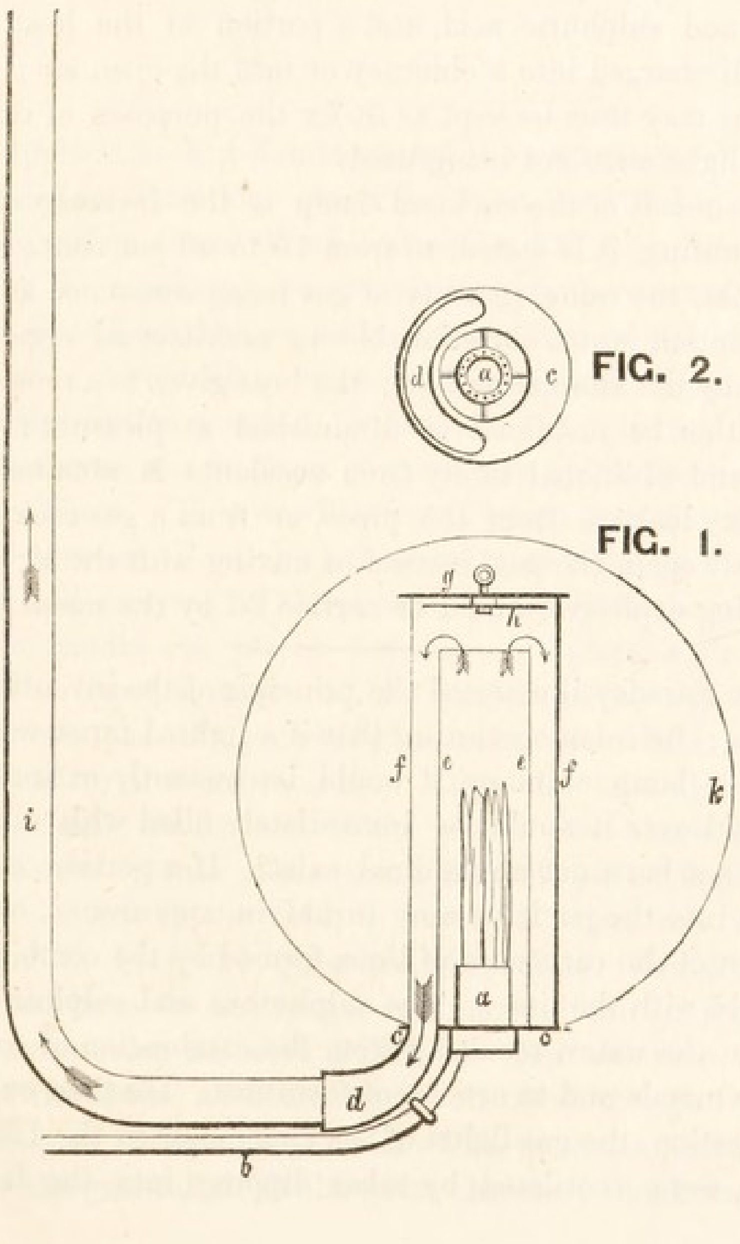


FIG. 2.

FIG. 1.

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 issues 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.

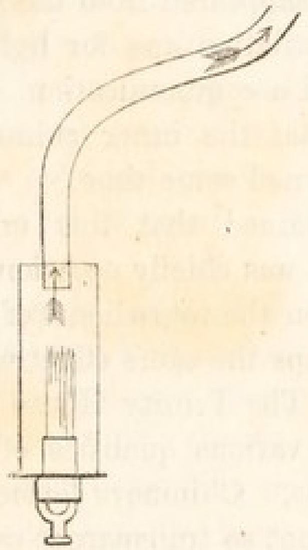
This invention is not objectionable in architectual appearance; the ventilation by the lamp is perfect; the heat given to a room is modified, and may either be sustained or diminished at pleasure; the light is increased, and additional safety from accidents is obtained, as in the event of any leakage 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.

Professor Faraday.

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 loug: 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 connection with the circulation of the blood and with the process of respiration?

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 phos-oxygen (oxygen) with the venous blood, and the liberation of carbonic acid and aqueous gas from it†." Professor Faraday.

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 pro-

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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 disparaît 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 est remplacé 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.

"Voilà 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."

position for purifying the air in a diving-bell, so that without using the air-pump the diver might remain under water for four hours, or even longer. This was, the professor believed, accomplished by absorbing the carbonic acid, and not by generating oxygen, has had been generally imagined.

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LECTURE ON LIGHT AND VENTILATION:

DELIVERED

AT THE ROYAL INSTITUTION, APRIL 7, 1843.

BY PROFESSOR FARADAY.

My business to-night will be exceedingly simple. I have no deep point of theory to bring before you and dilate upon, but merely a few plain simple facts, important only in their application to a useful purpose in the lighting and ventilation, especially, I may say, of light-houses. I shall endeavour to use the plainest and simplest language for the purpose of conveying my ideas in the clearest and most elementary form to your minds. I am perfectly satisfied that the matter itself, when fairly brought before you, is the only thing that I need recommend to your attention.

I have the honour of being engaged, or connected with the Trinity House, in reference to certain points on which they may think I may be useful to them in advising and observing upon certain of their light-houses; this has led me to think of the ventilation of their lights, for a purpose which will almost immediately be evident to you, and which is highly important in the present state of things. I am also, and have been from the first, a member of the Athenæum Club; and there again different circumstances have called my attention to the same point—the possibility of well ventilating lights. I use the word "ventilation" in its common sense, as meaning only the mode of withdrawing from places where human beings are to live and move, the bad atmosphere which light itself gives forth from the evaporation, and so leaving the air in its undisturbed and natural condition, in which alone it can be useful to man.

And now I will adduce the facts, as briefly as I can lay them before you, which have been the result of these observations, and which you will find abundantly sufficient for the hour we have to spare.

All the ordinary substances from which we obtain light by artificial means may be represented by oil and gas. Here is common olive oil, used in the countries where it is produced for the purpose of obtaining light; and there is a portion of olefiant gas. Although wax, tallow, or anything of that sort be used for the purpose of producing light, yet they all fall under one or other of these denominations, inasmuch as they are like the vapour of oil. These are the two substances to which we generally refer the light. I have put down on a table the composition of these two bodies, for your observation this evening, and you will find that the oil contains carbon, hydrogen, and oxygen, and the gas only carbon and hydrogen. The composition of oil is given according to Dr. Ure, of 100 parts, and is divided into—

Carbon	78 0
Hydrogen	11 5
Oxygen	10 5
	100 0

The gas I refer to is such coal gas as we have in this room, as it is burning here around me, and as commonly used in London; its composition (according to Henry, I think) is seventy of carbon and thirty of hydrogen per cent. These are the two things which are represented here; in this vessel below there is hydrogen, the other is carbon, which are in their elementary states existing separately; I give you at present the constituents of these two bodies. The oxygen which is there present I need not disturb you with now, inasmuch as it merges into these other bodies when burning in the air. The hydrogen, which is a very gaseous body, is burning; there is the carbon, and I will in a moment give you the combination of that body, as I shall want the phenomenon by and by for the purpose of illustrating a very curious point in these gaseous bodies. This is a piece of charcoal which I can burn by oxygen of the air, or in pure oxygen gas which I have taken for the purpose; the other is oxygen exactly of the same nature, but in the present case is in the atmosphere. The two instances illustrate all the modes in which we burn every one of the combustible substances, either in the ordinary way or by extraordinary means, for the production of light.

Now, whether I burn oil or olefiant gas—that is to say, oil gas—the same thing happens in all these cases, the same final result takes place as in this particular instance. Here I have the carbon and hydrogen combined in the form of gas. You will see by an instantaneous experiment that this gas partakes in the character of its combustion of these two compounded—that we shall have the flame of the hydrogen and the luminosity of the carbon combined in one act. There is the gas burning; and if I expel it by pouring in water, which displaces the gas, you will see it burning away very beautifully, giving the compound of the two elements. Here, of course, are the two things.

Now, when these bodies are thus burnt, as they are being burnt here around us in all these lamps or gas lamps, they produce—what? The hydrogen which is here burning produces water. You have heard this, I think, in the course of the lectures from Mr. Brand—that hydrogen produces water, therefore I need not for a moment dwell upon that point, except to show the amount of hydrogen. The carbon produces carbonic acid gas, which we have here; and this I can show you by one or two modes; one I have selected, because I shall by and by refer to it again for the identification of these substances in this case.

If I take a portion of lime water and pour it into water, in the product of that combination I get no visible effect; but if I pour it into carbonic acid—which is always the result of the combination of carbon with oxygen, or the air, then I have a certain effect which I will now show you; a strange milkyness is produced, (*obtaining the products of combustion from a lamp in a glass jar, and then testing it with lime water*,) as you see it here very evident and distinct, very immediate and satisfactory; because we take oil or gas and burn them, and we show that we have nothing formed but water and carbonic acid.

Now I must stop for a moment to show you what takes place in consequence of this; I mean the effects which take place on the atmosphere, which, under all these circumstances, is supporting the combustion of the light, and what it is that is thrown into that atmosphere from the oil or gas which is burnt. That lower table which I have affixed there to the wall represents to you, in a strong manner, the effects which are thus produced. (*Referring to a table of products.*) A pound of oil produces, because of the hydrogen it contains, rather more than a pound of water. A pound of olive oil, if burnt in the atmosphere, or oxygen, or in any other way, will produce rather more than a pound of water. Why? For this reason—that it takes from the atmosphere that portion of oxygen which the hydrogen produces—the water which you saw just now, when I held that glass jar over the jet of hydrogen. Now that is a jar in which no animal could live. The light takes the oxygen from the atmosphere, and forms with it water, and that water amounts to rather more in weight than the oil itself, because the one part of hydrogen in the oil takes eight parts of oxygen from the atmosphere, and thus produces nine parts of water. The carbon of the oil, which is seventy-eight, will produce two pounds and eighty-six hundredths (which would amount to nine-tenths) of carbonic acid. And it takes in doing this two pounds eight ounces, or nearly three pounds, of oxygen from the atmosphere; and it spoils thirteen pounds and a quarter, or one hundred and seventy-two and a half cubical feet of air, which is deprived of its oxygen, and thereby partially spoiled, and which, if we could carry on the process so far, would be utterly destroyed—the whole of the one hundred and seventy-two and a half cubical feet of air.

But look at gas, for that contains a greater proportion of hydrogen. I will give you London gas, for example. A pound of gas produces as much as two pounds and three-quarters of water; it produces two pounds and a half, or rather more, of carbonic acid, and takes twenty-one pounds and a quarter of oxygen from the atmosphere, and spoils nineteen pounds and one-third of air, or consumes 251 cubical feet.

The carbon which is found in all the gas we burn, is by no means an innocent thing. It is an exceedingly noxious and deleterious substance, and is instantly fatal to animal life. If I could take a portion of common air, and convert the oxygen into carbonic acid, and mix that air with other air, although there is so much nitrogen, it would still be fatal to human life. Now air, I will say, containing so much as only one-tenth of carbonic acid, is still fatal to animal life. Indeed, if I refer you to the cases of brewers' vats, to wells sunk in the ground, to boys who get to the lee side of a brick-kiln, to the numerous cases of deaths that happen annually from carbonic acid, from the deaths in mines after firing the fire-damp, when the choke-damp destroys the men; when you refer to all these cases, I think you will be convinced that this gas is very prejudicial indeed. In fact, it comes to this—that a man may go on breathing a certain amount of air seven or eight times as long if he abstracts the carbonic acid from the air, from what he could do if he left the carbonic acid to accumulate. He pines and dies, not for the want of oxygen, but because of the deleterious effects of this body so often produced.

Now, I mean to impress this point upon your attention, that when carbon is burnt into carbonic acid, in all these cases it directly and positively produces very injurious effects, not only by taking from the atmosphere the oxygen which is there, for you may abstract as much oxygen by other means, and yet find the air even for a long time wholesome and good, as has been shown in the diving-bell, and many other cases. Well, now, my point to-night is to dispose of the evils which arise under one state of circumstances, namely, the water that is formed together with the carbonic acid, by burning matter for the purpose of light.

I shall take, as being my duty, in the first instance, the case of the light-houses. It is my duty to think for the good of that body, who have so honoured me by calling me in at times when they think my services might be useful; and whether the thoughts that may arise on the present point may be followed out or not; whether they are justified by the experience of those practical men who alone can judge correctly of them, I am sure that my proposition to place them before both them and you will be received with all kindness.

First of all, we must bear in mind that a light-house is a structure erected upon the coast, or near the coast upon rocks and shoals, and is intended to warn the mariner, by the exhibition of a powerful light, of his approach to certain situations of danger or safety; of danger, if it is a rock, of safety, if a harbour is near. You may see of what it consists, from the beautiful little models belonging to the Trinity House, and which I have been allowed to have from there for the purpose of this evening's lecture. Here is a very beautiful model of a light-house erected recently at St. Catherine's Tower in the Isle of Wight. Here is the tower, and there is the lantern in which the light is placed which is to give notice to the approaching or receding mariner of his whereabouts. Here are two models of what are called "the lanterns." I will bring one upon the table for a moment, to show you more distinctly its general nature as a place needing ventilation. You see this is a model on a larger scale of the lantern of a light-house, very fairly and properly called a "*lantern*," from its appearance and size; a small room raised to the top of a tower, fitted to resist the waves, as in the case of the Eddystone light-house, and the winds in all cases; to bear all the beating about of those elements of nature, and yet withal to be walled only by glass, to be perfectly unchangeable; a place in which the man has to carry on his operations of watching the light and taking care of it, for sixteen hours in a winter's night, and eight in a summer's night. Here is a model of one, which you perceive is a mode of producing and dispensing and sending forth the light. It is a large powerful lamp; a strong light is put into the centre of the lantern, it is then surrounded by an arrangement of prisms, carved or cut in various forms or kinds across, with one place of lighting, the light radiating there, as it does here in this lamp, in that direction, rising up and down in a horizontal plane according to circumstances. All I need to trouble you with here is, to think of a very powerful lamp. The painted parts, which you see are coloured blue in the model, are glass. Now here is a lamp, which lamp, I believe, varies in size; it may be twelve or fourteen feet in diameter, perhaps from eight to ten high within. It is a very powerful lamp, which will burn from twelve to fourteen pints of oil in one night, or, it may be, in the case of separate lights, of which I have some there, there are various reflectors, each having its separate lamp, of an ordinary size, the same as this is. In that case, they vary from a small number up to twenty or thirty lamps, burning in one lantern. There is an arrangement, you see, of that kind of thing; there is a lantern containing the small reflectors, which they place in three planes, so that when the whole arrangement of parts revolves, it is giving a recurring light, three times in one revolution, which is regulated according to the experience of those who govern those matters, so as to distinguish one light from the other. Here you have a lamp which burns from twelve to fourteen pints of oil in an hour. There you have lamps, amounting to from twenty to thirty, which may be burning from fifteen to twenty pints in an hour; in fact, that is one-third of the Tynemouth Light-house, just by Newcastle-upon-Tyne. There, I think, the average consumption of oil was nineteen pints and six-tenths, all of which was burnt in a winter's night with eighteen lamps. Think how much water nineteen pints and six-tenths of oil will produce. We shall have above twenty pints of water, actually producing a combination of these elements, in this small chamber in one night in the Tynemouth Light-house.

Now, here is a lantern thus lit up, having a great deal of combustion going on within it, and the point is what happens or results from the presence of all these products of the light thrown into the air containing the lamps, from the lantern being very open, according to circumstances; and in Scotland, I believe, they are open for this purpose. This is a very beautiful arrangement; if it be sufficiently open, the air can manage to pass through to supply the combustion of all these lamps, and not only so, but the supply of a sufficient change of air, that the bad air may be carried out and replaced by fresh. Nothing particular is there evident, but there are many cases of lights where the effect is very apparent. There are plenty of cases of lights of this kind—I suppose I might advert to Scotland, but being at Tynemouth, I found there a light-house, which was very liable to damp on the surface of the glass. When that tower was first built, this light was first brought into use, I think I am right in saying so, towards the winter season, and there the quantity of water produced in the lantern was such, owing to the cold wind, which was sufficient to cool the water on the glass, that I found as much as one-half, one-third, and one-fourth of an inch thickness of ice had been formed on the inside of the glass—for all that water which is so produced by the cooling of the place where there is water. There are a number of persons here to-night, and who exhale water from the lamps which are burning—but the water which is so produced in this case, is so diffused through the room that it is all perfectly clear and transparent, and does not annoy any one; but if I cool any portion of water in this room, you will soon find what the effect of the decomposition of water is. Only think of one of these light-houses, what a refrigerator the surface of these lanterns is; then think how liable it is to moisture, that water is produced in such quantities as twenty pints in an hour—two gallons and a half produced by vapour! You will perceive it is hardly possible but that some of it should be condensing. Here is some condensing. I have put a little ice on the inside, it has not given a temperature so low. The moment I put it on the inside there is moisture on the outside, and that moisture can be better deposited on these windows, if there is not a very free current of air through, than it does in those cases where there is a current of air—this makes the windows dim: from the light being a revolving light, it mingles up the two lights together,—what should be dark is not dark, and what should be the brightest, is not the brightest; and if it goes on so far as I have stated, it will bring about ice on the windows, and you get all this kind of reflection. As you see in one of these glass globes, you destroy the shadow because no dispersion takes place, and in that case the revolving or intermitting character is very seriously impeded.

Well, then, I will try to save my time as much as I can. Let me hope you do perceive the importance of this subject. Speaking of the water only in the lighthouse, the producing of twenty pints of water re-converting as many pints of water into steam within that small place, which is cooling at all times the windows. I am trying to obviate the difficulty, if there is no danger. It may be a great inconvenience, and in fact it has been found so in many cases, and it was my object to cure it.

Well, here begins the value of ventilation. Before I come to this state of things which we really have now, I will show you what we did formerly. Over that central lamp we placed a chimney; and I must use one small lamp to represent a large one. I want to give you the effect of the chimney properly applied. You will allow me, if you please, to speak of "smoke" and "chimneys" with a little latitude. By smoke, (for I have not been able to find a better or a shorter phrase,)—by smoke let me now be understood to mean that current of spoiled air which, although it is not visible, is passing upwards from the flame. I would rather call it the impure current of air, which is rising from the flame, or gas-burner, or candle. I will to-night call it smoke for shortness. Now, here is a lamp which may for the present represent the central lamp of the light-house, or a lantern containing only one large lamp. Now, draft is a most beautiful thing, and I will give you an illustration of what draft does, and it is a very beautiful experiment, for the purpose of being able to follow out effectually—the idea being in your minds from visible appearances—the operation of draft in all our houses. Here is a tube of the same temperature as the air, and there is no air moving up or down in the atmosphere; the temperature is all alike in both cases. If I make the air hot within this tube it expands, and it becomes of course lighter, and it rapidly rises. Now, if I begin to make the air hot in the tube, if I keep one end of this tube near any source of heat, I shall continue the same thing. Observe how the flame is affected by it, the light is taking advantage of the draft the moment you find a little air gets up this tube. Now, look at the draft, it no longer goes this way, but that way, and I might put it down in a very low inclination, because I now have a column of air in this tube which is effectual in determining the mechanical force in this direction. I want, if I can, to make the action of draft clear to you, to get the succession of effects which are very beautiful. Here is the flame drawn up almost to my fingers by the effect of the first current. There is water produced even with the alcohol, and some from the oil and from the gas. In order to ventilate that central lamp (*referring to the light-house lamp*,) we used a chimney. You will see in a moment its effect and its efficacy; there is our ventilating chimney, only this is on a small scale as compared with others,—there the lamp is four inches in diameter; the chimney is of the same width. Now, what I want to show you there is, the beautiful effect of draft in carrying up all the carbon, all the spoiled or bad air being placed in the right place in regard to the chimney. This is a tube not larger in diameter than the glass chimney; it is open here, there, and there, and yet with all this, carrying every portion of the smoke, or every portion of the air that passes from the lamp. (*This was applying a very long tube or chimney to a lamp.*) There is nothing escaping—no water, no bad air, is escaping into the room at any of the apertures; it all goes up, and out at the top; and if I were to hold a jar over the top I could show you in a moment the moisture there present. I will blow this out and make the smoke of the light enter into this place. If I put it there (*varying the position*) I expect you will see it all go up the chimney, and all go out of the top. There it is. You see there is none coming out at the lower apertures, the ventilation is perfect, all that is in the inside must go up, and it all passes up to the top, none gets out here or there.

You will say, "What is the amount of this?" Look at the effects. I can by this kind of chimney carry up all the water out of the lantern of a light-house; it does not deposit itself and condense on the panes of glass of the lantern, as it used to do, but it goes out above. The use of that is this. When a lantern is put up in a light-house, which is always liable to gusts, the wind about the mouth or chimney will catch the mouth of the cowl, or the mouth out of which all the smoke is passing, and will not affect the light, showing, that although its mouth be surrounded by currents of air, it would not affect this. I might even put up a blowing apparatus there and it would not descend to the lamp; it would not affect the light; it finds escape at this place. I find if I stop this place the light is not affected; and I may make a great many variations, and I dare say we shall make all these variations, and yet the lamp goes on burning uniformly and steadily.

Now then, the first and most important thing in a light-house is, that the light should never vary; the light, above all things, must have the nursing care of those who are bound to attend to it, because on that the safety of the mariner depends. All other inconveniences must be borne with if necessary; but the light must go on burning steadily. I will show you by an experiment the necessity of keeping the thing clear and dry. What you see here on a small scale will be found equally prominent in a large one. First of all, let me show you an experiment. I will make a little light-house. Now, here is a glass jar, there is a chimney, (*a small glass tube passed through the upper part*,) here are some pieces of candle. I am going to make a little room, and then to put a chimney over a piece of candle if I can adjust it properly. I want the jar to be quite clear, and my glass is quite clear at present.

Now, I put the chimney over the light,—my glass tube is the chimney, that represents a small room there is sufficient leakage of air in, as you find the light to go on burning, and a sufficient escape out of the tube. All I want to show you is this, that so long as this or that chimney remains over the light, the glass will continue perfectly bright and clear, the light will go on burning regularly and uniformly, neither more nor less, proceeding at the same rate; but the moment I shift this, (*the chimney*,) not to close it, not to put it lower or higher, but merely to move away the aperture from over the light, and leave the vapour or smoke to ascend from the candle, to the interior of the glass jar, and mix with the air therein, then you will see the difference. I will just move the lower end of the chimney away to show you. All is open as before, but the chimney does not carry off the products of combustion; you will quickly see water produced; you will see the moisture which is now appearing, and is depositing itself on the sides of the glass jar, and the light is going out; the bad air of the light comes up and mixes with the air of the room,—I mean diffuses itself around with all the air in the small room (*the glass jar*). The moisture is appearing in the glass, it gets more and more dim, and the light will at last go out; yet I have not closed up any aperture, but in place of sending the smoke of the flame of the lamp up the chimney, I have admitted it in the room, as is done in all ordinary cases of private and public establishments. When this light has got very low, I can restore it by ventilation: it is now very nearly going out, yet if I bring the chimney over, and so gradually carry off the bad air as it is produced, the ventilation will become good again; the light will become bright; and if I keep it on long enough, the windows will become clear as before.

I do not say you cannot do this by other means, but it is our business as philosophers to try what we can do; and I think I am not saying too much, when I say, I believe it is the desire of the Trinity House, as it is assuredly mine, to have in their possession all the means and appliances of all sorts which can serve their purpose, and then to apply them in those cases where they may find necessary, either where ventilation is necessary of this especial kind, or in other cases. This ventilation is one among the rest, and this is proposed as one of the means of remedying that deficient ventilation which is found to exist.

But to return to this light-house. When I found the windows in this condition, I put up a chimney; and I have subsequently written to the man who has charge of the light, to ask him what was the effect of the alteration. The letter in reply says, there is no moisture and no dirt sticking to the lantern. You see the window having got so wet and moist with the vapour, the dirt stuck there, and the smoke was attracted and deposited itself there too. He says, "no damp condenses on the windows."

Now look; our lantern or little glass room has become bright again while I have been speaking to you, the candle burns perfectly bright and clear; and yet if I turn the chimney on one side again, you will see, although the lantern may not get dim again, that at all events the candle will go out.

I will pass on from these matters, having endeavoured to lay before you as plainly as I possibly can, a few thoughts with respect to light-houses, and our anxiety to ventilate them better. I come now to what seems to me of great importance, namely, the case of revolving light-houses. These revolving reflecting light-houses are, I believe, very numerous, and are often erected in low situations. These reflectors are often used in floating lights, where there is not the capability of ventilating in the same way as in the towers fixed on land. It became a point with us to remedy this evil, and we said, "Cannot we carry on a system of ventilation in those cases where we have several lamps, as well as in those instances where we have only one large central lamp?" The mode in which it is carried out, I shall give you as briefly as possible. There is our plan carried out, and the mode in which we are able to improve the ventilation is to this effect. (*Pointing to an arrangement of lamps, each lamp having a tube entering into the glass chimney, and the tubes acting as conductors to the chimney, by which all the bad air is carried away.*)

My object is to show you the result,—the practical and essential result,—of the use of the ventilation of this kind in a lantern. Excuse the roughness of our arrangements. I have put up here, you see, a gas lamp, and a chimney over it; the chimney here does not go on the outside as before, but enters the chimney; for one important point, a really important one in this investigation, was to ascertain that you do not require those large and long things which you see in the shop windows. If you go to a shop now, in many cases you see a large beautiful funnel in the wall with a fine bell. This bell is hung over the light. Why, that bell is nothing more than a lantern; the air that is rising from that lamp is mingling with the air in the room; the air that passes through the pipe carries off a little of the bad air, but all the rest is in the room. If I hold this lamp here, you will find that there is a pure current of fresh air entering in the middle. It is nothing more than the mixing of the bad air of the lamp with the air in the room. A small portion is carried off on the top and goes down with the heat; that is essential for keeping up the draft with heat, so that no good results. But take a small tube, and put it into the chimney of a lamp; let it pass out of the room, and the ascending current takes all away. I shall find that no air passes by that lamp into the atmosphere. I cannot very well get my chimney (*the long tube of smaller diameter introduced a short way into the glass chimney of the lamp*) to act centrally. I should have it just in the centre, but even with that irregularity I shall be able to show you that the bad air will actually go away at the top of this glass tube. I am drawing the bad air from the top of this glass now; before that, the bad air was passing out into the atmosphere. The light is the essential point in a light-house; we must never embarrass the reflectors, we shall have then, I trust, a light that will be for the general good. These reflectors all show forward with great power. If I were to bring down the chimney of a large size here, and were to hang it over this glass, it would be in the way of the reflectors; but see how it comes out if we try it by the right practice, that is, with a small tube to each burner. Here is a small tube which carries off every portion of the smoke, the water, and the carbonic acid. Here is the ordinary glass chimney; here is one small tube, and there is another, one to each burner. Here is the main chimney, which receives all the small tubes or chimneys, and which goes out above; each small tube taking the products from its own lamp, without any interference with others or with the reflectors. I have the happiness of saying, that the Trinity House authorities have informed me,—perhaps it may be kindness or flattery on their parts,—that they think that in this there is no interference with the light of the mirror to any extent.

I should just like to put a taper on the top of that chimney, to show you that the air which is going out is very bad air. This is merely to show you the way in which these lamps deliver their smoke and vapour. The system comes to this,—it is an adaptation of sewerage to the atmosphere, in place of throwing the refuse of the spoiled air into the atmosphere. We are applying a system of aërial sewers. (*One small tube being just introduced into the upper part of the glass chimney of each burner in place of having large funnels over the glass chimneys.*) Now here is a lighted taper. I will just put it over the top. Just look, and you will have abundant proof of the state of the air there. You see the air is very bad, for the taper has gone out in a moment. It is as bad in this or in the little glass chimney; if you try it with lime-water you will find it as bad as this. I have the pleasure of saying, that I have been requested to try this plan in two light-houses. What you see here is to be applied in this way to revolving lights. I will not disturb you by showing how we get this chimney into different parts, because in one case I effect the object by making one part of the chimney move, and the other rest. I had better turn this round a little, and then you will see how the pipes are arranged. (*Showing that the small tubes used for conveying off the products of combustion might be bent, and carried in almost any direction.*)

Well, now, I must hasten on, I am afraid I am losing time, but I cannot help it. I have one or two experiments, which I will give you on this subject when I come to the ventilation of rooms; in fact, I have said so much about the badness of the atmosphere, arising from imperfect ventilation in light-houses, that I need not say a word more about its inconvenience and injury in rooms. I would if I could, but I cannot as yet, relieve you from the effect of the many lamps which are burning in this room; were I to do so, you would be much more comfortable, and would like to stop an hour longer probably, although you would not wish to do so in the present state of the place.

At the Athenæum we began our improvements in the ventilation by carrying out this system of small tubes introduced into the glass chimney of the gas burners. The lights are applied to a chandelier, for instance, each with its own tube, and the tubes are all carried into one common tube, which passes up through a ceiling into the outer air, and in that manner all the smoke of the lamps in the reading-room and the library of the Athenæum is carried away. I am happy again to say,—for one is always obliged to take the kind expressions of one's friends with a good deal of respect,—that at the Athenæum everybody is of one mind, that the room is very much sweeter and pleasanter than it was. That is the first experiment; but we have gone further than that. I do not suppose they will ever repeat that particular experiment, for we have now a better one here; but it shows the effect of the general principle when it is fairly applied. The room is better and sweeter, and more advantageous for use. There has been a great interest excited among the members of the Athenæum about certain effects that have been produced on the binding of the books; and in fact, our loss in the destruction of books has been very great. Here are books, the binding of which is completely gone. It was supposed it was all the effect of the gas. I have very little doubt it is due to the gas as a whole, partly to the vapour that arises from the gas, and partly it is due to the heat, to the state in which the air is kept in the room, the high temperature of the atmosphere conjointly with certain things which the leather-dresser puts into the leather, and certain effects that are caused by the gas itself. However, this was the leading cause of the investigation; they wanted to purify the atmosphere of the place, and the members all acceded to these alterations. Now, first of all, we had that system which we have just described, but after that we tried another system.

And now I must carry you to another point. I must bring to your notice the phenomena of draft. I dare say you know what a descending flue is; but I will give you an illustration of it. Here is a very rough model of a descending flue. I shall be able to show you that we can actually draw the smoke down. (*Dr. Faraday here described the mode of action of descending flues, using glass flues and different coloured flames, so that the downward draft was rendered visible.*)

Now I have applied this descending draft to an argand lamp by a tube which gets hot, and you will observe what power I get for the purpose of drawing my flame down. What I do here on a small scale is done in furnaces of various kinds to a great extent throughout the country.

Now here is a case of descending ventilation for lamps, which I invented and communicated to my brother when abroad, and he in the proper manner has secured a patent,* for I take no pecuniary interest in these matters. The architect, Mr. Burton, complained, and said, that the previous mode was very effectual, "but it is not very beautiful." You know that in a light-house we do not care about beauty, we do not want appearances inside, but that a good light should be produced outside. "I like this very well," said Mr. Burton, "but they are annoying to us in appearance; cannot you do something better?" Well, the next thing was, instead of carrying the tube straight upwards, we carried it downwards.

(*Dr. Faraday then described his new mode of ventilating burners of lamps, which consists in using two glass chimneys, one within the other, the outer one being covered by a sheet of* mica, *and the products of combustion pass up the interior glass chimney, and then pass down inside the outer glass chimney, the products of combustion being then received into a pipe which carries them into the outer atmosphere.*)

That (*showing a lamp*) is an ordinary lamp; but if I close this (*an outer chimney*) at present, I shall put the lamp out. You see it makes a good deal of dirt and smoke, and the thing acts wrong altogether; but if I warm this (*the pipe to convey off the bad air*), you will see how very quickly I get the draft down. I have an ordinary glass chimney outside, and then I have a second tube; this is just to get an extensive current. There, you will see I have got an extensive draft. If I close that top, and try it with a higher one, and establish a draft, I then get all the smoke to ascend up the central tube or chimney, and to descend on the outside, then to enter this box here, and passes off by that tube. I really am trespassing on your time, but I hope you will excuse me. There is no air coming out here (*the top of the glass chimney*); it is perfectly shut. We have nothing wrong to show you here; yet we have no tube or anything unpleasant, although the lamp is burning as free

* For Specification of this Patent, see p. 21.

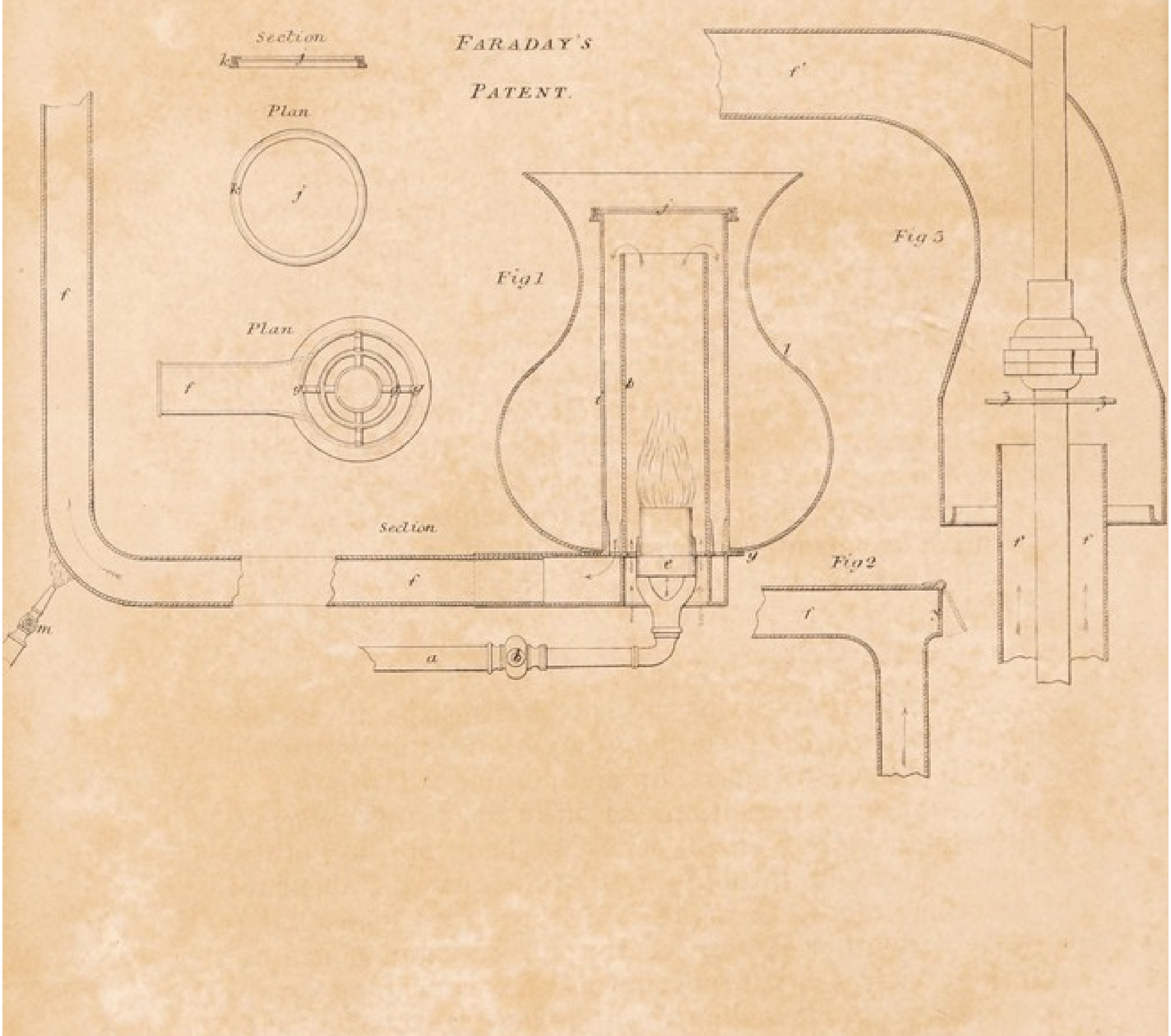
and clear as if I had cleaned the glass, or as it is in any shop-window, and yet the smoke which is going outside is passing away. If I get this glass held over it you cannot have anything coming out (*putting a spherical glass shade over, leaving no opening at top*); yet still the combustion is going on. I shall show you, first of all, the water that is going off here (*at the tube conveying off the products of combustion*), which we have got in the form of steam above. The air there is so bad, that in less than a minute it will put the taper out. By the bye, the size of the glass, and the quickness with which this happens, will show you how rapidly the air is rarefied by the lamp. You see, then, the lamp goes out; that is to say, this other light goes out which is put into the bad air. Now, only think of the difference which must occur;—there is foul bad air; there is the water; there is the carbonic acid; and you have the whole thing brought before you, in the simplest possible condition of a lamp perfectly ventilated.

I have here some of the water which was formed at the Athenæum,—truly, water formed from its elements; and I will just show you, by a few tests, its qualities. Here I have some water, which we have produced from our gas during the evening,—produced from our gas at the moment,—besides all that is gone from evaporation from the vessel being left open. There is the water from the Athenæum. Now, first of all, this water is acid: if you put a piece of test paper in it, it actually reddens. It does not take long to produce the red effect; although I do not know whether, by lamp-light, it may be visibly red to you at a distance. It is really vinegar, if I may so call it, which comes from the lights of the Athenæum, which used to go into the room, and which was condensed on the wall and every other part of the place. This is the water which came from there. But if I take this water and distil it, I get perfectly pure water. Now I will take that water, which the burners have formed to-night from its elements, to see whether there is any sulphuric acid here: I have not tried it under these circumstances. Let us look and see how it is. Well, now, there is sulphuric acid, which was in the water produced to-night, in the glass with the smoke: it is very bad water. Then it comes to this, that the water, for instance at the Athenæum, each particular portion of the water as it is evaporated goes away as distilled water, because, in the lengthy pipe, that sulphuric acid is retained and kept behind; and, in fact, here is a tube from the Athenæum, through which it has passed. Look at the state in which it is;—you see the green vitriol lying in it. If I take the water itself, here I have not much trouble in showing you the iron that is there present, all of which is caused by the sulphuric acid of the gas. There is the iron that is present. Now I really have not played any tricks with this water: that is, the iron which was dissolved from the pipe, which could not resist the deleterious influence of the water and its concomitants, arising from the combustion of London gas.

Architects are desirous to have all they possibly can have for the purpose of purifying the atmosphere, and they shut the doors and windows, keeping in all the foul air, and then call in the chemist to make the place sweet. When you have sweetened it, they say, there is a shadow about this light. Now here (*speaking of the new arrangement*) there is not even a shadow. Here is the final condition of this ventilated lamp. The result is the thing inside this glass. There is a space between the two glasses, and that lamp is now burning close. Everything is connected with this; the smoke of the lamp is carried out into the tube, into a chimney or tube, and you have only to carry out the tube, which is done by the very suspension of the chandelier;—there you have a magnificent chandelier. I use the word magnificent without any fear, because it really is a very beautiful thing, (*speaking of a very splendid chandelier,* [redacted] *with the new mode of ventilating the burners,*) it is a good light, with nothing bad coming from it. It forms a delicious little German stove, by which you may warm yourself, or you may carry off the heat if you please, and yet giving us all this light,—that perfectly steady light. We will call this a globe, if you please: look at this when we move away the glass. This is a globe, perfectly closed at the top, yet I am going to enclose that lamp within it. Now there is the globe; you have there a beautiful lunar globe, perfect in all its parts, standing on as simple a stand as you can possibly conceive; and I think you will agree with me, that it is a very beautiful thing. Here is a chandelier; there is a central suspending tube, which, at the same time, is the chimney of ventilation. The gas is lighted, it then comes down at the top. We have left a moderate aperture open, that you may see all the arrangements;—the gas rising up by the side tube, descending down the central tube, and going away to these burners, each burner being perfectly enclosed. Two of these burners are now covered over by the globes: it is perfect in every part, having no escape; and there is a beautiful chandelier, rightly ventilated. In this case I shall, if you please, take down my own chimney; I think its general character deserves to be shown to you. I want to give you the nature of the chimney. But, however, this is a chandelier ventilated on this principle, and which does not destroy the smallest portion of air in the room. One very remarkable condition, which, while you are admiring that lamp, I will call your attention to, so that we may see what may result, is this:—there is this good result, that from such a lamp as that, if by any accident we have the gas left on, there is a perfect channel in which the gas goes, and is carried away into the atmosphere, and can do no harm in houses, under counters, in cellars, and so forth, because it goes away, and cannot accumulate with such a chandelier: there is no chance of accident of this sort: there is one general draft, and it will make a very large way for its escape. I am sure of this, that you can ventilate the gas-lamp by it, and you may, at the same time, prevent any smell of gas.

Then, again, there is this other point, which is a very curious one, connected with a good philosophical reason, namely, that we have more light from our gas burnt in this way. Do not think,—as I am sure you will not, after thirty years' knowledge of me,—that I am inclined to be too sanguine of my own results; but there really is more light obtained from a certain amount of gas burnt in this way than by the ordinary way. I will prove it to you, and the proof is a very easy one. There is the light burning in the ventilated way: now I can convert that in a moment into a common light, by taking off the top. Now I will take off the top. Does it give you more or less light now? I will put it on again. It is now again burning in the ventilated way. Which gives more or less light? The former gives the whiter light, but it gives less light. I have put the top on, and now look at the light: look at a paper, or a book, or anything else. It gives a red light, it is true, and the reason is simple. The reason is this:—that having a longer flame, that flame is careful of the carbon. That beautiful gleaming carbon, which you saw burning in the jar, which produces all the light in a common flame, is in a larger flame here; it is a longer time in that flame than in a short flame: in fact, it is twice the time in the enclosed flame that it is in the short flame. Each particle of the carbon is ignited, and is luminous, and burns for twice the time in the enclosed lamp: it is not ignited so highly, therefore the light is red; but it is ignited for a longer time, and, consequently, the light is greater. If a painter wants to paint at night with different colours, he had better not use this lamp, or he may make that look red which he wanted to make look white. However, there can be no doubt the light is much better.

I have now only to beg your pardon for having detained you beyond your time; and I hope my endeavours to make out the various points which I have submitted to you this evening have been such as to give you satisfaction.



FARADAY'S PATENT.

Specification of the Patent granted to ROBERT FARADAY, *of Wardour-street, Soho, in the County of Middlesex, Gas Fitter, for Improvements in Ventilating Gas Burners and Burners for consuming Oil, Tallow, or other Matters.*—Sealed March 25, 1843.—Communication.

WITH AN ENGRAVING.

To all to whom these presents shall come, &c., &c.—This invention consists of a means of ventilating lamp burners, whether they are for consuming gas, oil, or other matters, and, consequently, whether using wicks or not, the object being so to arrange the glass chimneys used that the products obtained by combustion may pass up the inner glass or chimney, and then, in place of passing into the atmosphere of the room, or place in which the same is burning, such products of combustion are, by a downward draft, caused to descend downwards, and be conducted, by a suitable tube or enclosed passage, out of the room or place in which the lamp is situated. It will not be necessary to enter into a particular description of the various construction of lamps which are used, as a similar construction or arrangement of parts may be applied to various constructions of lamps.

Description of the Drawing.

Fig. 1, represents a gas burner, having the invention applied thereto. *a*, is the supply pipe from a gas main; *b*, the stop cock; *e*, is an argand burner, all which are of the ordinary construction; in place thereof, the burner of the same size of an oil lamp, or lamp burning other matters, might be introduced, or the apparatus about to be described might be made to a proper size, and varied so as to suit other lamps, whether for consuming gas or other matters; *f*, a tube or passage for conveying away the products of combustion from the burner, and this tube may be made of any suitable figure or material, depending on locality and other circumstances; *g*, is a gallery or chamber, formed on this tube or passage, for carrying the glass chimneys, *h*, and *i*, there being an opening through the gallery into the tube or passage, *f*, opposite the space between the glasses, *h*, and *i*, so that the products of combustion, coming from the interior of the glass or cylinder, *h* (which I prefer to make of glass not having any lead in it), may pass from between the glasses, *h*, and *i*, into the tube or passage, *f*, and thence into the outer atmosphere or other place, according to where the pipe, tube, or passage, *f*, is conducted. The upper end of the glass, *i*, is closed, so as to prevent the products of combustion passing in that direction, and I prefer to cover the top with a sheet of mica, *j*, in a proper frame, *k*, as is shown, or it may be done by other convenient means. The effect of this arrangement will be, that all the products of combustion will pass up the glass, *h*, then pass down between the outside of the glass, *h*, and the inside of the glass, *i*, and thence be conducted away out of the room or other place in which the burner is placed. *l*, is a ground-glass shade, the shape of which may be varied according to taste, or, when desired, no ground-glass shade is to be used. It will, therefore, be understood, that the peculiarity of this mode of ventilating lamps, or the burners of lamps, is, that the products of combustion, having passed up through a chimney, *h*, are to be caused to pass down outside thereof, there being another glass or chimney, *i*, (closed at top), applied as described, so as to conduct the products of combustion, whether from burning gas or other material, into a suitable passage, pipe, or tube, suitably arranged for conducting those products out of the room or place in which the burner is placed. In some cases, it has been found in small rooms, that the sudden shutting of a door has created a partial vacuity, and that the air has tended to return through the passage, *f*. In order to prevent this effect, I have in such cases applied a light valve to the passage, *f*, opening into the room, so that the force of air may overcome that valve in place of passing through the passage, *f*, as far as the burner or burners, as is indicated at fig. 2; *y*, being a light valve, or a valve for like purposes, may be placed in any convenient part of the apparatus, or the passage of the rush of air so occasioned may be prevented going to the burners by means of a stop or deflector, as is represented at fig. 3, where *f*, is the passage for the products of combustion, and f^1 is a continuation of that passage, *f*, so as to conduct the products of combustion out of the room; *z*, is a stop, which deflects off any sudden rush of air from the pipe, f^1, so that it does not enter the pipe, *f*, whilst the draft ordinarily in the pipe, *f*, will carry off the products of combustion, passing from the pipe, *f*, to the pipe, f^1. In some cases, particularly where the passages or pipes, *f*, are for a considerable length in a horizontal or inclined direction downwards, I conduct them into a chimney, in order to take advantage of the draft therein; or a fan or other well known means may be resorted to for obtaining a free draft in the pipes or passages, *f*, to ensure the products in those passages or pipes, *f*, being caused to pass freely away.

It should be remarked, that in order to obtain the necessary draft through the tube, pipe, or passage, *f*, when first lighting the lamp, the tube or passage is to be first heated by a gas or other flame, as is shown at *m*, fig. 1, or the draft through the pipe or tube, *f*, may be obtained, and, when necessary, maintained by any convenient means, such as by passing into a chimney, or by a fan or otherwise, as above-mentioned, and, when the lamp has been lighted for a short time, the heated products passing through the passage or tube, *f*, will, in most cases, keep up the draft in that direction.

I would also remark, that I do not confine myself to the shapes of the parts, nor the direction in which the tube or pipe, *f*, is carried, so long as the apparatus is suitably arranged for causing the products of combustion to pass away from the burner of a lamp according to the manner described.—In witness, &c.

ROBERT FARADAY.

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