REPORT OF A HEARING

BEFORE THE

COMMITTEE ON MANUFACTURES,

ON THE

PETITION OF THE BOSTON GAS LIGHT COMPANY THAT THE POLICY OF THE COMMONWEALTH IN RELATION TO CARBONIC OXIDE GAS BE MORE CLEARLY DEFINED.

BOSTON:
ALFRED MUDGE & SON, LAW PRINTERS, 24 FRANKLIN STREET.
1885.

PETITION.

The chairman read the following petition :—

To the Honorable the Senate and House of Representatives, in General Court assembled:

The undersigned respectfully petition that such changes may be made in Chap. 61, Sect. 14, of the Massachusetts Public Statutes as shall more distinctly define the policy of the Commonwealth relative to carbonic oxide as an impurity in gas.

THE BOSTON GAS LIGHT COMPANY.
By W. W. Greenough, *Treasr.*

Boston, Feb. 4, 1885.

OPENING STATEMENT OF CHARLES P. GREENOUGH, ESQ., COUNSEL FOR THE BOSTON GAS LIGHT COMPANY.

MARCH 17, 1885.

MR. CHAIRMAN AND GENTLEMEN: — The purpose of the petition which has just been read to you is, that the Legislature should define the policy of the State with regard to the quality of gas to be furnished by the gas companies in this State. This is a question which, of course, interests consumers of gas fully as much as it does the gas companies. A matter of such importance, which affects the health and even the lives of the community, is one which certainly should be carefully considered.

The reason why the petition was brought at this time was this: There are two other measures affecting the prosperity of the gas industry in this State to be decided at this session of the Legislature. These are, first, a petition brought by the city of Boston for the appointment of a gas commission; second, the petitions of two competing companies in Boston, asking for an increase of their capital stock to the amount of seven and a half million dollars. It therefore seemed a proper time to file the petition which is now before you, in order to have all the questions relating to the gas industry in this State considered and determined by the Legislature at one time. Before proceeding to the discussion of the question raised by the petition before you, I think you will pardon me, gentlemen, if I say a few words in regard to the other two matters pending before the House, because they are all intimately connected, and all of so much importance.

In the first place, what constitutes the gas industry, so called, in this State? It comprises some sixty-five or sixty-six gas companies, which have been organized from time to time, with a capital of about twelve millions of dollars, of which ninety-two and a half per cent is owned by citizens of Massachusetts, and seven and one half per cent only is held by people who live outside of the State. All of that capital was paid in, so far as I know, without a single exception. The stockholders, throughout the State, are among the best citizens of the Commonwealth. I will only refer as instances to Ex-Gov. Washburn, who is a stockholder in the Greenfield Gas Company, and to Ex-Gov. Gaston, who is a stockholder in the Roxbury Gas Company. It is held very generally as an investment by trustees and widows and persons living on small incomes, and is not a speculative stock.

It is therefore the duty of you, gentlemen, who are sitting here, to protect both the interest of the consumers of gas, and the holders of stock of the gas companies in this State, — although the interest of the consumer and the gas company is practically the same, — to consid r and decide these important questions, and to see that by a proper enforcement of the laws of this State, the consumer gets two things: first, that his gas shall be furnished him as cheaply as possible consistently with a proper payment of interest on the capital invested; and, secondly, that the article which is furnished him shall be as little dangerous to life and health as is possible.

Consider, first, the petition for the appointment of a gas commission, which is pending before the Committee on Public Service. It would have been better if all these three matters could have been referred to this committee, or to the same committee, because all being connected together, they could have been more intelligently considered and disposed of by one committee. But over that we had no control; and these various petitions have been sent to three different committees. The proposed bill for the gas commission provides that a commission of three gentlemen, who shall have no interest whatever in any gas company or gas stock, nor shall be in any way connected with any business relating to the manufacture and distribution of gas, shall be appointed by the governor of this State, and that to these gentlemen, with similar powers to those held by the railroad commissioners, all the questions relating to the manufacture, the quality, or the price of gas, together with the question of the expediency of competition in gas manufacture, should be referred and by them settled. The manufacture of gas is, of course, like any other great industry, a complicated and difficult one for any gentlemen to understand in a short time, or after a few days' study. It is impossible for a committee of the Legislature, or for a board of aldermen of a city to properly comprehend, in the short time they have to give to the matter, all the minutiæ and details of a great business like the gas industry. The gas companies therefore in this State have joined with the city of Boston in its petition, and desire that a gas commission should be appointed; that three men, who are disinterested and able, should be paid for devoting their time and energy to the study of the question. It has been decided by the Supreme Court of this State that the gas industry is a private business; that gas companies are not bound to furnish gas to people if they do not want to; that they can regulate their own charge for gas, and they are now no more under the control of the State government than any other private manufacturers or corporations. They, however, recognize the fact that the nature of their business is essentially different from that of any other manufacturer, or any other private industry in the State, in

that they deal directly with the community, and supply them with a necessary of life. Gas has ceased to be a luxury. In all the large cities and towns gas must be used; there is no other cheap method of lighting the streets, alley-ways, and kitchens; it is used practically in every house in Boston, in nearly every house in all the smaller cities, and in nearly all the houses in the larger towns in the State. The gas companies also recognize the fact that a disinterested tribunal, to which people can go with their complaints, will be of value both to them and to the community. There will always be complaints in the manufacture and distribution of a staple article, which is invisible in itself and measured by an instrument, the operation of which is not easily understood, especially when such staple is sold by a monopoly.

The gas companies have been given certain privileges by the State and among others that of using the streets of the cities or towns where they are situated without paying for the privilege. In return for these they feel that they are under the obligation of providing gas of a good quality and at a fair price, and I believe the gas companies in this State have generally performed their duty in this respect. If they should neglect to perform this duty, the commissioners proposed can enforce it. They are given by the proposed bill very great powers over the gas companies, the power to examine their books, to fix the proper price for gas, and to make all proper regulations and orders with regard to the conduct of their business.

The fact that the gas companies do not oppose the bill is strong proof that they are doing their duty by their customers.

Nor do the gas companies admit that there is a demand for a commission because there is any great cause for complaint. It is advocated as a measure of prevention rather than of cure. And this is shown by a comparison of the prices at which gas is sold in this State with the prices at which it is sold in other places in this country. It is well known that the price of gas depends in very large measure on the amount of gas sold, and that with a very slight increase in the expense at which you can make 250,000 cubic feet of gas, you can make 500,000 feet. But if you compare the prices at which gas is sold in the various towns in this State, — for instance, in Boston, Lowell, Lawrence, Lynn, New Bedford, and South Boston; I take those places merely as specimens, — and compare them with the prices at which gas is sold in the large cities of this country, like New York, Brooklyn, Albany, New Orleans, St. Louis, San Francisco, you will find that in almost every case gas is actually sold cheaper in small places in this State, like Haverhill or New Bedford, than it is in great cities like St. Louis and New York. This fact certainly tends to show,

first, that the gas companies in this State have been doing their business honorably, fairly, and ably; and, second, that the State, and the community generally, recognizing this fact, have, so far, protected the companies and the interests of its own citizens from what might be called foreign invasion.

And this brings me to the second question now pending before the Legislature, which involves the question of competition in gas manufacture. There are pending here petitions from two competing companies, who both desire to dig up the streets and supply gas in the city of Boston. The stock of these companies is subscribed almost entirely by citizens from other States. In one company, the Consumers' Gas Co., there are three Boston men who have subscribed for twenty shares apiece; in all, sixty shares of the capital stock of $500,000, which I believe has been paid in.

None of the capital of the other company, the Bay State Gas Company, has yet been paid in, and all the shares but forty-five are subscribed for by one gentleman, Mr. Addicks, of Philadelphia.

The State has never favored competition in gas. I am well aware that the very sound of the word "competition" is alluring. Such expressions as the familiar one, "competition is the life of trade," at once strike the imagination, and have their effect. It is difficult to make people understand why competition in gas is not as beneficial to the community as competition in any other business. But I think when you read the history of what has been done in other cities, and reason upon it, you will be satisfied that it is not so. Take, for instance, the proposed competition in the city of Boston. Why will not competition there reduce the price of gas? I will answer that question by asking who is to pay the interest on the investment of the additional seven millions and a half dollars which is to be invested in the business in Boston? Of course, these gentlemen from other States who constitute the new gas companies — and they say so very frankly — do not come here for any philanthropic purpose.

They come here to make an investment of their money, and get a return from it. Who is to pay the interest on that money, and the taxes to the city and State? Somebody is going to pay it. The interest at six per cent on that amount would be $450,000; and at ten per cent, $750,000; and the taxes would be over $100,000 besides. From whom is this $1,000,000 annually to be taken? It is not to be taken from the gas companies. It must therefore be taken from the consumers of gas, and from them only. And the reason why competition does not succeed in the gas business is that the number of consumers is limited. Where the consumers are limited, it is cheaper for them to pay interest on one capital than on two. Suppose

that one of those great manufactories in Lowell could only sell its products to the inhabitants of that city, and the inhabitants could buy nowhere else, would there be more than one cotton factory there to-day? A gas company is obliged to sell all its products in a place where it is doing business. Now, would anybody say for a moment that it would be profitable to build a parallel railroad from Boston to Worcester, side by side with the present railroad between these places? The Boston Gas Light Company, which supplies Boston proper, pays about eighty thousand dollars in taxes to the city of Boston; it also pays ten per cent dividend on its capital stock, which is two and a half million dollars. They get that money, of course, from the consumers of gas, by adding it to the total cost of the gas, which is made up of practically two elements: first, the cost of the gas in the holder, as it is called, — the cost of the actual manufacture of the gas, which includes the labor at the works, the cost of the material, deducting therefrom the receipts from the sale of the residuals; the second element is the cost of distribution, a somewhat larger sum than the cost of manufacture, which includes the cost of the pipes, the salaries of officers, and all the other expenses required to carry the gas from the gas works to the place of consumption. There are other small elements, such as depreciation of material, sums paid for damages from explosions, and allowance for the gas which is lost. This last item is sometimes a large one, as generally ten per cent of the gas manufactured cannot be accounted for. It is lost; it escapes through the pipes into the streets; it condenses in the pipes, or goes through the meter without being measured. In some cases a large proportion cannot be accounted for. I see from the testimony offered at the investigation going on in New York, that in one year, one of the gas companies in New York lost eighteen and one half per cent of the gas manufactured by it. These items make up the cost of gas; and the price at which gas is sold is fixed by adding to them the amount which will be required to pay a dividend on the capital stock. That amount in Boston is somewhere about twenty-eight cents per thousand cubic feet, and the price of gas sold in Boston represents the cost of manufacture and distribution, with twenty-eight cents added to pay interest on the capital.

Mr. Hallett. — How much is the interest? I understand you to say ten per cent?

Mr. Greenough. — Ten per cent. If we sold one thousand millions cubic feet, the interest would be just twenty-five cents, ten per cent of $2,500,000.

Q. That ten per cent comes out of the consumer? A. Yes, sir.

Mr. Hallett. — Now, if there was another company the price would be put down, so that the ten per cent could be divided up, and the consumer

would get the benefit of five per cent, and the stockholder get five per cent, and that would be a good deal better than most companies are doing at the present time with investments? A. Yes, sir; but if two companies are each getting five per cent on their capital, how is the consumer any better off than he is now when he is paying ten per cent on one capital.

We are not discussing the question whether ten per cent interest is a proper dividend or not. That is the rate of interest which has been fixed by the government in England, after a long series of disputes about the question. But the rate of interest does not affect the question. Suppose the gas company pays six, eight, or any other amount per cent, you have still got to pay dividends upon two capitals, while now you pay only upon one. That, however, is one of the questions which the gas commission can be asked to determine. If the commission say the price of gas is too high in Boston and elsewhere, and that the gas companies shall receive only five per cent on their investment, the price can be reduced; and then, it seems to me, the consumer will save the other five per cent, which you think now you would save by the introduction of a competing company, with additional capital? Is not that so, Mr. Hallett?

Q. Perhaps I owe the gentleman an apology. I do not wish to interrupt you, but it struck me when you spoke about the dividend you were paying, that it would be a benefit to the consumer to have a company to compete with the present company, so that the rate should be put down, and the benefit be derived by the consumer, instead of it going to the account of the stockholders. A. But under your plan the other half would go to the stockholders of the other company. Suppose we pay five per cent, and another company pays five per cent; those two five per cent dividends make ten per cent, and the consumer does not get any reduction whatever. Invest in Boston all this capital, upon which the consumer must pay some interest, whether at the rate of five, six, or ten per cent, it is the consumer who has got to pay the interest on the additional capital. What is the history of competition in other cities, and what can we learn from it? Why, gentlemen, there has been appointed in New York, within the last few months, what I think Mr. Hallett would call a vigilance committee of gas consumers. There are eight gas companies in New York City alone. The consumers have tried the benefits of competition until they are paying interest on a capital of fifty millions of dollars. Not satisfied with the blessings of competition, this vigilance committee secured the appointment by the Legislature of an investigating committee which has been examining the officials and the books of the gas companies in New York. They are also petitioning the Legislature for the appointment of a gas commission.

Competition began and was encouraged in London until they had thirteen companies competing in that city, the pipes of which were laid in the streets. The nuisance at last became unbearable. Every time there was a leak in the gas pipes in the streets it was almost impossible to tell from whose pipe the gas escaped. One company after another dug up the streets, and if they found it was not from one of their pipes, they would decline to repair the leak, and leave the gas escaping. Finally Parliament interfered, and said, "You shall not compete any longer"; the companies were obliged to combine, and the rate of dividends was fixed at ten per cent. The result is that gas is sold to-day in London for seventy cents a thousand feet.

The city of New York is a good instance of the folly of competition. Its streets are generally straight, there is very little made land, the houses are all occupied. From the lower end of the city up to the Park there is hardly a vacant lot. There they have tried the system of competition over and over again. The New York Gas Company was the first company organized, and it supplied the whole city. The people were dissatisfied with the price it charged for gas, and thought they could remedy the trouble by competition; and another company, the Manhattan, was organized. That company soon bought a district from the old company, and sold gas without competition, and the consumers had to pay interest on the two capitals. Again and again new companies were chartered to compete with the existing companies, until there are now eight companies in operation. One company after another came in, each promising cheaper gas, and lately six of them have combined in one huge monopoly, with a capital of forty millions of dollars. There are two other companies which have not yet come into the combination, and they have a capital of eight millions of dollars.

The result is, that in New York the consumers are paying interest on nearly fifty millions of dollars invested capital, while it is perfectly well settled that one gas company with a capital of fifteen or twenty millions could supply the city perfectly well, and sell gas cheaper. The difference between the interest on fifteen millions and on fifty millions anybody can easily calculate, and it constitutes an unnecessary annual tax on the people of New York City. What will be the practical results of competition in Boston? When the Bay State Gas Company has completed its works, and begins to sell gas in Boston, what inducement can they offer to the customers of the present company to take the new gas? That inducement will be, of course, to sell its gas at a lower price. The Boston Gas Light Company will not, if it can help it, lose its customers, and they will reduce the price

of their gas. The new company will then be obliged to still further reduce its price, and the old company will follow suit. Under similar circumstances, in other cities, gas has actually been given away by the companies, or sold at nominal prices to induce customers to take gas. This sounds very alluring. It is very pleasant to get gas for nothing. But a little reflection will show you that the gas companies are not going to sell gas very long for such prices; because they are not charitable institutions, and not organized for that object. After a while the companies have everywhere said, "Why should we sell gas to people for twelve and a half cents; we are losing a dollar on each thousand feet that we sell? That is not business. It is simpler and easier to combine, and fix upon a fair price, and leave each other alone." That has been done in every case of competition, gentlemen. The companies are not going to sell gas for less than it costs to make it. Then, of course, the companies put the price of gas up again, and get back what they have lost during the competition.

Q. (by Mr. HALLETT). Yes, but we want a company that won't combine and consolidate. A. I don't know where you can find one.

Q. In any other business you would not say it is not an advantage to the consumer to have competition? A. In almost every other business, except that of distributing gas and water, it may be a benefit to have competition. The reason why the rule does not apply to those industries is, as I said, because there are only a limited number of customers. You have only so many people to sell to, whatever price you ask for your gas or water. It is somewhat so in the case of a milk route. A man, we will say, has a hundred customers on a milk route, and that is all he has. If another milk man comes in and competes, he has to buy another set of wagons, and pay for another set of employés; he adds another capital to the capital invested by the original milk man, and yet there are only a hundred customers for the two men, and each supplies fifty. One man with one capital could do the business better and cheaper on one capital than two.

Q. (by Mr. HALLETT). That is not a parallel case, because the consumers of gas are increasing all the time, and the population is increasing all the time. A. No, sir; but we are supplying all the houses that are built now. The population in those houses does not increase. The increase in population is in the suburbs.

Q. (by Mr. CRANE). Suppose the gas company waters its stock without paying any money into it; don't you think it is a proper thing that the people should have competition in that town? A. Competition is not the remedy in that case. The proper remedy is such a government supervision as will compel the gas company to charge a fair price upon capital actually

invested. The result of competition in New York is that the gas companies have increased their capital to fifty millions of dollars, most of which was not paid in. There are, in my opinion, only two successful remedies to extortion on the part of gas companies, — either a strict government supervision, or the manufacture of gas by the cities and towns themselves. The latter has been tried in Philadelphia without much success, and the Boston Gas Light Company sells gas to-day cheaper than they do in Philadelphia.

The real test of the merits of competition is the price at which the consumer gets his gas. The price of gas is cheaper in Boston where there is no competition, than it is in New York, Baltimore, or Brooklyn, where they have had competition.

The result of competition in every place in which it has been tried has always been a combination of the competing companies; that will be the result when another company is introduced into Boston. The time when two competing companies will combine can be almost calculated from an almanac. It is perfectly natural that they should combine. So far as experience has shown anything, it has shown conclusively that competing companies always have, always will, and always must combine; and I have no doubt they will combine in Boston. There have been of course a large number of gas companies who desired to come into Boston and compete with the Boston Gas Light Company, and there have been a number of hearings on the subject before the Board of Aldermen. There was one in 1866, and another in 1874, when a gas company proposed to make gas from naphtha. In 1875, Mayor Cobb, a man whom we all know and respect, appointed a commission, consisting of Charles F. Choate, now president of the Old Colony Railroad Company, John Felt Osgood, a well-known merchant of the city, and Prof. Wood, the well-known chemist at Harvard College, to examine the whole subject of gas manufacture in this country, and they spent a year and a half in going over the country and examining the various processes for the manufacture of gas, and the results of competition. They made an elaborate report to the city of Boston, in 1876, in which they reached the conclusion that the only remedies for exorbitant charges in the price of gas were either for the city to make gas themselves, or for the appointment of a gas commission, and they especially recommended the city of Boston to apply for such a commission. They reported that competition had been shown by its results to have been a failure everywhere.

I am sorry to have taken up so much of your time, gentlemen; but it seems to me that both of these subjects are directly connected with the petition now before the committee. The Boston Gas Light Company asks this Legislature

to decide the kind of gas which it is desirable and proper for the community to use. It is for you to determine what kind of gas you wish to use in your houses, bedrooms, and places of business. The new company, the Consumers' Gas Company, who came before the Board of Aldermen of the city of Boston last year, asked permission to dig up the streets solely on the ground that they would sell to the citizens water gas, which they described as a new, bright. and beautiful gas, safer, better, and cheaper than the old coal gas, and one which it was for the interest of the community to adopt. We do not think so. We think it has certain advantages and disadvantages, to which I would call your attention; but what we want this Legislature to do is to settle the question whether the people of this Commonwealth shall have water gas or not. It is admitted that we *can* make water gas cheaper than any other gas company can, and if the Legislature say that there is no objection to the gas, why, we *will make* it cheaper than anybody else. If the Legislature of this State considers water gas objectionable and dangerous, then it is incumbent upon it to make the laws relating to the distribution of impure gas stronger.

The statute of this Commonwealth, as it now stands, inflicts a penalty of one hundred dollars upon any gas company which distributes gas containing more than ten per cent of carbonic oxide; but it also contains the provision that the penalty shall not be incurred until after three consecutive inspections; and provides that only one inspection shall be made each week. The utmost penalty of making water gas in this State, if the statute is enforced, is therefore the payment of about one hundred dollars a month.

Now you can see at once, gentlemen, that if the penalty is enforced, it amounts to an additional tax of only one hundred dollars a month. As the Boston Gas Light Company now pays $80,000 taxes annually to the city of Boston, an additional tax of $1,200 a year would be immaterial. If you conclude, therefore, that water gas is not a proper gas to be distributed in this State, then you must make the law stronger; for if you do not, water gas will be made all over the State, and it will be made just as it is made in Athol to-day, for the sole purpose of keeping out another competing water-gas company. At the hearing before the Board of Aldermen last year, Mr. Morse, counsel for the Consumers' Gas Company, said the law would be repealed this winter.

Q. (by Mr. Ames). Please explain that statement in regard to the Athol Gas Company. A. I said that they were making water gas in order to prevent another water-gas company from coming into Athol, to compete with them. If, for instance, we should make water gas in the city of Boston, no water gas company could come in to compete with us,

as there would be no inducement for any customer to change from one water-gas company to another. The Legislature, in my opinion, must do one of two things. If they want to keep out water gas from the State, they must make the law stronger. If they let the law stand as it is now, they will find that more than half the gas companies in the State will make water gas, before another Legislature meets, in order to protect themselves from competition.

I should like to ask your attention, for a few minutes, to the differences between water gas and coal gas. My preferences are, of course, for coal gas; but I think I can state the matter fairly, and state to you the advantages and disadvantages of the two gases. They are very similar in some things and dissimilar in others. The name of water gas in itself has a delightfully cheap sound. Water is cheap, one thinks, although, to be sure, water is not very cheap just now in Boston. It has been said that the very name of water gas has been worth millions of dollars to the inventors. It is a very old discovery. It was discovered about one hundred and fifty years ago. Water gas is made, in brief, by passing a quantity of steam over incandescent anthracite coal, which heats the steam, so that its elements are disintegrated. These elements combine with portions of the coal at the time it passes through the coal. It partially burns the coal, and takes some ingredients out of it, and the illuminating power of the gas is added by dropping naphtha from the top of the machinery into the steam, in which it is separated into its component parts. It then goes through various processes of purification, as coal gas does.

On the other hand, coal gas is made by roasting or baking coal in an oven; it is stewed out of the coal and leaves coke, which is, of course, sold and used. The main difference in the two gases is in the quantity of carbonic oxide which they contain. The other elements of gas, marsh gas and hydrogen, as far as I have been able to learn, are of no great consequence; they are not poisonous. As you heard Prof. Sedgwick testify, they are not powerful enough to kill a rabbit after twenty-four hours. As far as I have been able to learn, after a careful examination, the two gases are equally explosive, and they do not make the air of a room essentially different after burning.

The advantages of water gas are, that it gives a whiter light. The water gas made in New York City — which is, by the way, the only water gas that is good for anything, in my opinion — is a brighter light than the gas in Boston. We admit that at once, and if that is the only question to be considered, we can furnish the citizens of Boston a water gas which is

brighter than the coal gas now furnished in Boston. The illuminants in the gas are the parts that give the light; the rest of the gas merely carries it along. The illuminants in water gas are just the same as in coal gas, only there is a larger proportion of them.

Q. (by Mr. HALLETT). I thought this carbonic oxide was an illuminant in water gas, but not to the same extent as in coal gas? A. Carbonic oxide is not an illuminant. You will remember that Mr. Flannery testified on that point. The only claim that has been made for it is that it made the gas brighter by a more complete combustion of the carbon in the gas.

Q. (by the CHAIRMAN). I understand that carbonic oxide is the heating property in the gas? A. Yes, sir; to some extent.

Q. But isn't it more heating than hydrogen? A. No, sir. I think that Mr. Hinman, who has examined this question with great thoroughness, has referred in his report to this point. But I think it is fair to say that the elements in water gas, with the exception of carbonic oxide, are practically the same as those of coal gas in their effects on human life.

Q. (by Mr. HALLETT). Hydrogen is an illuminant in coal gas, surely? A. No, sir. The illuminants are ethyline, bituline, and olefiant gas. I am not enough of a chemist to know what these gases are exactly; but they are the elements of gas which give all the light. If you attempted to burn those gases by themselves, you could not use them satisfactorily. In water gas the vehicle to carry them in consists of carbonic oxide, hydrogen, and marsh gas; but the illuminants themselves are what give the light. The marsh gas and carbonic oxide give no light at all.

The advantage of water gas made by the process used in New York, therefore, is that it is brighter than the gas here. Water gas, in most of the other cities of the country, is no brighter than coal gas in Boston. Gas is measured by its candle-power, and if you will look in Mr. Hinman's report for this year, you will see that he measured the candle-power of a number of the water gases sold in various parts of the country, in Rochester, Toronto, Chicago, St. Louis, and so on, and in Athol; and he reports that the candle-power (that is, light-giving power) of these gases is about the same as of the gas in Boston. But the water gas in New York City is a better gas than we get here, as far as the light is concerned. We admit that at once. It is a bright and very handsome light.

The question to be decided is whether it would be better for the citizens of Boston to adopt the New York gas or to keep the coal gas. This same question came up nearly ten years ago, and the Board of Aldermen then decided against the change. The gas companies in this State have had ample opportunity before the present law was enacted to adopt water gas.

They were invited early and often to adopt water gas and make it here. They investigated the subject then just as carefully as they could, and made up their minds that they did not want to make water gas. The reasons they gave then for not making it are the same reasons they give to-day. They said then, and they say to-day, that it is no cheaper than coal gas. They say also, that as the material from which it is made is naphtha, and as the supply of naphtha is entirely under the control of the Standard Oil Company, they objected then, and still object, to having a great industry in this State put under the control of a corporation in another State. Thirdly, and chiefly, they said then they were afraid it was a more dangerous gas; they say now they are sure it is. Lastly, they objected to it because in the manufacture of water gas there are no residuals, there was nothing left over.

Q. (by Mr. HALLETT). Is there anything left from the manufacture of coal gas besides coke? A. Coke, coal tar, and ammonia. The value of these residuals depends entirely upon the condition of the business interests in the country. In England the residuals pay nearly all the dividends of the coal-gas companies.

Q. Are there any residuals from water gas? A. No, sir; there are none at all. This very year, on account of the depression in business, and in consequence of the fact that the Standard Oil Company has been trying to effect a corner in coal tar, the residuals are less in value to-day than they usually are. We could probably manufacture to-day water gas five cents per thousand feet cheaper than we can make coal gas, on that account. Next year, if business improves, and the residuals increase in price, we could make coal gas cheaper than we could make water gas. There are some other slight objections to water gas, in that the gas pipes get sticky, and in that naphtha itself is a very difficult thing to handle. If we should make water gas in Boston, we should have to keep in store about fifty thousand barrels of naphtha, which is a large amount. There have been several explosions of naphtha at water-gas works, and unless we see great additional advantages, we do not want to run that additional risk in the manufacture of water gas.

The main question of course is, Is water gas really more dangerous than coal gas? On that point there has been a battle raging for several years. Water gas was used in France some thirty years ago. The further use of it was prohibited in Paris, after an examination by a council of eminent chemists, appointed by the Emperor Napoleon. The eight companies which then supplied Paris were ordered to consolidate into one company, and were ordered to make only coal gas. It has never been popular in Europe,

and there is not a water-gas company in England or France to-day that I know of. The first company offering to make pure water gas in Massachusetts came in 1877. A company came on from New York and proposed to make water gas in Boston. The Board of Aldermen, however, referring to the report of the commissioners appointed by Mayor Cobb, in relation to the objectionable character of water gas, declined to allow the company to dig up the streets, and the report of the committee of the Board giving the petitioners leave to withdraw gave it as their principal reason for refusing them that permission, that the gas was too dangerous, and they did not want to have it made in Boston.

The gas companies also noticed from time to time that whenever water gas was introduced into a city or town, there was an increase in the number of deaths. This fact became so noticeable that attention was directed to it, and the gas companies began to investigate the matter more thoroughly, and they are now satisfied on that point. In 1884, a petition was offered to the Legislature by the American Gas and Fuel Company of New York, asking that the law limiting the amount of carbonic oxide in gas to ten per cent might be repealed, for the purpose of allowing them to sell their patents to the gas companies here. Their counsel stated at the hearing that they had no desire to compete with the coal-gas companies, but the petitioners only wished to be able to sell the right to use their patents, and that at that time there were a number of gas companies here which were desirous of purchasing the right to use these patents. All the coal-gas companies in the State thereupon united in a protest, which I presented to the committee, in which they stated that they did not want the patents, that they had known of them for ten years, that they did not believe water gas was any cheaper, that they believed it was more dangerous than coal gas, and, as it had been represented to the committee that they were desirous of procuring the patents, they wished to say distinctly that it was not the fact. There was a long hearing on the subject, as you have heard.

Mr. Bosworth, of your committee, was, I believe, one of the sufferers; he was there, I remember, during the whole of it. There was one striking feature of that hearing. A large number of scientific men appeared, who testified in various ways. Some of them testified that water gas was in their opinion more dangerous than coal gas, others testified that it was not so dangerous. All the chemists of this State who appeared at that hearing, however, testified that in their opinion water gas was too dangerous a gas to be distributed in this Commonwealth.

Several of the gentlemen from other States, who appeared here at the request of the petitioners, testified that carbonic oxide in gas was a dan-

gerous element, but on the whole they thought that in practical use one gas would not be more dangerous than another, because water gas, being made to burn, and not to breathe, would not be more dangerous than coal gas. Only one gentleman had the effrontery to say that carbonic oxide was not a dangerous element in illuminating gas.

It was a curious fact that of all these gentlemen, some of whom had been giving their opinions for years, not a single one had ever thought of trying the experiment which Profs. Nichols and Sedgwick tried. It appeared at that hearing, and I believe it is a fact, that nowhere in the country has there been such an examination made as was made here under the direction of our Board of Health. Mr. Hinman, the gas inspector, who is a very able chemist, while that hearing was going on thought that he would try some experiments himself. He thereupon made some experiments upon animals, similar to, but not on so large a scale as, those made by the gentlemen who have testified before you at this hearing. He reached the same result, however, that water gas would kill in a short time, and coal gas would kill in a long time. But not a single one of the gentlemen who appeared at the hearing last year, and not a single Board of Health in this country, have ever made experiments such as have been made by the Board of Health here.

I have taken the trouble myself to write to the different State Boards of Health in the country. Two of them, one in Toronto and the other in San Francisco, did not even know that water gas was being made in their cities, and not a single one of the Boards of Health, so far as I can learn, have really made any thorough investigation of the subject. Men of eminence in their profession, like Prof. Silliman, of New Haven, who has just died, and Prof. Morton, were strongly of the opinion that water gas was the more dangerous gas. Prof. Chandler, of New York, who testified last year, expressed the opinion that on the whole there was not much difference in the gases, but none of them made any experiments, and their opinions were valuable as opinions, but they do not have the convincing force of the opinions expressed to you by Profs. Nichols and Sedgwick, who have actually tried the gases themselves on living creatures. I do not propose now to add any evidence upon the subject. Nothing can be added which will help you in making up your minds. When it appears that the State Board of Health, established by this State and paid by this State, impartial and scientific men, who have made this examination of their own free will, without a request from anybody, and solely for the purpose of ascertaining the effect of these gases upon the public health, make a report like that now presented to you, advising that water gas should not be allowed to

be made and distributed in this State, I do not think that any evidence that could be produced here, or the opinions of any chemist in the country, however eminent, would be as satisfactory or as conclusive as the evidence of these gentlemen.

The only experiment which I have known to be made at all similar to those made here, has been made in New York City, and that is the experiment on the poor and ignorant citizens of the city of New York. I have here the reports of the Health Officer of the city of New York of the number of deaths from gas in New York City for the years 1883 and 1884. Whether from indifference or ignorance, the list he sent me was simply a list of the places where deaths from gas occurred during those years, without giving me either the names of the persons, the dates of their deaths, or the kind of gas which caused their deaths. Those details I have ascertained elsewhere, and I will furnish you with a list of the people in New York who have died during the last two years from the inhalation of illuminating gas, and their names, and the kind of gas they died from. Remember, gentlemen, that not quite one half the gas furnished to the consumers in New York is water gas; and in spite of the greatly advertised excellence, beauty, and brilliancy of this kind of gas, more than one half the people in New York prefer and buy coal gas at the same price to-day.

Moreover, I have ascertained that the deaths in New York, beginning in 1880, from water gas alone, were twelve; in 1881, nineteen; in 1882, twenty-three; in 1883, seventeen; and there were three deaths besides these, whether from water gas or coal gas I have not yet been able to find out; in 1884, eighteen, and so far in 1885 there have been seven or eight. In those five years there have been ninety-five deaths that we have been able to trace to water gas.

Q. (by Mr. Hallett). Have you made any effort to see how many have died from coal gas? A. Yes, sir. In 1880 there was one death from coal gas; in 1881, three; in 1882, two; in 1883 I do not know whether the three I have referred to were from coal or water gas, but if from coal gas there were no others; in 1884, two, one of which was a case of suicide, where the man had tried almost everything else, and finally shut himself up in a room, closed the windows, and turned on the gas.

Q. (by Mr. Dillaway). Why didn't he take water gas? A. Water gas was not sold in that district.

In those five years, therefore, instead of ninety-five deaths from water gas, you have only eight or nine from coal gas. Now, gentlemen, these figures mean something.

Q. (by Mr. Bosworth). How did you get those figures, from the hos-

pital folks? A. I got the names of the places where the death ensued from the Health Office; and when the victim was taken to the hospitals, the cause of death or sickness from the hospital records.

Q. The reason I asked you was because we went there to find out last year, and they told us they could not tell us whether it was water or coal gas. A. They did not know the difference at the hospitals, and do not record the kind of gas from which the patient is injured.

Q. Then how did you get the figures? A. Because in each case the locality where the accident occurred is recorded, and it is well known that every house in all the streets below Grand Street in New York is supplied with water gas only. The knowledge of that fact simplified the examination at once. If the place where the accident occurred was below Grand Street, it was positively known at once that the injury was caused from water gas, as no other was used. Then I employed a doctor in New York to go to the other places above Grand Street and find out exactly what gas was used in those houses, and the only places now left in doubt are those on streets above Grand Street, where the occupants either could not or would not tell him what gas they used. There are only four or five of these cases. So I have been able to tell pretty exactly what gas was the cause of these accidents.

These deaths, of course, were generally reported in the daily papers. You will remember that Dr. Abbott spoke of seeing and talking with one of the porters at one of the hotels. I have cut out and preserved occasionally such items in the papers. Here is one from the New York *Tribune*, of Wednesday, Jan. 29, 1884: —

"Lawrence Sullivan, a porter at the Van Dyke House, located in the Bowery, New York City, *who has saved fifty persons from death* by suffocation in that hotel, during the past eight years, at 9 A. M., on the morning of January 8th, detected the odor of escaping gas, which he traced to room number 50. Conrad Kuhn, proprietor of a beer saloon at Tenth Avenue and 169th Street, had gone to sleep in that room at a late hour of the previous night; when the porter forced an entrance into the room Kuhn was found in a state of insensibility, the gas having been blown out. He was taken to the New York Hospital, where it was said recovery would probably ensue."

From these extracts from the newspapers, and the reports of the Health Officer and of the hospitals, the list, I think, is as fairly correct a one as can be made, although there are many cases of injury not reported anywhere. I will furnish these lists and these newspaper accounts to the committee. I also sent for this same porter, Lawrence Sullivan, to get him to come on

here, to testify before the committee, and he agreed to come. But I found, curiously enough, that the landlord of the hotel where he was employed did not think it would be a sufficiently attractive advertisement for his hotel, and he would not permit him to come or give his evidence. I think, therefore, that I have the right to say that the experiments made in New York on the human frame have shown practically the same results as the experiments made here upon animals. The experiments were more expensive to the victims there. We do not wish to repeat them here, if we can help it.

Is water gas much cheaper than coal gas? Is it sold for less?

The gas companies in New York during the last two weeks have been summoned before the Legislative committee, to which I have already called your attention, and testified, under oath, what their gas cost them during the last ten years. The evidence I have only seen reported in the newspapers. The committee also employed an expert to examine the books of all the gas companies in New York City. Last year at the water-gas hearing, the water-gas advocates testified that water gas could be made thirty-three and a third per cent cheaper than coal gas. But when the New York expert had gone all through the books of the water-gas companies in New York City, he made a statement of what the cost had been in New York for the past ten years, from the books of the gas companies themselves, and he produced it to the Legislative committee, and it was put in evidence; and it appeared from that tabular statement that the average cost of gas made by the New York Gas Company for the past ten years was $1.41 a thousand cubic feet; and that made by the Municipal Gas Company, $1.16 per thousand cubic feet. That is the evidence from their own books; and that is the cost of gas without adding thereto interest on the capital invested.

Taking the statement made up from the books of the gas companies of New York, taking the price of water gas sold in the various cities in this country, and finding that there is not a single place, so far as I know, except in Chicago, where they are selling water gas as cheap as we are selling coal gas to-day in Boston, I think we are justified in saying that it is not the fact that water gas can be made thirty-three and a third per cent cheaper than coal gas. What the consumer is most interested in, however, is the price at which gas is sold to him, not what it costs the gas company.

I think, therefore, I have the right to say that water gas is very little, if any, cheaper than coal gas. Perhaps this year we can make water gas somewhat cheaper. But as the law now stands, we do not propose to take the responsibility of making water gas. If the Legislature repeals the law, we will perhaps make water gas ourselves. If we do, we want to make it

under the authority of the Legislature. Either amend the law, therefore, if you want it enforced; but if you consider water gas a sufficiently good and safe gas, repeal the law, and let it be made by anybody who wishes to.

I have an amendment which I propose to submit to the committee, which makes the penalty for violating the law with regard to carbonic oxide one hundred dollars per day. It is merely a method of making the law enforceable.

Q. (by Mr. CRANE). You said that if this law was not amended within a year, the gas light companies would all adopt water gas? A. No, I said I thought a great many of them would.

Q. Well, if there is so much danger, why should they be allowed to do it? A. They ought not to be allowed to do it. My opinion is very strong about it. It is the business of the Legislature to decide. We do not want to make water gas, and we ask the Legislature to decline to repeal the law, and to make it stronger and more effective. And it seemed to me, as I said in the beginning, that while these other matters were pending before this Legislature, which would give the consumers an opportunity to control the price of gas, the Legislature should also decide positively what kind of gas should be made and sold; and I think if no decided action is taken, you will find a good many gas companies in the State making water gas to prevent water-gas companies from coming in.

Q. And they will do so because they can make water gas cheaper than coal gas? A. No, sir; but to prevent water-gas companies from coming into their town, and competing.

Q. (by Mr. HALLETT). If water gas is better and cheaper than coal gas, is it not perfectly right for the people to have it? A. Yes, sir, certainly. If it is, repeal the law. It was testified last spring at the hearing before the Board of Aldermen in Boston, by the engineer of the Consumers' Gas Company, that the Boston Gas Light Company could make water gas cheaper than any new company could. There is no doubt about that fact. We prefer to make coal gas; but if the people determine that water gas is desirable, and the Legislature sanctions the manufacture of it, why of course we will make it.

Mr. DILLAWAY. — Who is to determine whether the people demand it?

Mr. GREENOUGH. — The Legislature.

Mr. DILLAWAY. — Does your amendment reduce the amount of carbonic oxide?

Mr. GREENOUGH. — No, sir. I leave the amount at ten per cent. I think the evidence shows pretty conclusively that ten per cent is the danger limit. If gas can be made without carbonic oxide, of course on some

accounts it would be better. But coal gas cannot be made without some amount of it, varying from four to six per cent. If some process could be invented to make gas without carbonic oxide, it would be better; but no such process has been put into successful operation yet. It would be safer to wait until it has been, rather than to put now such a limit to the amount of carbonic oxide in gas as would close at once all the coal-gas works in this State. I agree that it would be better to have no carbonic oxide in gas. But it appears positively that any quantity up to ten per cent is not specially dangerous, and I think it would be better to keep the limit as it is at present. This question of the leakage of gas, to which Mr. Crane referred, has also an important bearing upon the question of the danger from water gas as affecting the public health. In New York City, for instance, the gas companies lose about ten per cent of their manufacture, somewhere about five hundred millions of cubic feet of gas a year, a good deal of which is undoubtedly running into and mixing with the atmosphere of the city. That is a great deal of gas. One of the gas companies, as it appeared at a hearing held yesterday in New York City, lost in one year eighteen and a half per cent of their make, by leakage, — nearly twenty per cent of their total manufacture. Most of this leakage occurs in the winter, when the frost breaks the gas pipes. This gas does not, and cannot, make its way up through the frozen street. It goes wherever it can find an outlet, and that outlet is generally into either the sewers or houses. It is largely deodorized by passing through the ground, and both water and coal gas have their smell taken out.

There have been some very instructive experiments made in Germany, to see what became of the gas that leaked into the streets, a report of which I will read to the committee. And it was found that in winter, the occupied houses, being warmed, attracted the gas from the streets, by making a draught, and, having lost its smell, the gas has poisoned people, who could not discover what was the cause of their illness.

STATEMENT OF MALCOLM S. GREENOUGH, ESQ.

Q. (by C. P. Greenough). What position in the Boston Gas Light Company do you hold? A. I assist my father in the management of the Boston Gas Company, and have the especial charge of the manufacture of the gas in all its details. It is my more particular business to acquaint myself with the whole business of gas manufacture in all its branches, especially in regard to the new improvements of any kind, which are introduced in the manufacture of coal or water gas. I am supposed to be familiar with the details of the manufacture of gas in this country and abroad.

Q. What experience have you had, both in this country and abroad? A. Well, sir, since leaving college, in 1868, I have been in the employ of the Boston Gas Light Company practically the whole time, taking also a course in the Institute of Technology, and passing considerable time in an iron foundry. I have made myself pretty familiar with most of the gas works in the large cities in this country, and have made a very considerable examination of the gas works in England, Germany, and France. I have done what I could to make myself familiar with gas manufacture in that way. I am a member of various gas light societies in this country, and also in England and France.

Q. Are you president of the New England Gas Engineers' Association? A. I am, at present.

Q. Are you familiar with the manufacture of water gas? A. I am familiar with the manufacture of water gas to a considerable extent; not, of course, to the same extent that I am with coal gas. But I followed it with considerable care until the law was changed, which practically kept it out of Massachusetts, and until the agitation of the subject last year I did not give the question the detailed examination that I have since that time. After the Legislature adjourned last year, and when the question came up as to the advisability of manufacturing water gas in Boston, — for it was held up against us as our only crime that we would not make water gas, — I have given considerable study since then to the subject, and I believe to-day I can say I am an expert on water gas and its various details.

Q. Where did you examine the manufacture of water gas? A. I have examined it in a number of places, and have talked with a good many men who are making it, and to whose works I have been. I have visited the Chicago works, of which we heard a good deal said in the course of last year. I visited the Washington works, where they are using it in connection with coal gas. I have visited the Municipal works, in New York, and examined a considerable number of water-gas patents, and I have talked also with people in various parts of the country who are making water gas at present, and with people in other cities, as to its advantages and disadvantages; and I have been in consultation with other gas engineers as to the merits and demerits of water gas as compared with those of coal gas.

Q. Will you state to the committee what, in your opinion, are its advantages and disadvantages? A. Well sir, water gas is made in a dozen different ways in this country. In many cases water gas has no advantages over coal gas, except, perhaps, in the relative matter of cost. That is, if you should compare eighteen-candle water gas and eighteen-candle coal gas, then the question is simply one of cost.

In some places one is cheaper, and in some places the other is cheaper. Taking the gas as made by some of the companies in New York City, where a process is in use called the Tessie du Motay process, which was brought into notice by the establishment of the Municipal works in New York, that gas is of a very high grade, and there is no coal gas which will compare with it for light. There is no doubt about it. That is to say, while thirty candle-power gas can be made from cannel coal, it will not so easily burn as water gas of that quality. It is a very handsome gas, indeed. It is useless to say that the Boston gas gives as much light as that gas does. That gas is brighter than our gas. Now, the next question is as to the cost. That depends largely upon circumstances. It depends very largely upon the value of the residual products in the places where the companies do business. In a great city, like New York or Boston, where the production of gas per inhabitant is very large, and the production of coke is very large, the amount we net per ton of coke does not compare with what they net in the smaller cities. There is in some of the smaller cities and towns a great demand for coal tar for sidewalks. I have in mind a company in Massachusetts where they pay all their dividends from what they get from coal tar, ammonia, and coke. In Boston we can hardly do half that at the present time. In other places, it varies according to localities.

In some cases water gas is cheaper than coal gas. In other cases coal gas is very much cheaper than water gas. It is a question of degree. Supposing the two gases were of equal value in light and of equal cost, nobody would prefer the water gas. If water gas can be made more cheaply than coal gas, but with additional risk, then the question is, how much risk do you wish to take for the additional cheapness? Is the game worth the candle. That is what we want the Legislature to say, and we will accommodate ourselves to the circumstances. We do not think it is worth the difference. I know what I can make water gas for here in Boston within two cents a thousand feet. I have my prices of naphtha, and I know pretty well what hard coal would cost. I have looked the matter over, and I can make water gas like that which is used in New York for a certain price. I can make coal gas at the present price of residuals, within a very few cents of it. If naphtha went up a cent a gallon, and I could get a few cents more a bushel for coke, I could do better with coal gas. Now, I admit at once that the gas which I should make from water gas would be whiter than the gas from coal. But on the other hand, the result would be, in my judgment, that we should smother some of the people here in Boston in winter. It might not be a great number, and it might be from careless-

ness. It is a question for the Legislature to say, and we want you, gentlemen, to settle it. If you, gentlemen, say that you want water gas manufactured in this State, then we should consider ourselves at entire liberty to make it, if we think we can make money by it. That is about the position in which the Boston Gas Light Company stands at present.

Q. Then you say that you cannot dispose of your coke and coal tar as well as companies can in smaller cities? A. No, sir, we cannot. It is not so always. It depends upon the manufacturing industries of the State as to how we can get rid of the coke advantageously.

Q. Suppose you had the opportunity to sell your residuals at a higher price, you could make coal gas cheaper than you do now? A. Yes, sir, somewhat. If all the companies around Boston, except ourselves, would make water gas, I think I can make coal gas five or six cents cheaper than I can do it to-day, because I can sell my coke to their customers, and get the average price for it. In the interest of the Boston Gas Company, I would be very glad if every other company should sell water gas, because I know we could make coal gas cheaper than we can do it to-day.

[Adjourned to Tuesday, March 24, at 10 A. M.]

TUESDAY, March 24, 1885, 10 A. M.

Q. (by Mr. C. P. GREENOUGH). Please give the committee a statement as to your investigation of the danger of water gas, and when the matter was first called to your attention. A. I could not state definitely, but when the question of water gas was first brought before the gas companies of the country, there was, of course, no legislation on the subject. The various merits and demerits of water gas were considered solely in relation to the cost and the inconveniences of its use. It was not until the various processes had been in use for some time that it was noticed that the deaths in cities where water gas was used had materially increased in number, and then it was seen that the reason was the presence in it of the large amount of carbonic oxide. The result of the use of water gas was such as to cause a strong protest against it from the coal-gas people, who believed, I think, in most cases, that if coal gas had been used, the deaths would not have ensued, and therefore they felt that water gas was not a proper gas to make. It was about 1878 or 1879, perhaps a little earlier than that, that these deaths became noticeable from their frequency. They occurred then and afterwards in New York, Brooklyn, and Toronto, and in other places where they had changed from coal gas to water gas. They occurred in various cities out West, and it was noticed that in Baltimore, where they

had changed from coal gas to water gas, in the course of a short time several people were smothered. I know that a great many coal-gas companies in this country feel a strong sense of responsibility, from the fact that they have been monopolies. I know that is the feeling of several of the Boston gas companies, and I know it is especially so with the Boston Gas Light Company. There have been no better citizens of Boston than the directors of the Boston Gas Light Company. They have felt the responsibility of their public position, and desired to meet the public demand. The feeling of these gentlemen is, that they do not want to supply water gas to the citizens of Boston, because they believe that it is a more dangerous gas. Because they have taken that position, public sentiment has been somewhat excited against them, the charge being made that the company was keeping from the public something that they want.

The Boston Gas Light Company want the Legislature to express their views on this subject. It is possible that we may be prejudiced against water gas; but we do not believe that the benefits from its use will counterbalance the danger. I do not suppose that if water gas is used in Boston, it will increase the death rate very largely, but I have no doubt that, by the use of it in this city, we should smother four or five people every winter. That would be my expectation. We do not want to take that responsibility; but if the public want water gas, I suppose we can give it to them.

Q. (by the CHAIRMAN). Do you think it is possible to eliminate carbonic oxide from water gas? A. I can only say that it has never been done. I have always taken the ground that it could be done. As soon as the public say, "We want to be supplied with water gas without carbonic oxide," it will be done.

Q. (by Mr. HALLETT). You are a chemist? A. To some extent.

Q. And know the whole thing. Now, why is it they want the thirty per cent of carbonic oxide in their gas, when it is not an illuminant, but a heating element? Why do they retain such a large per cent of poison in their gas? A. They cannot get it out, and it is cheaper to leave it in than it is to try to take it out.

Q. Yes, yes. A. When water gas is made, it is made in a cupola. They fill this up with hard coal, put an air blast into the bottom, and blow it up quite hot. Then they turn a jet of steam as hot as they can get it into the bottom of the cupola. The steam at once burns the coal, which is decomposed. When you burn coal with steam, you make carbonic oxide and hydrogen, water being composed of oxygen and hydrogen. The oxygen unites with the coal and makes carbonic acid and hydrogen. Now, it is one of the qualities of carbonic acid that, if you pass it through coal, it

becomes carbonic oxide, and the resulting gases are carbonic oxide and hydrogen. Now, that would be about half and half of carbonic oxide and hydrogen. They then put oil gas into it, and they reduce the percentage of carbonic oxide, and they get as a result a gas which contains about thirty per cent of carbonic oxide. Now, if they want to take that out, they have got to turn that carbonic oxide back again into carbonic acid, and take out the carbonic acid. I have always been of the opinion that when the public demanded water gas without carbonic oxide, they would treat it with an excess of steam, or something of that kind, which can be done in various ways, and that would reduce the product of carbonic oxide. But as long as the public allows them to make it with thirty per cent of carbonic oxide, they will do it. They have been experimenting in various places to reduce the amount of carbonic oxide. The Equitable Company, in New York, was organized some years ago for that purpose.

The Municipal Gas Company, in New York, was the first company to make water gas, and they were successful, as far as the gas is concerned. The other gases were not all of first-rate quality. They condense in the pipes. There was some talk the other day about tar in the pipes. When the pipes are cleaned out there is no more coal tar in them, but they do get a deposit of oily matter in the pipes, unless the water gas is made very carefully. I have known oily matter to come out from the pipe and be set on fire, and spurt out from a pipe as it is turned on, and fall down into a man's shop window and burn holes in his goods. I cite this as an example, to show how badly it can be made. But the Municipal people were a good deal disturbed about this carbonic oxide. There were deaths occurring every day. Mr. Tessie du Motay, the inventor, was a very kind-hearted man, and set to work to see if he could not take out the carbonic oxide. At the works one day I met the general manager, Mr. Franklin, to whom I was accredited, and he gave me a circular showing that they had a process for taking out carbonic oxide. Their process was such as I have described. Mr. Tessie du Motay died, and there was a quarrel over the control of the patents. The Equitable Company was organized to furnish gas without this carbonic oxide. They have put in a capital of $2,000,000, laid several miles of pipe, and have started business. They are now in operation in New York. It is very difficult to find out what they are doing, but I understand that they had the gas analyzed, and that they had reduced the amount of carbonic oxide to about fifteen per cent. The process does not work as well as they expected, but they have reduced the amount of carbonic oxide below what the other companies send out. I have no doubt that if the public demand it they will succeed in getting a complete removal of the

carbonic oxide. I do not believe there is danger of carbonic oxide below ten per cent, but I think it ought to be got down below thirty per cent. If it is reduced to fifteen per cent you reduce the danger just one half, and you would have to get double the quantity of gas leaking in a room to get the same effect from it.

Q. (by Mr. CRANE). Of course if there is a great deal less in it, a man would stand it a good deal longer, and live through the night? A. Yes, sir.

Q. (by Mr. C. P. GREENOUGH). Have you made inquiries as to the popularity and success of this water gas where it is sold? A. Well, I have talked with engineers of gas companies, who have been manufacturing it, and also, in some cases, with engineers of companies that are competing with water gas. Of course I am more familiar with it in New York than elsewhere; but I have seen it during the last year in Chicago, and have talked with the engineers of both companies there, and have also seen it in Washington, where the coal gas company is using it in their own works.

Q. When were you in Chicago, last? A. I was in Chicago last winter.

Q. Did you make any inquiries then? A. Yes, sir; I visited the works of the water-gas companies, and also visited the office of the company where they are manufacturing coal gas in opposition to water gas.

Q. Did you make any inquiries as to the popularity of the gas? A. Yes, sir; the gas, as made in Chicago, is not a successful gas. It was made by what is known as the Granger process, and also by the Lowe process. At the water-gas works, they admitted that the gas was not satisfactory; and they claimed that it was owing to the unsatisfactory condensation in the works. But whatever the difficulty was, the gas was certainly not giving satisfaction to the people in Chicago. The coal-gas company had prepared, and gave me at that time, a list showing the names of the gas consumers in Chicago who, after using water gas, had returned to the coal-gas company. This list contains the names of over five hundred people, who, after having gone over to water gas had come back to coal gas. It contains some of the largest consumers which the water-gas company had, including the Chicago *Tribune*, I think. I do not know whether the *Tribune* is in the list or not; perhaps they came over afterwards. The gas was not a carefully made gas.

It is by no means an easy thing to make a good water gas. It is an easy thing to make a cheap water gas. It is easy to make a water gas which shall not be a thoroughly well made gas; but in order to make a

good water gas you have got to take a great deal of pains about it, or else the gas is not permanent. To make naphtha into gas which will stay gas is a much more difficult process than to make coal into permanent gas. The temperature in which the gas is distilled affects the quality of the gas very materially. If you distil it at too high a heat, you turn it into lampblack. If you distil it at too low a heat, the gas does not become good illuminating gas. Most of the water gases are not so arranged that naphtha can be subjected to the same heat. If you do not do that, you do not make a good gas. That is the case in Chicago. The process in New York is much superior for making gas of a regular grade than any other process in use. The gas at Chicago was not satisfactory.

Q. (by Mr. HALLETT). Do they use anthracite or bituminous coal in making water gas? A. Anthracite.

Mr. HALLETT. — I have understood that the other was better, and would generate more gas, and cost one and a half or two dollars less than anthracite. Is not that it, Mr. Chairman?

The CHAIRMAN. — Yes, but bituminous coal could not be used in the manufacture of water gas.

Mr. HALLETT. — I understood they used it, and that is the reason why they could furnish it for about half.

The CHAIRMAN. — No, sir; they could use incandescent coke instead of anthracite, and pass their mixture through that to take out the carbon, the same as they would through anthracite coal. That is a fuel gas.

Mr. HALLETT. — I got the two things confounded.

Mr. M. S. GREENOUGH. — There have been made various claims about using bituminous coal in that way; but I do not think they have done it. When you turn steam upon bituminous coal it seems to melt in a way it does not hard coal. If they could do it I think it might reduce the cost, but I do not think they have done it satisfactorily.

Q. (by Mr. C. P. GREENOUGH). Did you go last year to the hospitals in New York, to find out the effect of water gas and coal gas upon the patients? A. I did not go to the hospitals myself. I sent a man there.

Q. What did you find there? A. The effect of the different kinds of gases was not appreciated by the gentlemen in charge of the hospitals so as to keep a record of the kind of gas by which the effect was caused. I went to see Dr. Bull, who had charge of one of these hospitals. He did not know much about the matter, but in his judgment the effect was what we supposed it to be, that one gas poisoned and the other suffocated. Then he gave me an interesting account of some experiments made by him on two or three people brought to the hospital in an unconscious state, from the

use of gas. He made a transfusion of blood in one case, as showing the effect of poison upon the man; he had drawn a large portion of blood from the man, had shaken it up, and had put back the oxygen which had been taken out by the carbonic oxide, and the man had lived. In another case he had filled the man up with blood from another person, and he pulled through. In another case he had drawn out the blood and put in salt and water to keep the veins moving, and at the same time drew the poisoned blood from the body; that person at first recovered, but had subsequently died, according to my recollection.

Q. You only saw the doctor who had charge of the hospital? A. Yes, sir; and he gave me a pamphlet on the subject.

Q. Did you see anybody in New York the other day connected with the hotels in the lower part of the city? A. Yes, sir; I saw a man, he may have been the same one whom Dr. Abbott saw. He was employed as night watchman at one of the hotels in the lower part of the city. He described to me substantially what was described the other day by Dr. Abbott. It was his business to go through the hotel every night and open a little slide into the room to smell it, and see if the gas was leaking, and if it was leaking, to go into the room and drag the person out. He had saved the lives of several persons during the past year. He was perfectly willing to make an affidavit of the fact, if necessary. But he had been there only a short time, only a year and a quarter, and they had used no gas there except water gas.

Q. Is there any gas except water gas sold south of Grand Street, in New York? A. No, sir.

Q. So that where any accident occurs in any locality in New York south of Grand Street, it must necessarily have happened from water gas alone? A. Yes, sir. The Mutual has a pipe running down beside that of the New York Company, and they are making water gas also.

Q. You went on to Yonkers last week, I understand, to make an investigation of some gas there. What result did you find there? I wish you to state to the committee also what the result of competition was in Yonkers. A. Well, the gas I went on to examine did not turn out to be what I expected. I brought some of the gas home with me and I am having an analysis made, but have not got through. It is a gas made from coal, naphtha, steam, and air. It is a very bright gas, co ntaining a very small percentage of carbonic oxide, and a considerable percentage of nitrogen. I wanted to see if they could make this gas without carbonic oxide, or with a comparatively small percentage of it. It is not exactly water gas. They have had three gas companies in Yonkers, and also a fuel gas company.

The original company which supplied Yonkers with gas was a coal-gas company. It is rather amusing, the way in which this thing has worked there. It has worked in one way for the benefit of the company, and in another way not for the benefit of the company. Yonkers is a place of about twenty thousand inhabitants. In 1876 a small company, with $100,000 capital and $100,000 bonds, was supplying gas at $4 a thousand feet.

The public became dissatisfied with the price of $4 a thousand feet, and demanded a reduction. They secured the passage of a bill through the Legislature, and the old company reduced the price to $3. Some rich men in the vicinity were not satisfied, and got up a new company with $185,000 capital and $50,000 bonds, and set up a water-gas process, the Lowe process; and also got hold of the Strong fuel process. When the new company came in, the result was that the price was put down from $3 to $1.50, and then from $1.50 to $1. Then the new company got sick of it, and offered to sell out body and bones for fifty thousand dollars, and clear out. But the old company said, "No; we will divide the town with you; you give us your pipes in our section, and we will give you our pipes in your section, and you can stay." They divided the town, and put the price of gas up to $2.80. Then the Municipal Company, in New York, were looking about for some small place to try their process. Some people had objected that this process did not pay in a small town, and there being great dissatisfaction in Yonkers, they sent there, and put in another company, with $165,000 capital and $50,000 bonds, to supply this small town with gas, when one company could have done it easily with $100,000. When they came in, the companies agreed all around that they would not put the price below $2 a thousand for consumers. They kept on for some time, until the old company heard that the Municipal Company was cutting rates. So the old company put the price down to $1.50. Now they are selling for $1.25, and they are trying to see what they can do to damage each other's business. Now, there is nearly $700,000 worth of money put into that town, and they are going to make the public pay the interest on it.

Q. (by Mr. HALLETT). And $100,000 would do the business, you say? A. Yes, sir; perhaps $100,000, but $150,000 certainly would. It is a small town, with about twenty thousand population, spread over a considerable country. The result is, that at present there are three sets of gas pipes in all the streets. They told me that when they had a leak there, each company disowned the leak, and declined to have anything to do with digging up, or looking for it. So the superintendent of streets, who is ordered by ordinance to fix any gas leaks and charge the expense to the gas company, cannot tell which company the pipe belongs to, and when he has

fixed up the leaks the town has to pay for the expense from the general appropriation.

Q. (by Mr. C. P. GREENOUGH). How much of this carbonic oxide is found in the gas of the Boston Gas Light Company, on an average? A. I think about five and six per cent, on an average. We have had it less than four per cent, and sometimes as high as six per cent.

Q. Is there any way of getting it out? A. None that I know of at all. I do not know any way in which that carbonic oxide can be eliminated, and it has never been found advisable to attempt to do so, because it exists in so small a percentage; and because when it is used it is, as a general thing, innocuous, and there seems to be no reason to try to get it out below six or seven per cent. The amount of that gas liable to remain in a room, in case of a leak, is so small that it is excessively rare to have accidents from it. It was stated, last year, that there had been ten or eleven deaths from gas in Boston; but if that is so, I can say that we never knew it; and I do not believe it. Most of them were put down, in the office at City Hall, as cases of suffocation, and there was very little to be discovered about them. A man died here, year before last, at one of the hotels, but I do not know under what circumstances. We smothered a person once by breaking a gas main in the street. She slept in a cellar which led out into a court, in which there was a gas pipe. They had put a sewer through the court after our gas pipe had been put down there, and it had made the ground settle, and there was this large leak of gas which communicated through the wall into the cellar of the room. The woman died, but her children were got out, and resuscitated.

Q. That was in 1879, I think? A. I think it was longer ago than that.

Q. 1878, I think; but since then you have had no notice of anybody being suffocated from coal gas? A. I have no recollection of it; but since then I have heard of one man being suffocated in Boston.

Q. What is your opinion as to the necessity of limiting the amount of carbonic oxide to five per cent? A. It does not seem to be necessary. Of course it is all a tentative question. As coal gas is at present manufactured you rarely get an accident from it. With gas containing thirty per cent of carbonic oxide, you occasionally smother somebody. The experiments related by Prof. Sedgwick the other day were entirely new to me, especially the discovery that it is impossible to retain a large quantity of gas in a room, although you are continually turning gas into it. He said you cannot get more than three and a half per cent into a room. If you have three and a half per cent of gas in a room, and one per cent of that is car-

bonic oxide, the chemists say it will kill. On the other hand, if you leak that quantity of gas into a room, and the gas contains ten per cent of carbonic oxide, instead of thirty per cent of carbonic oxide, you get less than one third of one per cent, and that quantity will not kill. Take those two limits, thirty per cent and ten per cent of carbonic oxide, and you may say that one kills and the other does not. Now you might get fifteen per cent of carbonic oxide and not kill; but at ten per cent there seems to be no special danger from it, and there does not seem to be any special reason for reducing the percentage.

Q. (by a member of the COMMITTTE). If it were possible to get that element, carbonic oxide, entirely out of the gas, would it give as good a light? A. I think not.

Q. You would have to have some of it to improve the light? A. I think some of it does. I think if we had fifteen per cent of carbonic oxide in our gas it would improve the light.

Q. (by the CHAIRMAN.) Carbonic oxide aids combustion? A. I think it does, and increases the temperature of the light.

Q. (by Mr. AMES). Is that the reason water gas is brighter? A. There is a good deal of difference of opinion why that is so. It is one opinion that water gas has a higher temperature than the coal gas flame.

Q. (by Mr. GREENOUGH). Do you mean that the gas is more completely burned? A. Yes. I will tell you one reason that leads me to think so. It has been found that if you increase the temperature of the flame you can largely increase the light-giving power of the gas. In the burning of ordinary coal gas we do not get all the light there is in the gas. But burners have beeen greatly improved during the past few years. Burners have been invented which give more light by a more complete burning of the gas. If you do not have a good burner, you are likely to lose fifty per cent of the light. I think the Argand burner is the most satisfactory burner you can use.

The same Mr. Siemens, who invented the regenerative furnace used in smelting iron, also invented the regenerative gas burner, by which the products of combustion are turned over and used to heat the incoming air, so that the burning power would be greatly increased from what it would be in any ordinary burner; and that has been the result, although at a large additional cost. By that burner double the quantity of light can be got from the same quantity of gas; in fact more than that. I have taken our gas at my office, in my photometric room, which, if it were twenty-candle gas, would give four candles to the cubic foot, and I have taken the Sie-

mens burner and got out of the gas between nine and ten candle-power per foot. Now they cannot increase the light given from oil-gas flame in the same way. By comparing twenty-candle coal gas with thirty-candle oil gas it was found that the coal gas gives as much light as the oil gas, although ordinarily the oil gas gives more than the coal gas. It looked as if from coal gas properly burned, the light would be equal to the oil-gas flame. I think if we were able to increase somewhat the percentage of carbonic oxide in our gas, with the same light-giving constituents, we should get more light.

Q. (by Mr. AMES). Is that Siemens burner used here in the city at all? A. Yes; there are only one or two in use. I know a club-house where it is in use. We made various experiments with them in the streets. They give a beautiful light; but they require to be watched all the time. We have no governor that will hold them against the wind, and they break up the glasses.

Q. (by Mr. GREENOUGH). Can you give the amount of water gas and coal gas delivered in New York City, in general? A. Well, I think at present about two thirds of the gas is water gas; perhaps more than that.

Q. 2,700,000,000 of feet of coal gas, and 2,543,000,000 of water gas were delivered last year, were they not? A. Yes; but lately they have shut up the Harlem works, which was a coal-gas works, and put water gas in, which is supplied from the Knickerbocker works, and it has caused the greatest dissatisfaction in Harlem. Of course, not only are the workmen turned out of a job, and distress is caused to their families, but the public are considerably worked up about having this gas forced upon them. There is a good deal of feeling in the town at being obliged to have water gas. I saw it so stated in the newspapers the other day.

Q. (by Mr. C. P. GREENOUGH). What is the effect of the cold weather upon gas? A. Cold weather plays the mischief with the gas supply. If you suddenly lower the temperature from fifty degrees to zero, it condenses some gaseous matter back into liquid, and it will settle back in the pipes and freeze there. If you consider the cold weather we have been having for the last two months, you can see how the freezing of the ground must affect the pipes. There has been an immense amount of trouble in the supply all over the town. The people have come to the office a hundred a day, and all you can do is to go around and clean out the pipes.

Q. (by a member of the COMMITTEE). I would like to know if water gas would freeze up? A. That would depend. I do not know whether they have the same trouble in the pipes that we do. But they have an immense amount of trouble from naphthalene, if the gas is made of good quality.

That trouble is entirely unknown to us. But in water-gas works, where the oil is all turned into gas, they have sometimes an immense trouble from naphthalene. Naphthalene is a very peculiar crystalline substance, which evaporates when exposed to air, and which contains a great deal of the light-giving qualities of gas. It is held in solution and suspension by the rich part of the gas. If the gas falls below a certain temperature this naphthalene seems to come out of it, which is a very curious thing. I have known them to have a twenty-four inch pipe stopped up by naphthalene. If the water gas is not thoroughly made they would have more trouble than we would from naphthalene.

Q. (by C. P. GREENOUGH). What is its effect upon meters and gasometers? A. That depends upon the gas. In the Municipal Gas Works, in New York, they have had an immense amount of trouble in their holders, from this naphthalene in the gas taking the oil out of the joints, and making the holders and fixtures leak. If the water gas is not so well made they do not have this trouble with naphthalene. Where they do not have that, they do not seem to have the same trouble with the holders, but they are liable to have trouble with the fixtures in the houses. The fixtures get clogged up, and the oil gets out of the joints.

In using water gas you have got to have all the old burners changed, as they find that in the case of the ordinary lava-tipped burner, the water gas forms a deposit on the burner, and does not give good light, and you have got to use a metal-tip burner in order to get good light.

Q. How is it in regard to the danger of explosions at the works? Have there been any explosions at the water-gas works? A. There have been explosions from the use of naphtha. That is the risk which causes considerable anxiety to the manufacturer. There have been occasional deaths, and four men were killed at the Municipal Works, in New York. But they are getting more careful with it, and accidents are more infrequent than they used to be.

Q. (by a member of the COMMITTEE). Can they use the same capacity of tip to the burner with water gas as they do with coal gas? A. I think they can, but I do not think it it is customary. I think they generally use a rather smaller burner to burn this water gas in. I do not think it works so well in an Argand burner. It is somewhat liable to smoke. It is a very pretty gas for theatres and stores. I do not think they like it as well in private houses as they do coal gas. In fact, it has been the judgment of a great many coal-gas people throughout this country, that the gas furnished by the Boston Gas Light Company was of too high a quality, and that the public liked a gas which did not give much over sixteen-candles light, which

would burn freely, and would not smoke up the ceilings. I think it is so myself; but the public seem to like a high grade of gas, and, therefore we make it.

Q. (by Mr. HALLETT). What do you use for enriching your gas? A. Cannel coal. We have made some experiments with naphtha, but I do not know that it is on the whole much richer.

Q. Is not rosin used? A. They used to make gas out of it, but I don't think they are using it now. It will enrich the gas. All these things are questions of locality as to which is the cheapest thing to use.

Q. Now, as I like to learn, the way to learn is to ask questions. Now, in our town the price of gas was $3 a thousand, and a good many people discontinued using it. By and by the company thought it was advisable to put the price down to $1.50 a thousand, and the result was that a great many commenced using it, that had discontinued it before. I had been using it all the while. I was burning the same Argand burner in the house all the time. But I found my bills were just as large when the gas was $1.50 a thousand, as they were at $3 a thousand. I asked about it, and they said they had a way of thinning it down, and forcing more of it through the pipes. A. I don't think they could do quite that.

Q. But how did they manage to keep the bills up just the same? A. I should want to be more familiar with the circumstances, before replying fully. It may be that you burn more gas. It is unquestionably the fact that people use gas with more freedom when it is cheaper.

Q. Exactly; just as when apples are one dollar a barrel, I would buy five or six barrels, but if they were five dollars a barrel, I should not come in for more than one half that. A. Yes; and you would use gas more freely at $1.50. You would say, "It is cheap; and you need not put that burner out." Admitting, of course, that the gas may have been thin, and that they put a pressure upon it, you cannot always compare the bills of one month with those of another, because the weather affects the use greatly. Now, last spring, there was great complaint because of the bills of the Boston Gas Company. But last spring was the darkest spring ever known in Boston, and we sold more gas during February of last year than we did for the February before; it was burned pretty much all the time. February of this year we sold much less gas than we did a year ago, simply because we had a bright, clear month, against a dark month of a year ago. You may be comparing a clear season with a dark season, or a clear month with a dark month. The weather affects the consumption of gas very much.

Q. My gas meter is what is called a dry meter. A. They are all dry, now.

Q. They used to be wet, and they gave that up? A. Yes, sir; they had to go around and see that your meter did not freeze, and dry meters were substituted in a cold climate. We do not charge any meter rents, here in Boston, at all.

Q. Then you have more conscience than our gas people have. A. Our conscience is pretty clear.

Q. (by Mr. C. P. GREENOUGH). How much gas that you make in Boston is not sold? A. I think that last year we lost eight per cent.

Q. That is about eighty million cubic feet of gas? A. About that.

Q. How much was lost in New York? A. They have lost a great deal more. They have run as high as from eleven to twelve per cent, which is the lowest, I think up to as high as eighteen per cent. I think that they lost in New York last year seven hundred millions of feet.

Q. (by the COMMITTEE). I would like to know if a gas company measures all the gas they make before it passes through the supply pipes; if you meter it at your works? A. Yes, sir; that is the last thing that is done with it before it goes into the gas-holder.

Q. So you can measure the difference between what is made and what is lost? A. Yes, sir; the loss is figured between the amount that is supplied and the amount that is made. Some of our loss goes into the street lamps. We are paid so much for our street lamps, and if we burn more than we are paid for that gas goes into leakage.

Q. (by Mr. DILLAWAY). One of the troubles in making coal gas, and one of the things you try to get out, is ammonia, is it not? A. We get it out, because we can sell it.

Q. If it is left in, it does not benefit the gas? A. No, I think not. I do not think it is possible to take it out unless you take out a little of the illuminating power with it, but, at the same time, I think it ought to come out. It is undoubtedly deleterious if it remains in the gas in large quantities.

Q. Another element that you try to get out is sulphur, is it not? A. Yes, sir.

Q. There is a limit, in the law of this State, to the quantity of sulphur that shall be permitted in gas? A. Yes, sir.

Q. Of course you have to get out the coal tar? A. You could not make coal gas without taking out the coal tar.

Q. Now, do you have these elements in water gas, sulphur, coal tar, and ammonia? A. No, sir; you do not have coal tar. You have some sticky stuff in your pipes, but it is not coal tar.

Q. Is it not a fact that ammonia has an injurious effect upon the registering power of the meter? A. I do not think that is true, unless it appeared in large quantities. If you did not take out the ammonia of course it would have a deleterious effect, but with the small quantity allowed in this State I do not think it is deleterious; nothing like naphtha.

Q. Well, what is the matter in coal gas that interferes with the action of the meter? A. Tarry matter.

Q. Is there not something which dries the diaphragm? A. The diaphragm gets dry, if it is not in use.

Q. Is it not true that the presence of sulphur and ammonia in the gas fittings affects them? A. Do you mean in tarnishing them, or what?

Q. I mean, does not it injure the joints? A. No; I do not think it does.

Q. Does it not have any effect upon the joints, and does it not cause any leakages? A. I never knew of it.

Q. The average amount of carbonic oxide in the gas which your company makes here in Boston, I have seen stated in the inspector's report, to be 6.74. I refer to page 23 of House Document No. 50.

Mr. C. P. Greenough. — Is there not a note, at the bottom of the page, in regard to that? That is only one sample. You asked the question whether it is the average.

Mr. Dillaway. — I ask whether it is not a fair average of the amount of carbonic oxide found in your gas.

Mr. M. S. Greenough. — I have already testified that it was rather high. I have had some analyses made by our own chemist, and he found in one gas that we had as low as four per cent.

Q. Is that an average sample? A. So far as I knew it was, but other tests show a higher rate. I should think it was high at six per cent, but I could not swear to it, because it requires a very careful test to ascertain the quantity, and you have got to analyze it carefully to get out the carbonic oxide in the gas. It is not like a matter that is tested daily.

Q. The average in the Dorchester gas works was 3.19 per cent. Can you explain the difference? A. I should say it is simply an accident on that occasion?

Mr. C. P. Greenough. — That is not stated to be the average.

Mr. M. S. Greenough. — That was the only test made of our gas by Mr. Hinman, and probably the only one in Dorchester; and the next day he might have struck gas with seven per cent in it in Dorchester.

Q. (by Mr. Dillaway). Now, the different percentages of the different gases, according to these analyses, vary according to the company that makes the gas? A. And according to the day they are tested.

Q. There is not a regular quality about coal gas? A. I should not know how to put in the carbonic oxide, or take it out.

Q. Now, do you observe in the inspector's report the statement that, in his opinion, he don't think the carbonic oxide can be taken out of coal gas without destroying the illuminating power? A. I remember it.

Q. Do you coincide with that? A. I do not know what connection there is between the illuminating power and the carbonic oxide. I do not know any way of getting it out.

Q. I thought that in your statement you said that carbonic oxide tended to increase the illuminating power by increasing the flame. A. I think it does, and possibly it may have an effect in that connection as a vehicle for carrying the gas. It may increase the flame in that way.

Q. Now do you understand from the inspector's report that carbonic oxide can be entirely eliminated from water gas? A. I read it over hastily. What does he say?

Q. He says it can be reduced to a small percentage, and he refers to some places where the percentage is as low as two per cent. Have you any reason to question that statement? A. Only to this extent, that it is not being done, so far as I know; and theory and practice are sometimes different things. Various people have professed to possess processes by which it could be done. I have in my mind three separate persons who say they can do it. The Equitable people said they could do it, but they have not done it. I think it can be done at a little extra cost. You have got to throw away a portion of the gas, probably, and then it is going to take some lime to get it out afterwards, and unless you can revivify that lime in the process it is going to be an expensive job. That is what the Equitable Company set out to do, but they have not succeeded. I think they will succeed, however.

Q. You heard Mr. Flannery's statement? A. Yes, sir; I think he testified very fairly.

Q. And you have not any particular reason to doubt his statement? A. Except that I have seen the best gas engineers mistaken as to what could be done practically from the result of previous satisfactory experiments. Mr. Flannery has undoubtedly obtained some process for taking out carbonic oxide, and perhaps it is going to work. But it has not been put in practical operation, so as to authorize any man to say it will work.

Q. Now, if carbonic oxide can be eliminated from water gas, there is no need of prejudice against water gas? A. None, so far as I am concerned, and so far as legislation is concerned. The only question that would bring it in comparison with coal gas in its use would be the satisfaction that the public would get from it.

Q. Now, as to the naphtha used in it, what objection do you think there would be in operating it? A. I confess to an unwillingness to store great quantities of naphtha for use in water gas.

Q. You mean to say that if you store that quantity of naphtha in your location at the North End, the danger would be so great that you would hesitate to do it? A. Well, sir, if I were going to make water gas I would like to make it down there. In any case you cannot pump fifty thousand gallons of naphtha a day without running some risk. They take the best possible care of it in the best organized works, but it is a constant anxiety to the people who have it in hand. With the greatest care, they have accidents at the large gas works where it is used. In New York they keep the naphtha across the river, and bring it over in fifty thousand gallon boats, and give it to the manufacturers every day or two. They pump it straight from the boat into the reservoirs, and from the reservoirs into the tank overhead, whence it goes into the gas works. They do it with great care. But in Boston you cannot keep it stored without a double risk. You cannot get your naphtha directly from New York by boat, as they do in New York City and Brooklyn. If you undertake to get it by tank cars, you are then hauling it in comparatively small quantities, each car holding only about five or six thousand gallons. It is a risky thing.

It has been suggested to me, that we should dig a pipe line from Harrison Square down to City Point, as has been done elsewhere, but I question whether the city of Boston would allow it to be done. They might, however. It is a substance which is liable to evaporate so rapidly that the amount of naphtha actually paid for is much larger than that practically used when it goes into the gas. If you are going to make naphtha gas here in Boston, you are going to use a great deal of naphtha. Suppose we made four millions of cubic feet a day, we would require twenty thousand gallons of naphtha. If you keep a thirty-day supply on hand, that would be six hundred thousand gallons of naphtha. It may be we have got to do it, but I do not want to store twelve thousand barrels of naphtha around our works. I suppose we could keep it at Squantum.

Q. Suppose you were to keep it at the Calf Pasture? A. Yes; but suppose it should get afire and burn out the Calf Pasture?

Q. But would it do any serious damage? A. There are a great many small boats around there.

Q. But those are away beyond. Would it not be practical, in your experience, and with common-sense in handling; would they not be likely to locate in some place near tide-water, away from the populous localities, so that the danger would be reduced to a minimum? A. They would if they were wise.

Q. And in a location remote from the inhabited parts of the city? A. That would materially reduce the danger.

Q. How much naphtha is brought into the city now? A. I do not know. I suppose that what is used about here is manufactured at South Boston.

Q. You never heard that there are thousands and thousands of barrels of naphtha brought daily in here now? A. No, sir; I should be surprised to hear that such is the case.

Q. And the quantity manufactured at South Boston is quite large? A. I believe it is.

Q. So that the works located here could draw a very large supply of naphtha here in Boston? A. If they wanted to pay for it. It would cost at least a cent more than in New York.

Q. But suppose it was located in Boston, on First Street? A. I know they charge fifteen cents a gallon for it in small quantities.

Q. It is in comparatively small quantities that you use it? A. We buy it in considerable quantities, and buy it about as cheap as you can get it?

Q. But, pardon me, you do not mean to say that the Boston Gas Light Company use naphtha in the amount that the water-gas company would use it? A. No, sir; I do not mean to be so understood.

Q. The use of a large quantity would cause a considerable reduction in the price. A. I do not know whether they would be in a position at South Boston to furnish any such quantity as would be required by a large gas company.

Q. That we will show by other evidence, perhaps. Now, Mr. Greenough, you say that the effect of competition among these various gas companies has been combination in some instances, or that competition only lasted while each company was trying to get the better of the other? A. I said that was the case in Yonkers. I do not think I have testified here about competition in any way.

Q. Is there any instance that you can name where competition of itself has not reduced the price of gas while competition lasted? A. Of course while competition lasted, the price was reduced. When you compete, you have got to offer inducements.

Q. Now, can you name us an instance where there has been a competitive war, and the companies combined and the price of gas was raised, where it was not higher before competition than it was afterward? A. I do not know about that; but I can name places where the price of gas is raised higher than it is in places where there is only one gas company.

Q. But do you know where the price has been higher than it was before competition? A. I am not prepared to give you any instances of that kind.

Q. Well, take Yonkers; it is a small place? A. Yes, sir.

Q. Is it not a fact that in cities of large size the location of the pipes is accurately planned and recorded? A. Yes, sir. Excuse me, my brother calls my attention to the case of Providence where they have put the price back higher, because they said they had this additional capital to pay dividends on. They lowered the price to $2.00 and put it back to $2.25. The Citizens' Gas Light Company was organized in 1876, and gas was sold at $2.25. In 1877 gas was sold by the old company at $2.00. In 1878 the Citizens' sold out to the old company, and competition ceased, and the price of gas advanced at once to $2.25. That was in 1878.

Q. That price was not put up above what it was before competition began? A. No, sir.

Mr. C. P. Greenough. — I think the competition did not begin until 1877. It was just before the other company came in.

Mr. Dillaway. — I should be glad to have you point to that.

Mr. M. S. Greenough. — As I said before, that is not a fair comparison.

Mr. Dillaway. — We see the thing through different eyes.

Mr. M. S. Greenough. — The true comparison, we contend, is not what gas was sold at in those towns before competition began, but what gas sold at in other cities where there has been no competition; and we defy the opposition companies to produce any place in this country where gas is sold as cheap as it is in Boston.

Q. (by Mr. Dillaway). Now take the facts here in Boston: gas is sold cheaper here than in the outlying districts? A. Certainly, of course.

Q. Did you say that there has been no watering of the stock of the Boston gas light companies? A. I answer only in reference to the Boston Gas Light Company.

Q. I understood you to make the statement in regard to some of the other companies, and I think some reference was made to the capital invested by the different companies about Boston, and it was stated that it all represented money paid in, and that there was no water in the capital? A. I did not make that statement. You asked me yesterday what the capital was of the companies about Boston, and somebody prompted me as to the fact, and I stated what the capital of the various companies was. I have no personal knowledge as to what has been the course in the other companies.

Q. Are the different companies in this State using naphtha to enrich their gas? A. Some of them; yes.

Q. It is pretty generally used, is it not, by coal-gas companies, as an enricher? A. I don't think that can be said. Most of the people prefer cannel coal, if they can get it at a fair price.

Q. Does not naphtha produce carbonic oxide? A. I do not suppose so. I should say not. If naphtha and steam are used together to enrich coal gas it might have an effect of that kind.

Q. But you don't know that it does? You mean to say it does? A. No, sir; I have not said so.

Q. Now is it not a fact that it is claimed generally by the manufacturers of water gas that they are able to make it cheaper than coal gas? A. Well, I know it is claimed that they can, in certain localities.

Q. Well, in what localities, speaking generally? A. They claim that they can make water gas cheaper in the large cities.

Q. But how much cheaper do they claim that they can make it? A. You heard what Mr. Flannery said the other day.

Q. I am not speaking of Mr. Flannery. I am asking you what is the general claim of the water-gas manufacturers throughout the country? You say that they claim that it can be made cheaper? A. I have heard all kinds of claims. I have had a man come to me and claim to be able to make water gas for three cents a thousand feet.

Q. Was he sane? A. I don't think he was.

Q. Please confine yourself to men who are sane. Is it not claimed that the process of manufacturing water gas is cheaper than that of manufacturing coal gas? A. Any one of those gentlemen would admit at once it would depend upon the locality he was talking about.

Q. I admit that; but is it not claimed that in the large cities they can make it cheaper? A. Yes, sir; it is claimed by the water-gas men that in the large Eastern cities they can make water gas cheaper than coal gas.

Q. I take it that the process of making water gas is a difficult and scientific one? A. It depends upon how it is made. It can be made by rule of thumb, or it can be made by machinery, and made by hand.

Q. Is there not a great deal of experience and care required in the manufacture of coal gas? A. There ought to be.

Q. I mean in making coal gas, is it not required? A. You ask me about scientific knowledge. I say it is advisable to have a man of brains to do it. I have had no practical experience in the manufacture of water gas.

Q. I suppose it is equally difficult to make water gas? A. I have never made any.

Q. Regarding Chicago, of which you spoke, have you any information as to the price of gas there? A. The price of gas in Chicago is different in the two parts of the city. In one part, I think they are selling coal gas for $1 a thousand, and water gas at $1.25; in the other part of the city, I think that they are selling water gas at $2.25 or $2.50.

Q. Is that in the outlying districts? A. No; it is across the river. Chicago has had the benefits of competition before this. They had a company go out there before, which compromised with the old company, and set up in a district of its own, and they are selling gas at $2.25 or $2.50.

Q. That is the old company? A. Yes, sir.

Q. Now you produced a list of those people who had taken out water gas and put back coal gas. Don't you know that it is claimed by the new company in Chicago, that the number of their meters is greatly increasing? A. It seems to me an engineer of the new company told me that although they had lost a great many new customers, they had more meters out. I would not swear to that. As they have laid new pipes they say they have got new customers. They are continually laying new pipes.

Q. Is it the general result of competition that one company gets some of the other company's business? A. People who do not wish to pay their gas bills are apt to change companies.

Q. Does anybody ever succeed in that with a gas company. A. We have seldom sued anybody for gas bills. We wait until they want more gas, and then we make them pay up. If we had another gas company here they would go to them.

Q. Is it not a fact that where one company has the lighting of an entire place that the private individual is powerless against the company, in case of a dispute about the bills? A. That is where the advantage of the proposed gas commission comes in.

Q. I think I have heard you say that the lot of a gas man is not a happy one? A. I think you may have heard it.

Q. There is a great complaint against the company about gas bills? A Yes, sir.

Q. In the office they have a desk for complaints? A. All companies should have.

Q. And if a man has a grievance he is practically remediless? A. There may have been companies that have been so exorbitant in their charges as to bring the whole business into disrepute.

Q. Is it not a fact that gas companies resorted to this rule, that if the bills against an estate were not paid by the party moving out, they declined to furnish gas to that estate to a new occupant until their bills were paid? A. I do not know what that has to do with water gas.

Mr. Dillaway. — I think it has something to do with competition.

Mr. M. S. Greenough. — I have not given any testimony here about competition except what happened at Yonkers.

Mr. Dillaway. — I will withdraw the question. I do not care the snap of my finger for it.

Mr. C. P. Greenough. — I am interested, as we all are, in hearing these questions, but perhaps it would be proper for Mr. Dillaway, if he appears here, to define his position.

Mr. Dillaway. — I have defined my position very clearly. I came here as counsel, stating that the policy of the Commonwealth should be either that this restriction regarding the quantity of carbonic oxide should be removed, or else it should be put at five per cent, and that that should be the policy of the Commonwealth. In a discussion of this kind, where the general discussion is a matter of policy, I do not know that I should have taken the position of a remonstrant or anything else.

Mr. C. P. Greenough. — That is the first time I have heard you state your position.

Mr. Dillaway. — I should think you would have understood it before, from the questions I have asked.

Mr. M. S. Greenough. — I should be glad to go into the whole question of competition here.

Mr. Dillaway. — I think you have gone into it.

The Chairman. — The scope of the petition was only to go into the effects of the carbonic oxide in gas, but the Chair has allowed the investigation to go into other matters, and the Chair thinks that the matter can be settled between the parties without the ruling of the Chair.

Q. (by Mr. Dillaway). Now, Mr. Greenough, will you tell us the history of the manufacture of water gas? Is not this the fact, that the records of deaths resulting from the use of coal gas have been kept exclusively by coal-gas people? A. Why no; no more than they have seen the deaths noticed in the papers.

Q. Is that the only record of deaths from coal gas, that which can be found in the newspapers? A. The companies have not kept any records of deaths from the use of coal gas, because they have not had them.

Q. Do you mean to say there have not been any deaths from coal gas? A. Very few; not enough to be practically noticed. I told you that I had only heard of two that I have ever known of in Boston; one was either a suicide or an accident.

Q. You have only heard of two? A. I do not mean to say there have been no others. I never heard of them.

Q. Has there been any record kept in New York of deaths from coal gas? A. I think there has. I think it appeared in evidence last year. In the last five or six years, since the thing became noticeable, of course they have kept a more careful record.

Q. At the instigation of the coal-gas people? A. The coal-gas people kept them to some extent.

Q. So that the one authentic record of deaths from coal gas that we have are the records kept by the coal-gas people? A. These records came from the coroner's office, to some extent; of course the coal-gas people take pains to investigate and see what sort of gas killed the people.

Q. Don't you recollect that last year Prof. Chandler, of New York, was asked about the investigation by coroners, in New York? A. Very likely. I don't recollect.

Q. Don't you recollect that he testified that they were kept very loosely? A. Very likely he testified in that way.

Q. Now these records of deaths from coal gas are not separated? A. They are simply kept in the coroner's office as deaths from inhalation of gas. The coal-gas people examine and find out about them. The coal-gas people are naturally interested in the matter. The water-gas people are not interested in keeping these records.

STATEMENT OF CHARLES W. HINMAN, STATE INSPECTOR OF GAS.

Q. (by Mr. C. P. Greenough). You have made some examination in regard to the relative explosive power of water and coal gas. A. Yes, sir.

Q. You are the gas inspector of this State? A. Yes, sir.

Q. When were you appointed inspector? A. I was appointed in 1871, by Governor Claflin, on the recommendation of the president of the Institute of Technology, and have held the position ever since.

Q. You have made some investigations as to the comparative explosive power of water gas and coal gas? A. Yes, sir.

Q. Will you state briefly what the result of your examination was? A. I had seen some statements in regard to the different explosive effects of water gas and coal gas, and an argument based on the fact that coal gas contained considerably more marsh gas than water gas, and therefore was considerably more explosive. I did not think those arguments well founded, and to test them I made some experiments. The experiments were made in this way: I took an iron bottle, such as is used for containing mercury, containing about one tenth of a cubic foot. I had carefully screwed into

it a rifle barrel, and had means of exploding gas inside of the iron bottle, by means of electricity. The iron bottle was filled with the mixture of gas and air to be tested. The gas and air were mixed in the right proportions to make the greatest explosive force, and the bullet being fitted in the barrel, the gas was exploded. The force was measured by the impression the bullet made in a piece of board. I have one board here upon which I made some experiments [*showing the board to the committee*]. I found that there was very little difference in the explosive force of the two gases. I think that on careful experiment the water gas had slightly the greater explosive force.

Q. That is, the depth of the holes in that board show the force with which the projectile was sent? A. Yes, sir.

Q. And you think the water gas fully as explosive as coal gas, as a result of that experiment? A. I do not think the result showed any great difference. It was repeated several times; but there was no marked difference.

Q. Have you made any investigations as to the effect upon the atmosphere of the burning of the two gases? A. I have analyzed the products of the two gases. The result is, that taking water gas and coal gas of practically the same candle-power, in Toronto and Boston, that the Boston gas used a little more air and furnished a little less carbonic acid on combustion than the Toronto water gas. There was no very great difference in either gas, perhaps ten per cent, or something like that. The result is given in my report.

Q. That is, the result of your investigation was that the burning of either gas made no difference in the atmosphere? A. I think very little difference. Perhaps the carbonic acid was a little more in burning water gas. I think that Prof. Morton said that water gas, compared with coal gas, would give about half more carbonic acid.

Q. Then the burning of the water gas would vitiate the air more than the coal gas? A. Yes, sir, if the ventilation was not so good.

Q. What is the effect of carbonic oxide upon the light of coal gas? A. I think the amount in coal gas does not count very much either way. When the carbonic oxide in gas is not more than ten per cent, we will say, it would not make much difference whether that carbonic oxide was replaced with hydrogen; there would be very little difference in the light whether it was carbonic oxide or hydrogen, but it is not so good as marsh gas as regards giving light.

Q. Then the more marsh gas there is in illuminating gas, the better it is for the light? A. Yes, sir, the better it is for the light as compared with carbonic oxide or hydrogen.

Q. So that the more marsh gas coal gas has, the more light it gives? A. Yes, sir. The water gas contains the more illuminants for producing the same candle-power.

Q. You have given your opinion in your annual report; but I will ask you what you think is the dangerous limit of carbonic oxide in gas? A. About all I have to base my opinion on is the experiments I have made with the various mixtures. In reading the coroners' reports in the newspapers, I saw there were very few deaths from breathing coal gas, and in a large city like New York there would sometimes in one year be no deaths at all, while with water gas I think it has run up to something like twenty a year. The experiments I made with animals seemed to show that the increased number of deaths is due to the increased amount of carbonic oxide in water gas.

Q. You made some experiments with animals last year, similar to those made by Profs. Sedgwick and Nichols? A. Yes, sir; they were similar; but instead of using a room such as a person would naturally sleep in, I used an air-tight box, and passed a definite mixture over the animal experimented on, which was a rabbit in each case. He had no chance to breathe anything but gas and the products of combustion were taken away. I found that with naphtha gas, which contains no carbonic oxide at all, there was almost no effect discernible. I made one experiment this spring, and one last spring. In the experiments last spring I passed five per cent of naphtha gas, mixed with air, over the rabbit for two or three hours, and he did not seem to be affected at all; possibly a bit sleepy, but there was practically no effect. This year I made rather a more severe experiment. I took a very good rabbit, and passed a mixture of air and a very rich naphtha gas, containing more than fifty per cent of illuminants; I passed this over the rabbit at the rate of seven feet an hour. I passed about ten or twelve feet over him, and it took about an hour and three quarters. The rabbit was just a trifle stupid; but after he had been out two or three minutes he was apparently as good as ever. This mixture I passed over him was so very rich that after he breathed it the flame could be lighted and burnt. This naphtha gas contained over half its volume of illuminants. I think that proves conclusively that it is not the illuminants in gas that are poisonous.

Q. (by Mr. Greenough). You did not answer my question in regard to the danger limit. What would you recommend as to the amount of carbonic oxide to be left in gas, as practically the dangerous limit? A. Well, it is a little hard to say just where the line should be drawn. I think the records show that the ordinary amount in coal gas is not particularly dan-

gerous. I do not see any special reason for putting the limit much lower than ten per cent. If you put it down to six or seven, or thereabouts, it means only a good deal of extra work for the inspector. The inspector has got to inspect the gas every time for carbonic oxide, and it is more work to do that than it is to make the other tests all together. I think that the gas which contains six or eight or ten per cent of carbonic oxide is not specially dangerous.

Q. Of course it would be desirable, as I understand it, to have all the carbonic oxide taken out; but is there any practical danger in leaving eight or ten per cent of carbonic oxide in gas as it is delivered to-day? A. No, sir; that is what I thought, and recommended.

Q. You went out West, this summer? A. Yes, sir.

Q. And made some tests of gas in various places where they are delivering water gas? A. Yes, sir; I did.

Q. And those were put in your report? A. Some of them.

Q. And you found the gas in Toronto to be of seventeen and a half candle-power? A. I think that was so; Toronto seventeen and a half; that was the test made one day.

Q. (by Mr. HALLETT). Have you been to Fredonia, N. Y.? A. No, sir.

Q. They are burning marsh gas there. A. It is a natural gas.

Q. It is from marsh and decomposed wood? A. Yes sir.

Q. (Mr. GREENOUGH). I see you make reference to the practicability of taking carbonic oxide out of water gas. What does this mean? A. Water gas consists of two parts. There is the pure water gas, a mixture of hydrogen and carbonic oxide, and there is naphtha gas. The naphtha gas is not really water gas, but they use it with water gas to get the light. You can make a poor water gas without any great amount of carbonic oxide in it, and you can make a naphtha gas separate, and add the two together, and in that way you get the light.

Q. You make a new vehicle to carry the illuminants? A. Yes, sir; but you make the illuminants and the gas separately. After the illuminants are once in, I do not know any way to get the carbonic oxide out. You would have to take out all the illuminating power in order to take out the carbonic oxide.

Q. But you can make a different kind of vehicle to carry the naphtha gas, which gives the light? A. Yes, sir; instead of making the gas from hydrogen and carbonic oxide, you would make it principally from hydrogen.

Q. And then put in the illuminants? A. Yes, sir.

Q. But that is not taking the carbonic oxide out of water gas; it is making practically a different gas? A. That is what it amounts to.

Q. (by Mr. DILLAWAY). Mr. Hinman, when was this restriction placed in the law which provides that there shall not be any gas made that contains more than ten per cent of carbonic oxide? A. The restriction was put in in 1880.

Q. Well, now, did you procure the putting in of that restriction? A. I think I am responsible for it. I prepared the bill, and reported it to the committee.

Q. When were you appointed inspector? A. In 1871.

Q. And it was not until 1880 that you thought fit to attend to this matter of carbonic oxide? A. Well, in regard to the bill of 1880, Mr. Webster, a member of the Committee on Mercantile Affairs, or Manufactures, I do not remember which it was, came to my office and said he had read my report, and seen that I had made certain recommendations covering changes in the law; that he thought well of those recommendations, and if I would get up a bill embodying them, he would bring it before the committeee, and see what the prospect was of having it passed. In making up the bill for that purpose, I had to give some attention to the quantity of carbonic oxide in gas.

Q. Was there anything in the report that mentioned carbonic oxide? A. No, sir; not in that report.

Q. Then Mr. Webster did not gather anything about carbonic oxide from that report? A. No, sir.

Q. Now, did you make any experiments regarding carbonic oxide? A. I did not.

Q. Did you make any experiments in 1880 regarding carbonic oxide, or when did you begin to make experiments to see whether the recommendation was according to your own knowledge or not? A. The first experiments I made were last year.

Q. In 1882, do you remember reporting that you had not made any experiments on this subject? A. I do.

Q. And you did not make any yourself, you say, before the water-gas hearing? A. While it was going on I think I made them.

Q. Now, when you had this matter of carbonic oxide under consideration, in 1880, did you confer with anybody to ascertain the danger limit? A. No, sir.

Q. How came you to fix the limit at ten per cent? A. Well, I knew about what amount of carbonic oxide was in coal gas, and I saw that that was comparatively harmless, and I fixed it at ten per cent as a round num-

ber, and as a number that would not require me to make an examination for carbonic oxide every time I made one for coal gas.

Q. Then you fixed it at ten per cent for your own convenience? A. That was, as I say, one of the reasons, but not the principal reason.

Q. You made no experiments to see whether ten was a safe percentage to have, or the danger line, or not? A. I knew about what coal gas contained, and I knew from reading the papers that there had been very few deaths from coal gas.

Q. What was the usual percentage that coal gas contained at that time? A. Something like six or six and a half.

Q. And you thought ten was safe, because coal gas contained six? A. Something like that.

Q. That was a scientific mode of ascertaining it, in your opinion? A. The limit had to be set somewhere, hadn't it?

Q. But was that the scientific mode of ascertaining it? A. I stated that I did not wish to make an examination for carbonic oxide every time I made an examination of coal gas.

Q. Then in making a statute on a scientific subject, which affects the health of the people, you only considered yourself and your labor in making the analysis of gas, and that was your idea of putting the limit at ten per cent, or any other limit? A. I think there would be no great harm in using gas of fifteen per cent of carbonic oxide.

Q. Had you any idea of what the effect of using it with fifteen per cent was? A. It would be somewhat more dangerous.

Q. In your opinion how much carbonic oxide could be in a room without endangering life? A. I should say about one half of one per cent.

Q. Your experiments show that? A. Something like that.

Q. Your experiments show that one half of one per cent would have an effect on human life? A. I have made no experiments on human life.

Q. Well, what per cent would have an effect on human life? A. I do not know of any experiments on human life; but reasoning from the effects upon animals, I say that it shows that somewhere about one half to one per cent is dangerous to the life of animals; and reasoning from that we infer the same in regard to human life.

Q. On what animals have you made experiments? A. Rabbits.

Q. Do you know how many cubic feet of air an animal breathes at each inhalation? A. No, sir.

Q. Then how can you tell how much effect it will have if you don't know

how much an animal breathes, and how can you compare it if you don't know how much a human being breathes? A. I let him breathe a gas not containing carbonic oxide, and then I let him breathe at the same rate a gas with carbonic oxide.

Q. But I ask you how much knowledge have you of the amount of air that a rabbit breathes? A. I judge of the amount by analogy, as to the amount a human being breathes.

Q. But you don't know how much he inhales? A. No, sir; not precisely.

Q. Do you consider that experiment practically worth anything? A. Yes, sir; I do.

Q. In determining the effect upon human life? A. I do.

Q. Do you mean to say that your experiment on a rabbit shows anything of the effect at all upon human beings, except in the most general way? A. We know from experiments that the effects upon animals and human beings agree.

Q. Please to stick to the rabbit for a minute. Do your experiments on rabbits show anything, except in the most general way, that carbonic oxide is a poison, and what is the danger line, and how much it will take to poison a human being? A. You can't tell from experiments on a rabbit how much it will take to poison a human being.

Q. Now, is it not a fact that ammonia and sulphur are deleterious and injurious to meters? A. To a certain extent.

Q. Have you not so reported? A. I have.

Q. I am reading from your report of 1878.

"Ammonia is objectionable, because it gets on the meters, causing them to register incorrectly; and the change is usually against the consumer. It also corrodes the fixtures, and in some instances produces nitric acid, when burned." Haven't you complained in all your reports that ammonia was not sufficiently removed, up to two or three years ago? A. I have referred to some companies.

Q. The companies about Boston? A. Yes, sir.

Q. And you report now that this matter is not sufficiently removed? A. I do.

Q. This matter affects the fixtures? A. That is a minor point. It affects the brass and causes the cocks to turn hard.

Q. It is an injury to the fittings? A. They are brass.

Q. It is an injury to the joints? A. I don't know.

Q. You have not reported on anything of that kind? A. No, sir; I don't know that I have.

Q. Now, you have been travelling in the West, and you gave the result of your trip in the report? A. Yes, sir.

Q. That is the trip you asked the Commonwealth to pay the expense of? A. Yes, sir; I thought they might pay it.

Q. And they gave you leave to withdraw? A. I understood so.

Q. In your trip did you make any investigation to ascertain the percentage of carbonic oxide in the different gases you analyzed? A. Yes, sir; that is what I went for.

Q. And what else did you ascertain? A. The candle-power.

Q. What else? A. I got the general composition of the gas.

Q. Did you make any investigations to find out whether water gas killed people or not? A. I asked one or two people. I did not have any great amount of time to go into that matter.

Q. How many places did you go to? A. I should think ten or a dozen.

Q. Is the list of them in your report? A. Yes, sir.

Q. What page, do you remember? A. There are ten; Rochester, Toronto, Chicago, Lancaster, Harrisburg, Wilkesbarre, Scranton, St. Louis, Washington, and Baltimore.

Q. Well, now, you went to these places, and where did you get your samples of gas? A. From the hotels where I stopped.

Q. Did you analyze it there? A. I made an approximate determination as to what the amount of carbonic oxide was.

Q. At the hotel? A. Right at the hotel.

Q. Did you ascertain the amount of candle-power? A. Yes, sir; I did.

Q. You did not make any inquiries as to the effect water gas had upon human life? A. I did not.

Q. You did not make any inquiries to determine its effect upon human life? A. I thought it had been determined.

Q. Where has it been determined? A. I think by the records of people who die in New York, Brooklyn, and Baltimore.

Q. Were those the only places where you had any record of deaths from water gas? A. I have seen some statements about Toronto.

Q. Did you make any inquiries to see whether these records were true or not? A. I did not.

Q. Then the result of your trip was to ascertain the candle-power of the gas and the carbonic oxide in it? A. And these other gases.

Q. The other gases contained in combustion? A. That is what I started out to find.

Q. And you did not ascertain about the effect upon the public health? A. Not in that trip; no, sir.

Q. Well, now, take this experiment you have made here with this board. Do you mean to say that such a result scientifically shows whether water gas is more or less explosive than coal gas? A. I do not see what other interpretation can be drawn from it.

Q. And you are willing to state from the result of that experiment that one gas is as explosive as the other? A. Pretty nearly. In all experiments there is a variation from the exact mean. I do not say that is the exact mean. I made several trials, and that appeared to be the result.

Q. Scientific experiment then is a matter of guess-work? A. No, sir. That is not intended to register exactly, but it shows pretty nearly.

Q. What does it show? A. It shows that the explosive force of one gas is pretty nearly equal to that of the other.

Q. How nearly equal? A. Except as to the error in the experiment.

Q. Now you think that is a satisfactory result? A. Yes, sir.

Q. What causes the water gas to explode? A. On account of the combustible gases which it contains.

Q. What combustible gases? A. Hydrogen, carbonic oxide, marsh gas, and the illuminants.

Q. Which is the most explosive? A. I think hydrogen will take fire the quickest.

Q. Which would have the most explosive force? A. I think hydrogen would take fire the quickest.

Q. Which would have the most explosive force? A. Reckoned from ——

Q. By the quickness of taking fire? A. It would depend upon what you take as a unit of comparison. If you take one foot of hydrogen mixed with the proper amount of air, and one foot of marsh gas mixed with its proper amount of air, the marsh gas would produce more than three times as much force as a cubic foot of hydrogen would. But if you reckoned upon a cubic foot of the explosive mixture, after the hydrogen and marsh gas were mixed with air, there would not be anything like that difference.

Q. Now, what are the explosive gases in coal gas? A. They are practically the same as in water gas.

Q. Don't you think the gas which has the same relative quantity of hydrogen and a larger quantity of marsh gas, would be more explosive than when it contained the same quantity of hydrogen and a less quantity of marsh gas? A. That would depend on the nature of the other gases.

Q. Take those two gases first. A. Do you mean to ask which is the more explosive, marsh gas or hydrogen?

Q. I mean to take both gases, hydrogen and marsh gas, each having the same quantity of hydrogen, and another having a larger quantity of hydrogen, which would be the more explosive? A. The explosive force of the mixture containing marsh gas, if you reckon upon one cubic foot of each gas, but if you reckon on equal volumes of explosive mixture, there would be little difference.

Q. Now, suppose one contains more hydrogen and the other more marsh gas, with the same quantity of carbonic oxide, and the same quantity of hydrogen and nitrogen? A. It would depend upon what the other things are made up with.

Q. But take it with the same proportions? A. But you cannot have a greater proportion of hydrogen and marsh gas.

Q. Well, sir, will you please tell us how you make it out when coal gas has a larger percentage of hydrogen and marsh gas, and a smaller percentage of carbonic oxide, and you cannot tell us which is the more or less explosive? A. I understood you to say, if you had a gaseous mixture of one gas containing a larger percentage of hydrogen and marsh gas, and the same percentage in the other mixture.

Q. No; I did not put that question at all. Now do you know of any explosions that have occurred from the use of water gas? A. I have read of some.

Q. What have you read of? One at St. Johnsbury, Vt.

Q. What others? A. I don't recollect any.

Q. Have you ever read of any explosions from coal gas? A. Yes, sir.

Q. Quite a number of them? A. Quite a number.

Q. They have happened rather frequently? A. Yes, sir; you might say frequently, — every little while.

Mr. C. P. Greenough. — I will now offer the following letters and names of people who died from the use of illuminating gas in New York. The lists of deaths are not kept by the coal-gas companies. The record of deaths is kept by the health department in New York City. I wrote to the chief of the health department, and received these letters from him: —

CHARLES P. GREENOUGH, Esq.

Deaths by Asphyxia from Inhalation of Illuminating Gas.

Accidental.

Sturtevant House	1
Leggat's Hotel	1
Ashland House	1
38 Cherry Street	2
102 West Street	1
288 8th Avenue	1
244 West 27th Street	1
Equitable Gas Works while pumping	1
162 East 94th Street	1
Brevoort House	1
115 East 9th Street	1
Summit Hotel	1
49–53 West 57th Street	2
Northern Hotel	1
Van Dyke House	1
60 West Street	1
Total accidental deaths	18

Suicidal Deaths.

109 West 25th Street	1

Dear Sir, — I give you the information above of deaths from illuminating gas during the year 1884. How many of these deaths were from water or coal gas I am unable to state. The investigations are made by the coroners, and to them you will have to make the inquiry; their address is 15 Chatham Street.

Dr. J. H. Raymond, Health Commissioner of Brooklyn, N. Y., submitted a report to the Common Council of that city on illuminating gas, and the amount of cubic feet used in New York and Brooklyn, together with the deaths in both cities from coal and water gas, giving names, etc. I think he would send you the report on application.

E. G. Love, Ph. D., gas examiner, Department of Public Works, 31 Chambers Street, will probably be able to give you any information about the gas we use that you desire.

Very respectfully yours, etc.,

JOHN T. NAGLE, M. D.

CHARLES P. GREENOUGH, Esq.

Suffocation by Illuminating Gas in New York.

First quarter, 1883.			Putnam House, 4th Avenue	1
"	"	"	St. Stephen's Hotel, 11th Street and University Place	1
"	"	"	48 Chatham Street	1
"	"	"	32 Bowery	1
Second	"	"	200 West 57th Street	1
"	"	"	Summit House (suicide)	1
Third	"	"	Illuminating Gas, 178 South Street	1
"	"	"	93 Bowery (suicide)	1
Fourth	"	"	45 Bowery	1
"	"	"	20 Bowery	1
"	"	"	Bowery Hotel	1
"	"	"	98 Barclay Street	1
"	"	"	235 Canal Street	1
Total				13

Yours, etc.,

JOHN T. NAGLE.

Mr. Greenough:

These letters merely give the places where the accidents occurred. The names and dates I found in reports in the New York *Tribune* and *Herald;* some in the *Gas-Light Journal*, and some in the Boston *Herald*. Knowing the place where the accident occurred, those reports gave me the date and name, and an account of how the accident happened. All of New York City below Grand Street, being supplied solely with water gas, by looking at the place where the accident occurred I could tell it was caused by water gas if it happened in any street below Grand Street.

RÉSUMÉ.

Accidents from the Use of Water Gas in New York City.

Years.	Deaths.	Injuries not Fatal.
1880	12	8
1881	19	14
1882	23	22
1883	20	22
1884	19	20
1885 to March 12	7	6
	100	92

Deaths from the Use of Coal Gas in New York City.

Years.	Number.
1880	1
1881	3
1882	2
1883	0
1884	2
	8

Consumption of coal gas in New York in 1884...2,763,000,000 cubic feet.
" " water gas " " ...2,583,000,000 "

Deaths in Boston from the Use of Coal Gas.

Years.	Number.
1878	2
1880	0
1881	0
1882	1
1883	0
1884	0

DEATHS FROM USE OF WATER GAS IN NEW YORK CITY IN 1884.

		Names.	Locality.	Authority.	
Feb.	19,	George Hall,	North River Hotel,	Dr. Nagle,	New York Tribune.
"	23,	Unknown man,	Northern Hotel,	"	
March	1,	Unknown man,	Frank's Hotel, 60 West Street,	"	New York Post.
"	11,	Joseph Carter,	Van Dyke House,	"	Gas Journal, New York Post.
April	26,	George E Ewing,	Brevoort House,	"	New York Herald.
"	26,	John Ford,	Summit House,	"	New York Herald.
May	7,	Ellen G. Smith,	30 Third Avenue,	.....	Gas Journal.
"	16,	Minnie Hilis, Caroline Dittenhoefer,	49 West 35th Street,	Dr. Nagle,	Gas Journal.
July	5,	Hannah Schissler,	162 East 94th Street,	Dr. Wilkie's report,	Boston Herald.
Oct.	22,	Daniel Flynn, Pete Coleman,	38 Cherry Street,	Dr. Nagle,	Chambers St. Hospital.
Nov.	1,	Mr. Crawford,	Central Hotel, 102 West St.,	"	Gas Journal.
"	23,	Mary O'Rourke,	288 Eighth Avenue,	"	New York Herald.
Dec.	3,	M. L. Paul,	Sturtevant House,	"	New York Times.
"	6,	Francis Rosenbauer,	Leggatt's Hotel, 44 Chatham St.,	"	Gas Journal.
"	21,	John Kelly,	1st Avenue and 40th Street,	"	New York Times.
"	31,	A. P. Bloomfield,	Ashland House,	"	Gas Journal.
"	31,	Unknown man,	115 East 9th Street,	Dr. Nagle's report,	

INJURIES, NOT FATAL, FROM USE OF WATER GAS IN NEW YORK CITY IN 1884.

		Name.	Locality.	Authority.
Jan	6,	Christine Kerswurm,	215 Canal Street,	Gas Journal.
"	8,	Conrad Kuhn,	Van Dyke House,	New York Tribune.
March	2,	Joseph Sweeny,	58 Beach Street,	Chambers Street Hospital.
"	10,	Henry Gilseck, Herman Leinester, Carl Witte,	College Place Hotel,	Chambers Street Hospital.
"	11,	W. H. Walters,	Corner Bayard St. and Bowery,	New York Post.
May	16,	Lena Shepard,	53 West 47th St., Cable's Hotel,	Gas Journal.
June	8,	C. W. Drew,	141 Fulton Street,	Chambers Street Hospital.
July	9,	Chester Foland,	.....	Chambers Street Hospital.
Oct.	8,	Jacob Haas,	125 West Street,	Gas Journal.
Nov.	8,	—— Breen,	New England Hotel,	Gas Journal.
"	9,	Jacob Katz,	New England Hotel,	New York Hospital.
"	29,	Mrs. Mary Scott and 5 children,	440 Greenwich Street,	New York Times.
Dec.	13,	Alex. Smith,	66 New Church Street,	Chambers Street Hospital.

DEATHS FROM USE OF WATER GAS IN NEW YORK CITY IN 1883.

	Name.	Locality.	Authority.
Jan. 10,	Andrew L. Culver,	112 West St.,	New York Sun.
" 20,	Arthur Scholfield,	Hotel St. Stephen,	Dr. Nagle. N. Y. Sun.
" 27,	Frank M. Tornowska,	30 Bowery,	Dr. Raymond's Report.
1st Quar.	Unknown man,	32 Bowery,	Dr. Nagle.
March 1,	William Lawrence,	Putnam House, 4th Ave.,	Dr. Nagle. N.Y. Herald.
March 17,	William Mulcahey,	48 Chatham St.,	Dr. Nagle.
April 5,	Lizzie Hoag,	200 West 57th St.,	Dr. Nagle, Roosevelt Hospital.
May 4,	Emmanuel Miller,	313 West 23d St.,	New York Herald.
" 18,	Anson G. Gurney,	Fall River Boat,	New York Herald.
" 29,	Eliz. W. Nauschwitz,	Summit Hotel, Bowery,	Dr. Nagle.
Sept. 11,	F. Leighton,	Spencer House, 93 Bowery,	Dr. Nagle. N. Y. Herald.
" 11,	Karl A. Karstel,	178 South St., Beyer's Hotel,	Dr. Nagle. N. Y. Herald.
" 11,	Louis Gareurer,	178 South St., Beyer's Hotel,	N. Y. Herald, Sept. 13.
Oct. 17,	H. Greenberg,	Hartmann's Hotel, 47 Bowery,	Gas Journal.
" 17,	Gustave Plunger,	395 Bowery,	Gas Journal.
" 25,	Frederick C. Burrhus,	Everett House,	Dr. Nagle. N. Y. Herald.
" 28,	James Courtney,	Hotel Bowery,	Dr. Nagle. N. Y. Herald.
4th Quar.	Unknown man,	45 Bowery,	Dr. Nagle.
"	"	20 Bowery,	Dr. Nagle.
"	"	235 Canal St.,	Dr. Nagle.

Mr. GREENOUGH. — Above Grand Street there are three or four kinds of gas used. The only way I could find out about those cases was by getting a man to go and inquire at the places. He found exactly what company they got their gas from. If they were supplied from the Harlem Gas Company, they got coal gas; and if from the Municipal Company, they got water gas. Of course they knew nothing about the object of his errand, and answered the questions just as they would any civil question. In that way I have made up the list, which I think is correct. It is of course subject to error, like all lists of this kind; but I think it is as correct as it can be made, and the result is very curious.

Mr. CRANE. — Now, in regard to those pipes in Yonkers. How could they be laid in the street without the officer knowing which was the proper company to repair the pipes?

Mr. C. P. GREENOUGH. — The company cannot always tell themselves. If a large number of companies put their pipes into the same narrow street, the gas companies cannot tell their own pipes, unless they have an accurate plan. In London, there were at one time seven companies which had pipes in the same narrow streets, and one company attached a pipe to the pipe of one of the other companies, and sucked gas from it for a year before it was found out.

MARCH 25, 1885.

Mr. C. P. GREENOUGH. — I now present to the committee the report of Prof. Max Von Pettenkofer, the most eminent chemist in Germany, giving an account of the examination made under his orders, to which I I referred.

"GAS POISONING," BY MAX VON PETTENKOFER.

Extract.

"If we now ask why it is that illuminating gas is so poisonous, we shall learn, from the experimental investigations of Orsila, that it is owing to its strength in carbonic oxide, which is also the poison of the so-called fire-damp.

The quantity of carbonic oxide varies in different gases, and *one is, therefore, more dangerous than another.* Anthracite coal gas usually contains ten per cent, oil gas seventeen, peat gas twenty, and wood gas thirty. *Coal gas is at present the kind generally used in the lighting of cities, and this has indeed, very fortunately, the smallest quantity of carbonic oxide.*

The other component parts of illuminating gases are the so-called irre-

spirable gases, that is to say, gases which supply no air to the lungs, but they are not directly poisonous.

Dr. Max Gruber has proved that a large quantity of gas, from which the carbonic oxide has been removed, may be administered without fatal results to animals which are very sensitive to the admixture of a very small quantity of carbonic oxide with the air they breathe. *It would be, therefore, of the greatest hygienic value if means applicable on a large scale could be devised for the removal of carbonic oxide from illuminating gases*, means similar to those which have been devised for the removal of sulphuretted hydrogen through hydrate of peroxide of iron, and of carbonic acid through hydrate of lime. So long, however, as such a result is not attained, we must regard every unignited gas as dangerous to health and life.

Another weighty question, which can only be solved through scientific experiment, is, in what quantity is carbonic oxide dangerous in the air we breathe? In this direction, Gruber has made, at the Scientific Institute, in Munich, some decisive experiments upon animals, as well as upon himself.

The carbonic oxide works, in the first place, upon the blood corpuscles, which we may regard, for the most part, as a combination of hematine globules with the carbonic acid of the air. From this supplanting of carbonic acid occurs a combination of carbonic oxide and hematine globules, which renders, in even very small quantities, the blood unserviceable for the processes of life.

It has hitherto been supposed that the respiration of even the smallest quantity of carbonic oxide would produce symptoms of poisoning, provided it was continued long enough to allow the carbonic oxide to increase in the blood to the requisite quantity. But Gruber has shown that our organism possesses the means whereby to rid itself of a small quantity of carbonic oxide; it happens, therefore, that no increase of it in the blood occurs through the continued respiration of it, and that the gravity of the symptons of poisoning are proportional, not to the duration of the respiration of the carbonic oxide, but solely to the concentration of carbonic oxide in the respired air.

Gruber invented, for his experiments upon animals, an apparatus which enabled him not only to regulate at will the amount of carbonic oxide to be conveyed to them, but to save them from any other constraint than confinement in roomy and comfortable glass cases, into which the air, charged with a certain quantity of carbonic oxide, flowed as into a completely and equally ventilated room. He found that when less than one twentieth of one per cent of the poisonous gas was mixed with the air, there was no perceptible discom-

fort in either animals or men. He once kept a rabbit for sixty-six consecutive hours in such an atmosphere, without noticing the least disturbance of the animal's comfort or of its appetite. Gruber himself breathed, for a period of three hours on each of two successive days, an atmosphere charged with 0.021 and 0.024 per cent of carbonic oxide without feeling the least discomfort or injurious effect.

But it is otherwise when the quantity of carbonic oxide is slightly increased. When it is between 0.07 and 0.08 per cent, the condition of the animal is no longer normal. In a short time its breathing becomes quick and dull, and it remains as quiet as possible, every motion producing a considerable increase of respiratory activity. But no other disturbances result from the respiration of such a concentration of carbonic oxide, even if it be continued for *days*.

If the carbonic oxide is increased from 0.08 to one fifth of one per cent, other pathological symptoms occur. The breathing is so accelerated as to become difficult; the mouth remains open; the nostrils, and the whole body move with each respiration. To the difficulty in breathing are added lassitude, and uncertainty of movement.

If the concentration of the poisonous gas remain at one fifth of one per cent, the above phenomena, after once being established, undergo no increase, even if the experiment be continued for nine or ten days. The animals, moreover, recover in the fresh air.

When the concentration is still further increased, the animals are no longer able to stand upright, they sink down, and lie in a state of deepest stupefaction and in the most uncomfortable positions. From time to time they raise themselves and endeavor, by badly concerted movements, to attain an upright position, but they soon fall down again, only to renew their efforts after a long interval. When the per cent is from 0.2 to 0.4 the difficulty in breathing becomes secondary to the stupefaction, but even then the animals completely recover when carried into the fresh air.

It is only when the quantity of carbonic oxide is four tenths of one per cent and above, that the poisoning becomes uncommonly rapid and deadly, death ensuing after from thirty to sixty minutes of great disturbance,—risings and fallings, writhings and convulsions.

Carbonic oxide works at first, it is true, upon the blood, but the symptoms of poisoning often result from the effect of the carbonic oxide in the blood upon the brain and spinal marrow. The respiratory centre in the brain is next affected, then follows the weakness and the uncertainty of voluntary movements, and finally convulsions and death, when the concentration of carbonic oxide is sufficiently large.

Gruber experimented only upon rabbits and chickens, with an extract of carbonic oxide, but all who have had an opportunity to observe cases of poisoning by carbonic oxide, whether through fire-damp, that is to say, through the premature closure of the smoke-dampers of a stove, or through illuminating gas, know how great a likeness there is between the symptoms shown by men and by animals. Men also endure for a long time an injurious but not deadly quantity of the oxide, and, for the most part, recover speedily and completely when brought into the air.

A concentration as small as from 0.05 to 0.08 per cent is, without doubt, felt by human beings. We find such an atmosphere heavy, that is, perceptibly difficult to be breathed; we experience headache; we seek to leave a room which contains such an atmosphere, or we endeavor to supply it with better air; we open a window or a door, and we at once feel better.

If we neglect to do this, and if the quantity of carbonic oxide is increased (say from 0.08 to 0.2 per cent) we, like the animals, experience difficulty in breathing, lassitude, and uncertainty of movement, the headache becomes severer, and vomiting frequently occurs. Such a degree of poisoning from carbonic oxide I myself once experienced, when, during one of my investigations with regard to the amount of free ventilation in our dwelling-houses, I generated carbonic acid in a room by means of a quick ignition of coal in a disconnected blast furnace, for the purpose of measuring the diminution of carbonic acid within a given time, through the free entrance of fresh air.

This was by all means the cheapest way to produce carbonic acid, but there came from the ignition of the coal, even when the blast-furnace drew well, some carbonic oxide. As I made these experiments nearly thirty years ago, I had not the least idea how small a quantity of the oxide was deleterious. In these experiments I always burned the same quantity of coal in the same blast furnace, and experienced from my earliest experiments no particular uneasiness; but when, for the purpose of determining how much free ventilation would be diminished, I once closed all the joints and crannies of the windows, and even the keyholes of a room, I felt, even before the end of the experiment, very unwell; I breathed heavily; had severe headache; was unable to properly handle my apparatus; and had just presence of mind enough to open the door of the room and stagger into the entry, where, like the rabbits of Gruber, I sank down. But, like them, I soon recovered.

I discovered from this experiment, after my experience with the generated carbonic acid, that the free ventilation of the room was much diminished, and that there was not only quite a large increase of carbonic acid

in the air, but also a considerable increase of carbonic oxide. From that time forth I no longer generated the carbonic acid necessary for my investigations from the cheap substance, but from compound carbonated nitrate, by means of oxygen, and was never again sick during an experiment, though the ventilation was often very imperfect.

Severe headache is with men a very constant symptom of incipient poisoning from carbonic oxide, and one may assume that the brain is, with animals also, affected. Gruber could not, it is true, ask his hares and chickens whether their heads ached, but there were indications that they did.

From what has been shown, it may be assumed that the quantity of carbonic oxide which is fatal to animal life is likewise fatal to human; and that men can bear such a quantity no longer than Gruber's animals could, — that is, from thirty to sixty minutes only.

These assumptions agree very well with the experiments accidentally made with men, which may for all intents and purposes be regarded as specially instituted investigations.

. . . . . .

In the above-mentioned case of the Caimi family there were during the night, in the same room with the mother and her two daughters, a bird and a little dog. The two girls and the bird were found dead; the mother and the dog in a state of stupefaction. The mother, moreover, subsequently died, but the dog completely recovered. In a case reported by Dr. Wolffberg ("Gas Poisoning from Broken Street Mains," by Dr. S. Wolffberg, private instructor in Bonn, Archives of Hygiene, Vol. I, p. 168), a cage containing a pair of birds was in the room. The sitting female was found still alive; the male was dead. It seems, then, that men and warm-blooded animals, whether large or small, are very sensitive to carbonic oxide gas. Individual differences are of no hygienic, but only of physiological and pathological interest, and there is, therefore, no need of my considering them closely."

No evidence was offered by the remonstrants, and the hearing was declared closed, after arguments by W. E. L. Dillaway for the Bay State Gas Company, and Charles P. Greenough, Esq., for the petitioners.

Hearings on Report State Board
&c. on Carbonic Oxide in illuminating
gas. 8° Boston 1885.

Agricult. Dept
for Hayward

Jan 11-1907.