before this migration. From being the idol of London society to being the pastor of a country parish with no educated neighbour within 7 miles was a violent change; but Sydney Smith accommodated himself cheerfully to his new circumstances, and won the hearts of his parishioners as quickly as he had conquered a wider world. Not the least entertaining chapter in his daughter's biography of him is the account of his Yorkshire life. An interesting contrast might be drawn between it and Carlyle's life in somewhat similar circumstances at Craigenputtock. Sydney Smith's life at Foston, with its cheerful energy and ingenuity, its vigorous jesting at difficulties and eccentric ways of conquering them, is of much better example, and moralists might do worse than put the story into form for general edification.[1]

Sydney Smith, after twenty years' service in Yorkshire, obtained preferment at last from a Tory minister, Lord Lyndhurst, who presented him with a canonry in Bristol cathedral in 1828, and afterwards enabled him to exchange Foston for the living of Combe Florey near Taunton. From this time he discontinued writing for the *Edinburgh Review* on the ground that it was more becoming in a dignitary of the church to put his name to what he wrote. It was expected that when the Whigs came into power Sydney Smith would be made a bishop. There was nothing in his writings, as in the case of Swift, to stand in the way, for with all his humour and high spirits he had always, as he said himself, fashioned his manners and conversation so as not to bring discredit on his reverend profession. He had been most sedulous as a parochial clergyman. Still, though he was not without warm friends at headquarters, the opposition was too strong for them. One of the first things that Lord Grey said on entering Downing Street was, "Now I shall be able to do something for Sydney Smith"; but he was not able to do more than appoint him to a prebendal stall at St Paul's in exchange for the one of inferior value he held at Bristol. Lord Melbourne is reported to have said that there was nothing he more regretted than the not having made Sydney Smith a bishop. Some surprise must be felt now that Sydney Smith's reputation as a humourist and wit should have caused any hesitation about elevating him to the episcopal dignity, and perhaps he was right in thinking that the real obstacle lay in his being known as "a high-spirited, honest, uncompromising man, whom all the bench of bishops could not turn upon vital questions." With characteristic philosophy, when he saw that the promotion was doubtful, he made his position certain by resolving not to be a bishop and definitely forbidding his friends to intercede for him. This loss and the much more painful loss of his eldest son did not destroy the cheerfulness of his later life. He retained his high spirits, his wit, practical energy, and powers of argumentative ridicule to the last. His *Letters to Archdeacon Singleton* on the Ecclesiastical Commission (1837), and his *Petition* and *Letters* on the repudiation of debts by the State of Pennsylvania (1843), are as bright and trenchant as his best contributions to the *Edinburgh Review*. Smith died in London on 22d February 1845.

Lady Holland's *Memoir* of her father, containing such specimens of his table talk as give one some idea of his charm and worth as a mirthful companion and philosopher, is one of the most interesting of biographies. A cheap edition of his *Works* was published in 1869. (W. M.)

SMITH, SIR THOMAS (1512-1577), the contemporary and friend of Sir John Cheke, was born at Saffron-Walden in Essex in 1512. He became a fellow of Queens' College, Cambridge, in 1531, and was afterwards appointed to read the public Greek lecture, in the discharge of which function he first introduced the new Greek pronunciation, which soon became universal in England. After studying in France and Italy and taking a degree in law at Padua, he was appointed first regius professor of civil law in Cambridge in 1542. During Somerset's protectorate he entered public life and was sent as ambassador first to Brussels and afterwards to France. In 1548 he was made a secretary of state and knighted. On the accession of Mary he was deprived of all his offices, but in the succeeding reign was frequently employed in public affairs. He died in 1577.

His best-known work, entitled *De Republica Anglorum: the Maner of Government or Policie of the Realme of England*, was published posthumously in 1583, and passed through many editions. His epistle to Gardiner, *De recta et emendata linguæ Græcæ pronunciatione*, was printed at Paris in 1568; the same volume includes his dialogue *De recta et emendata linguæ Anglicanæ scriptione*.

SMITH, WILLIAM (1769-1839), called "the father of English geology," and among his acquaintances "Stratum Smith," will be generally remembered as the framer and author of the first complete geological map of England and Wales, and as the discoverer of the principle of the identification of strata by their included organic remains. He was born at Churchill in Oxfordshire on 23d March 1769. Deprived of his father, an ingenious mechanic, before he was eight years old, he depended upon his father's eldest brother, who was but little pleased with his nephew's love of collecting "pundribs" (*Terebratulæ*) and "pound-stones" or "quoit-stones" (large *Echinites*, frequently employed as a pound weight by dairywomen), and had no sympathy with his propensity for carving sundials on the soft brown "oven-stone" of his neighbourhood. William became a mineral surveyor and civil engineer. In the former capacity he traversed the Oolitic lands of Oxfordshire and Gloucestershire, the Lias clays and red marls of Warwickshire, and other districts, studying their varieties of strata and soils. In 1791 he surveyed an estate in Somersetshire and observed the strata of the district. In 1793 he executed the surveys and completed the levellings for the line of a proposed canal, in the course of which he confirmed a previous supposition, that the strata lying above the coal were not horizontal, but inclined in one direction—to the eastwards—so as to terminate successively at the surface, and to resemble on a large scale the ordinary disposition of the slices of bread and butter on a breakfast plate—an illustration which he was wont to use on all occasions.

On being appointed engineer to the Somerset Coal Canal in 1794, he was deputed to make a tour of observation with relation to inland navigation. During this tour, which occupied nearly two months, and extended over 900 miles, he carefully examined the geological structure of the country, and corroborated his preconceived generalization of a settled order of succession in the several strata, a continuity of range at the surface, and a general declination eastwards. Five years subsequently he prepared a tabular view of the *Order of the Strata, and their embedded Organic Remains, in the neighbourhood of Bath, examined and proved prior to 1799*. From this period to 1812 he was completing and arranging the data for his large *Geological Map of England and Wales, with part of Scotland*, which appeared in 1815, in fifteen sheets, engraved on a scale of 5 miles to 1 inch. The map was reduced to smaller form in 1819; and from this date to 1822 separate county geological maps were published in successive years, the whole constituting a *Geological Atlas of England and Wales*. In January 1831 the Geological Society of London conferred on Smith the first Wollaston medal; and the Government, at the request of several English geologists, conferred upon him a life-pension of £100 per annum. The degree of LL.D. he received from Dublin, at the meeting of the British Association in that city in 1835. At such meetings he was nearly always

[1] See Lady Holland's *Memoir*, chaps. v., vi. Lady Holland, Sydney Smith's eldest daughter, was the wife of Sir Henry Holland, the famous physician,—not of Lord Holland, as is sometimes absurdly stated.

present. In 1838 he was appointed one of the commissioners to select building stone for the new Houses of Parliament. The last years of his life were spent at Hackness (of which he made a good geological map), near Scarborough, and in the latter town. His usually robust health failed in 1839, and on 28th August of that year he died at Northampton. He once said he was born on the Oolite, and should wish to be buried on it; and so he was, at Northampton.

His *Memoirs* by Professor John Phillips appeared in 1844.

SMITH, WILLIAM HENRY (1808-1872), best known as the author of *Thorndale*, is one of those thinkers and students whose work, whilst scarcely recognized in their own day and soon all but overlooked in the larger perspective of history, is yet of real value for an appreciation of the intellectual character of the time. The literary production of which *Thorndale* is the most representative example affords a moral countenance to contemporary workers in philosophy which is invaluable, but which for obvious reasons can never be exactly appraised. With a fine and reflective, rather than robust and active, intelligence, Smith deals suggestively in the form of conversation—which he adopts in *Thorndale* and in his later book *Gravenhurst*—with the problem of good and evil, with materialism and idealism, with most of the subtle modern perplexities in the interaction of religion, philosophy, and science. But his more exact contributions to thought, such as the *Discourse on the Ethics of the School of Paley* and the *Essays on Knowing and Feeling*, do not work out anything like a complete system, and are somewhat lacking in intellectual grip. Smith also wrote several books of verse and two plays, one of which, *Athelwold*, was produced by Macready in 1842. Much graceful reflexion and a true feeling for nature are found in his verse, but it lacks energy. Smith spent a serene uneventful life, chiefly in the studious seclusion which he loved, but which must have tended to foster the inactive tendencies that led him to call himself playfully in his latter days "the snail." He was born at Hammersmith in 1808 in comfortable surroundings, his father being a retired merchant; his mother was of German extraction, with a vein of mysticism, which is worth noticing in view of the son's metaphysical tendencies. He was sent in 1821 to Glasgow, where Byron's poetry and Scottish metaphysics seem to have had most influence upon him. Then he entered a lawyer's office, in which he remained for five years. His first writings appeared in the *Literary Gazette* and in the *Athenæum*, to which he contributed under the name of "Wool-gatherer," attracting some attention by the delicacy and finish of his style. His ambition was at the outset chiefly poetical, however, and, when his first book appeared and was almost completely ignored, he dug a grave and buried the unsold copies in a fit of Byronic despondency. *Ernesto*, a philosophical romance, also belongs to this early period. In 1836 he wrote for the *Quarterly Review*, and in 1839 he formed a connexion with *Blackwood's Magazine*, which lasted for thirty years, during the latter part of which he acted as its philosophical critic. In 1846 a visit to Italy led to the writing of a tale entitled *Mildred*, which was too purely reflective to be successful. In 1851 he declined the chair of moral philosophy at Edinburgh, having determined a year or two previously to retire to the English Lake district, there to study in seclusion. There he completed *Thorndale*, which was published in 1857. *Gravenhurst* appeared in 1862; a second edition contained a memoir of the author by his wife. He died at Brighton on 28th March 1872.

SMITH, SIR WILLIAM SIDNEY (1764-1840), English admiral, was the second son of Captain John Smith of the Guards, and was born at Westminster on 21st July 1764. He entered the navy, according to his own account, "at the beginning of the American War," being only about eleven years of age. For his bravery under Rodney in the action near Cape St Vincent in January 1780, he was on 25th September appointed lieutenant of the "Alcide." After serving in the actions against the French fought by Graves off Chesapeake in 1781 and by Rodney at the Leeward Islands in 1782, he was on 6th May of the latter year promoted to be commander of the "Fury" sloop, and on 18th October advanced to the rank of captain. His ship having been paid off in the beginning of 1784, he spent two years in France and afterwards visited Spain. From 1790 to 1792 he was employed in advising the king of Sweden in the war with Russia, receiving for his services the honour of knighthood. After his return to England he was sent on a mission to Constantinople, and, having joined Lord Hood at Toulon from Smyrna in December 1793, he burnt the enemy's ships and arsenal. In the following years he cleared the Channel of French privateers; but, having with the boats of his squadron boarded in Havre-de-Grâce harbour a lugger which was driven by the tide above the French forts, he was on 19th April 1796 compelled to surrender and sent a prisoner to Paris. By means of forged orders for his removal to another prison he made his escape from the Temple, and, crossing the Channel in a small skiff picked up at Havre, arrived in London on 8th May 1798. In October he was sent as plenipotentiary to Constantinople. Learning of Buonaparte's approach to St Jean d'Acre, he hastened to its relief, and on 16th March 1799 captured the enemy's flotilla, after which he successfully defended the town against several furious attacks of the French, compelling Napoleon on 20th May to raise the siege and retreat in disorder, leaving all his artillery behind. For this brilliant exploit he received the special thanks of the Houses of Parliament and was awarded an annuity of £1000. Subsequently he co-operated with Abercromby, under whom he served as brigadier-general at the battle of Aboukir, where he was wounded. On his return to England he was in 1802 elected M.P. for the city of Rochester. In March 1803 he was commissioned to watch the preparations of the French for an invasion of England. Having on 9th November 1805 been promoted to be rear-admiral of the blue, he was in the following January despatched on secret service for the protection of Sicily and Naples. He relieved Gaeta and captured Capri, but on 25th January 1807 received orders to proceed to Malta, whence he joined Sir John Duckworth, who was sent to act against the Turks. On 7th February, with the rear division of the squadron, he destroyed the Turkish fleet and spiked the batteries off Abydos. In November following he was sent to blockade the Tagus and was mainly instrumental in embarking the Portuguese prince regent and royal family and sending them under safe protection to Rio de Janeiro, after which he was sent as commander-in-chief to the coast of South America. On 31st July 1810 he was made vice-admiral of the blue and on 18th July 1812 was despatched as second in command under Sir Edward Pellew to the Mediterranean, but the expedition was uneventful. His term of active service practically closed in 1814. He was made K.C.B. in 1815 and in 1821 admiral. The later years of his life were spent at Paris, where he died on 26th May 1840.

See Barrow's *Life of Admiral Sir W. S. Smith*, 2 vols., 1848.

SMOKE ABATEMENT. The nuisance created by coal smoke seems to have been recognized in London as early as the reign of Queen Elizabeth; but it is only in more modern times that the question has come to be regarded as one of real practical importance, and even yet it is far from receiving that general attention which it demands.

In 1785 the first smoke-abating invention was patented by James Watt, who, as the inventor of the steam-engine, is responsible for so many boiler fires and so much consumption of coal. In 1815 Cutler patented the first would-be smokeless grate for domestic purposes; and his principle of feeding underneath was afterwards adopted by Dr Neil Arnott in a grate which has now been in use in one form or another for more than half a century. There is now a vast number of such inventions, good and bad. In 1819 the attention of parliament was directed to the question, and a select committee was appointed "to inquire how far persons using steam-engines and furnaces could erect them in a manner less prejudicial to public health and comfort." This committee gave an encouraging report. In 1843 another select committee recommended the introduction of a bill prohibiting the production of smoke from furnaces and steam-engines. In 1845 yet another select committee reported that such an Act could not in the existing state of affairs be made to apply to dwelling-houses. The Acts of 1845 and 1847 followed as the results of these inquiries; and since then there has been much legislation brought to bear on factories and railways. The results have been most beneficial; but very much still remains to be done. One is apt to think that, because steam-engines and factories consume individually much more coal than dwelling-houses, they alone are responsible for the smoke nuisance, forgetting how greatly the dwelling-houses outnumber the factories. In reality there is little doubt that domestic fires are mainly responsible for the smoky condition of the atmosphere of our towns; and they for the most part continue to evolve smoke undeterred by legislation or scientific invention. In 1881, however, a movement was commenced by the National Health Society and the Kyrle Society, which resulted in a great smoke-abatement exhibition being held at South Kensington. At the close of the exhibition a national smoke-abatement institution, with offices in London, was incorporated by authority of the Board of Trade.

Combustion of coal.

A knowledge of the nature of coal and of the chemical changes that it undergoes when burnt is essential for an understanding of the smoke problem. More detailed information on these points is given under COAL, where the several varieties are described. For the purposes of this article coals may be classified as smoke-producing and smokeless, the former including all those varieties most commonly used as fuel. The elementary constituents of such coals are carbon (generally about 80 per cent. of the whole), hydrogen, nitrogen, oxygen, and sulphur; and they also contain a varying quantity of earthy impurity or ash. The process which occurs in a coal fire consists of two distinct operations. The first, which requires a comparatively low temperature and is independent of the presence of air, is one of destructive distillation, and is similar to that which occurs in the retorts of gasworks. It results in the decomposition of the coal, and in the rearrangement of its constituent elements and the formation of the following substances:—(1) hydrogen, marsh gas, carbonic oxide, olefiant gas, benzine, other hydrocarbons of the type of marsh gas or of benzine, water,—all of which are either gaseous at the temperature at which they are formed or capable of being converted into gas at somewhat higher temperatures, and all of which are combustible except the water; (2) ammonia and other compounds of nitrogen, and certain compounds of sulphur, which are also volatile and combustible; (3) coke, which consists of carbon (and ash) and is non-volatile but combustible. It is these products of distillation, not the coal itself, that burn, in the strict sense of the word; and this second process requires the presence of air and also a much higher temperature than the first. If the combustion is perfect, the only products are (1) water-vapour, (2) carbonic acid, (3) nitrogen, and (4) sulphurous acid, the first of which contains all the hydrogen originally present in the coal, the second all the carbon, the fourth all the sulphur, while the nitrogen is liberated as such together with the very much larger volumes of nitrogen derived from the air which has supplied the necessary oxygen. All these products of combustion are discharged through the chimney.

Two things are necessary for the ensuring of such complete combustion, viz., an adequate, but not too large, supply of air, properly administered, and the maintenance of the requisite temperature. In practice, however, these conditions are never perfectly fulfilled, and consequently the combustion of coal is always more or less imperfect and gives rise to a complex mixture of vapours. This mixture contains not only the combustion products already mentioned but also the following unburnt or partly burnt distillation products:—(5) hydrogen, (6) hydrocarbons, (7) carbonic oxide, which contains a lower proportion of oxygen than carbonic acid, (8) unburnt carbon in a very finely divided state,—and also considerable volumes of unused air.

Usually the name "smoke" is applied to this vaporous mixture discharged from a chimney only when it contains a sufficient amount of finely divided carbon to render it dark-coloured and distinctly visible. The quantity, however, of this particular ingredient is apt to be overrated. It always bears an extremely small proportion to the vast volumes of water-vapour, carbonic acid, and nitrogen with which it is mixed; it probably never amounts, even in the worst cases, to 3 per cent. of the weight of the coal from which it is formed; and its importance, reckoned in terms of so much fuel wasted, is certainly not greater than that of the unburnt hydrogen and hydrocarbons. It is perhaps best to use the name "smoke" for all the products of imperfect combustion (5 to 8) which are avoidable, as contrasted with the necessary and unavoidable ingredients (1 to 4) of the mixture. The problem of smoke abatement is thus seen to resolve itself into the problem of the production of perfect combustion.

The first advantage to be gained by the solution of this problem is an important saving in fuel. It has been calculated that at least twice as much coal is used in boiler fires and six times as much in domestic fires as is theoretically required for the production of the effects obtained. A considerable portion of this loss is due to causes other than those that can be treated of here, and some is certainly unavoidable; but there is no doubt that much of this enormous waste could be prevented by improved methods of combustion, such as would solve the smoke problem. The second advantage to be looked for is a great gain in cleanliness and public convenience. Not only would there be an end to sooty chimneys but the atmosphere of towns would no longer be polluted as it is now by the discharge of unburnt carbon, whose total quantity is enormous, though the amount contained in any given puff of smoke is very small. The "London fog" would be a thing of the past,—not because fogs would become any less frequent than now in London and other large cities, but because they would lose their distinctive character of grimy opacity. It is often stated that these fogs are *caused* by the smoke that blackens them; but this is an error. The combustion of coal is certainly responsible for their existence, but it is the sulphur of the coal (oxidized ultimately to sulphuric acid), and not the carbon, that is the active agent. And so long as coal is burnt at all this manufacture of sulphuric acid and of fogs must continue; it is not to be got rid of by improved methods of combustion, though the character of the fogs may be materially altered for the better. The evil effects of town air on plant life and human lungs, also often attributed to preventible smoke, are in like manner due to this non-preventible sulphuric acid. The great gain in cleanliness, however, that would follow the abolition of smoke cannot be overrated.

The methods that have been suggested for the abolition of smoke may be divided into two great classes, viz., those that seek to attain this end by improving the appliances for the burning of bituminous coal, and those that propose to abolish its use and substitute for it some other kind of fuel. The proposals of the first class may be divided into those applicable to domestic purposes and those applicable to boiler fires and other large-scale operations. Those of the second class may be divided according to the nature of the fuel which they suggest. The innumerable inventions of the first class depend for their success (so far as they are successful) on the attention bestowed on the scientific requisites for complete combustion, viz., a sufficient but not too great supply of air, the thorough admixture of this air with the products of the destructive distillation of the coal, and the maintenance of a high temperature within the fire. In our old and crude methods the facts which most militate against the attainment of these desiderata are—(1) that large masses of fresh fuel are continually being thrown on at the top, which cool down the fire just at that point where highest temperature is required; (2) that the products of the distillation of this fresh fuel, heated from below, do not get properly mixed with air till they have been drawn up the chimney; (3) that unduly large volumes of cold air are continually being sucked up through the fire, cooling it and carrying its heat away from where it is wanted, and yet without remedying the second evil. In the improved methods regularity of supply of both fuel and air is sought so as to maintain a steady evolution of distillation products, a steady temperature, and a steady and complete combustion. In many cases it is sought to warm fresh air before it enters the room by a regenerative system, the heat being taken from the escaping gases which would otherwise carry it up the chimney; and in some cases the air which feeds the fire is heated in the same way.

We cannot here discuss the merits of individual inventions; but we may summarize the chief results of the tests applied at the South Kensington Exhibition. These tests, for domestic grates and stoves, included a chemical examination of the chimney gases, observations of the "smoke-shade" as indicating the proportion of unburnt carbon, and a record of the amount of coal burnt, of the rise of temperature produced, of the radiation, and of the amount of heat lost by being carried away through the chimney. Domestic grates and stoves were divided into six classes as follows:—(1) open grates having ordinary bottom grids and upward draught; (2) open grates having solid floors (adapted for "slow combustion") and upward draught; (3) open grates fed from below,—supplied with fresh fuel beneath the incandescent fuel; (4) open grates fed from the back or from the sides or from hoppers; (5) open grates having downward or backward or lateral draught; (6) close stoves. Each of these classes was subdivided according as the apparatus was "air-heating" or "non-air-heating," *i.e.*, according as an attempt was or was not made to save heat on the regenerative principle. This attempt does not appear to have been distinctly successful in any class except the fifth; indeed the evidence of the tests as a whole is rather against the air-heating principle. The following table gives the average results of tests for each class and sub-class as regards general rise of temperature and radiation per pound of coal and smoke-shade. The figures under the last head refer to a standard of shades ranging from 0 (smoke imperceptible) to 10 (black and dense). It was found in practice that the results of

this smoke-shade test were in general accord with those of the chemical examination of the chimney gases. The letters "a" and "n" in the first column signify air-heating and non-air-heating respectively, the average results for the whole class being given before those for each sub-class. All the experiments were made with Wallsend coal, a fair representative of the bituminous coals.

Class.	No. of appliances tested.	Average rise of temp. per lb of coal per hour, in degrees Fahr.	Average radiation per lb of coal per hour, in degrees Fahr.	Average smoke-shade.
1	19	2·88	3·58	3·01
„ a	9	3·37	2·88	3·22
„ n	10	2·45	4·21	2·78
2	12	2·99	4·07	3·23
„ a	2	2·81	3·93	4·11
„ n	10	3·02	4·09	3·09
3 n	5	3·81	3·61	2·82
„ a	non	...	...	...
4	6	3·05	3·14	2·66
„ a	2	2·41	2·42	2·23
„ n	4	3·37	3·50	2·88
5	18	3·38	3·70	2·73
„ a	11	3·45	4·00	2·29
„ n	7	3·28	3·22	3·21
6	10	4·14	1·66	2·11
„ a	2	3·79	1·78	1·58
„ n	8	4·23	1·64	2·25
1-5 (total average).	60	3·22	3·62	2·89

From this table the following facts, among others, may be deduced:—(*a*) the air-heating principle has not been applied with success except in class 5; (*b*) close stoves (class 6) are superior to open grates (total average of classes 1-5) in respect of freedom from smoke and of general heating effect, but they are greatly inferior in radiating power,—a deficiency which partly explains their unpopularity in the United Kingdom; (*c*) the "slow-combustion" principle gives a high radiation factor, but is otherwise not successful; (*d*) the class of air-heating grates with downward, backward, or lateral draughts is, on the whole, most efficient.

Much attention has been devoted for many years to the question of how to work boiler fires, both for locomotives and for fixed appliances, with the least possible production of smoke and the greatest possible evaporative power. Here the desiderata are essentially the same as in the case of domestic fires, viz., adequate admixture of the combustible vapours given off by the coal with the necessary air and the maintenance of a high temperature; and the principles involved are consequently also the same, though the appliances are necessarily different. These improvements may be all classed under one or other of two heads, according as the mode of supplying the fuel or the mode of supplying the air is the subject of the improvement. These two kinds of improvement may of course be combined. The article FURNACE may be consulted: see also STEAM-ENGINE, sect. "Boilers."

In the old forms of furnace fresh fuel, as it is wanted, is supplied by hand labour, the furnace doors being opened and large quantities of coal thrown in. One result of this is the inrush of great volumes of cold air, which, aided by the equally cold fuel, lowers the general temperature of the furnace. Mechanical stokers meet this difficulty by supplying the coal regularly in small quantities at a time. They may be divided into those which deliver the coal at the front and gradually push it backward, those which scatter it generally over the surface of the grate, and those which raise it from below so that the products of its distillation pass through the already incandescent fuel. The mechanism by which these results are attained is often of a complex nature.

It is generally recognized that air cannot be efficiently supplied to the furnace if admitted only in front, and accordingly there have been many plans devised for supplying it also at the back. In some cases currents of air are induced by steam-jets; but this plan has not proved very successful. The best inventions are on the regenerative principle. In them the air, before entering the furnace, is made to circulate through chambers heated externally by the products of combustion, and, having thus acquired a high temperature and absorbed heat that would otherwise have been lost, is admitted through openings at the bridge. Many of these appliances are almost absolutely smokeless, and they are much in use.

The advocates of the total or partial disuse of smoke-producing coals are variously in favour of the following substitutes—anthracite, coke, liquid fuel, and gas.

For some purposes anthracite and other coals containing a high percentage of carbon may be, and have long been, advantageously used as fuel. They yield a much smaller percentage of distillation products than ordinary coals, and produce no smoke, or almost none. But they are difficult to ignite, and in small fires difficult to keep burning; they give very little flame, and are comparatively expensive, so that they are under considerable disadvantage as compared with the usual kinds of coal. Many of the grates and stoves exhibited at South Kensington were specially devised for burning anthracite, and some of them are decidedly successful; but it is not likely that anthracite will ever take the place of bituminous coal to any great extent in the British Isles. There the great coal-fields undoubtedly are the natural sources of fuel, and no proposal involving a complete neglect of this fact can ever be successfully carried out.

This remark, however, does not apply to the use of coke and of gas, which are themselves made from coal. Coke is produced in large quantities both for its own sake and as a bye-product in the manufacture of gas for lighting purposes, and is largely used in various kinds of furnace. It gives no smoke; but it resembles anthracite also in being but ill adapted to use in open grates on account of the difficulty of ignition and the absence of flame (see FUEL).

In America, where natural petroleum is obtained in such enormous quantities, the experiment has been made of using it as the source of heat for boilers. A jet of superheated steam (at about 600° Fahr.) is blown into the hot combustion chamber and the oil and air enter mixed with it. The results are said to be excellent,—the fire smokeless and the efficiency high. The residue from coal-tar, after the naphtha and light oils have been recovered from it, can also be advantageously used in this way. The chief disadvantage attending the use of liquid fuels such as petroleum seems to lie in the fact that they are somewhat dangerous, fatal accidents having occurred in America; and the range of their application is necessarily limited. To use them for the heating of houses is of course quite out of the question.

Of all the schemes and inventions for the abatement of smoke that one which proposes to distil coal in one operation, and to burn the products of the distillation in another and quite separate operation, is without doubt the most thoroughly scientific; and to it, rather than to patent grates and furnaces, we must look for the ultimate solution of the question. Many arguments may be adduced in favour of gas-heating as opposed to coal-heating, the most important of which are here briefly given. (1) Coal gives, on distillation, not only gas and coke, which are both good heating agents, but intermediate products, many of which are of commercial value; these include ammonia, benzine, carbolic acid, anthracine, &c. As science advances the value of coal-tar will probably be enhanced by further discoveries; already it gives the raw material for the preparation of numberless beautiful dyes, of antiseptics, and of some drugs, and quite lately a substance described as an admirable substitute for sugar has been prepared from it. All these intermediate products are now, according to our barbarous methods of burning coal, used simply as fuel. (2) Gas can be laid on in pipes to any spot, can be lit or turned out at any moment, and can be so managed that less heat is frittered away and more applied to the specific object than in the case of coal-burning. (3) It produces no smoke and leaves no ash or cinder, so that cleanliness is attained and much labour and expense are saved. (4) The coke produced during the preparation of the gas has uses of its own as solid fuel and for other purposes. (5) As has been already said, sulphur is an ingredient of all coals, and sulphuric acid is one of the necessary results of burning them, not to be got rid of by "smoke abatement." Coal gas, however, can to a great extent be freed from sulphur compounds, and it is possible that the purification methods in vogue may hereafter be improved, so that we have here a means, if any exist, of curing the chief evils of our present system,—injury to our respiratory organs, production of fogs, and destruction of vegetation in towns. The principal disadvantage of the proposal is to be found in the high cost of coal gas, which now varies generally from 3s. to 4s. per 1000 cubic feet, whereas it has been calculated that it would have to cost not more than 1s. or at most 1s. 6d. to compete successfully with coal. There is no doubt, however, that the cost might, and it probably will, be brought down to this, as the high rate is due to causes not inherent in the nature of things. Sir William Siemens proposed that two sets of mains should be laid in English towns, one for heating and one for lighting gas, and showed that the first and last portions of every preparation of gas are possessed of very low illuminating power, but if collected apart would do excellently for heating purposes, while the rest would be improved for lighting. It is probable, however, that electricity will ultimately drive gas out of the field as an illuminating agent and that it will then be relegated to its true place as a heating agent. When that is done coal will no longer be burnt as a whole, but only those of its products (gas and coke) which are good for heating and for nothing else.

Meanwhile, ordinary coal gas has already, expensive as it now is, been largely applied to certain purposes, notably to cooking stoves and other domestic requirements, to gas-engines (in which the generation of steam is unnecessary), and to bakers' ovens; and these inventions are calculated materially to diminish the smoke nuisance. In order to obtain an economical gas capable of being generated on the spot and used for operations on a large scale, Sir W. Siemens devised a gas-producer in which coal is partially burnt in a limited atmosphere and is wholly converted into gaseous products (chiefly carbonic oxide), only the ash being left. This "producer-gas" is a weak fuel, being largely diluted with atmospheric nitrogen, and is therefore inapplicable to domestic purposes; but for many others it suits admirably, one of the best examples of its application being Siemens's own regenerative gas furnace for melting steel (see SIEMENS). Other gas-producers have been patented, and the cost of the gas so made is as low as 4d. per 1000 cubic feet, or even less. It is probably, however, but a temporary substitute for true coal gas. In the use of this latter we shall, without doubt, find the true scientific solution of the smoke-abatement problem. As an example of what gaseous fuel can do, it may be mentioned that in Pittsburgh in Pennsylvania the furnaces are now being fed by natural oil gas and that that city, once one of the dirtiest of manufacturing towns, is becoming one of the cleanest.

Literature.—The specifications of patents may be consulted. See also C. W. Williams, *The Combustion of Coal and the Prevention of Smoke* (London, 1858); W. W. Barr, *Practical Treatise on the Combustion of Coal* (Indianapolis, 1879); *Official Report of the Smoke-Abatement Committee* (London, 1882); *Smoke-Abatement Exhibition Review* (London, 1882); and papers and discussions in the *Journal of the Society of Chemical Industry*, 1881 and following years. (O. M.)

SMOLENSK, a government of middle Russia, belonging partly to Great Russia and partly to White Russia, is bounded by Moscow and Kaluga on the E., Orel and Tchernigoff on the S., Moghileff and Vitebsk on the W., and Pskoff and Tver on the N. It covers an area of 21,638 square miles in the west of the great central plateau, its northern districts extending towards the hilly region of the Valdais, where the flat-topped gentle declivities reach about 1000 feet above the sea. The rivers being deeply cut in the plateau, the surface is also hilly in the western districts (Smolensk, Dorogobuzh), whence it slopes away gently towards immense plains on the east and south. Carboniferous limestones, containing a few layers of coal (in Yuchnoff) and quarried for building purposes, occupy the east of Smolensk; white Chalk appears in the southern extremity; while Tertiary sands, marls, and ferruginous clays cover all the west. The whole is overlain with a thick sheet of boulder clay, with irregular extensions to the north; Post-Tertiary sands are spread over wide surfaces; and peat-bog fills the marshy depressions. The soil, mostly clay, is generally unfertile, and stony and sandy in several districts. Many large rivers belonging to the basins of the Volga, the Oka, the Dnieper, and the Dwina have their origin in Smolensk. The Vazuza and the Gzhat, both flowing into the Volga, and the Moskva and the Ugra, tributaries of the Oka, are channels for floating timber. The two tributaries of the Dwina—the Kasplya and the Mezha—are of much more importance, as they and their affluents carry considerable numbers of boats to Riga. The Dnieper takes its origin in Smolensk and waters it for more than 300 miles; but neither this river nor its tributaries (Vop, Vyazma, Sozh, and Desna), whose upper courses belong to Smolensk, are navigable; timber only is floated down some of them. Many small lakes and extensive marshes occur in the north-west. One-third of the area is under forests. The population of Smolensk reached 1,191,172 in 1882, of whom only 106,133 lived in towns, and consists of White Russians in the west (46·7 per cent.), Great Russians in the east (42·6), and of a mixed population of both (10·4). Nearly 1000 Jews and 1000 Poles are scattered through the towns.

The climate is like that of middle Russia generally, although the moderating influence of the wet climate of western Europe is felt to some extent. The average yearly temperature at Smolensk is 45°·5 Fahr. (January, 13°·5; July, 67°·2). Notwithstanding the unproductive soil and the frequent failures of crops (especially in the north-west), the chief occupation is agriculture. In 1884 3,040,000 acres were under crops, and 2,379,600 quarters of grain of various kinds were raised (2,930,400 in 1883),—the potato crop yielding 5,498,400 bushels. Nearly all the land is cultivated by the peasant communes,—only 766,500 acres (out of 6,868,900) in the hands of single individuals being under cultivation. Oats are an important crop. Hemp and flax are largely raised and exported. Cattle-breeding stands at a low level; the cattle of the peasantry suffer from a want of meadow and pasture land, which is mostly in private ownership. In 1882 there were 329,850 horses, 349,000 horned cattle, 401,000 sheep, and 162,000 pigs. The peasantry are mostly very poor, in consequence not only of the desolation inflicted on Smolensk in 1812, the effects of which are still felt, but also of insufficient allotments and want of meadows. Gardening and bee-keeping, which formerly flourished, have almost disappeared. The timber trade and boat-building are important sources of income, but do not furnish employment for all who are in need of it; more than one-half of the male population of west Smolensk leave their homes every year in search of work, principally as navvies throughout Russia. The manufactures are developing but slowly, and in 1882 employed only about 5100 workmen,—their annual production being valued at £328,800; of this amount the distilleries yielded nearly one-third. A few cotton-mills in the east have a production valued at £62,160 per annum. A lively traffic is carried on on the rivers, principally the Kasplya, the Obzha, and the Ugra, where corn, hemp, hempseed, linseed, and especially timber are shipped to the amount of nearly £400,000 annually. A considerable quantity of corn is imported into the western districts. Smolensk is crossed by two important railways, from Moscow to Warsaw and from Riga to Saratoff; a branch-line connects Vyazma with Kaluga. The educational institutions embrace eleven gymnasia and progymnasia (830 boys and 1402 girls), and 394 primary schools (15,031 boys and 2142 girls). Smolensk is divided into twelve districts, the chief towns of which, with their populations in 1882, are—Smolensk (see below), Byelyi (7150), Dorogobuzh (8400), Duhovshina (3660), Elnya (4850), Gzhatsk (7050), Krasnyi (3550), Poryetchie (4650), Roslavl (9050), Sytchevka (5720), Vyazma (13,000), and Yuchnoff (3230).

SMOLENSK, capital of the above government, is situated on both banks of the Dnieper, at the junction of the railways from Moscow to Warsaw and from Riga to Orel, 262 miles by rail west-south-west of Moscow. The town, with the ruins of its old kremlin, is built on the high crags of the left bank of the Dnieper, its suburbs extending around and on the opposite bank of the river. Its walls are now rapidly falling into decay, as well as all other remainders of its past. The cathedral was erected in 1676-1772, on the site of a more primitive building (erected in 1101), which was blown up in 1611 by the defenders of the city. The picture of the Virgin brought to Russia in 1046, and attributed to St Luke, which is kept in this cathedral, is much venerated throughout central Russia. Two other churches, built in the 12th century, have been spoiled by recent additions. Smolensk is neither a commercial nor a manufacturing centre; its population was 35,830 in 1882.

Smolensk, one of the oldest towns of Russia, is mentioned in Nestor as the chief town of the Crivitchis, situated on the great commercial route "from the Varyaghs to the Greeks." It maintained a lively traffic with Constantinople down to the 11th century, when the principality of Smolensk included Vitebsk, Moscow, Kaluga, and parts of the present government of Pskoff. The princes of Kieff were often recognized as military chiefs by the *vyetche* (council) of Smolensk, who mostly preferred Mstislaff and his descendants, and Rostislaff Mstislavovitch became the head of a series of nearly independent princes of Smolensk. From the 14th century these last fell more and more under the influence of the Lithuanian princes, and in 1404 Smolensk was annexed to Lithuania. In 1449 the Moscow princes renounced their claims upon Smolensk; nevertheless this important city, which was both a stronghold and a commercial centre with nearly 100,000 inhabitants, was a constant source of contention between Moscow and Lithuania. In 1514 it fell under Russian dominion; but during the disturbances of 1611 it was taken by Sigismund III. of Poland, and it remained under Polish rule until 1654, when the Russians retook it; in 1686 it was definitively annexed to Russia. In the 18th century it played an important part as a basis for the military operations of Peter I. during his wars with Sweden. In 1812 it was well fortified; but the French took it, when it suffered much from conflagrations, and generally, during the war.

SMOLLETT, TOBIAS GEORGE (1721-1771), novelist, was born at Dalquhurn, in the valley of Leven, Dumbartonshire, in 1721. His buoyant humour and energy were the gifts of nature, and early experience furnished him with abundant provocation for the harsh and cynical views of human nature to be traced in his novels. At a very early age he was placed in a position calculated to harden the heart of a proud and sensitive child. His father, the youngest son of the laird of Bonhill, a Scottish legal dignitary, married against the ambition of his family, and died young, leaving three children, of whom the future novelist was the second son, entirely unprovided for. The boy, being thus left dependent on the charity of relatives, grudgingly and insolently bestowed, as it seemed to him, learned to look with suspicion on kindly professions. He seems to have received the ordinary book education of the place and period. He was sent to the neighbouring grammar-school of Dumbarton—taught at the time by one of the most eminent schoolmasters in Scotland—and thereafter to the university of Glasgow. He wished then to enter the army, as his elder brother had done, but much against his will was apprenticed to a surgeon. His