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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
	<hr/>	
	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 combus-

tible 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-l. 1/2, 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 light-house, 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.

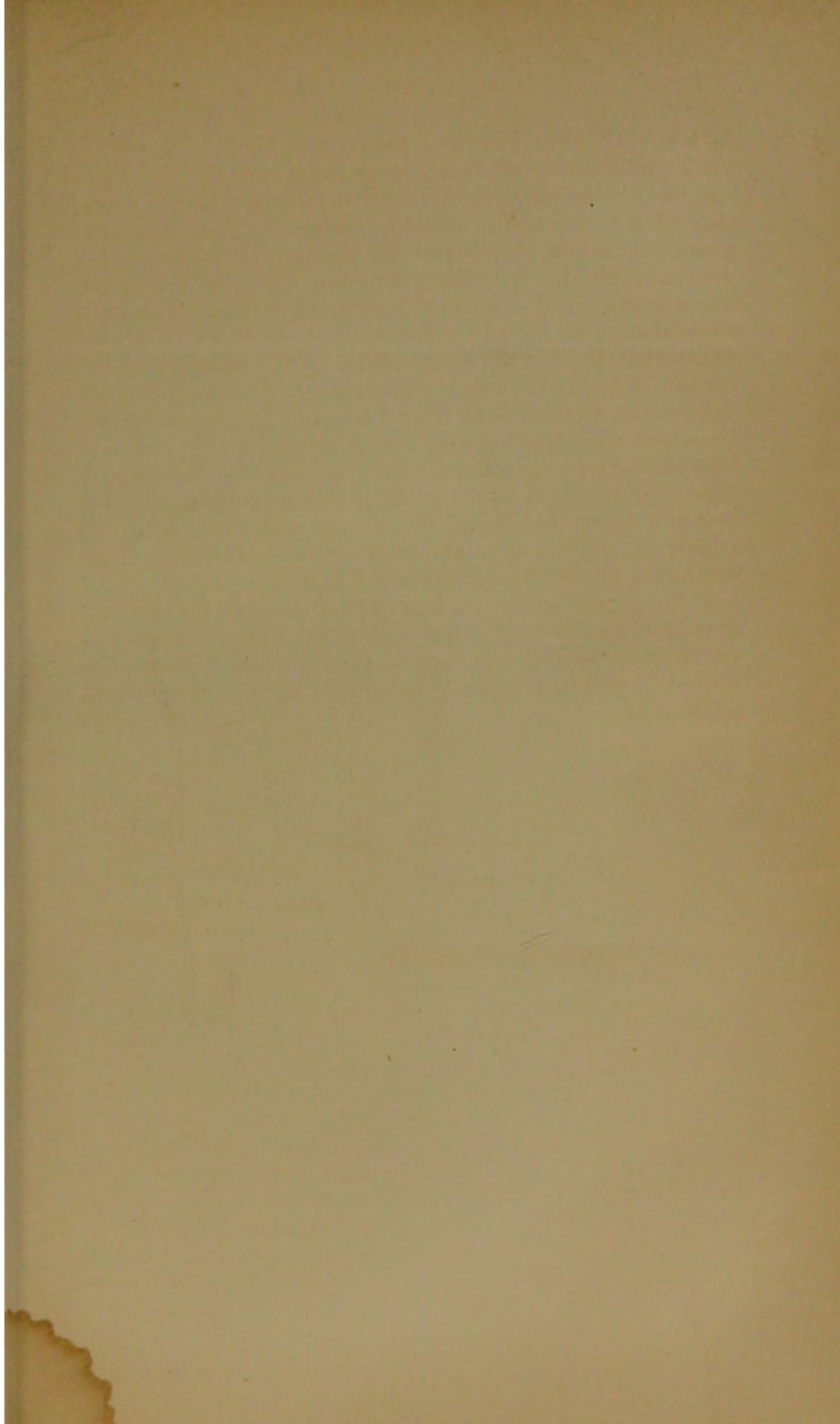
Architects are desirous to have all they possibly can have for the purpose of purifying the atmosphere, and they shut the doors and windows, keeping in all the foul air, and then call in the chemist to make the place sweet. When you have sweetened it, they say, there is a shadow about this light. Now 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]* [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.

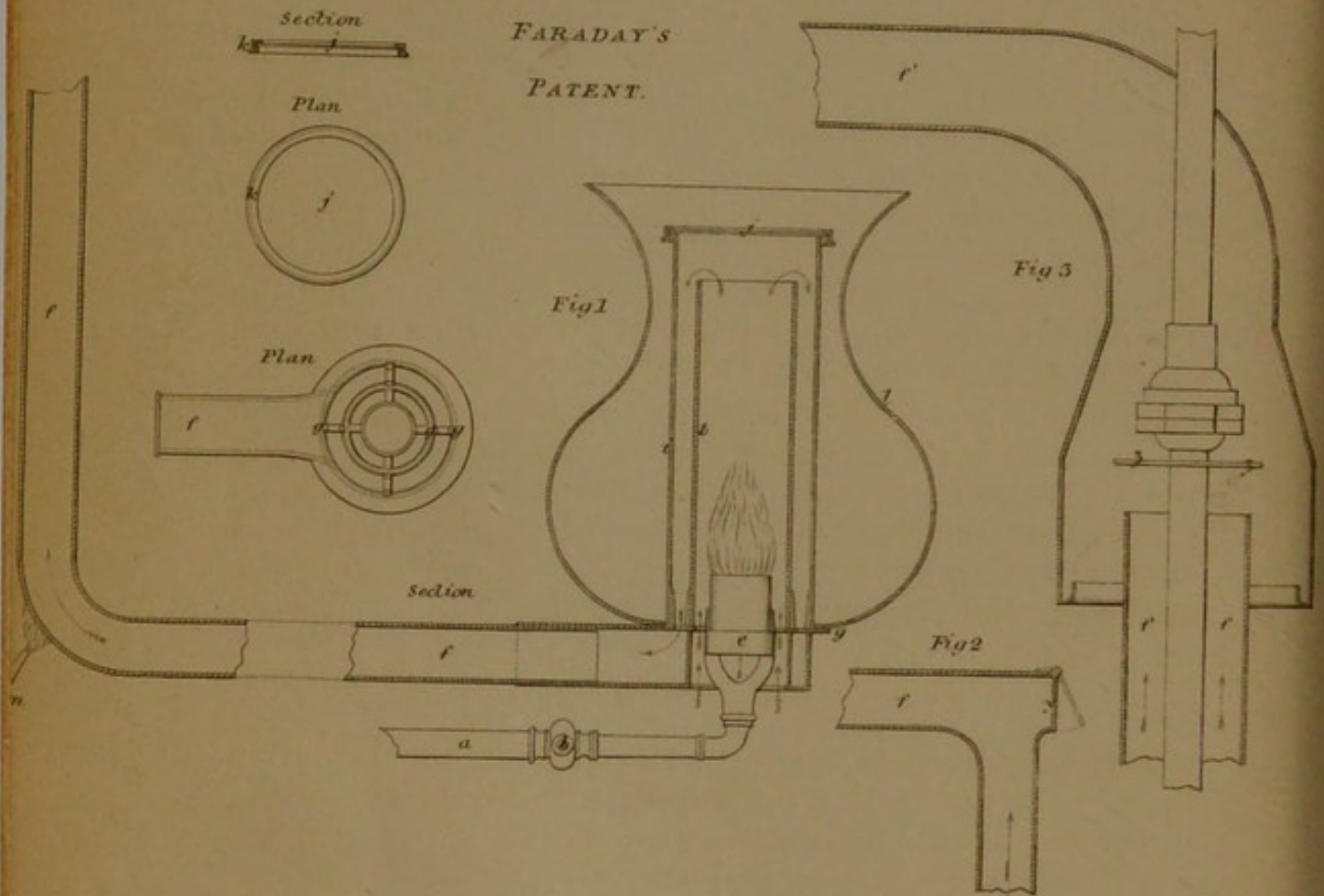
Then, again, there is this other point, which is a very curious one, connected with a good philosophical reason, namely, that we have more light from our gas burnt in this way. Do not think,—as I am sure you will not, after thirty years' knowledge of me,—that I am inclined to be too sanguine of my own 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; *c*, 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 com-

