THE SMOKELESS CITY

BY

E. D. SIMON

AND

MARION FITZGERALD

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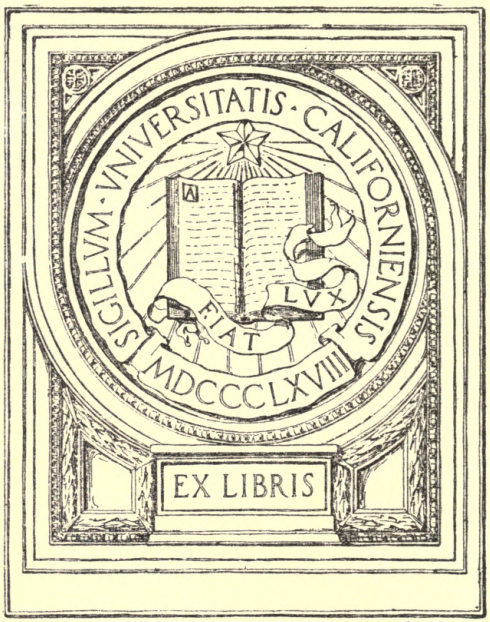
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This photograph, taken in Manchester on June 23rd, 1922, shows how large a part the house chimney plays in polluting the atmosphere, even in summer time.

THE SMOKELESS CITY

BY

E. D. SIMON

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MEMBER OF THE DEPARTMENTAL COMMITTEE ON SMOKE ABATEMENT,

AND

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WITH A PREFACE

BY

LORD NEWTON

CHAIRMAN OF THE DEPARTMENTAL COMMITTEE ON SMOKE ABATEMENT

WITH FRONTISPIECE

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PREFACE.

THOSE persons, who have paid any attention to the subject of smoke and air pollution, and, considering the many millions of human beings affected, they are remarkably few in number, are aware that, roughly speaking, there are two kinds of smoke—industrial and domestic. The efforts of reformers in the past have been directed almost entirely against the former, and the public spirited work carried on for many years by various Coal Smoke Abatement Leagues in the face of active obstruction and of official apathy, seem to be within measurable distance of success, since the present Minister of Health has recently undertaken to bring in a Bill embodying the recommendations of the Departmental Committee on Smoke and Noxious Vapours Abatement.

The battle therefore against industrial smoke may be said to have been won in principle ; but it is scarcely necessary to warn enthusiasts that there are many parliamentary dangers to overcome, and that governments are not as a rule particularly zealous in forcing through bills of a non-vote-catching nature. Even if we can assume that a thoroughly satisfactory measure is passed and duly enforced, the melancholy fact remains that, if we are fortunate enough to get rid of industrial smoke, we shall, nevertheless, remain dirtier than other European countries owing to domestic smoke.

The relative share of industrial smoke and domestic smoke in polluting our atmosphere has been hotly disputed, and the conclusions arrived at in this book will doubtless arouse much opposition. But in any case there can be no question as to the competence of the writers. Miss FitzGerald, who has had valuable experience in public health work, is a well known

authority on questions connected with heating and cooking in working class houses. Mr. Simon, Lord Mayor of Manchester at the present moment, has for some years been one of the prominent figures in the smoke abatement campaign. He is honourably distinguished for the many services which he has rendered to his native city; he is Chairman of the Housing Committee and also of the Air Pollution Advisory Board; and enjoys the practical advantage of being an engineer possessing works of his own. In view of the knowledge and experience of these writers, it would be idle to dismiss their case against coal fires and kitchen ranges as unfounded, and it might be added that no more appropriate town could be selected for investigation than Manchester, where it has been calculated that the necessary extra washing of collars alone costs £50,000 at pre-war prices, and that the damage due to smoke amounts to over one million pounds annually.

The fact that the authors have so frequently used Manchester statistics to illustrate their arguments might be taken as indicating that Manchester is worse as regards air pollution than other great cities. The reverse is nearer the truth; it is because not only smoke reformers, but also the municipality, through several of its committees, have been particularly active in Manchester, that the facts concerning smoke abatement are better known for that city than for any other.

Leaving aside, for the moment, the question of industrial smoke, it is a remarkable and deplorable fact that the very Ministry which was established to protect the health of the people has hitherto completely ignored the damage, waste, and discomfort caused by domestic smoke. A striking instance of this indifference was furnished in 1920, when the Committee to which reference has already been made was requested by the Ministry of Health to issue an interim report which might be of assistance to the various local authorities in connection with their housing schemes. An interim

report was accordingly drawn up, containing recommendations with reference to the heating of the new houses, and one special recommendation was to the effect that no building scheme should be sanctioned unless provision was made for the adoption of smokeless methods, except in cases where the central authorities were satisfied that it was impracticable. Strange to say, the Ministry of Health did not even go to the trouble of sending the report to the local building authorities until remonstrated with in Parliament, and the natural result was that plans were passed all over the country perpetuating all the old objectionable features, whilst a magnificent opportunity for improvement was lost. Fortunately some municipalities and public utility societies have been wise enough to act in spite of this disheartening official apathy.

It would be impossible for any unprejudiced person to read the lucid and convincing statement of Miss FitzGerald and Mr. Simon without realising the strength of the case against the open coal fire and the old fashioned kitchen range. Hitherto all criticisms of our present system have been met by indignant expostulations that the open fire is one of the sources of England's greatness and prosperity, and that any attack upon it is in the nature of high treason. But it must eventually dawn upon people, if in fact it has not already occurred to them, that whatever legislation may be passed with regard to industrial smoke, so long as raw coal is continually consumed for all domestic purposes, our atmosphere will remain polluted to a degree unknown in other European countries. The truth is that, looking at it from the view of cleanliness, cheap coal has been little short of a curse. It has in the past been so abundant and so cheap that there was no object in economising its use, and consequently it has been employed indiscriminately for all domestic purposes. We are now beginning tardily to recognise the waste, dirt and trouble involved; strikes have taught us that there

need be no apprehension of cheapness in the future, and we are also beginning slowly to realise, for instance, that the process of hauling coals up to the fourth or fifth floor has its disadvantages. No one in his senses would propose that the householder should be forthwith compelled by law to substitute some other form of heating for his existing open coal fire, but a study of this book will show how a compromise can be arrived at, and local authorities would be well advised to pay attention to the valuable and practical suggestions which it contains.

The deplorable atmospheric conditions under which a large proportion of the British race lives can only be appreciated fully by those who have had the opportunity of comparing them with those prevailing in other countries. It is no exaggeration to say that many millions of inhabitants of the north of England have never seen real sunlight in their places of residence except in the event of a bank holiday or of a coal strike, and most of them have become so inured to this deprivation that they are profoundly sceptical as to any possible remedy. There are, too, a large number who entertain the conviction, naturally encouraged by certain manufacturers, that dirt and wealth are synonymous, and that consequently any attempt to abate smoke must be disastrous to industry. It is a pity that persons holding these views should not have the opportunity of seeing what can be effected in other countries. Last autumn, Mr. Simon and I, representing the Smoke Abatement Committee, visited part of the Rhine industrial district, where the conditions largely resemble those of South Lancashire. The conclusions we arrived at will be found in an appendix to the Report of the Committee, and are not flattering to our national pride. Obviously one of the main factors which contribute to the superiority of German over English conditions is the almost complete absence of domestic smoke in Germany, and it is painful to an Englishman to compare

cities like Cologne and Düsseldorf with corresponding industrial towns such as Manchester and Leeds. One simple fact illustrates the difference. A manufacturer in Cologne or Düsseldorf is content to reside in the town, because the town is an agreeable place of residence. But a manufacturer in Manchester or Leeds hastens to remove his residence to as great a distance as is compatible with his business, as soon as he can afford to do so. Is it surprising in view of the evidence contained in this book ?

It would be difficult, as has been already pointed out, to over-estimate the value of the work of Smoke Abatement Societies, both in London and in the provinces, in endeavouring to educate the public. For years they have struggled against official and unofficial apathy and have at last succeeded in inducing a Government to introduce legislation. To Sir Alfred Mond belongs the credit of being the first Minister to act, but if the truth must be told, he is only doing his obvious duty. What is the use of creating a Ministry of Health unless it occupies itself with a nuisance which closely affects the daily life of many millions of British citizens ? Where is the logic of spending millions of pounds on so-called social reform if this particular nuisance, expensive, unnecessary, and offensive, is to be permitted to continue unchecked ? The only answer to these queries is that very little thought has been given to the matter, and that we are only just awakening to the fact that the conditions described in this book are discreditable to a highly civilized community.

NEWTON.

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CHAPTER I.

INTRODUCTION.

THE smoke abater is almost universally regarded as an amiable and unpractical faddist; and when one considers the long and sterile history of the movement, and the methods generally pursued by the smoke abatement enthusiast in the past, one cannot deny that the indictment has at least some justification.

The nuisance of coal smoke was complained of and legislated against as early as the time of Edward I., who firmly believed that smoke affected his health. He issued proclamations forbidding the use of coal while Parliament was sitting, and it is related that a man was actually hanged in the 14th century for causing a smoke nuisance! That even this somewhat drastic penalty was not completely effective as a deterrent is proved by constant references to the evils of coal smoke during the intervening centuries. In 1661 Evelyn wrote in his Diary of "that hellish and dismal cloud of sea-coal which is perpetually over this august and opulent city of London."

A century and a half later, Henry Luttrell, a well-known wit, wrote a society epic called "Advice to Julia" in the course of which, after describing a London fog, he made an appeal to the Science of Chemistry to

> "Make all our chimneys chew the cud
> Like hungry cows, as chimneys should."

From which it appears that literary men, at any rate, made their protest against the smoke evil.

During the last century the problem has become steadily more acute through the enormously increased consumption of coal, and the concentration of factories and dwelling houses in great cities. Parliament has appointed committee after committee to inquire into

it, and has with great consistency paid no attention to their reports, except to pigeon-hole them. The only national legislation has been in the Public Health Act of 1875.

The increase of smoke has been gradual, and as it has corresponded with the spread of the factory system and with industrial prosperity, it has been looked upon with a too tolerant eye. The chimney belching forth black smoke is, even to-day, sometimes regarded as a cheering proof of prosperity. Complaints of the smoke nuisance have been continuous, but the methods advocated for combating it have left much to be desired. The smoke abater has generally relied on passionate appeals to clean up the atmosphere of our grimy towns, without any indication as to how it should be done; and on the prosecution of manufacturers who make smoke, again without showing them how it can be prevented. There are books by keen reformers who, with boundless enthusiasm and a complete lack of technical knowledge, do not hesitate to explain to manufacturers and engineers that smoke from a factory chimney always means waste and inefficiency and always proves that the manager of the factory in question is no less a fool to incur such waste than a knave to inflict such damage on his neighbours.

This is, of course, sheer nonsense. While it is true under normal conditions that anything more than quite light smoke from an ordinary boiler furnace is unnecessary and should be prevented, yet every competent person who has given any serious consideration to the problem knows perfectly well that there are special processes in which the prevention of factory smoke may prove an exceedingly difficult and costly matter for the manufacturer.

During the past 30 years, smoke abatement societies have arisen in this country in large numbers. They have rarely survived more than a few years. They failed in their earlier days to recognise the complexity and the

difficulty of the problem, and have thought that it could be dealt with by enthusiastic propaganda, combined with larger fines and more active prosecution of manufacturers. As they gained experience, they began to appreciate the hopelessness of the problem when tackled along these lines, the members gradually lost interest, and after a time the society died, to be succeeded in a few years by another one which duly went through the same cycle.

From the same cause has arisen the apathy, not only of the public, but of the business world, of engineers and scientists, of local authorities, and of the government, in face of this great and urgent question of the cleansing of our atmosphere. The average practical man appreciates that the kind of talk which we have quoted above will lead nowhere, and as he hears no other suggestions regarding smoke abatement, he simply loses interest in the whole subject and writes it off as a fad.

New Methods.

The time has come for entirely new methods. The difficulty and complexity of the problem must be recognised. Promiscuous prosecution and ignorant propaganda must be replaced by research, by scientific method, by helpful technical advice, and by education both of the manufacturer and of the public. The increased price of coal will help. Coal has been so cheap that it has been wasted to an astounding extent. The higher level of post war prices will force manufacturers and others to take more pains, and so, out of self interest, to help forward the great twin causes of fuel economy and smoke abatement.

Hitherto the efforts of reformers have been directed almost entirely against factory smoke. The first step on the road to success is to realise that the house chimney is a much more dangerous enemy than the factory chimney, both because domestic smoke is far greater in quantity and far more harmful in quality than factory smoke, and because factory smoke is already rapidly

decreasing, and will almost certainly be immensely reduced in the next 10 or 20 years.

Factory Smoke.

Although this book deals mainly with smoke from the domestic chimney, it is perhaps desirable, in view of the still prevalent idea that the smoke nuisance means only factory smoke, to explain shortly the reasons for regarding this side of the problem as relatively unimportant in most areas, though, of course, still a serious and urgent question in our great industrial centres.

We give in Chapter II. very strong reasons for the belief that, taking the country as a whole, factory smoke is responsible for less than one quarter of the damage done by smoke What is even more important is that factory smoke is steadily—though none too rapidly—decreasing, owing to the growing use of electricity and gas. Hundreds of small and smoky factory furnaces are being closed down in order to get a cheaper and more reliable supply of power from electric power stations, which being large, efficient plants, produce much less smoke than the chimneys they replace.

This closing down of individual manufacturers' plants will certainly be accelerated by the new movement in the electrical world, the building of great super-stations and the inter-connection of all plants in each industrial area. Experts assure us that this will mean a big reduction in the price of electricity.

The use of gas for power has led to the abolition of many steam engines, and its application to industrial purposes is extending rapidly, especially in connection with many metallurgical and other processes where black smoke has hitherto been considered unavoidable. The difficulty is often completely overcome by the use of gas. It seems likely that in the gas industry, as in the electrical industry, super-stations will be built in some areas close to the coal fields, probably in the

form of coke ovens, and as far as 10 to 20 miles away from the town where the gas is to be used. This would remove the nuisance of the gas-works from the city, and would, it is hoped, substantially reduce the price of gas.

Notwithstanding the increased use of gas and electricity, there will always remain a number of factory chimneys, for heating the works and other special purposes. A better organisation is needed to ensure that manufacturers use the best available smokeless methods: to advise them what to do, and in case of necessity to prosecute. But as the experience of the inspectors of chemical works under the Alkali Acts shows, given skilled inspection and advice by high class experts in whom the manufacturers have confidence, prosecution becomes almost unnecessary. After all, the average manufacturer is a reasonable being, and takes no pleasure whatever in creating a nuisance in his own works.

The Departmental Committee on smoke abatement has made recommendations on these points which are very clearly summarised as follows by Sir Frederick Willis, whose long administrative experience at the Local Government Board, and the Ministry of Health, gives great weight to his views :—

"As to the legislation recommended by the Departmental Committee the position, as I look at it, is this. The Public Health Act of 1875 absolutely prohibits the sending of black smoke into the atmosphere in such quantity as to be a nuisance. Two defects exist, I think, in the present law: (1) the absolute prohibition which, if it were actually enforced, would destroy much of the trade of this country; and (2) the fact that the administration of this important law has been placed in the hands of all the 1,800 big and little sanitary authorities of this country.

"The law we propose is that everybody should do everything practicable to reduce smoke from manu-

facturing chimneys. We propose that this law shall be administered by the great authorities of this country, viz., county councils and county borough councils. I quite agree that you do not want in every case to put on the prosecutors the onus of showing that the manufacturer is not doing what is practicable. For that reason we have recommended presumptive standards, infringement of which will constitute a *prima facie* case that the manufacturer has committed an offence; if the manufacturer is doing worse than the standard he will have to prove that he could not do better.

"In practice I believe a law in this form, with the presumptive standard fixed by the Minister of Health, will be a simple law to enforce. For example, the Mersey and Irwell Rivers Board are entitled to prosecute a local authority which is not purifying its sewage as far as practicable. The Board have themselves framed a provisional standard and take action whenever the effluent is worse than that. I am not aware of any case in which a local authority has endeavoured to show that it was not practicable to purify up to that standard. It seems to me that a law in this new form, placed in the hands of the new authorities, is likely to be of much greater value and much more effective than the present absolute prohibition, which cannot be observed."

These recommendations, if embodied in a wisely-drafted bill, should meet with little or no opposition, and if put into force would do a great deal to improve matters. It is to be hoped that the Ministry of Health, instead of pigeon-holing the report in the time-honoured way, will at once bring in and push through a government bill.

There is every indication that the gas and electricity industries are entering on a period of vigorous development, both technical and commercial. It seems not unreasonable to forecast that factory smoke will rapidly diminish, and may cease to be a question of urgent national importance in the next 20 years.

The Domestic Chimney.

The problem with which we propose to deal in this book is that of domestic smoke, which is far worse and in some respects more difficult to deal with than factory smoke.

We shall have in mind throughout the workman's cottage and the small middle-class house, which together make up the majority of dwellings in any community. There is to-day a grave shortage of such houses, and it is necessary that many hundred thousands shall be built in the near future. Are they to be built in the bad old way, with smoky extravagant coal ranges and coal fires, to contribute further to making our cities uninhabitably filthy; or can the builders be induced to take advantage of modern knowledge, and to use clean, efficient and convenient methods of heating?

The first thing that strikes anybody who investigates the domestic smoke abatement problem is the extraordinary lack of knowledge as to the efficiency of the various kinds of apparatus. The worst example is that of the coal fire.

There are tens of millions of open coal fires in Great Britain, and yet, it is literally true to say that up to three or four years ago nobody had ever taken the trouble to make any sort of scientific investigation into the factors upon which their efficiency depends. No less an authority than Sir Dugald Clerk stated in the *Gas Journal* for November 4th, 1919, that "in coal fires as ordinarily used only 8 per cent. of the heat of combustion of the coal is utilised in the room." The Manchester experiments have now proved that the correct figure (under test conditions) is from 20 per cent. to 25 per cent.[1] It is clear that any attempt to advise

[1] See *The Coal Fire*. A Research by Margaret White Fishenden, D.Sc., for the Manchester Corporation Air Pollution Advisory Board, published in 1920 by H.M. Stationery Office for the Department of Scientific and Industrial Research.

We are indebted to Dr. Fishenden and also to Mr. A. H. Barker, author of *Domestic Fuel Consumption*, for much information on the subject of domestic heating.

on the use of different types of apparatus in given conditions must be utterly futile until accurate data are available for all types.

Why have such apparently inexcusable conditions been allowed to continue ? The explanation is probably that it is to nobody's interest to undertake research into smoke abatement and domestic fuel economy except the public's. In most industries progress is vital to the manufacturer, and out of self-interest he carries on the necessary research. But in domestic heating, regarded as a whole, this does not apply.

What are the motives of the purchaser of a kitchen range or coal fire ? It must be remembered that we are dealing with the small house, built almost invariably by the speculative builder. He cannot get a higher price or rent for the house if the heating apparatus is more efficient. In practice the purchaser or tenant rarely asks about it, being quite as ignorant as to what is an efficient apparatus as is the landlord himself. The builder therefore buys the cheapest decent looking grate, and relies on the reputation of the maker to ensure that it will work. He never dreams of asking how much coal it will burn or how much smoke it will make. The inevitable result is that the maker cares nothing for these points, and is often as ignorant about them as the user.

Then again there are at least half a dozen different sets of manufacturers concerned in house heating : the makers of gas and electrical apparatus, of coal fires, of kitchen ranges, and of stoves, and central heating engineers. There is no way in which the public can find out the relative merits of apparatus used by the different classes of manufacturers, so there is little incentive to any of them to improve or cheapen their own productions. It is only in the gas industry that really effective research has been carried out, and great steps have been taken in improving the efficiency, ventilating power, and amenity of the gas fire. The British Commercial Gas Association is also now carrying on a vigorous and

effective campaign to educate the public in the advantages of gas.

One extraordinary fact is our ignorance of foreign practice in heating houses. On the continent small houses have almost invariably a large slow combustion stove, which serves both for heating and cooking, and apparently does them both efficiently with very small fuel consumption. But neither the manufacturer of gas stoves nor of coal grates nor of any of the other apparatus used in this country considers it his business to know anything about so foreign an apparatus as the continental stove. While it can be asserted definitely that such stoves are much more efficient heaters than anything we have except central heating, yet it is not known whether they would be suitable for our purpose. Clearly it ought to be known.

If the public are to have reliable and impartial guidance on the general position of home heating, it must be directed by the representatives of the public, the government, or the local authorities. This has fortunately begun to be appreciated during the last few years, and a useful start has been made. The Government Fuel Research Board have realised the close connection between fuel economy and smoke abatement, and are in various ways helping forward the cause of atmospheric cleanliness. They are carrying out a most important investigation into the possibility of producing a smokeless solid fuel for domestic use, and they are giving grants in aid to at least three different researches closely connected with smoke abatement. The Manchester City Council has also set an excellent example by forming in 1912 the Air Pollution Advisory Board, and by giving the Board a grant up to £500 a year for the valuable research into domestic smoke abatement which has been carried on by Dr. Fishenden, at the Manchester College of Technology.

Government committees are notoriously inclined to report on cautious and non-committal lines, and to

be careful not to overstate their case. But anybody who spends some time in studying the smoke abatement question is so aghast at the folly and wastefulness of our methods, that Lord Newton's Departmental Committee were at times forced into the use of perhaps rather non-governmental language. They go so far as to talk of "the dirty, wasteful and unscientific habit of burning raw coal." Our endeavour in this book is to justify this statement and to show how cleaner, and more economical and scientific methods may be adopted.

CHAPTER II.

THE DAMAGE DONE BY SMOKE.

FEW people have any idea of the immense and varied damage done by smoke. What has been well called "The Black Smoke Tax" falls upon everybody living in our cities. The tax is levied on buildings, furniture, curtains, wall-paper, goods in shops and warehouses, trees and other vegetation, paint, and clothes, and above all on personal health and well being. The extent of the damage is not realised largely because it is so difficult to measure. It is only recently that any successful efforts have been made to arrive at a reliable cash value for some of the damage. An interesting report (reprinted in the appendix) works out the difference in the cost of the weekly wash in working-class houses in a clean and dirty town respectively. The conclusion, confirmed by a certificate from a leading firm of accountants, who state that the figures are on a very conservative basis, shows that the cost of household washing in Manchester would be reduced by about £250,000 a year if Manchester was as clean as Harrogate.

Again, we may estimate the extra cost of washing one single item of clothing: namely, collars. In Manchester a collar can hardly be worn more than one day; in really clean air it can easily be worn two or three days. The pre-war charge for washing a collar was one penny, so that assuming one extra collar to be needed every other day, the cost of living in Manchester in this item alone may be taken at ½d. per head per day. It is interesting to speculate as to what proportion of the population wears reasonably clean collars; but taking it as low as one in ten, the extra annual cost of

washing Manchester collars owing to the smoky atmosphere works out at well over £50,000 at pre-war prices.

Another interesting case where it has proved possible to get a pecuniary measure of the cost of smoke damage was given in evidence by Mr. A. G. Ruston before the Departmental Committee on Smoke Abatement in connection with the cost of milk production. In 1919 the Food Controller appointed a travelling commission of experts to advise on the cost of milk production. The farmers of the West Riding of Yorkshire made the following complaint :—

> " Milk producers in the West Riding of Yorkshire, particularly in the immediate vicinity of our manufacturing towns, experience a great difficulty in retaining cows in their herds for more than one year. When, as last year, newly calved milk cows have been fetching in an open market as much as £60 or £70 per head, and when, with a controlled price for beef, these same cows at the end of their lactation period, if sold fat, would only realise £35—£40, it will readily be seen that the man who had to replace the whole of the cows in his herd each year, stood to lose last year roughly £30 per head on his cows from this cause alone. That means that in the industrial area of the West Riding of Yorkshire, on account of that fact, the cost of producing milk is much greater than it is in other areas."

This evidence was accepted by the Commission and as a result of this report the Food Controller allowed an extra twopence per gallon for the farmers in the industrial area of the West Riding.

In this case it will be noted that the claim was allowed because the district was an industrial one. This might at the first glance seem to tend to disprove our contention that the greater part of the damage is due to domestic smoke. But it must be borne in mind that a factory area is always one where there are large numbers of people living and it is therefore just in factory areas

that domestic smoke is worst. For instance, Harrogate and Bath are clean towns, mainly because they are small. If Harrogate had a population of a million instead of 39,000, it would be a dirty, smoky town in spite of the absence of factory chimneys.

An elaborate investigation into the damage done by snoke was carried out in Pittsburg in 1912, by a committee of experts acting under the auspices of the University of Pittsburg. They concluded that the damage amounted annually to two million pounds sterling, or to £4 per head of the population per annum.

One of the authors estimated in 1910 that the annual damage due to smoke in Manchester amounted to at least one million pounds sterling per annum. This estimate has been freely quoted since, and has never been seriously questioned. Its reasonableness is supported by the facts that washing alone accounts for over a quarter of the total, and that the Pittsburg estimate amounts to more than three times as much per head of the population as the Manchester estimate.

But though the material damage done by smoke is enormous, the damage done to the health and nerves of human beings is far more serious. Consider the conditions under which the unfortunate town dweller's lungs have to work. Every day he breathes into his lungs some 40 pounds weight of air, many times the weight of what he eats, laden with soot, tar and acid. This air deposits dirt inside him, and his lungs, if examined after death, are found to have lost their natural pink hue and to be permeated with a black sooty deposit. No lungs can do their best under such conditions, and it is not surprising that the Medical Officers of Health of Glasgow and Manchester have found a marked rise in the death rate from respiratory diseases after periods of fog, when the soot and dirt in the air is most marked. This is strikingly illustrated by the curve shown in Fig. 1.

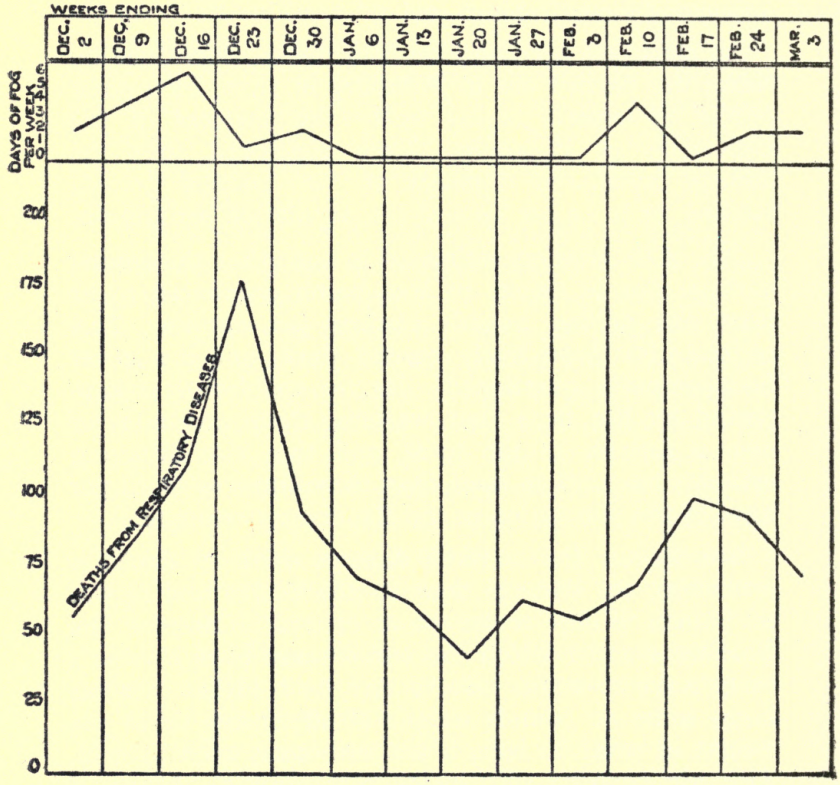

Fig 1.

Diagram prepared in the Manchester Public Health Department showing the rise in the death-rate from respiratory diseases

(*a*) In the fourth week of December, 1916, following on 6 days of fog in the previous week; and

(*b*) In the third week of February, 1917, following on 4 days of fog in the previous week.

The cutting off of sunlight is even more harmful. It is easy to measure the number of hours of " bright " sunshine ; these are reduced in Manchester about 20 per cent. by the smoky atmosphere. But the intensity of what is recorded as " bright sunshine " is seriously decreased by smoke. It is estimated that about half the effective sunshine is intercepted by smoke in the centre of Manchester.

Sunshine and Health.

There is an old Italian proverb which says that " all diseases come in the dark and are cured in the sun," and modern medical science has proved that sunlight is both a disinfectant and a healer. It takes four days to kill anthrax spores by means of carbolic acid and a day with a 5 per cent. solution of potassium permanganate, but sunlight will destroy them in 1½ hours. The germs of tuberculosis are rapidly killed by being exposed to the action of direct sunlight, but have been found to be still virulent after two months when kept in the dark. Those towns which have their sunlight diminished through smoke are deprived to a greater extent of a powerful, natural germicide, and in such places man's bacterial enemies have every opportunity to lead prolonged and mischievous lives.

That sunshine is also a healer is proved by the excellent results obtained by the sun-cures for tuberculosis and other diseases, which are carried out in the high altitudes of Switzerland and elsewhere. Dr. Bernard in St. Moritz and Dr. Rollier at Leysin have found that the sun, which kills germs, will disinfect all kinds of sores better than any chemical products and without harming cellular tissues. It has a great stimulating effect on the skin, helps to keep the muscles well-nourished and vivifies the blood by increasing the amount of hæmoglobin. If sunlight is so potent for healing it must also play an important part in maintaining the human body in health, and the loss of sunlight must mean a loss of

health. There is also this further consideration; a smoke-darkened atmosphere affects the spirits and energy of those who live and work under such conditions, and this again has an indirect bearing on health. To what extent it operates is difficult to measure and it depends largely on the personal factor; but that it makes life in winter drab, dreary and depressing for thousands of people is unquestioned. The winter gloom almost certainly also lowers the powers of resistance to infectious disease.

If we could only get it into people's heads that the material damage done by smoke in Manchester alone amounts to one million pounds sterling per annum and that the damage done to health and nerves is even greater than this—if the general public could be made really to believe these undisputed facts and to understand and grasp what they mean, the cause of smoke abatement would be won.

Proportion of Total Damage due to Domestic Smoke.

It has generally been assumed that the smoke nuisance was far more due to factory than to house chimneys. Not only is this incorrect, but it is the exact reverse of the truth. The fallacy has doubtless arisen because a single factory chimney pouring forth masses of smoke produces a much more striking and obvious effect than a hundred house chimneys. Nevertheless, taking the country as a whole, the domestic chimney is responsible for three-quarters of the smoke and more than three-quarters of the damage.

In the first place, owing to the fact that coal is burnt at a much lower temperature in a domestic grate than in a factory furnace, the particles that escape as soot are not so completely burnt. Factory soot consists of practically pure carbon and ash; domestic soot contains a large percentage of tar and acid. The former is accordingly hard and relatively harmless; the latter, owing to the tar, sticks to anything on which it lodges, and the

acid then attacks and eats away the surface. So that the damage done by soot to stone, fabrics, vegetation, etc., is far more due to domestic than to factory smoke.

The report of the Advisory Committee on Atmospheric Pollution for the year ending March, 1920, contains an interesting measurement of the average amount of air pollution in London throughout the 24 hours of the day. London is largely residential and might be described from a commercial point of view as a distributing rather than a manufacturing centre, though there are a good many industries carried on within its area. London, therefore, suffers from both domestic and industrial smoke. The curve of impurity arrived at by means of an automatic filter showed that there is a definite cycle in the distribution of the impurities throughout the 24 hours. Usually from about midnight to 6 a.m. the air is practically clear of impurity—very little being recorded except during the prevalence of fogs in winter. At about 6 a.m., when people light their fires, the impurity begins to increase in quantity and continues to do so until about 11 a.m. From 11 a.m. till about 10 p.m. the quantity varies very little from hour to hour, but about 10 p.m. it rapidly begins to diminish and has almost disappeared by midnight. This rapid decrease in the amount of impurity after 10 p.m. is very significant. It is not the time of the closing down of factories, which takes place, in these times of shortened hours of labour, about 6 p.m., but the time when house fires are dying down.

Sir Napier Shaw, head of the Meteorological Office, who has directed these investigations, points out in particular that the dirt on Sundays is about two-thirds of week-day dirt; and concludes that "domestic smoke is responsible for about two-thirds of the smoke problem."[1]

Another striking proof of the relative importance of factory and domestic smoke is due to facts provided by

[1] Letter to *Times*, April 5th, 1922.

Professor Cohen and Mr. A. G. Ruston. They have proved that when coal is burnt under average domestic conditions, no less than 6 per cent. of the total weight of the coal escapes from the top of the chimney in the form of soot, whereas from the average factory furnace only about 0·5 per cent. escapes. "Taking the average loss at 6 per cent. on the 32 million tons of coal used for domestic consumption, and 0·5 per cent on 100 million tons used for industrial purposes, we get :—

32,000,000 at 6 per cent. = 1,920,000
100,000,000 at 0·5 per cent. = 500,000

2,430,000 tons."[1]

So that on these figures very nearly four-fifths of the total pollution of the air is due to domestic smoke.

The recent report of the Departmental Committee on Smoke Abatement published Professor Cohen's and Mr. Ruston's figures ; and nothing in the report has been so freely criticised. Several reviewers state that they do not believe that the proportion of domestic smoke is anything like so great as four-fifths of the total —though none of them gives any reasons for his disbelief. It is all the more interesting that Sir Napier Shaw arrives at much the same result.[2] The fact that two such authorities, working on totally different lines, arrive at such concordant results, must convince the most sceptical.

Taking the mean of the two results, we may act on the assumption that three-fourths of the total atmospheric pollution is due to the house chimney. It is more difficult to divide the responsibility for actual damage

[1] *Smoke, a Study of Town Air.* 1912.

[2] It should be noted that Sir Napier Shaw's estimate refers to London, and Professor Cohen's to the whole country ; but London probably contains factories and houses in roughly the same proportion as the whole country, so that Sir Napier Shaw's estimate may, without serious error, be compared with Professor Cohen's.

between the two kinds of smoke. Domestic smoke is certainly much the more harmful when in contact with stone, plants or lungs on account of the tar and acid which it contains. As regards the cutting off of sunlight there is probably nothing to choose between the two. But there is one thing which increases the power for harm of factory smoke: its concentration. A chimney which pours forth vast masses of smoke for a few minutes may do immense harm to plant life. Many complaints of this kind were made by farmers before the Departmental Committee; but the worst cases were those of chimneys of chemical works, which sometimes produce far more deadly fumes than a coal-burning furnace and may completely destroy the harvest in several fields in one day.

The factory chimney tends to concentrate its damage over a smaller area and to that extent is more serious where it occurs; domestic smoke is diffused but far more harmful in quality.

The greatest individual sufferers are those who live near factory chimneys, and yet taking everything into consideration we must estimate that over the whole country domestic smoke is responsible for more than three-fourths of the total damage.

Summary.

The facts stated in this chapter are so striking that a short summary of the estimated damage due to smoke in Manchester may be useful:—

1. Extra cost of washing based on working-class expenditure .. £250,000
2. Extra cost of washing collars alone (at pre-war price) £50,000
3. Total material damage in Manchester £1,000,000
4. Damage to health and spirits even more serious but cannot be measured.
5. Over three-fourths of the total damage is due to domestic smoke.

CHAPTER III.

CRITICISM OF PRESENT METHODS OF OBTAINING HEAT IN DWELLING HOUSES.

HEAT in dwelling-houses is needed mainly for three different purposes :—

1. For warming the house ;
2. For cooking ;
3. For heating water.

The standard practice to-day is to obtain the heat for all purposes by burning raw coal, either in an open grate or a kitchen range. Indeed the kitchen range is designed to serve the three purposes simultaneously ; in addition to providing the heat necessary for cooking, it warms the room, and, by means of a back boiler, provides hot water.

It is held by chemists that to burn raw coal in this way is nothing less than a " method of barbarism." All sorts of valuable by-products are obtained by converting coal into the smokeless fuels, coke and gas : coal tar, the source of endless valuable dyes and medicines ; benzol, most useful as a motor spirit ; sulphate of ammonia, essential for our agriculture. All these by-products are worth many times more than their mere value as fuel, which is all they are worth when burnt as constituents of raw coal.

WASTE DUE TO BURNING RAW COAL.

What is more important is that the present methods are exceedingly wasteful as regards the quantity of fuel burnt. It is generally recognised now that our coal supplies are the very life blood of British industry, and that wasteful methods of using coal are little less than criminal. The strictest economy of fuel is essential

in the national interest. What is the position as regards household coal ?

The Royal Commission on Coal Supplies in its report issued in 1905 estimated that no less than half the coal burnt for household use might be saved if better methods were adopted. It follows that, of the 40 million tons burnt annually in domestic grates, no less than 20 millions are wasted.

Mr. A. H. Barker states [1] :—" Of all the fuel burnt in a house for cooking and heating it would probably be under the mark to estimate that three-quarters is wasted, partly by carelessness and ignorance, and partly by defects in the design of the plant employed." Mr. Barker has done more work than anybody else on the general question of the fuel economy of domestic heating apparatus, and his estimate must therefore be taken to be a reasonable one. According to him the annual waste of household coal is not less than 30 million tons ! As we have previously stated, fuel economy and smoke abatement are very closely related ; and if this immense saving could be effected it would, at the same time, go far to solve the smoke problem.

But this is by no means the full measure of the loss caused by the wasteful burning of raw coal, as against the use of smokeless fuel. We have already shown how great is the loss to the locality through the damage done by smoke. And further than this, there is the very serious amount of extra labour required in the house, for carrying coal and cinders, laying the fire and cleaning the grate, and extra cleaning in the rooms due to dirt caused by the fire.

The total extra cost due to the present methods of burning raw coal may then be summarised thus :—

(1). A loss to the nation of twenty to thirty million tons of coal each year ;

[1] *Domestic Fuel Consumption*, p. 1.

(2). A loss to the locality due to the damage caused by coal smoke, estimated for Manchester alone, at one million pounds sterling a year ;

(3). A loss to the household, which can hardly be estimated in figures, due to the extra labour involved.

"THE SILLY, WASTEFUL, AIR POISONING, FOG CREATING FIREPLACE."

So runs Mr. H. G. Wells' comment on the coal grate, and though we are inclined to agree with him, it is necessary that we should examine the coal fire scientifically and not condemn it off-hand.

We have already stated that the coal fire is not so hopelessly inefficient as was formerly thought. Dr. Fishenden's valuable experiments in Manchester have shown that the proportion of the available heat in the coal which is radiated into the room is not a miserable 8 per cent., but between 20 and 25 per cent. The remainder of the heat either soaks into the walls of the fire-place or the flue, or escapes from the top of the chimney. Probably about 5 per cent. is given off as convected heat in the room where the fire is situated ; of the remaining amount, say 70 per cent., anything from 15 to 55 per cent. may escape from the chimney top, depending mainly on the draught, but also on other conditions. When the draught is cut down to a minimum so that only 15 per cent. escapes from the chimney top (partly in the form of soot and unburnt gases, partly as heat) the remaining 55 per cent. is absorbed by the walls. If the chimney is in an inside wall a great part of this heat may be useful in warming the upper rooms ; if in an outside wall, probably half of it, amounting to 20 per cent. or 25 per cent. of the total heat in the coal, will be completely wasted. And yet architects dearly love to place chimneys on outside walls and have little idea how much valuable heat they are wasting.

Objections to the Coal Fire.

The main objections to the use of the coal fire are, of course, those on which we have already laid so much stress: the waste of coal, and the damage done by smoke. Many people believe that the modern slow combustion grate makes much less smoke than the older types. But there is no evidence whatever to support this belief. The point in favour of the slow combustion grate is that it can be made to burn slowly if the user so desires, whereas the old-fashioned grate burns rapidly and consumes much fuel.

But there are many other reasons why the coal fire is far from being an ideal heating apparatus. Its surface is nearly horizontal in form and so directs a large amount of the heat towards the ceiling, where it is not wanted. There is also a considerable loss through direct radiation up the chimney flue. While the coal fire ventilates excellently, it generally does so to excess and renews the air of the room much more rapidly than is necessary for health. This means extra heat to warm up the unnecessary air that is being drawn through the room, and, what is much more serious, the creation of draughts. It is a common experience while "hugging the fire" to feel a chilly draught at the back of one's neck, and at the same time to smell one's shoe-leather scorching. A coal fire warms by radiation; those near the fire may be too hot, anybody sitting away from the fire and near a window may be shivering with cold.

Then again, with a system of coal fire heating, many of the rooms of a house are as a rule not warmed. In the cottage and the small house there is usually only one, or, at most, two fires going; the rest of the rooms are fireless from one year to another, with the very common result, in this moist climate, of dampness.

The Housewife's Endless Work.

It is sometimes said ironically that a woman's work is never done, and the implication is that her methods

are less good than those of the man in the office or workshop. When, however, we consider that the housewife wages continual war against dirt, both that which is created inside the house and constant invasions of it from without, it is easy to see that if she has a high standard of domestic cleanliness her work is literally never done. Coal fires inside her own house will create dust, and thin desposits of soot will be found upon the furniture, curtains and covers. To get rid of this means more labour in addition to what she has already expended on clearing up grates, laying fires and dragging coals about; it is an indisputable fact that coals are carried over distances, amounting to many thousands of miles, in British homes in a single year! Then, unless our house-wife keeps her windows tightly shut and violates the laws of hygiene, dirt, caused by her neighbours' chimneys, will add to her labours. To sleep with open windows in a smoky town means that, not only will the sleeper, who went to bed with a clean face, wake with a dirty one, but that a considerable shower of soot will fall on pillows, sheets and blankets during the night. The town-dwelling woman, if she is really particular, will dust her rooms more than once a day, and wash her curtains six times as often as the housewife in the country. Hence another charge against the coal fire is that it involves a great deal of unnecessary work for women in the home.

Coal Fires are Slow.

In certain circumstances, as when heat is required in a hurry, the coal fire may be quite the worst-adapted means for the purpose. Take, for example, the breakfast time fire in a small middle-class house where the family use the dining-room as the general living-room as well as for meals. To be really efficient the fire should be lighted an hour before the room is required for the early breakfast, but, as nobody can be found to rise in time to do this, the so-called fire is but a mass of charred wood and smouldering coal, with just enough heat to

set up air currents in the room but not enough to warm the occupants. The result is that the people in the room experience a greater sensation of cold than they would do in a fireless room with an extra garment on. By the time breakfast is over and the family have departed to work and school and the housewife to active duties in the other parts of the house, the room begins to be pleasantly warm, but there is nobody left to enjoy it. The best remedy for this state of affairs is not necessarily to have breakfast clad in a top coat, but to set apart a room for meals and install a mode of heating, a gas fire or an electric radiator, which reaches its maximum intensity in a very short time and can be turned on and off as required.

The Kitchen Range.

While there is much to be said in defence of the coal fire, nothing whatever can be urged in favour of the ordinary open kitchen range. Its primary object is, of course, cooking, and though it does this satisfactorily, the amount of coal wasted in the process is enormous. Mr. Barker says that an average range would use in the oven about 2 per cent. to 3 per cent. of the available heat, a very "economical" range might use 5 per cent. "The total efficiency of the entire apparatus when it is all in use at the same time to its greatest capacity, including the hot water supply, the hot plate, and the oven, is usually about 7 per cent."[1] It is, in fact, efficient only as a producer of vast and unnecessary quantities of smoke. And yet such ranges are still commonly fixed in new houses; even in housing schemes controlled by the Ministry of Health.

Perhaps the most striking fact about the evidence given by the numerous witnesses who appeared before the Departmental Committee on Smoke Abatement was the great difference of opinion on almost every

[1] *Domestic Fuel Consumption*, p. 38.

point. One of the very few subjects on which they practically all agreed was the condemnation of the open coal range.

The back boiler behind the kitchen range, as fitted in the ordinary small house, is not only wasteful of coal, but most unsatisfactory in providing an adequate supply of hot water. The common experience is that two baths can never be taken in succession, unless a very large fire is made up in the evening, and " bath-nights " have to be strictly rationed amongst the family. No one must indulge in a bath when the fancy takes him. A working-class woman, in criticising this method of obtaining hot water, put the matter to one of the writers very concretely : she said—" When my two boys come home from football on Saturday afternoon they have to toss up to settle which shall have a bath."

We have taken the opportunity of discussing the subject of kitchen ranges with large numbers of working-class women, and the most intelligent and practical amongst them tell us they have no use for them ; they are convinced that they involve much labour and cause dirt in the house, and they greatly prefer to cook by gas. A small garden suburb of 136 houses, which was supposed to be an up-to-date housing experiment, was started in 1908 on the outskirts of Manchester. The promoters of the scheme, fearing to be too much in advance of the times, put kitchen ranges in half of the houses. The tenants were, however, in advance of the promoters ; sixteen of them had the kitchen ranges removed and sitting-room grates installed at their own expense. Forty-two more now say they would like to have their ranges removed at once, but the present high prices make it impracticable. Fifty-three families have been without kitchen ranges since the beginning of their tenancy, and they say they never want to have them. On the whole estate only nine tenants could be found who expressed a liking for kitchen ranges and used them regularly.

Now is the Time to Adopt Better Methods.

The British householder cherishes his open fire because it is cheerful and homely, but, above all, because he has always been accustomed to it; certainly not because he has critically examined its efficiency and convinced himself, after comparing it with other methods, that it provides the best possible method of heating his room. We hope we have already convinced the reader that although we burn a prodigious quantity of coal, produce volumes of smoke, and give ourselves much unnecessary labour, we really do not make a great success of the production of heat for domestic purposes. Knowledge has now reached a stage which justifies us in stating unhesitatingly that our methods are wasteful and the results indifferent. It is accordingly only common sense that we should set to work energetically to try to do better.

There are at least three other reasons why the matter should be dealt with now :—

Firstly, public attention has been called to the whole question by the excellent report of the Departmental Committee on Smoke Abatement which has just been published.

Secondly, the house-building on a large scale, which is now going on, and must go on for many years to come, gives a unique opportunity for new methods, if only those responsible for housing—the Government, local authorities and private builders—will rise to the occasion and design houses from the point of view of fuel economy and smokelessness. In the past it was urged, with some reason, that it was impracticable to attempt smoke abatement by altering existing appliances installed in houses constructed on old-fashioned lines. The situation is now changed and it is possible to construct houses provided with better methods of heating for a very small increased capital outlay, and, in some cases, even for less, than on the old-fashioned method.

And lastly, the present time is opportune because the public mind, or, at any rate the housewifely mind, is prepared for changes, as a result of war conditions and subsequent events. It is a very ill wind indeed that blows nobody any good at all, and coal rationing, high prices, and strikes have prepared people for considering fuel economy without the prejudice they would have exhibited in pre-war days.

We should like at this stage to reassure the anxious reader. We do not wish to propose legislation prohibiting the use of the coal fire, even in new houses. Although the inhabitants of all the countries in the world outside the British Isles seem to get on passably well without open fires, yet their total abolition would be too much of a wrench here. What we suggest is that they should be cut down to a minimum, regarding them as luxuries, to be used sparingly as other luxuries are.

The next three chapters will be devoted to discussion of improved methods of supplying heat for the three domestic purposes: warming rooms, cooking and heating water; and to the consideration of the question as to how far it is possible to combine comfort and efficiency and smokelessness.

CHAPTER IV.

WARMING THE HOUSE.

BEFORE discussing the merits of different systems of heating it will be as well to attempt to explain roughly what conditions are necessary if a room is to be comfortable for the average person to live in. This depends on complicated physiological and psychological factors which are only just beginning to be understood, but some of the principal conditions can be quite simply explained.

RADIATION AND CONVECTION.

Firstly, it is necessary to understand clearly the two methods by which a room may be warmed. In convection a hot body heats the air round it; the air rises and in its turn heats other things in the room. This is the method employed in central heating, where the cold air coming into contact with hot "radiators" is warmed by the contact, rises, and gradually warms the whole air in the room, and then the walls and furniture.

It should be noted that the name "radiator" is most misleading, as so-called radiators give out their heat almost entirely by convection. "Convector" would be a much more correct name.

The other method of warming is by radiation. Heat is emitted from a hot body by means of rays of radiant energy, which pass through the air without warming it at all, but on impinging on a solid body become converted into heat, which is largely absorbed by that body. A portion of the radiant energy may, however, be reflected from the surface, just as light is reflected; and in some cases a portion may pass through the solid body, as,

for instance, the heat rays from the sun pass through a glass window.

The difference between a space heated by radiation and convection respectively is perhaps best explained by comparing the exhilarating conditions of a sunny winter day in the Swiss Alps, where, although the air may be below freezing point, the radiation from the sun keeps one comfortably warm, with the relatively stuffy and depressing conditions of a hotel which is warmed by a hot air supply; in the former case the air is very cold, and the body is kept warm by radiation; in the latter the air is warm, and there is no radiant heat.

Although the matter is by no means fully understood it is now generally agreed that the best conditions for comfort in a room involve moderately warm air, combined with radiant heat, and, of course, adequate ventilation. This is generally best obtained by a central heating system to warm the air, combined with a coal or gas fire to supply radiant heat and ventilation.

"Drying the Air."

It is necessary to say a few words on this subject, as many people, who ought to know better, suffer from the strangest delusions about it. The fundamental point to grasp is that no method of heating can, under any circumstances, increase or reduce the amount of moisture in the air.

The idea that the air is dried by certain kinds of heating apparatus has probably arisen from two causes. The higher the temperature to which air is heated, the greater is the quantity of water vapour that it can carry. So that as air gets hotter it becomes "drier," relatively to its total capacity for carrying moisture; and air, which when cool is pleasant to breathe, may be uncomfortably dry when hot. Heating air may thus be said to dry it, though scientifically it does nothing of the sort.

In this sense the air is "dried" when a room is heated by convection, that is, by central heating, but not when

it is heated by radiation, that is, by a coal or gas fire. The widespread belief that gas fires dry the air is due to a quite different cause. If a gas fire is badly installed, some of the burnt gases may escape into the air of the room. These affect the throat unpleasantly and produce the feelings which are so often attributed to dryness of the air. Some years ago it was quite common to find such carelessly fixed fires; nowadays, the majority of gas undertakings thoroughly understand the need of careful installation of all fires to avoid this risk, and it rarely occurs; though, unfortunately, not all private firms of gas fitters realise the importance of paying careful attention to the ventilation of gas fires. Should trouble be experienced, a complaint to the gas office will very quickly cause the trouble to be remedied. The delusion as to gas fires drying the air affords an interesting illustration of the extent to which an individual's feeling of comfort in a room depends on psychological factors. The feeling of dryness is often removed by placing a saucer of water in front of the fire. Now we have already explained that it is utterly impossible for any drying of the air to take place. Further, if it had taken place, it would be equally impossible for the saucer of water to remove it, as the small amount of water vapour evaporated would certainly go up the chimney. And yet it is an undoubted fact that the saucer often does remove the *feeling* of dryness !

A curious instance of prejudice against the use of gas, entirely without any basis in fact, was told at a smoke abatement meeting in Manchester by a member of the audience. She said, " I am a confectioner and I have always used a gas oven for my baking. The other day one of my best customers, whom I had served for over nine years, gave me a big order for a birthday party and said as she was leaving, " You know, Mrs. G., I always give you my orders because I should die if I ate anything that was cooked by gas ! "

Ventilation.

In any system of warming good ventilation is of the greatest importance. A coal fire generally gives several times as much ventilation as is necessary for health, thus tending to cause draughts and involving extra cost for heating. A gas fire, connected to proper flues, creates less draught than a coal fire, but, if well fitted, gives ample ventilation. An anthracite stove gives much less, and in central heating special means have to be taken to secure proper ventilation, which is by no means easy.

It has recently been shown that it is not so much the chemical purity of the air that matters as the fact that it should be moving. The movement of the air must of course be short of producing a " draught " that leads to the occupant of a room closing up the openings completely. A stagnant, warm atmosphere is most undesirable, and it is well seen in America that children, especially, suffer from such conditions .

If the weather is not excessively cold, most people, educated in modern hygienic methods, would keep a window partly open. If the weather is too cold for this, or the window so inconveniently placed that ventilation is impracticable without draughts, it is possible to freshen the air of a room by opening windows at intervals. Curtains, even of washable cotton material, have a considerable effect in lessening draughts from open windows. It is usually in the evenings that rooms get stuffy, and the curtains, which are generally drawn then, can be arranged to direct the in-coming air so that it does not fall directly on the occupants of the room.

Windows constructed to ventilate without draughts, as far as possible, should be a feature of all houses, and special attention should be paid to this point in houses planned for central heating. The casement window, now so much in vogue, should always be provided with top lights, made to open in such a way as to admit fresh air at a moderate rate, should the weather be unsuitable for opening the whole window.

The Best Use of the Coal Fire.

The Interim Report of the Departmental Committee on Smoke Abatement has recommended that not more than one, or, at the most, two coal grates should be fixed in any house. Accepting this recommendation as a wise compromise in view of the strong popular prejudice in favour of open fires, we shall discuss alternative methods of heating to replace the coal fires omitted, their relative cost as regards installation and working expenses, and the extent to which they will severally reduce the amount of smoke from dwelling houses.

But, before dealing with alternatives to the coal fire, something should be said about the coal fire itself, and the conditions which render it most efficient and least harmful, if one or two coal grates are to be fitted in each house.

The following conclusions are based mainly on Dr. Fishenden's work :—

(1). The slow combustion or bar-less type of grate gives no more heat into the room than the old types, nor is there any reason to suppose that it emits less smoke per pound of coal burnt. Its great advantage is that the rate of burning can be regulated, and when the coal is burnt more slowly, less smoke is, of course, produced.

(2). The most important thing about a coal fire is draught regulation. A strong draught is needed to enable the fire to be started easily ; then, when once it is going well, half the draught or less, is often ample, and causes slower burning, and in many cases actually a warmer room. The draught must be regulated in two places to be effective ; below the fire, to vary the amount of air actually passing through the fire, and in the chimney, to vary the chimney draught, so affecting both the air drawn through the fire and the supplementary air which passes above the fire direct to the chimney.

Both these draught regulators should be fully open for lighting, and partly closed later. With well designed fittings, intelligently used, the quantity of coal burnt could be largely reduced without in any way making the room less comfortable.

(3). Chimney flues should always be built on inner walls. On an outer wall as much as 25 per cent. of the heat in the coal may be lost to the open air; on an inner wall that loss is avoided, the heat going to warm the walls of the upper rooms in the house.

(4). A mixture of coal and coke, about half and half, forms a very good fuel for the open grate. It is easy to light, it burns well, but a little more slowly than unmixed coal, and is cheaper. Also, of course, there is much less smoke.

Advantages of the Gas Fire.

The first alternative to the coal fire that suggests itself will naturally be the gas fire.

The gas fire has many very great advantages. To begin with it is entirely smokeless. It involves no trouble in the form of laying fires, carrying coals, or clearing up ashes, and needs no attention. It can be turned on when required and reaches its maximum heat within a few minutes of being lighted, unlike the coal fire, which requires about an hour. For this reason a gas fire is particularly suitable for intermittent use and when heat is required quickly. The modern gas fire being vertical sends the heat towards the persons in the room, while the horizontal coal fire directs it upwards towards the ceiling, where it is largely wasted. The gas fire has a considerable ventilating effect, but less than a coal fire. This, on the whole, is an advantage, for the excessive air currents caused by the coal fire are one of its drawbacks.

Objections Raised Against Gas Fires.

There are three principal reasons why many people prefer coal fires to gas; they allege that the gas fire is

unattractive, expensive and dangerous. The first is a matter of personal preference and custom. The second is true for continuous burning, but not for intermittent use. The third is a popular belief due to a newspaper stunt, and, like many such stunts, is untrue. Let us deal with these three points separately, or rather with the last two, as it would be a waste of time to discuss the first, which is purely a matter of personal taste.

Cost of Gas Fires.

For continuous burning a gas fire is, at present prices, much more expensive than a coal fire. With coal at 40s. a ton, and gas at 4s. a thousand cubic feet, one penny will buy 60,000 heat units in the form of coal, and 10,000 in the form of gas.[1] Taking the whole of the heat given to the room by a coal and a gas fire respectively, including both radiated and convected heat, the former will give about 30 per cent. of its available heat, the latter 60 per cent. That is to say, that the number of heat units actually delivered into the room for one penny would be, in the case of coal, 18,000; in the case of gas, 6,000. In other words, for continuous heating at these prices, it costs three times as much to deliver a given number of heat units into a room by a gas fire as by a coal fire. But it would not be quite fair to say that it costs three times as much to provide equally comfortable conditions, for two reasons. Firstly, extra heat is needed to counteract the excessive draught of the coal fire; and secondly, a larger proportion of the radiation from the coal fire is, as already explained, wasted by being directed at the ceiling, where it is useless. We have not the knowledge to measure the importance of these two factors; but they certainly mean that for equal comfort the gas fire will be distinctly less than three times as expensive as coal.

[1] For purposes of measurement, heat is divided into units, and these are called "British Thermal Units." A B.T.U. of heat is the amount which is required to raise one pound of water 1 degree on the thermometer, or one ounce of water through 16 degrees.

Cost of Gas Fires for Intermittent Heating.

When heat is required only for a short time, the gas fire is often much cheaper than the coal fire. The former, with gas at 4s. a thousand cubic feet, costs from 1d. to 2d. an hour, according to size and pressure, whether used for a long or a short time. The coal fire, on the other hand, costs a certain minimum amount to set going, for however short a time it may be required. This is a matter of great importance for anybody who has to decide which kind of fire to install. We have accordingly made very careful inquiries, as the result of which we work out the minimum cost of lighting a coal fire, at the level of prices prevailing in April, 1922, as follows :—

Minimum cost of lighting a coal fire.

Laying fire	4 minutes.
Cleaning grate	5 ,,
Carrying coals and ashes ..	2 ,,
" Coaxing " fire to burn ..	2 ,,
Total labour employed	13 ,,

The full cost of a servant, including wages, food, house-room, washing, firing, and insurance, is at least £104 per annum. Assuming that she does an 8-hour day all the year round, and allowing nothing for illness, holidays and days out, the cost of 13 minutes labour is 1·9 pence.

We consider the estimate for labour represents a fair general average. While a modern bar-less grate might be cleaned in less time than we have allowed, an old-fashioned one, requiring blackleading, would take much longer. And, although, theoretically, a well-laid fire should burn readily, it often happens that, owing to weather conditions and other causes, a considerable time is taken up in getting the fire started. We have allowed no margin of time for getting from one room to

another, and the total time taken will, in practice, probably be much greater than we have allowed.

Seven pounds of coal (costing say 2s. 6d. a cwt.) are required to make a good fire, which will last for about 2½ hours, and would then require replenishing if kept burning for a longer time. The cost of the wood for lighting would be approximately a half-penny.

The total cost of lighting the fire would then work out thus :—

Labour	1·9 pence.
Cost of wood	·5 ,,
Cost of coal	1·9 ,,
	4·3 ,,

A gas fire in the parlour or one of the bedrooms of a working-class house would be a small one, probably with six burners, and with gas at 4s. a thousand would cost 1¼d. per hour if used at full pressure ; so that the relative cost of coal and gas fires would be as follows :—

Length of time. *Hours.*	*Coal Fire.* *Pence.*	*Gas Fire.* *Pence.*
1 ..	4·3 ..	1·25
2 ..	4·3 ..	2·5
3 ..	4·5 ..	3·75
4 ..	4·9 ..	5
5 ..	5·3 ..	6·25
6 ..	5·7 ..	7·5
7 ..	6·1 ..	8·75
8 ..	6·5 ..	10

It will be seen from the above table that, if a fire is required for one or two hours only, gas is much cheaper than coal. If the fire is required for 4 hours, the costs of gas and coal are approximately the same ; if for more than 4 hours the coal fire is cheaper.

A great advantage of the gas fire is that it can be used as wanted for short periods, while the coal fire must

either burn continuously or be relaid and relighted. Heat is frequently required in a room for an hour in the morning, again for the middle-day meal and then perhaps for two hours or so in the evening.

It may be argued that the housewife lays a coal fire without charge, and that labour ought accordingly not to be counted in a working-class house. This, again, is a matter for consideration in each individual case, but when the labour is paid for at its fair value, as in hotels, boarding houses, hostels, etc., the coal fire figures in our table are definitely on the low side.

Alleged Dangers of Gas.

There has recently been an active "stunt" in a section of the press regarding the alleged serious risk of accident through leakage of gas in houses fitted with gas fires or cookers. It has been suggested that gas, as now sold, contains a larger amount than formerly of the poisonous carbon-monoxide; that the characteristic pungent smell of gas is now less strong than before; and that accordingly a leakage is more dangerous and less likely to be detected. If any fatal accident has happened it has been very prominently reported in the press, both when it occurred and again at the inquest, and the result is that there is now a good deal of uneasiness, quite enough to make people hesitate about installing new gas fires.

What are the facts?

(1) Gas has been used in this country for 100 years.

(2) It is installed in many districts in almost every house.

(3) It is, and always has been, poisonous and therefore dangerous to breathe when unburnt.

(4) The only danger is from leakage. This danger is decreasing because the fitting is better done than formerly, and because people, especially servants, have more experience in managing gas fittings.

(5) It is probable that an increased percentage of carbon-monoxide is used in some gas undertakings. This does not convert a safe gas into a poisonous one, but makes the gas more quickly dangerous if breathed in a closed room. Even so, the gas sold in Washington has twice as much carbon-monoxide as any sold in this country; and the Bureau of Public Health for that city has stated that no detrimental effect on the health of the inhabitants has resulted.

(6) Gas is never, and could not be, sold without the characteristically pungent and instantly noticeable smell, which is the real safeguard.

(7) Deaths caused by gas represent 2 per annum per million of the population; deaths from railway accidents are 22 per annum, or 11 times more. Street accidents in London represent 100 deaths per annum per million of the population of that city. Fatalities from coal fires are much more numerous than from gas, but the public have grown used to them. The danger is, however, recognised in the Children's Act of 1908, which makes failure to provide a fireguard a punishable offence in cases where children have been fatally burnt. In the year 1919 (the last for which the Registrar General's complete figures are available) no less than 992 inquests were held on children under 5, who had been fatally burnt through accidents with fires (conflagrations excluded).

Apart from danger to life, the destruction of property through coal fires is so great that anyone who consulted fire insurance statistics might have reason for hesitating before fixing coal grates in a new house. One large insurance company alone, in the last quarter of 1921, dealt with no less than

876 claims for losses directly traceable to fireplaces and paid £3,602 in compensation. These losses were apportioned as follows :—

Coals falling from fire ... 265 claims.
Wood falling from fire ... 51 claims.
Sparks from the fire ... 560 claims.

The estimated yearly loss for the United Kingdom based on the statistics from this one company, which has about 4 per cent. of the total insurance business, would amount to no less than 87,000 claims, and a money loss through accidents by fireplaces of over £360,000.

(8) The death rate from gas poisoning is in no way comparable to the saving of life which would result if all coal were converted into gas and coke before being burnt. True a few houses now without them would then have gas fittings, and the risk of gas poisoning would be increased to an infinitesimal extent ; but the air would be clear and free from fogs, the general level of health would be higher, and thousands of lives would be saved.

Precautions that should be taken with Gas.

(1) Every householder should make sure that his gas fittings are in good condition and free from leaks and should call in an authorised gas fitter if any escape of gas is detected. Those people are simply asking for trouble, who, through misplaced economy, attach gas rings and heaters to lighting brackets by means of rubber tubes, which do not fit properly and which quickly perish and become porous.

(2) To avoid the risk of children interfering with the taps of gas fires, they should be removable, so that they can be placed out of reach.

(3) All gas fires should be fitted with wire guards, which can be obtained for a few shillings.

Using the Gas Fire to the Best Advantage.

While the all-gas house is at present not practicable except where expense is no object, the use of some gas fires in all houses is strongly to be recommended. The Manchester Corporation Housing Committee has made a careful study of the whole subject, and, after receiving evidence from architects, engineers, builders, and committees representing housewives, has, on the advice of its own experts, built its new houses with one coal fire in the living room, another in the bedroom directly above the living-room, and gas fires in the parlour and other bedrooms. There is a gas cooker and a gas copper in the scullery, and water is heated by a boiler behind the coal fire in the living-room. Some other municipalities have also adopted this system. From the landlord's point of view certain definite economies are effected in this way as regards capital expenditure. The gas fire needs only a 4½ inch flue in place of the 9 inch flue required by the coal fire, and the chimney stack can be shorter. Hence the saving of an appreciable amount of materials and bricklayers' labour. By judicious planning, where houses adjoin one another, the flues from the coal grates can be taken into one chimney stack, and those from the gas fires into another. The cost of a gas fireplace is rather higher than that of the type of bedroom grate used in government housing schemes, but the saving in brick-work and forming of hearths can be set against this, and houses built with a majority of gas fires work out cheaper than those with coal grates in every room.

Owing to the slighter projection of the chimney breasts in a room constructed with a gas fire, there is a saving of floor space, and this is of considerable importance now-a-days when, owing to the high cost of building, the tendency is to make small rooms, not only in municipal housing schemes, but in houses built by private enterprise.

This method of building is also far better for the tenant than the all-coal house. The parlour is a room that is only used occasionally, generally for a short time. A gas fire in this case will not only save labour, and cost actually less in fuel, but can be ready and cheerful at a moment's notice when wanted, whereas a coal fire means, probably, some time and annoyance in lighting, and then nearly an hour's wait before it is fit to sit by.

Similar arguments apply to the bedroom. If it is necessary to warm a bedroom before a child, invalid, or elderly person goes to bed, a gas fire which can be put on for half-a-hour beforehand and turned off when the person is in bed, is obviously better than a coal fire. And for the luxuriously inclined a gas fire is a boon for dressing by on a cold morning.

There is still some difference of opinion as to the respective merits of gas and coal in case of illness. With a properly constructed and installed gas fire we have no doubt whatever of its suitability ; it is clean and creates no dust, a most important point in case of severe illness! when it may not be possible to clean out the room properly for weeks on end ; it requires no attention, and the patient is not disturbed by the noise of putting on coals ; it can be regulated at any moment to give exactly the amount of heat required ; and it ventilates the room thoroughly well. One of the authors has recently gone through a severe illness, and he spent six weeks in bed in a room heated by a gas fire, which was burning continuously, day and night, for the whole period. While it would be too much to attribute recovery to the gas fire, yet the conditions in the room, as regards heating and ventilation and cleanliness, were certainly better than could have been obtained by a coal fire or by any other method.

In our opinion, where central heating or central hot water cannot be installed, the heating methods adopted

by the Manchester Corporation are the best practicable, with two exceptions :—

Firstly, the method of heating the water by a back boiler is not really satisfactory, and there are now much improved methods available which will be described in Chapter VI.

Secondly, we should prefer to install one coal fire only, in the living room, and to put gas fires in the parlour and *all* bedrooms. This would, if anything, be cheaper as regards capital cost ; would be as convenient for the tenant, and would mean a more nearly smokeless house. A number of tenants in the new Manchester houses have actually asked to have this alteration made and the Corporation has, when requested, fixed an additional gas fire, leaving one coal grate only in each house.

Anthracite Stoves.

These are smokeless and very efficient, and are extremely useful where heat is required continuously over long periods. They can be kept burning night and day throughout a whole winter, if necessary, and require little attention. They are not as pleasant as an open fire and they have little ventilating effect. We do not think they are suitable for cottages though they might be placed in the hall of a somewhat larger type of house to give warmth generally throughout, the rooms themselves being heated by gas fires. They are mostly suited to countries in which winter is constant and severe, such as Canada, North Germany and Russia.

Central Heating.

Central heating is by far the most economical method of heating large buildings. Sometimes supplemented by gas or coal fires, it is almost universally found in all new hotels, blocks of offices, etc., and in many large private houses. In such cases it is not expensive to install and is by far the cheapest method of warming. In the small house the position is different. Where the dwellings are

built in blocks, as in the Scottish tenement houses, and in most Continental working-class housing schemes, central heating is applicable. But when cottages are built on the new English plan, in blocks of two or four, and not more than 12 to the acre, the cost of the connexions between the houses is so great that the problem of a common central heating system becomes much more difficult.

We propose first to give in a general way the case for and against central heating, and then to consider whether and how it can be applied to new working class houses.

Advantages of Central Heating.

The advantages of central heating are :—

(*a*) The fuel used is almost always, and should always be, coke. Central heating is, therefore, smokeless.

(*b*) It requires very little labour, as there is only one fire to attend to, and that at long intervals.

(*c*) The whole house is warmed. In the small house, dependent on coal fires for heating, it is one or at most two rooms only which are warmed.

(*d*) Each individual room is thoroughly warmed throughout. In a coal heated room only the occupants near the fire are really warm ; the others, according to their positions, are more or less cold ; and some may be so placed as to miss the radiation from the fire entirely, but get the full blast of the excessive ventilation which it causes.

(*e*) Central heating, where it can be installed with success, is by far the cheapest way of warming a house. Mr. Barker estimates that the cost in fuel is approximately one-third of that of a coal fire ; and that central heating can be kept on night and day, as against burning coal fires in the day only, at a cost in fuel not exceeding half of that required by the coal fires.

Drawbacks of Central Heating.

On the other hand certain drawbacks are alleged against central heating :—

(*a*) It is said to dry the air, to cause feelings of stuffiness and discomfort, and sometimes to cause an unpleasant smell of "burnt air." This smell only arises with high temperature steam heated radiators, which partly burn some of the organic matter in the air. Installations for small houses are almost always designed for hot water circulation, so that the maximum temperature is below the boiling point of water, and this trouble cannot arise.

The stuffy feeling is a more real difficulty. Central heating warms the rooms by heating the air, and there is practically no radiated heat. As soon as the temperature gets too high, especially if the ventilation is not good, the feeling of stuffiness appears.

Stuffiness can be avoided by noticing when the room is getting too hot and then opening a window. In America, where central heating is almost universal, the installation is always fitted with an apparatus called a "thermostat," which automatically shuts off the heat from the radiator in each room when the desired temperature is reached. This economises fuel and prevents discomfort, and should be regarded as an essential part of a central heating plant. Unfortunately, no central heating engineers in this country seem to have realised the importance of proper regulation of radiator temperature, and the apparatus is not on the English market.

The best ventilation for rooms that are used all day is a supplementary gas or coal fire, where the tenant can afford such a luxury. Otherwise the architect must arrange the best possible system of ventilation by flues, taking advantage

of the lightness of the heated air. This is a technical question which must be settled to suit local conditions. A favoured method is to place the radiator under a window, and to introduce cold air from outside to flow over the radiator, and, when warmed to rise in front of the window, so as to warm first what is normally the coldest part of the room. Proper outlets for the hot air must be provided near the ceiling.

(*b*) Central heating is accused of being cheerless, and the radiators of being ugly. But radiators need not be in full evidence in the room, and, if painted to match the walls, they are not unsightly. It must be admitted that they do nothing to add to the cheerful aspect of a room, but we shall discuss below the arguments for supplementary heating by radiation, at such times as people have opportunity to enjoy it. It is certain that the single-handed housewife has little time during her busy day to sit down and enjoy a cheerful fire, and the rest of her household, who are old enough to appreciate æsthetic effects, are generally at school or at work during the day.

Central Heating Plant.

We have already referred to the fact that, in cottages built 12 to the acre, a common central heating plant is expensive to install; in fact, the bulk of engineering opinion considers the cost prohibitive, though this can hardly yet be regarded as proved, and we shall describe later a recent successful installation of this type. It seems probable, however, that at least for the present any big development of central heating for small houses is more likely to be on the lines of separate installations for each house. Here again, many people will argue the initial cost will be prohibitive. We do not think that it will necessarily work out so in practice with careful planning, and, if some chimneys can be eliminated,

there is a considerable saving in brickwork and fireplaces, which partly off-sets the additional cost of the installation. To take an actual instance, the Acton Borough Council has experimentally fitted a few houses with a combined central heating and hot water supply. Each house has its own boiler, placed either in the scullery or in the fuel store (the former is the better arrangement), and no less than four gas fires in addition to four radiators, which must be regarded as somewhat luxurious. The cost worked out at £22 more than that of a house with a range in the kitchen and coal grates in the other rooms. This was in 1920 when prices were at the top. It does not seem to us to be an excessively high additional capital outlay for a much more efficiently warmed house.

Very little attention had until recently been devoted to small central heating plants in this country, but a good deal of invention and research has now been turned towards the production of better apparatus. In order to save space in small modern houses which are built without cellars, new types of boilers have been designed which are suitable for placing in a living room. The makers claim that, owing to their special construction, they can perform efficiently the three services of cooking, heating water, and warming the house, from one coke or anthracite fire.[1] Mica panels in the fire doors allow a glow from the fire to show when the stove is closed for water heating or cooking. When heat is not required for these purposes, the fire doors can be thrown back revealing a cheerful open fire. A small installation of this kind will warm the room in which it is placed and will serve three or four medium sized radiators in other rooms as well. It is undoubtedly a great improvement on the ugly vertical boiler, which has to be concealed in a cellar or out-house, with the result that much valuable heat is wasted. Some of these boilers have been installed in centrally-heated houses erected by Labour

[1] See also Chapter VI., page 62, where these stoves are described, with illustrations, as cooking apparatus.

Saving Houses, Ltd., at Welwyn, the new garden city in Hertfordshire, and we are told that they are working satisfactorily on a low fuel consumption.

There seems every reason to hope that with further experience much more effective and cheaper central heating plants will be designed in the future. Central heating for small houses is, at present, in the trial stage, and it is too soon to pronounce a final opinion as yet. Meanwhile actual experiments are being made in different parts of the country, and that is all to the good.

Examples of Centrally Heated Housing Schemes.

We have already explained that the whole idea of central heating for small houses is a new one in this country. The speculative builder, who built 95 per cent. of such houses before the war, worked on stereotyped lines and did not attempt to develop new ideas. Nor have municipalities shown much initiative in their post-war building, though a few have made useful experiments.

We are indebted mainly to private firms, who have built houses for their workers, either themselves or through public utility societies, for such progress as has been made. Several firms have rendered valuable service to the cause of smoke abatement and fuel economy by their courageous experiments.

The Austin Motor Co., Ltd., led the way by building centrally-heated houses for their workpeople during the war; each house having its own installation. As a new departure it was a highly creditable scheme, though we think the method of having radiators upstairs, and gas fires downstairs, might be improved upon.

The Sentinel Steam Wagon Works, Ltd., of Shrewsbury, have recently built a large number of houses for their workpeople. The houses are built on the standard post-war lines, about 12 to the acre, and are just across

the road from the works. Exhaust steam from the works, which would otherwise be largely wasted, is made use of to heat water, which is circulated to the houses. These are warmed by radiators, and hot water is also laid on to the bath and sink. The living room, which has no radiator, is fitted with a small convertible coal grate with oven, and there is a gas cooker in the kitchen-scullery. The tenants pay 2s. per week throughout the year for the combined heating and domestic hot water supply. The houses were visited last year by the authors, and the tenants, who had then recently moved in, expressed themselves as highly satifised with the heating arrangements. There is no doubt that they get very good value for their money. A report from the firm, a year after our visit and when 98 houses were tenanted, states that " the installation is working very satisfactorily and giving satisfaction to the tenants. There is a constant supply of hot water, day and night, and the rooms are kept at a good temperature at all times."

Conditions for Successful Central Heating.

As it seems not unlikely, judging by recent improvements in plant and the actual experiments made in building centrally-heated houses, that developments in this direction may be expected, it will not be out of place, in conclusion, to discuss what are the conditions which would make for success with central heating.

The main consideration is what temperature should be aimed at in central heating and what supplementary heating, if any, should be provided. The subject of ventilation has already been discussed.

The American system of keeping rooms at a temperature of 70° F. is obviously not desirable here, and it tends to accentuate any disadvantages there are connected with central heating. A small radiator system capable of maintaining a room temperature of

58° or 60° F., supplemented *when necessary* with radiant heat, is probably the most satisfactory method of house-warming. During the daytime, when the housewife is engaged on her active duties, the central heating alone would be ample for comfort. As a matter of fact, in the average small house with its one coal fire, a great part of a woman's work, sweeping, dusting, bed-making and so on, is performed in cold rooms, interrupted by occasional spells in a hot kitchen, which serve to make her more sensitive to cold. The other adults and the older children are away from home during the day, leaving only the children under school age at home. For these a room temperature of between 58° F. and 60° F. would be sufficient. The " toddlers," with their ceaseless activities, would keep themselves warm. Infants, who spend most of their time asleep in their cradles, do not need rooms with a high temperature ; modern medical opinion is emphatic that the practice of keeping infants in hot rooms is a fruitful source of ill-health and conduces to a high mortality rate. In the case of a household containing very old people, an exception to this rule might have to be made, as radiator-heating of moderate temperature would probably not suffice for them.

It may be of interest to record that, after the foregoing was written, one of the writers, when visiting the centrally heated houses at Acton, was told by a tenant, who never used any supplementary heating, that her old grandfather liked to visit her better than any of his other relatives, because her's was the only house where he felt really warm ! The other relatives, of course, had nothing but coal fires in their houses.

It is in the evening, when the housewife has leisure to sit down, and the other members of the family return from work or school, that auxiliary heating by coal or gas fire for the sake of extra warmth and cheerfulness may be needed. The second reason will probably be

the dominant one, except in very cold weather, because small houses with central heating become fairly hot towards evening, and the tenants of such houses, whom we have interviewed, say they seldom need to light fires ; and, if they do so when entertaining friends, they generally let them go out before the evening is over.

To comply strictly with smoke abatement requirements, the supplementary heating should be by means of gas fires. Then indeed complete smokelessness would be secured. But if cheerfulness and sociability are the main objects, coal fires in the evening will probably be preferred. It is pretty certain, though, that, when no longer actually required for warming purposes, the fact that they cause labour will tend to limit their use ; and the housewife will regard them as luxuries, not because she is convinced that burning raw coal is an extravagance, but because coal fires involve the same sort of extra trouble for her as making delicacies to eat ; and, like those delicacies, the supplementary fires will be conceded on occasion, but not as a regular thing.

Summary.

(1) Central heating for small houses still in the experimental stage, but developments may be expected.

(2) Gas at present too expensive for continuous use, therefore all-gas house not yet practicable.

(3) Gas for intermittent use cheaper and quicker than coal fire.

(4) Each house should have but one coal grate of small fuel capacity and fitted with draught regulators ; gas fires in the other rooms of the house.

CHAPTER V.

HOT WATER SUPPLY.

An adequate supply of hot water to the bath and sink is essential in every house, however small. Indeed it is in the workman's cottage that the need for hot water is greatest. The children from such homes have no clean nurseries to play in, but only the street. The wage earners come home dirty from works or mines, and all the family washing is done at home.

It is regrettable that many cottages, even among those built in recent years, have no such hot water supply, and the tenants have to depend entirely on boiling kettles on the fire. This is most unsatisfactory. It is true that, even under such conditions, some exceptional women succeed in keeping their homes and families clean, but only at the expense of much patience, labour and fatigue.

For the most part the houses built under the government schemes have a proper hot water circulation, though unfortunately in many cases the old-fashioned kitchen range has been installed to supply it. But there are cases where a gas geyser in the bath room or a gas fired copper in the scullery is the sole means for obtaining hot water. This is a thoroughly bad arrangement and should have been condemned by the Ministry of Health as unfair to the tenant ; not only because the hot water is supplied at one point only instead of to both bath and sink, but, still more, because gas for water heating purposes is too expensive at present for the needs of an ordinary family.

Best Methods of Heating Water.

We have just stated that gas may be dismissed as a fuel for water heating purposes on account of cost, though it may be useful for supplementing other methods, or when small quantities are required, or for occasional use.

Electricity is entirely out of the question for the same reason, so that we are left to decide between coal and coke.

Coal should, of course, only be used where a coal fire is installed for other reasons. In that case it may be advantageous to fit a back boiler to the living room grate. The heat thrown out into the room is somewhat reduced by the presence of the boiler, but, with good design, an open fire is capable of warming a room of medium size and giving also a fair supply of hot water.

But the best way of heating water is by an independent coke boiler, which may be placed in the living room, or better in the scullery. Several good designs of such boilers have recently been placed on the market, and we illustrate one of them below.

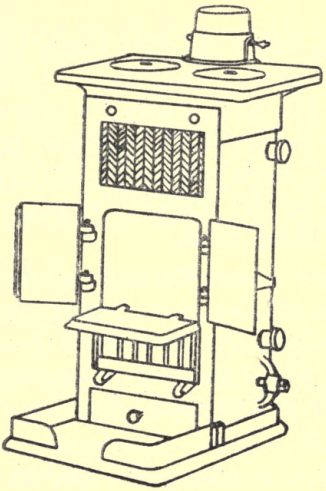

Fig 2.

It will be seen that it is not unsightly like the old vertical boiler, but quite fit for the kitchen or scullery. It is not only a boiler, but has a hot plate for cooking on the top; and, when the doors are open, as in the illustration, it provides a pleasant open coke fire, which the tenant can poke to his heart's content. It also serves as an excellent refuse destructor, being capable of consuming all refuse, including even old tins. Further it makes the drying and airing of clothes much easier. This is always a problem, especially in the north of England, where, owing to the dampness of the climate, drying must be done indoors during at least eight months of the year.

As regards its main duty, the heating of water, Dr. Margaret Fishenden, as the result of a series of tests, found that this boiler will heat, in a given time, from two to two and a half times as much water as the usual back boiler, and that the efficiency as regards fuel consumption is more than double that of the back boiler. That is to say, that a given quantity of fuel will heat more than twice the amount of water to the required temperature.

It is clear then that the coke boiler has great advantages. In the summer when the coal fire is used only to get hot water, the advantages are overwhelming. The coke boiler will do the work with half the fuel, and will, at the same time, burn refuse and will dry clothes better. Also, if placed in the scullery, it will cause less overheating in the living room.

In winter when a coal fire is in use in the living room the advantages of the coke boiler are less. But, if both are installed, the individual housewife will be able to choose which method of heating water she will employ, and she will probably find the coke boiler more convenient.

In our opinion a coke boiler should be installed in every house. If the design can be further improved,

especially in appearance, and this will almost certainly be the case, these combined coke boilers and open fires might well be installed in the living room in place of the open coal fire. They are not only more efficient for heating the water, but they will perform adequately other services in addition ; the newest types are made with an oven. Even if, in their present form, they are not so attractive and cheerful as the coal fire, yet we believe many householders would be glad to use them on account of the increased comfort and economy which they offer, and because of their smokelessness. We regard the improvement of this type of apparatus as one of the most important and practical lines of development.

In using coke, precautions should be taken to keep it dry. It is commonly, and mistakenly, thought that it may lie in the open, exposed to damp and rain, without harm. Dr. Fishenden found that the radiant efficiency of coke was diminished in proportion to the amount of moisture it contained. This is an important point where a coke boiler is used as an open fire.

Where houses are fitted with central heating, the hot water will normally be supplied from the same boiler. It is generally supplied on a separate circulation, so that in summer time the radiators can be cut off, and the fire used for heating the hot water supply only. In that case it is the equivalent of the independent coke fired boiler which we have described above.

Communal Hot Water Systems.

Some interesting experiments in the direction of a common supply of hot water to colonies of houses are being made in connexion with the new housing schemes. Such a supply is commonly laid on in blocks of flats and in hotels, and is undoubtedly economical in such cases. Two blocks of working-class tenements in Liverpool have had a similar supply for many years, water at a temper-

ature of about 140° F. being laid on to the bath and sink in each house. This installation has been successful and economical.

The problem has become much more difficult now that separate cottages are being built about 12 to the acre. There are no serious engineering difficulties, but the pipes from house to house have to be laid in properly built conduits, and must be very well coated to avoid loss of heat. All this is expensive, and the question is whether such plants can be made to pay.

The Manchester Corporation has a scheme for a communal supply of hot water to 500 houses ; the heat is to be obtained cheaply from an existing refuse destructor, where steam is largely a by-product. The intention is to charge the tenants 1s. 6d. a week. As they will certainly save 1 cwt. of coal a week on an average, they will be glad to pay this amount for a constant supply of hot water, and it is estimated that the charge will suffice to pay working expenses, also interest and sinking fund. There will be a considerable saving of labour for the housewife, and the hot water production will be smokeless. As cooking will be done by gas, there will be no smoke whatever from this estate in summer.

The experiment is an important one, and its results will be watched with interest.

Summary.

1. Gas and electricity are too expensive for general use.
2. A back boiler behind the living room coal fire is fairly satisfactory, but not economical.
3. A separate coke boiler is far more efficient and is smokeless.
4. Experiments should be made in installing such coke boilers, convertible into open fires, in the living rooms, to replace the coal fires.

CHAPTER VI.

COOKING.

THEORETICAL considerations as to the application of heat for cooking purposes need not detain us long. This is not a cookery book, so we will not enter into the difference between baking, frying, and boiling, or, as Mr. Barker classifies them—oven cookery, open air cookery and moist heat cookery. There is, however, one more distinction in cooking operations which has a bearing on fuel economy, to which we would direct attention.

Cooking operations are divided into two classes :—

(*a*) Those which require a high temperature, *e.g.*, frying, roasting.

(*b*) Those in which, once the food has been raised to a certain temperature, cooking will go on without the application of more heat, provided heat is not allowed to escape from the hot food or from the vessel containing it.

Emphatically, it is not economical to conduct both kinds of operation by means of the same apparatus. Cookery books frequently contain instructions such as the following :—" Bring to boiling point, and then draw the pan away from the fire and simmer gently." And this process is sometimes to be kept up for hours at a stretch, that is to say, the housewife is to place the food to be cooked so that it may avoid most of the heat of the fire. This amounts, practically, to a recommendation to waste fuel. In this case, provided the heat could be prevented from escaping, the food would go on cooking without the expenditure of further heat. As, however, the ordinary saucepan is not constructed on the principle of a thermos flask, heat escapes, and has

to be made good by keeping the pan near the fire or on a gas burner turned low.

The hay box, which is an adaptation of the thermos flask principle, is very useful as a fuel sparer, and should be found in all houses where economy in an object—though as a matter of fact, fuel economy should be an object in every house, not only in those where means are limited. The principle of hay box cookery is that the hot vessel, already heated on the gas or fire, is placed, surrounded by hay, in a non-conducting box, from which the heat will only escape very slowly, thus permitting the food to go on cooking.

There are some really elaborate fireless cookers on the market now, some of which have an electric bulb to make good any loss of heat; but a hay box that is satisfactory for ordinary purposes can be made at home by lining an ordinary packing case with stout brown paper. A bed is made to contain the pans (these should preferably be without projecting handles), a cushion filled with hay is placed on the top, and the lid is then securely fastened.

Slow cooking, at a low temperature, forms a large part of a family's cooking operations, except where a thriftless housewife rules, who contents herself with frying or boiling in haste. It is sometimes urged against the gas cooker that it is not so good for "slow cooking" as a coal range. Doubtless there is something in this argument, as it is probably easier to evade heat with a kitchen range than with a gas cooker. A solution of the difficulty lies in supplementing the gas stove with a hay box—not in retaining the coal range because, as its advocates say, it "bakes a rice pudding so nicely."

Gas Cooking.

Owing to the increasing popularity of the gas stove our cooking methods are less open to the charge of crudeness than are our ways of warming rooms and heating

water. There is reason to hope that we may level up these in time, because it is not so very long ago that women, who prided themselves on their housewifery, looked with suspicion and contempt upon the gas-cooker and were heard to proclaim that they would never demean themselves by using such a thing. To-day, thanks to much invention, research, and enterprise on the part of the gas undertakings—commercial and municipal—gas cooking is extremely popular. In London, for instance, nearly every house will be found to have its cooker or griller, and even the poorest people will have a gas-ring. The practice, followed by some municipal corporations, of lending and fixing gas cookers free of charge has done good service to the cause of smoke abatement.

We need not enlarge upon the advantages of gas for cooking. It is there when wanted without the trouble of lighting fires and carrying coals; it is clean and smokeless ; when cooking is over, there are no ashes to clear up and the periodical flue cleaning, so trying to the temper, is abolished. Most people appreciate these points, and expect to have gas-cookers in their houses, if they live in the area of a gas supply. This being so, there is no justification for the common practice of putting kitchen ranges into *new* houses. It is usual to put a gas-cooker in the scullery and to fix an anachronism in the shape of a range in the kitchen. For the most part, cooking will be done by gas and the kitchen range will be merely used to warm the room and supply hot water ; perhaps also for warming plates and keeping food hot ; and it may be, for cooking that rice pudding already referred to. As all these operations can be performed without a kitchen range, it is regrettable that private builders, and some local authorities, are continuing the use of a wasteful, smoke producing, and, discredited apparatus.

Gas Cooking under the Best Conditions.

Manufacturers have greatly improved gas cooking

it causes more labour than gas. If cooking alone were required, there would be no point in using either of these where a supply of gas is available ; but if it is desired to perform more than one operation by means of a single installation, then the question of using either of these fuels has to be considered. Coke fired cooking stoves have been in use for some time, and recently, new types, designed not only to cook, but to heat the domestic hot water supply, and to warm the rooms by means of radiators, have been placed on the market. We referred to these boilers in Chapter IV., in dealing with central heating. For use as cooking apparatus, they have an oven and a hot plate with rings on which boiling may be done. We have made careful enquiries about their cooking efficiency, and those who have used them state that the oven heating is entirely satisfactory and that they can do all kinds of cooking with the stoves.

The accompanying illustration shows two types of these boilers. In one the oven is beside the fire—in the other, above it. Both can be used with an open fire when cooking operations are not in progress, and they are therefore suitable for placing in a kitchen, living-room or scullery.

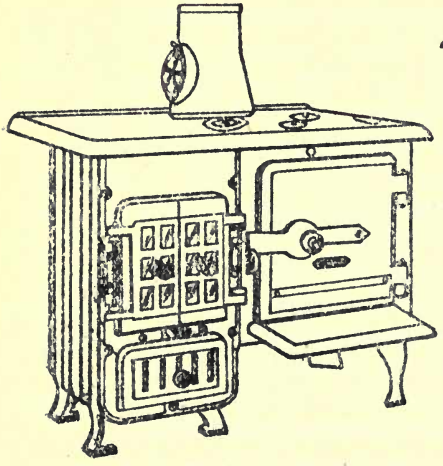

Fig. 3.

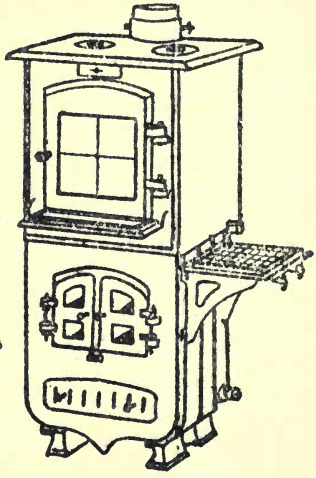

Fig. 4.

Dr. Fishenden made tests of these boilers and she found that the ovens heated well and that there was no diminution in the water heating efficiency when the oven was in circuit. In her opinion, when coke boilers are installed, it is desirable, on grounds of fuel economy, that they should be furnished with an oven and a hot plate.

Coal Cooking with a Minimum of Smoke.

There is no doubt that gas cooking is the best, since it is labour saving as well as smokeless, and that coke and anthracite come next in merit, having the advantage of smokelessness, but involving more labour than gas. From the smoke abatement point of view, cooking should be done with one of these fuels. It will, however, be urged that the Departmental Committee has pronounced that one coal grate in a house is permissible, and should not this, when a fire is burning, be used for some cooking operations at least? On grounds of economy this argument is sound, and the living room grate should be adaptable for cooking when in use for room warming purposes.

The modern, low, bar-less types of sitting-room grates can be fitted with ovens as well as back boilers, and there are now on the market a great many varieties of these grates, which combine the functions of an open fire and a cooking range. They are probably familiar to our readers under the different descriptive, if somewhat fanciful, names given to them in advertisements. They can be divided into two classes :—

(*a*) A shallow fireplace with an oven beside it, as illustrated in Fig. 5. This is frankly and undisguisedly a cooking apparatus. The low fire is, however, pleasanter in a living room than a kitchen range, and, although one cannot conceal the oven, this kind of grate has the advantage of being uncomplicated and easy to manage. The fireplace is shallow compared with an open range and does not tempt the housewife to waste fuel.

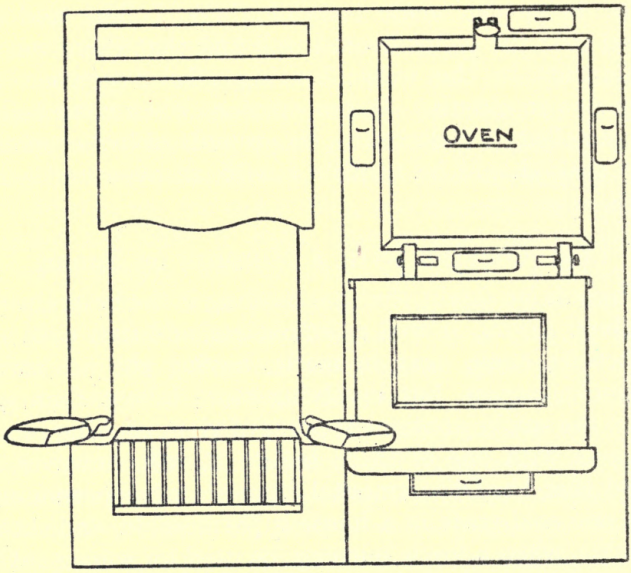

Fig. 5.

(*b*) The other type when used as an open fire, has the appearance of an ordinary sitting-room grate, (Fig. 6). The oven is above the fire, and its door simulates a canopy. When cooking operations are in progress, metal plates can be dropped over the open fire. The grate is then converted into a small closed range (Fig 7). When properly fixed and intelligently managed, these grates are efficient for cooking and room-warming and fairly so for water heating, though they cannot compare in this respect with the independent boiler. Their fuel capacity is small, which makes it actually difficult to waste coal. They cost no more in capital outlay than the old-fashioned ranges, which devour large quantities of fuel and produce much smoke.

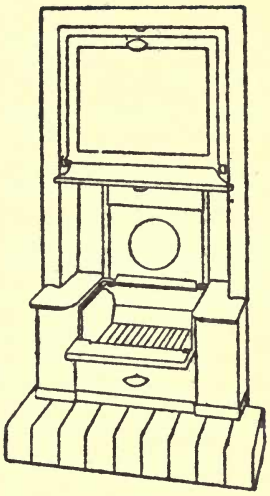

Fig. 6.
As open fire.

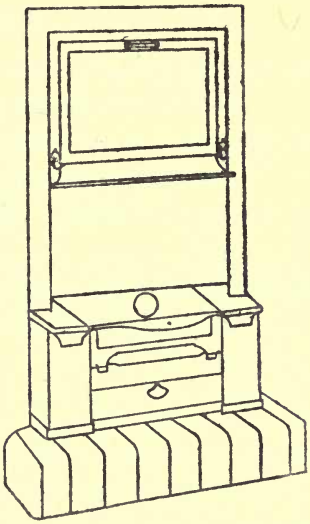

Fig. 7.
As closed range.

Housewives who prefer gas to coal cooking (and they are fairly numerous now-a-days) would probably not attempt to heat up the ovens in these grates, but would only use them as a rule for keeping food hot, warming plates and so on. Still, even the greatest enthusiast for gas should make use of a trivet attached to her coal grate, to boil saucepans, if she has a fire burning.

It must be admitted that this convertible type of grate is a little complicated and needs intelligent management and the choice of a suitable coal. But if we are going to have improved methods of heating and cooking, we must look for intelligence and skill in the use of apparatus. We cannot expect to achieve fuel economy and smokelessness without taking some trouble about the business.

The important point about these grates is the limited size of the fire, which can be started with a much smaller amount of coal than a kitchen range and can be maintained on a low fuel consumption. Hence less coal burnt and less smoke produced.

SUMMARY.

(1) No coal range of the Yorkshire or Lancashire type should ever be fixed in a new house.

(2) Wherever there is a gas supply, a gas cooker should be installed in every house.

(3) A range, burning coke or anthracite, is the next best.

(4) Where there is a solid fuel fire in the living room, it should be adapted for cooking.

CHAPTER VII.

LOW TEMPERATURE FUEL (COALITE).

THERE is only one way in which a complete solution of the domestic smoke problem might be attained in reasonable time : by the discovery of a smokeless solid fuel to replace coal. Even if our recommendations were generally acted on, there would still be some smoke in winter from that one coal fire ; and the great bulk of the smoke, that from existing houses, though it would be greatly decreased by the installation of gas cookers and fires, would only disappear as the houses were pulled down. As the life of the ordinary house is about 100 years, that is a long time to look ahead for any reform. But a smokeless solid fuel that would burn cheerfully and well, and would be no more expensive than coal, would alter the whole position. If such a fuel were available in adequate quantity and at a reasonable price, it would clearly be possible, it would in fact be the obvious duty of Parliament in the general interest, to prohibit the burning of raw coal in houses.

Such a fuel has actually been on the market for some years, though only intermittently and in small quantities. It is known to the public best under the proprietary name of " Coalite." The Coalite Company has successfully placed on the market several thousand tons of this smokeless fuel, and sold it at prices considerably in excess of best domestic coal.

The principle on which such fuels are made is now well known. Coal, suitable for coking, consists mainly of carbon, mixed with certain tarry and oily constituents. To make ordinary coke, the coal is heated to a high temperature in the absence of air, and all the tar is

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The principle on which such fuels are made is now well known. Coal, suitable for coking, consists mainly of carbon, mixed with certain tarry and oily constituents. To make ordinary coke, the coal is heated to a high temperature in the absence of air, and all the tar is

driven off. It is the tar and oil which enable the coal to be easily lit, and also cause smoke ; so that ordinary coke, from which they are completely absent, is smokeless and hard to light. To make a good domestic fuel the coal is heated to a much lower temperature (low temperature carbonisation), with the result that only a portion of the tar and oil is driven off. In this way a fuel is produced, known in scientific circles as low temperature coke or semi-coked coal, which is both easily lit and smokeless, and is, in fact, an almost ideally perfect domestic fuel.

As regards the suitability of a well-made semi-coked coal for domestic use, there is no doubt whatever. Such fuels have been on the market on a small scale for about 15 years, and hundreds of people have tested them exhaustively. Dr. Fishenden has recently made a series of tests [1] on semi-coked coals manufactured by the Fuel Research Department, and by various firms. She reports that the coke lights easily, and produces a smokeless, bright and very hot fire, which is easily kept going. Curiously enough it is more efficient than coal when burnt in the open grate ; where coal gives a radiant efficiency of 20 to 25 per cent., semi-coked coal gives 30 to 33 per cent. For water heating and oven heating the efficiency is about the same as coal.

The volume of semi-coked coal is nearly double that of an equal weight of coal, and this involves some extra labour in carrying and in feeding the fire.

Efforts have been made for many years and in various countries to put a good semi-coked coal on the market. There are many technical difficulties to be overcome which we need not refer to here, except to say that, although steady progress has been made, they can hardly be regarded yet as finally overcome. Much experimenting

[1] *The Efficiency of Low Temperature Coke.* Fuel Research Board Technical Paper No. 3.

is still going on, and continual improvements are being made.

But the technical difficulties are likely to prove less important than the economic difficulties. It is still quite uncertain at what price, in relation to household coal and gas coke, a good semi-coked coal can be manufactured. This depends on many unknown factors: on the cost of manufacture, on the overcoming of existing technical difficulties, on the market for the gas, which is difficult to sell at its full value owing to its abnormal richness, and on the price obtainable for the by-products, which differ from those now on the market and are therefore of uncertain value. It is equally uncertain at what price a general demand would arise for semi-coked coal. Although its calorific value is about the same as coal, in view of its superior radiant efficiency it is probably worth 20 per cent. more than coal for use in open fires.

An elaborate and valuable series of experiments on low temperature carbonisation have been carried on for the last two years by the Fuel Research Board, and plants are actually at work in Glasgow and Barnsley. It is to be hoped that the problem is near solution, but experts differ profoundly, and it is impossible to make any reliable estimate as to whether and when a semi-coked coal is likely to be placed on the market in large quantities and at an acceptable price.

The possibility and the uncertainty of this do not in any way affect our recommendations. Assuming the burning of semi-coked coal to become general, it will still save time and labour to cook by gas and to use it in rooms where heat is wanted quickly or intermittently; and an independent boiler will still be the best means for obtaining hot water and disposing of household refuse. The only difference in the new houses will be that semi-coked coal will replace raw coal in the one open fire. And what is much more important is that it will replace

coal in the old all-coal houses, and is probably the only way of making them smokeless.

There is no service that anybody can render to the cause of smoke abatement that is in any way comparable in importance with effective work for the successful and economical production of good semi-coked coal.

CHAPTER VIII.

CONCLUSION.

It now remains to sum up all the foregoing. Under the headings of the three services for which heat is required in a house, we have discussed different systems which, range from entire smokelessness down to methods which though not completely smokeless, are, as regards efficiency, the saving of labour and the amount of smoke produced, a great improvement on our present dependence on coal fires. The alternative systems may be set out and classified as follows :—

(*a*) *Entirely Smokeless.*—Central heating by means of a coke fired boiler which will also supply the domestic hot water. Supplementary (or auxiliary) heating by means of gas fires. Cooking done by gas or by the central heating plant, if the latter is provided with oven and hot plate.

(*b*) *Almost Entirely Smokeless.*—The same as the above, except that one coal grate is retained in a living room for supplementary heating.

(*c*) *Smokeless in Summer.*—Gas cooking. Independent coke-fired boiler for hot water supply ; preferably it should have an oven and hot plate and be placed where the heat can be utilised for drying clothes. Modern barless grate of small fuel capacity for the living room ; gas fires in other rooms.

(*d*) *Some Smoke all through the year but much less than on present methods.*—Coal grate in living room with oven ; hot water supply from boiler at back of grate Gas cooking and gas fires in all rooms but one.

The Standard House.

Under ordinary conditions, and where central heating is not available, the standard house would have the following heating arrangements :—

In the scullery a gas cooker, and a coke fired boiler. Hot water would be laid on from the boiler to the bath and sink, and ample hot water for baths, etc., would be available with a very moderate consumption of coke. The coke boiler would be useful for drying clothes and destroying refuse.

A convertible grate in the living room, which would generally be used as an open fire, and could also be used for cooking. It would never be used in summer, as all cooking would be done in the scullery.

Gas fires in the parlour and in all bedrooms.

We believe this to be an economical arrangement, both in first cost and in cost of fuel used ; to involve little labour for the tenant, and to provide all the services needed satisfactorily and well. It is quite smokeless in summer, and in winter will probably produce far less than half the smoke made by the ordinary all-coal house. Universally adopted it would reduce domestic smoke so much that it would hardly be a serious nuisance.

What Can Be Done.

We have made clear how new houses should in our opinion be equipped with regard to fuel consumption. It may be useful in addition to indicate the lines along which those who are prepared to take an active interest in domestic smoke abatement can—we consider—most effectively work. We have arranged our suggestions under five headings, roughly in accordance with their importance. Whether education or research should come first is difficult to say, as there is the most pressing need both of more knowledge, and of very much wider diffusion of existing knowledge. We have put research

first because as we have already stated, if a satisfactory smokeless solid fuel could be put on the market, the whole problem of domestic smoke would be solved almost at a stroke.

I. Research.

We have already laid stress on the need for more knowledge.

Subjects where further knowledge is urgently required are :—

(*a*) The regulation of coal fire draughts.

(*b*) The design of convenient and cheap central heating systems for small houses.

(*c*) The construction of coke heaters for hot water circulation and for cooking.

But entirely overshadowing in importance all the others is the problem of a smokeless solid domestic fuel. The Government has shown wisdom and foresight in investigating this matter through the Fuel Research Board, under the able direction of Sir George Beilby. It is much to be hoped that the Research Board will continue this valuable work with all energy, and that concrete results may emerge from the Barnsley and Glasgow plants. If such a fuel is to be effectively placed on the market in large quantities it can only be by the existing gas undertakings, who have a market both for the solid fuel and for the gas. There is no doubt that many of them realise the importance of endeavouring to produce such a fuel. Success would mean an enormous increase in the importance of what would then be better called, not the gas industry, but the gas and coke industry. It would be difficult to say which would be the main product and which the by-product.

II. Education of the Public.

Probably the most important and at the same time the most difficult question in connexion with domestic abatement is how to get the public interested. People

do not realise what smoke means to themselves and others, and even if they do, they almost invariably fail to realise their personal responsibility. There are probably 20 million coal fires in Great Britain ; what difference can it make if I take the trouble to get rid of my one or two ?

There could be no more fatal line of argument, and we can only appeal to the citizen's public spirit to realise that his first and most pressing duty is to set his own house in order.

But he may well continue with a much sounder argument : " Even if I want to, where can I get unbiassed and reliable advice as to how to replace my coal fires ? I can only go to a manufacturer of one kind of apparatus, and clearly I can't accept his statement as to the advantages of his own apparatus ; nor can I accept his competitors' criticisms. I may be let in for something quite unsuitable."

This is a very real difficulty. The householder in quest of improvements would have to spend a long time going from place to place to make his own comparisons, and at each he would receive prejudiced counsel. Very few people, even those with enthusiasm for reform, have the time and energy for this.

Mr. R. H. Clayton of Manchester, giving evidence before the Departmental Committee on Smoke Abatement, put forward a suggestion to meet this difficulty. He recommended special buildings, in some central thoroughfare, where heating and ventilating departments should be established. The buildings should have attractive and conspicuous exteriors so as to catch the attention of the citizens. In the vestibule at the entrance there would be demonstrations, by means of samples, charts and diagrams, of the waste and damage done by smoke. The interior would be divided up into rooms by partitions, which would be furnished and equipped with heating installations suitable for cottages

and small houses as well as for the homes of the rich. The existing show rooms are mostly arranged to interest people with plenty of money to spend, but progress in this matter of smokeless heating depends on interesting the general public as a whole. A demonstration is wanted where the average working-class woman can see that there are alternatives to the old-fashioned kitchen range, which she knows by experience produces a great deal of soot and gives her a great deal of trouble ; and middle class people, who want to dispense with servants and have labour-saving devices instead, should be able to see actual specimens and not depend on illustrated advertisements. All kinds of apparatus could be shown.

An essential feature of this scheme would be an engineer with a skilled staff, who would give scientific and unprejudiced advice, not only on smokeless methods of heating, but on ventilation as well—a point that is often neglected.

Architects and builders would find such an establishment useful when planning the heating and ventilation of new houses.

Such an institution could only be run by the local authority. The show rooms of the gas and electricity department would, of course, be in the building and would be under the control of their departmental staffs. Space could be let to manufacturers of all kinds of heating and ventilating apparatus, and, as everybody in search of such apparatus would go straight to the institution, it would be worth the manufacturers' while to pay a good rent. This would go some way towards the salary of the skilled staff. The staff would probably give general advice free of charge. Where actual plans were required a fee might well be charged.

The expense which would fall on the local authority under these conditions would be very small, and more than justified by the benefits.

The institution, if well designed and managed, would be invaluable to those seeking actual help in a specified case. But it would have an equally great value in educating the public. Thousands of people would be interested, and by a visit to the institution would learn for the first time how great is the damage done by smoke, and how in their own case they could do something to reduce it. For the chief duty of the central staff would be to induce people, not to sympathise generally, but to introduce smokeless apparatus in their own homes.

Another valuable method of educating the public is through the Press. We owe a debt of gratitude to Dr. C. W. Saleeby for his work in this connection. For years he has continued indefatigably to write instructive and interesting articles in many journals on the various aspects of the smoke problem. In particular he has given us most useful information about the facts in foreign countries. It is to be hoped that he will in future receive more help in what has been his almost single-handed task.

III. Cheap Gas and Coke.

Progress in smokeless heating means, in practice, increasing the use of gas and coke, and decreasing correspondingly the use of raw coal. It is clearly the duty of the government and municipalities to encourage this movement by all means in their power. And yet we find many municipalities actively hindering it, by deliberately putting a tax on the use of gas, while leaving the burning of raw coal free. This is not done openly in the form of an honest tax, so that the gas user may know what is happening, but is called a profit on the gas undertaking. But what does it mean? The undertaking must of course pay interest and sinking fund on the capital invested, and should accumulate any reserve fund that may be necessary. Any profit beyond that goes in relief of rates, and is nothing

but a direct tax on the use of gas. Now a tax on coal would be bad enough ; fuel is an absolute necessity, and everybody agrees that such a tax falls unduly on the poor, and is in every way a bad tax. But if fuel is to be taxed at all, why tax gas (often by as much as ten per cent. of its value) and leave coal fires ? Think what it means ; of two householders, living next door to one another, one has an all-coal house and pours forth smoke on his neighbour's garden all the year round ; the other takes the trouble to install central heating, gas cooker and gas fires and makes no smoke at all. The latter is taxed heavily on his gas, the former pays not a penny. Truly a curious way of encouraging smokeless methods !

The custom of Parliament in recent years when dealing with gas legislation has been to reduce or prohibit this tax on gas ; it is high time that a general act was passed rendering it once and for all illegal.

IV. Municipal Houses.

The Ministry of Health controls the houses built by municipalities down to the smallest detail. It is in a position to insist in each case on the best practicable heating methods. It is clearly its urgent duty to give this matter immediate and effective attention. As recommended by the Departmental Committee, " they should decline to sanction any housing scheme . . . unless specific provision is made for the adoption of smokeless methods for supplying the required heat."

V. Prohibitive Legislation.

The time has, in our opinion, come to prohibit the installation of the old fashioned and smoky kitchen range in any house. It also seems reasonable now to prohibit the fixing of coal fires in any new building, such as blocks of offices, hotels, etc., where central heating is installed. This would admittedly require careful consideration, as exceptions would have to

be made. The legislation should probably be in the form of power to the local authority to take the necessary action.

It is related that a certain Member of Parliament who had a speaking engagement, and was not feeling well, went to see a leading consultant, and asked whether he was fit to keep his engagement, which happened to be in Manchester. "Manchester?" said the consultant, "certainly not. Nobody is well enough to go to Manchester!"

That is perhaps only a slight exaggeration of what some people (mostly those who have never been there) feel about Manchester, mainly owing to its reputation for smoke and grime. It may be ridiculous, but there is admittedly some foundation for it. Manchester might be a much healthier and infinitely pleasanter place than it is, if the public would realise that smoke abatement is not a fad, but a business proposition, closely linked with, and no less important to the nation than, the great question of fuel economy. There are few fields of effort in which steady hard work will give a better return. It is a serious reflection on our technical education, on our scientific spirit, and, above all, on our business ability and common sense, that we continue to suffer apathetically and helplessly from our grimy atmosphere and, at the same time, to waste 20 million tons of coal a year in heating our houses.

New York and Paris and Düsseldorf are clean cities. London, Glasgow and Sheffield could be made equally clean, if we really wished it. And not only could we make them clean and attractive, but we could save millions of tons of coal in the process. Is it not very much worth while?

APPENDIX.

INQUIRY into the comparative cost of household washing in Manchester and Harrogate made by the Statistical Sub-Committee of the Manchester Air Pollution Advisory Board.[1]

The services of a trained investigator, one of the Public Health Inspectors of the Corporation, were placed at the disposal of the Statistical Sub-Committee. Her instructions were to obtain one hundred exact and comparable statements, for Manchester and Harrogate respectively, as to the cost of the weekly washing in working-class houses. To do this she had to pay a number of visits largely in excess of the number of estimates required, in order to be able to reject all unreliable material that did not furnish an exact basis of comparison. She carried out her investigations in the two towns in the months of July and August, 1918, under similar seasonal conditions, and she ascertained that the retail price of coal and washing materials was practically the same in Manchester and Harrogate. As far as possible she visited houses of the same class in both towns; the average weekly rent of the houses visited in Manchester was 5s. 11d. and in Harrogate 5s. 9d.

(*a*) *Time Lost.*—The investigator's returns show that, on an average, the weekly wash was one hour longer in the performance in Manchester than in Harrogate. There are in Manchester 112,616 small houses where the house-wives, as a general rule, do their own housework single-handed. If they all take one hour longer each

[1] Reprinted from pamphlet issued by the Air Pollution Advisory Board in 1919.

week to do the washing than they would do if they lived in a clean town, the sum total of time wasted in the course of a year is equivalent to 5,850,000 hours, or 668 years!

(*b*) *Money Lost.*—The inquiry showed that, as between Manchester and Harrogate, the extra cost of the Manchester wash in materials and fuel was 7½d. a week per household.

An extra cost of 7½d. per week is equal to a loss of £1 12s. 6d. per household per annum, and for the 112,616 families living in houses where housewives do their own washing, this amounts to a loss of £183,000 per annum.

It now remains to estimate the loss for the 36,742 families living in the larger houses. Most of these families send the whole or part of their washing to laundries, and their washing bills do not, as in the case of the Manchester-Harrogate investigation, represent the actual expenditure on washing materials, but include charges for collection, labour, and the laundryman's profits. These charges would vary between one laundry and another. It is not possible, therefore, to estimate the cost of middle-class washing on the basis of working-class washing. For the purpose, however, of arriving at an estimate of the loss on household washing for the whole City, it has been assumed that the loss in the larger households is the same as in the smaller ones, which is an extremely conservative assumption. On this basis the loss for the larger houses amounts to £59,705, making, with £183,000 for the families living in smaller houses, a total loss of £242,705 per annum. These figures take no account of the added wear and tear entailed by the extra washing involved. The whole of the figures, as contained in the inquiry, were submitted to the well-known firm of auditors, Messrs. David Smith, Garnett & Co. Their report verifying this estimate as correct follows.

61 BROWN STREET, MANCHESTER.

25th July, 1919.

The Chairman of the Statistical Sub-Committee
of the Air Pollution Board,
Civic Buildings, Manchester.

Dear Sir,

Atmospheric Pollution.

We have examined the statement upon which are based the figures given as the result of the investigation by an official of the Manchester Public Health Committee into the extra cost to households in the City of Manchester occupying houses of under 11s. weekly, as compared with the occupiers of similar houses in the town of Harrogate.

The investigation deals only with the extra cost incurred in the form of materials (soap, starch, etc., and fuel), and it entirely disregards the outlay caused by the extra labour. The figures based on this inquiry lead to the conclusion that the extra cost in the case of households occupying houses of under 11s. weekly may be taken at £183,000 per annum, which, as shown below, is equal to 7½d. per household per week.

Although the replies to the questionnaires addressed to households in Manchester occupying houses of 11s. per week and upwards indicates a very much higher weekly loss (namely, 1s. 4d. per week) than in the case of the lower rented households, we think it advisable, in order not to overstate the case, to estimate the loss for such households on the same basis as that of the lower rented houses. The total estimated extra cost may, therefore, be taken as under :—

112,616 families living in houses of less than 11s. per week, at £1 12s. 6d. (equal to 7½d. per week)	£183,000
36,742 families living in houses of 11s. per week and upwards at £1 12s. 6d. per annum (equal to 7½d. per week) ..	59,705
	£242,705

This sum of £242,705 is, in our opinion, a very conservative estimate.

Yours faithfully,

Signed, DAVID SMITH, GARNETT & CO.