missionary post in Africa, which had to be transported by negroes on foot one thousand miles from the point of unloading.

"Considering the fact that canned goods are really the only article of food which will successfully withstand the rigors of an Arctic winter as well as the heat of the Tropics, and the additional fact that new countries are being constantly settled, it is apparent that the demand for this article of food will increase rather than decrease.

"The consumption of canned goods in the mountain regions and in the Western Territories and the new States is simply enormous. Many of the Western States are now producing canned corn of a very good quality, and can do this at much less expense than in Maine, but while the corn averages very good, yet it is believed that no State has succeeded or will succeed in producing canned corn which will be as nutritious, sweet, and tender as that produced in Maine. This fact results in a great measure from the nature of the soil and the large quantity of manure required and the rapid growth of the corn. A recent chemical analysis of corn packed in Maine, Maryland, and one of the Western States disclosed the following as to the food value of the three lots, namely: Winslow's corn, 456 8-10; Iowa corn, 350 7-10 and Maryland corn, 303 7-10. In other words, the Winslow stood 30 per cent. above the Iowa and 50 per cent. above the Maryland in food value; or, if Maryland corn is worth 80 cents per dozen, and the Iowa a dollar, the Winslow would be worth one dollar and twenty cents. Among the modern improvements for packing corn are the steam retorts, which do the process in about an hour and thirty minutes, whereas the Winslow process requires about five hours. While many of the packers have adopted the retort system, the Winslow Packing Company still retains the old five hour process, which is more expensive than the modern processes, but which this company claims gives a better quality of corn.

"In connection with this business, the printing of labels for cans has grown in like proportion, from plain labels of one color on white paper to labels of many colors, needing the most skillful designers, and the large capacity for production, requiring presses of the latest manufacture. The largest number of labels are printed in Boston, there being no label printing establishments in Maine."

ON THE EMPLOYMENT OF GAS FOR COOKING.

By W. IVISON MACADAM, F.C.S., F.I.C., Edinburgh.

THE subject of cooking by gas is one of the most important which is at present before the gas manufacturing industry. Great strides have of late years been made in this direction; and the many hundreds and thousands of "cookers" now in use in various cities and towns speak volumes in favor of the system. Ignorance, prejudice, and an attachment to time-honored usages all tend to retard the general introduction of gas as a substitute for coal. Soot, smoke, and ashes are so familiar to every cook, that the idea of providing meat without these being present seems both impossible and improbable. The fact that the ordinary open fire or cooking range only does very imperfectly what the gas retort manufactures in a pure state seems to be ignored, and the public continue to burn valuable deposits of fuel, at the same time wasting the greater part of the constituents it yields, and polluting our atmosphere with that large quantity of finely-divided carbon which, accompanied by water-vapor, goes to produce those dense fogs which envelop our cities from time to time, causing loss of business, and being at the same time a hotbed of disease. Much of the dust and a large proportion of the dirt which soils our linen and makes city life almost unbearable can be traced to smoke. Moreover, the carbon in this state is useless, and is simply wasted; for plants cannot assimilate it, while the sulphurous acid fumes, etc., which accompany the sooty particles kill all the more tender and beautiful plants which delight our eyes, and render it impossible to grow healthy, strong, and vigorous trees in populous places. Much of the beauty of Continental cities may readily be traced to the custom of the inhabitants of cooking with charcoal, from which no carbon in a free state is evolved.

The very great waste of fuel rendered possible by the use of the common coal fire can be readily understood when we remember that a ton of coal can, with ease, be consumed in a month; while if the same amount of the substance were placed in a retort and distilled, a quantity of gas would be obtained equal to about 8,000 cubic feet, and sufficient to keep an ordinary-sized family in cooked provisions for a period of fully six months. The actual money value of the fuel is also increased; for from the ton of coal, which may be estimated as being worth 16 s., we get 8,000 cubic feet of gas, which at 2 s. 6 d. per 1,000 cubic feet will be equal to a sum of 20 s., and the residue of coke left in the retort may be put at half a ton in weight and at 8 s. in money value. We thus have a return of 28 s. for the ton of coal, worth 16 s., and have as residual materials all the tar and ammoniacal liquor produced. Moreover, to the gas consumer a very great saving in money is effected; for while the 20 s. worth of gas will cook for him for six months, he would require, in using coal, to expend at least 96 s. in the same time.

Granting, then, that some advantage may be gained by the employment of gas, the question comes to be, How are we to adapt our arrangements so as to obtain from the fuel the greatest amount of the available heat? To thoroughly understand this part of the subject it will be necessary for us first to have a knowledge of the nature of combustion, and of the products derived therefrom. It is now generally known that ordinary coal gas contains, as its principal constituents, marsh gas, hydrogen, carbonic oxide, and ethylene, with an admixture of nitrogen and carbonic anhydride. The first three of these gases yield, when burned, flames which are practically non-luminous, but which give a considerable proportion of heat; while the ethylene burns with a luminous flame, and gives, in addition to the heat, a certain proportion of light. These gases have no power within themselves of supporting combustion; and, when introduced in a lighted state into an atmosphere of their own gas, are instantly extinguished. The process of combustion, in its commonly accepted sense, consists of the oxidation of the constituents of the gas; and the presence of more or less oxy-

gen is essential. This oxygen is derived from the air, which contains about 21 per cent. of it by volume; the remaining 79 per cent. consisting of nitrogen. This latter gas is an inert body, and acts merely as a diluent. It is not combustible, and does not support combustion; nor does it enter into combination with any portion of the gas when the latter is burnt in air. The oxygen, on the other hand, readily combines with or oxidizes the carbon and hydrogen of the gas, whether these substances are present in the free or elementary state, or combined together. The oxygen, however, has a much greater desire to attach itself to the hydrogen than to the carbon; and the result is that, where substances rich in carbon are present in the coal gas, a certain amount of the carbon is thrown out of its states of combination, and floats in the flame. These small solid particles, becoming highly heated, begin to radiate a proportion of the heat, and at the same time to radiate also a considerable quantity of light. This throwing out of carbon from its state of combination is principally found to take place by the disintegration of the heavier hydrocarbons, of which ethylene may be considered the type.

This, then, is the explanation of luminous flame. The oxygen of the air, selecting the hydrogen in preference to the carbon, causes the latter body to be returned to the solid state; and these little particles of carbon, then becoming highly heated, emit light. This reaction is carried on in the luminous portion of the ordinary white gas light, and is marked as zone B in the annexed diagram.

This zone is known as the area of partial combustion, or selective combustion, because the reaction between the oxygen and the hydrogen only proceeds; the carbon being thrown out of its states of combination as a solid body. The zone A is the area of no combustion. The extent of this area depends greatly on the pressure at which the gas is forced through the pipes toward the burner. The greater the pressure, the larger the area. In the better class of burners various devices are employed to check the flow of gas; and the more perfectly this is accomplished the better the burner—the greater the zone B will become, and consequently the more light will be obtained. In zone A the air has not impinged on or become mixed with the gas; and therefore no active combustion can proceed. Outside of zone B another (and usually invisible) zone, C, is found. In this area the carbon which in B has been producing light meets with the oxygen of the surrounding air, and becomes oxidized or burnt into carbonic anhydride. This is the area of complete combustion. Place a small white plate over an ordinary gas-flame, and—provided the gas-burner is a good one, and the plate be held not nearer than (say) 3 inches to the visible flame—no soot or carbon will be deposited on the plate; in other words, perfect combustion is taking place. Now lower the plate until it touches the luminous portion, and immediately it becomes black from the deposited carbon, which was previously floating in the flame, and producing light. The result, then, of burning gas in an ordinary burner is the complete oxidation of the carbon and hydrogen of the gas into carbonic anhydride (carbonic acid) and water vapor. The luminosity of the flame depends upon the fact that a sufficient quantity of air is not present to burn both the hydrogen and carbon, and that the oxygen, having a preference for hydrogen, selects this element, and leaves uncombined carbon floating in the flame. Provided, therefore, that we can, by some means, mix with the gas, before it arrives at the burner, air in quantity sufficient to oxidize both the hydrogen and the carbon, the result should be a non-luminous flame, or a combustion in which we have no area B, but only zone C. Such is the principle of the Bunsen, or blue or atmospheric, burner. In this burner, air is admitted, and mixed with the gas, and the resulting combination burnt; the flame being perfectly non-luminous when properly worked. Having no solid in the flame, we can have no radiation of heat; and consequently, the whole calorific power of the burner is concentrated immediately over the flame.

Such are the flames available for utilizing the gas fuel for cooking purposes—the one a radiating flame, the other a concentrated heat flame. Suppose now that we desire to roast or bake in an oven; the heat we wish will be a radiant one. We do not intend to bathe the meat or bread in the heated vapors evolved from our burning gas, but we wish to conserve their heat, and radiate it from the heated sides of the oven, and also from the flame itself, if possible. If, then, we use ordinary white-flame jets, we shall obtain the desired effect. The blue flame will also enable us to cook in the oven; but the radiation will be entirely from the sides of the metal plates, and none from the burner itself. The white flame is, therefore, to be preferred. Moreover, if we desire a low heat, and our apparatus is fitted with blue jets, we are liable to set up an imperfect combustion, which produces a variety of hydrocarbon in which only one-half of the hydrogen has been oxidized, viz., acetylene. This body is one with an acid smell and somewhat irritating properties; and it readily taints meat placed in its vapor. With the white light this substance cannot be produced, unless, indeed, the burner fits badly, and is allowed to burn at the sides. This partial combustion, or "striking back," is the great difficulty of the blue flame when applied to close ovens. Another difficulty arises in the more or less liability of the jets to be blown out when the door is rapidly closed; care being especially necessary with the blue flame. For boiling vegetables or water, or for grilling or toasting, the oven heat is not available; and therefore other apparatus is necessary. The burners for these purposes are placed over the oven, and are

not closed in. For boiling it is desirable to have a flame which concentrates the heat at one point; and therefore, the blue or atmospheric burner is to be preferred to the white or heat-radiating burner.

For roasting purposes the temperature required is one about 340° Fahr., while for baking a somewhat higher heat is desirable. There is no difficulty in raising the heat in the gas cooker to as high as 400° to 500°, or even higher; and one of the points to be guarded against is the possibility of having too high a heat. Not only does a high temperature mean waste of gas, but it also causes loss in the weight of the meat by undue evaporation of water vapor; and at the same time the fat is liable to be decomposed, the glycerine being converted into a body called acrolein, which possesses an extremely pungent odor and poisonous properties. Care, therefore, is necessary to avoid too great a heat in the oven. This difficulty might be guarded against by making the stove-gas pipe of smaller dimensions; but the rapid heating of the oven to the roasting temperature would then become impossible. The best method is to turn on the gas fully for about a quarter of an hour, when the proper heat will have been attained, and then to lower the gas one half. For this preliminary raising of the heat, about 3 cubic feet of gas will require to be burnt, which is equal to an hourly consumption of 12 cubic feet; but the proportion necessary for the after-cooking of the joint will not exceed 6 cubic feet, or say a total consumption of 20 cubic feet in the two hours required for the thorough cooking of the joint.

One point in the cooking of meat by gaseous fuel is the very small loss sustained in the actual weight of the meat operated upon. In an ordinary coal range, the loss in weight through cooking amounts to fully 40 per cent. In other words, every 100 lb. of meat treated represents 60 lb. of cooked material, or a 10 lb. joint only weighs 6 lb. after roasting. This is the result with our common coal-fires. With gas, however, we find that the actual loss in weight is reduced from 40 per cent. to 25 per cent., or 100 lb. of raw meat becomes 75 lb. of cooked material, and a 10 lb. joint comes out of the gas cooker weighing 7½ lb. That this should be so is readily understood, when we remember that one of the constituents of the combustion of the gas is water vapor—1 cubic foot of gas producing about 1½ cubic feet of steam vapor—and that, therefore, there is not the same tendency for water to escape from the joint. The meat, too, when cooked by gas, is less shrunken and more juicy, and is, therefore, more easily digested than food cooked by the ordinary methods. It also cuts up better, and goes further. Being more juicy, it has not the same keeping powers as the drier coal-cooked meat has; and, therefore, it should be retained for a shorter period before consumption.

From the foregoing figures it is easy to calculate the amount of gas which will be consumed in cooking a dinner for eight or ten persons. An ordinary joint of some 10 to 12 lb. weight requires from 1½ to 2 hours for cooking; and after making all allowances for extra time in raising the heat of the oven and some waste, the total quantity of gas should not exceed 20 cubic feet for the 2 hours, or 10 cubic feet per hour. The oven, moreover, will not only cook a joint, but pastry can be baked at the same time, and that without extra cost for fuel. Vegetables can be boiled or steamed on the upper open rings, or "boilers;" and as the ranges are usually furnished with at least three of these appliances, so many pots can be kept at work. These upper rings will consume a quantity of gas equal to that required by the oven, and therefore we must double our previous estimate of gas, and lay our account for a total consumption of 40 cubic feet for the two hours' cooking of a dinner for eight or ten persons. But let us employ a figure certain to cover even careless working, and say 50 cubic feet, or 25 cubic feet per hour, what is the actual money cost of cooking this dinner? Supposing the gas costs 2 s. 6 d. per 1,000, or 3 d. per 100 cubic feet, the 50 feet cost the consumer exactly 1½ d. Breakfast, tea, and possibly supper require to be provided, and also hot water for washing purposes. Let us, then, add 50 feet for these, and the total daily cost of cooking by gas for a family of eight or ten people may be set down at 3 d. For a like amount of work, an ordinary range would consume at least ½ cwt. of coal. This at 16 s. per ton is equal in money value to about 5 d.; or a clear saving of 2 d. per day. Calculating these figures to the yearly cost, we find, from the above data, that the gas cooker costs the house £4 11 s. 3 d., and the coal range £7 16 s. 3 d.; showing a difference in favor of the gas of £3 5 s. per annum. In most families daily joints are not common, and cold meat must be consumed, with a consequent lowering of the gas bill. This in the case of gas will be equal to at least one-third, leaving the yearly cost of the gas cooker at £3. Of course a smaller amount of coal will also be required; but the fire must be kept burning, and therefore not a fourth less coal will be used. Allowing, however, this proportion, a deduction from the £7 16 s. 3 d. of £1 19 s. must be made, which leaves as the cost of the coal fire £5 17 s. 3 d., and gives a balance in favor of gas cooking of £2 17 s. 3 d. per year. That the above results are based on figures which may be relied on as above the possible cost will be acknowledged when it is stated that, in one case which has recently come to the writer's knowledge, where a gas cooker had been employed for some 14 months, and had during this period cooked the whole food for a family of six or seven people (besides visitors), the total gas consumed was 15,000 feet, at a cost of £1 17 s. 6 d., or about 1 d. per day. For the same cooking by coal not less than 4 d. per day would have been required; and a saving was thus effected of £5 12 s. 6 d. for the period of 14 months. The actual coal bills of the family had been reduced to an even greater extent; but, accepting the above figures, the balance is on the side of the gas.

Further considerations may also be urged in favor of gas over coal for cooking. Not the least of these is the absolute cleanliness of the fuel. No dust is thrown into the air of the room, to be washed or dusted off; no ashes are left to be removed. Time is thus actually saved, and the labor conserved for other purposes. This last item is one of no inconsiderable importance; for, in a large establishment, service is required to carry coal and remove ashes first from the rooms, and then to the street or ashpit. Taking the sum of £7 16 s. 3 d., which we found to be the money value of the coal necessary for an ordinary family's cooking, and dividing it by the cost per ton—viz., 16 s.—we get 9¼ as the figure which

represents the number of tons of coal obtainable for the money. Now, these $9\frac{1}{4}$ tons of coal require to be carried to the kitchen; and a small computation of the time necessary for this work will be some five minutes' daily labor, or a yearly period of $31\frac{1}{4}$ hours, or some three working days' labor. The ash left will amount to an average of (say) 5 per cent. of the coal—in other words, about $\frac{1}{2}$ ton per annum; and allowing for the time occupied in cleaning, and in removing the refuse, not less than ten minutes per day will be required, or other six working days per year. The total saving of labor alone by the use of gas for cooking will thus be equal to nine days' work per year. Further, in lighting up the ordinary coal fire in the morning, paper and sticks are necessary, as well as labor. The sticks alone will be equal to 2d. per week, and the labor to at least five minutes per day. The saving in sticks will amount to 8s. 6d. per year—a sum sufficient to keep the gas cooker working for a month; while the labor saved is again equal to three working days. Let us tabulate these statements:

	Gas Cooker.	Coal Range.
Cost of fuel.....	£4 11 3	£7 16 3
Cost of sticks.....	none	0 8 6
Total.....	£4 11 3	£8 4 9
Time employed—		
In carrying coals (say).....	3 working days.	
In removing ashes and cleaning ash receptacle	6 “ “	
In lighting fires.....	3 “ “	

Saving in time by employing gas..... 12 working days per year.

The figures speak for themselves, and show that we may confidently expect, by the use of gas, to save in cooking operations some £4 per annum, and labor equivalent to twelve days per year.

Let us come now to the first cost of the stoves and ranges. An ordinary good kitchen range will cost about £12; and the building in and fitting up will amount to (say) £1 more. A better class of apparatus may be valued at from £20 to £30. Gas cookers of a size sufficient to do work similar to these ranges may be had for £6 15s., and do not require building in. The gas companies will generally carry their own gas connections to the stove and supply meters. There are, therefore, no extras; and the saving on this head alone will be equal to nearly £7—a not inconsiderable economy in the furnishing of a house. Nearly all the gas companies now have gas cookers for hire, and these they supply to their customers at rents varying from 10s. to 20s. per year; the companies at the same time keeping the stoves in repair.

The question is frequently asked: “Is it not the case that gas-cooked meat tastes of the gas?” This is impossible, provided that even ordinary care is taken to insure complete combustion of the fuel. Let us inquire what burns, and what products are obtained therefrom. In my previous article I stated that ordinary coal gas consists of the following bodies: Hydrogen, carbonic oxide, ethylene and other hydrocarbons, marsh gas, and nitrogen. The proportions are given below:

Composition of Coal Gas.

	From Cannel Coal (Bunsen and Roscoe.)	From Ordinary Coal. (Frankland.)
Hydrogen.....	45.58	35.94
Marsh gas.....	34.90	41.99
Carbonic oxide.....	6.64	10.07
Olefiant gas, etc.....	6.46	10.81
Nitrogen.....	2.46	—
Carbonic anhydride..	3.67	1.19

Of these substances only the nitrogen and the carbonic anhydride are not combustible. The gas, on burning, combines with the oxygen of the air, and the process of combustion is simply one of oxidation, or the combining of oxygen with the various elementary bodies present in the gases. The hydrogen burns into water vapor. The marsh gas consists of carbon and hydrogen (CH_4), and, on burning, yields carbonic anhydride and water vapor. The olefiant gas also contains carbon and hydrogen (C_2H_4), and gives off carbonic anhydride and water vapor. The carbonic oxide gives only carbonic anhydride. The nitrogen is an inert body. Carbonic anhydride is not absorbed by the meat in the hot condition, and the water vapor is harmless. Let us now look for a moment to what coal contains:

Chemical Composition of Coal.

	Per cent.	Per cent.
Carbon.....	79.68	81.19
Hydrogen.....	5.96	6.34
Oxygen.....	7.63	6.48
Nitrogen.....	1.21	1.34
Sulphur.....	0.33	0.27
Ash.....	1.57	1.21
Moisture.....	3.62	3.17

Coal, therefore, contains the very same bodies as gas; in fact, gas is simply the purified essence of coal, and is really a purer fuel, as it contains practically no sulphur. In burning, the coal has its carbon oxidized into carbonic anhydride, and the hydrogen passes into water vapor. The products, therefore, of the coal fire and the gas flame are the very same, viz., carbonic anhydride and water vapor. If gas is supposed to taint food in the cooking, why does coal not do so? The fact is that, so long as either coal or gas is properly consumed, neither substance can damage or render unwholesome the food placed over it. Burn the coal improperly, or employ too great a heat, and the result will be the production of noxious ingredients; and a similar result will be obtained with gas.

But while the products of the combustion of the gas cannot exert any influence on the quality of the meat, the waste products should not be allowed to escape into the atmosphere of the room. In working with an ordinary coal fire, the soot compels us to conduct our cooking under a chimney; and thus it frequently happens that people fancy it is only the deposited carbon which is objectionable. Were this the case, the substitution of anthracite or coke (neither of which gives a smoky flame) would enable us to do away with the vent; but it is well known that even in such cases a chimney is necessary. This necessity arises from the fact that carbonic anhydride (or, as it is commonly

called, carbonic acid) is a very poisonous body. Frequently accidents have taken place, due entirely to want of care in the removal of the carbonic anhydride formed by combustion. It will thus be readily understood why it is necessary, and why in all cases it should be insisted upon, that a perfect system of ventilation be carried out in all rooms; and when coal or gas is burnt in the room, the necessity is even more urgent, for a greater quantity of the noxious ingredient is thrown into the atmosphere. By no known practical means can the products of combustion from a gas or coal stove be removed and rendered so innocuous as to be thrown into the air of a closed space without danger to the inhabitants. Sometimes it is urged that no greater danger can accrue from the products of the combustion of a gas stove than from the same ingredients produced at our common gas-burners. Now, in the first place, a common burner will rarely consume more than 3 cubic feet of gas per hour, or (say) 10 cubic feet per hour for three jets, while, in our gas cooker, we are burning from 40 to 50 cubic feet of gas per hour; so we are passing into the air as much carbonic acid every hour as we should form in a 3 jet luster in five or six hours, and as much as if we had from 40 to 50 adult persons in the room. In the second place, “two blacks do not make one white,” and while we may err in burning our lighting gas as we do, this is no reason why we are to continue in fault with our cooking appliances. In a word, then, every cooker should communicate with the outside air, either directly, by passing the flue through the wall, or into a chimney. In most gas cooking-ranges, flues can only be attached to the ovens, and thus only half of the spent gases are carried off. By the very simple arrangement of adjusting a hood over the upper boiling-rings, the fumes of the burnt gas and the odor of cooking can be removed into the chimney. This is a point to which stove makers have not given sufficient attention. One very easy method is to stand the gas cooker in the fireplace, leaving the chimney perfectly open. In most cases where this arrangement is carried out, no flues whatever need to be attached to the range; but should the chimney not draw well, then a few feet of stove-pipe (say 6 feet) can be fixed to the cooker, and passed up the chimney. No iron plate is necessary over the stove, and none should be allowed, as such only stops ventilation by the chimney.

The quantity of the gas supplied in our towns and cities varies greatly; and the question is naturally asked whether all these gases have a similar heat-producing power—whether the 25 to 30 candle power gas from canal coal is as good as the 15 to 20 candle power gas obtained from a mixture of soft and canal coal; and, if as good, what amount of heat can one obtain for a certain sum of money or from a given quantity of gas. The substances to be considered in answering these questions are the combustible bodies only; in other words, the hydrogen, marsh gas, olefiant gas, and carbonic oxide. The proportion of heat produced during the combustion of these substances varies much. In calorific power, hydrogen stands first. This is followed by the marsh gas and olefiant gas; the carbonic oxide giving only a very small proportion of actual heat. The following table gives the units of heat obtainable by the combustion of 1 gramme (15.43255 grains) weight of each of the gases named:

Heat of Combustion.

1 gramme of hydrogen.....	= 33,808 thermal units.
“ marsh gas.....	= 13,108 “
“ carbonic oxide.....	= 2,431 “
“ olefiant gas.....	= 11,942 “

In other words, we find that hydrogen gives during combustion $2\frac{1}{2}$ times more heat than marsh gas, nearly 3 times ($2\frac{3}{4}$) that of olefiant gas, and almost 14 times that obtainable from carbonic oxide. Marsh gas is rather more useful than olefiant gas, and $5\frac{1}{2}$ times better than carbonic oxide; and olefiant gas is better for heating purposes than the carbonic oxide in the proportion of 1 to 5. Where 1 part of hydrogen might be employed, the same heat could be obtained from $2\frac{1}{2}$ parts of marsh gas, 3 parts of olefiant gas, or 14 parts of carbonic oxide.

The composition of gases obtained from canal and ordinary coal has been already noted. The figures given in that table are percentages by volume; and before we can calculate the amount of heat obtainable we must convert them into percentages by weight. The following table is so calculated:

Gas from Canal Coal.

	Percentage Composition by Volume.	Weight of Substance in Grammes.	Thermal Units obtained on Complete Combustion of 100 parts of Gas by Volume.
Hydrogen.....	45.58	= 4.073	= 137,699.984
Marsh gas.....	34.90	= 24.944	= 326,965.952
Carbonic oxide.....	6.64	= 8.302	= 20,182.162
Olefiant gas.....	6.46	= 8.078	= 96,467.479
Nitrogen.....	2.46		
Carbonic anhy- dride.....	3.67		

Total thermal value of 100 volumes of
gas..... 581,315.574

Gas from Ordinary Coal.

	Percentage Composition by Volume.	Weight of Substance in Grammes.	Thermal Units obtained on Complete Combustion of 100 parts of Gas by Volume.
Hydrogen.....	50.05	= 4.472	= 151,189.376
Marsh gas.....	32.87	= 23.496	= 307,985.568
Carbonic oxide.....	12.89	= 16.114	= 39,173.134
Olefiant gas.....	3.87	= 4.844	= 57,847.048
Nitrogen.....			
Carbonic anhy- dride.....	0.32		

Total thermal value of 100 volumes of
gas..... 556,095.126

It would thus appear that no great difference exists, so far as calorific power is concerned, between a gas of low and one of high lighting power. This is no new point; for it has frequently been suggested that gas companies should manufacture two gases—one from canal coal for lighting and the other from common coal for heating and motive power. Such, however, must entail enormous expense; as, in most cases, it

would be equivalent to the building of entirely new gas-works, and in all cases the laying of miles of pipes. Moreover, all houses in which gas for heating purposes was employed would require to be furnished with two sets of pipes; and, therefore, it becomes most doubtful whether any saving would be effected. It comes to be a question whether gas companies should not allow a considerable percentage off the cost of gas used for cooking purposes. In the statistical report on the Gas Supply of Scotland, published by the Committee of the North British Association of Gas Managers, it is stated that in Easter Buckie—a small village of 2,500 inhabitants, where the total annual make of gas is only 1,600,000 cubic feet—the cost of gas for heaters and cookers is 3s. 9d. per 1,000, while for ordinary lighting purposes the charge is 7s. 6d. per 1,000 cubic feet. So far as stated in this report, Easter Buckie stands alone in respect to heating and cooking; but the point is one well worthy the attention of gas companies.

From the figures previously given, it will be easy to estimate the cost at which gas ceases to be cheaper than coal for cooking purposes. Taking coal at 16s. per ton, and gas at 2s. 6d. per 1,000 cubic feet, a balance was found in favor of gas equal to fully 50 per cent.; in other words, gas cost only one-half what coal would have done. It therefore stands to reason that, in all places where the price of coal does not exceed 16s. per ton, the gas supply should not cost 5s. per 1,000 cubic feet to effect a saving by its use. Even at this price the only points in favor of the consumer will be the cleanliness and ease of working—points which are, however, by no means to be disregarded.—*Journal of Gas Lighting.*

LACTIC ACID IN THE STOMACH.

BEFORE the Physiological Society, Berlin, Prof. Ewald recently spoke on the occurrence of lactic acid in human gastric juices, which was now universally regarded as a pathological formation, *i. e.*, a product of fermenting processes which did not obtain under normal conditions. In conformity with this opinion he had, in a former investigation, clearly demonstrated the absence of lactic acid, even after milk had been partaken. On the other hand, he had regularly found hydrochloric acid in the gastric juice. Two cases of hysteric vomiting, which had come under his observation in the infirmary, induced him to resume this investigation, one of the cases especially inviting such inquiry. The female patient was able to retain on her stomach and normally digest solid food, but whenever she swallowed anything fluid the whole contents of the stomach were at once vomited. Opportunity was, therefore, here offered at any time to examine the contents of the stomach after food had been received. Prof. Ewald mentioned the different chemical reactions by means of which the presence of lactic acid might be easily detected in the gastric juice, and among them he deemed carbonic acid and chloride of iron the most trustworthy. He then described the experiments he had carried out on the female patient above referred to, which had yielded the following results: After a mixed meal (of bread, vegetables, and meat), lactic acid was found 26 times out of 31 in the contents of the stomach in the space of 10 to 100 minutes after the reception of the food; in 5 cases, however, not till 120 minutes or more after that point of time. Hydrochloric acid was found in the contents of the stomach only in the second hour and later, after the lactic acid had disappeared. Out of 26 cases in which white bread was alone eaten, lactic acid was demonstrated in 17 cases, occurring in 10 to 100 minutes from the time of eating. Out of 15 cases in which cooked albumen was administered, lactic acid was found only in one case, within one and a half hours from the time of its being taken; while, on “schabefleisch” (scraped raw meat) being administered, lactic acid became again demonstrable; in the majority of cases in 10 to 100 minutes' time. From these experiments it was to be inferred that lactic acid occurred normally in the contents of the stomach, namely, in the first period of digestion. It was, however, in the opinion of Prof. Ewald, no normal constituent of the gastric juice, but in the case of a mixed and meat diet originated in the carno-lactic acid obtained from the meat, and, in the case of white bread being taken, from the fermentation of the starch. On albumen being taken, lactic acid was, therefore, not found, because it occurred in the stomach only when it was introduced with the food—in the case of meat, for example—or when it arose from a fermentive aliment. With reference to the ulterior issues of the lactic acid, the speaker adopted the view of Prof. Maly, that it was employed toward the formation of the free hydrochloric acid afterward appearing in the gastric juice.

ON A VARIATION IN THE SIZE OF AN IMAGE ON THE RETINA ACCORDING TO THE DISTANCE OF THE BACKGROUND ON WHICH IT IS SEEN.

By ALFRED BROTHERS, F.R.A.S.

THE effect on the retina when the eyes have been fixed intently for a few seconds on a brightly illuminated colored object is well known; the color complementary to the one looked at always appears when the gaze is removed to a colorless surface. It is also a matter of common observation that when the eyes have been directed to a bright light for a short time, the image left on the retina as seen when the eyes are averted is dark; but if the eyes are rapidly opened and closed, the image is still seen bright. I am not aware, however, that it has ever been noticed that this image varies in size according to the distance of the background to which the eyes are directed. A circle of gas jets, perhaps, affords the simplest test. It will be seen, after looking at the circle of light for a few seconds (in some cases a more or less lengthened gaze at the light is necessary, owing to the varying sensitiveness of the retina), that if the vision be turned to a distant background the size of the image is instantly enlarged, and then, if the eyes be directed to a near background, the image is reduced in size. If any difficulty should be found in seeing the reversed image of the gas jets, it may readily be seen as a bright object by rapidly closing and opening the eyelids. The effect is the same as if the image were seen through a cone, the apex of the cone being held close to the eyes. In other words, the effect is the reverse of the ordinary rules of perspective.