they are greatly inferior in radiating power; (c) the "slow-combustion ” principle gives a high radiation factor, with a lower consumption of fuel, but is otherwise not successful; (d) the class of air-heating grates with downward, backward, or lateral draughts and with a large surface of fire-brick for radiating heat is, on the whole, most efficient (see Heating).

In boiler fires, both for locomotives and for fixed appliances, the desiderata are essentially the same as in the case of domestic fires; 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.

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 “ coking ” stokers, which deliver the coal at the front and gradually push it backward; “ sprinkling ” stokers, which scatter it generally oyer the surface of the grate; and " underfeed ” stokers, 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 many plans have been devised for supplying it also at the back and sides. In some cases currents of air are induced by steam-jets; but this plan has not always proved successful. The inventions on the regenerative principle are more generally satisfactory. 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, as they have been shown to effect great economy in coal consumption.

It must not be forgotten, however, that with the use of trained stokers a high degree of boiler efficiency is reached by hand-firing alone. Indeed, it has been proved by actual tests that, when pitted against untrained men, skilled stokers have raised the thermal efficiency of their plant by over 16%, without creating smoke nuisances. In Germany stokers are trained under careful state super­vision, and similar work has been started at the Borough Polytechnic Institute by the London County Council.

The advocates of the total or partial disuse of smoke-producing coals are variously in favour of anthracite, coke, electric power, liquid fuel or gas.

In some factories, such as malting works, 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 without forced draught; 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 grates and stoves have been devised for burning anthracite for domestic heating, and some of them are successful and economical; but, in view of the national prejudice in favour of a bright and open fire, it is not likely that anthracite will ever replace bituminous coal to any great extent in the British Isles, where the great coal-fields undoubtedly are the natural sources of fuel.

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 by-product in the manu­facture of gas for lighting purposes, and is largely used in various kinds of furnaces It gives no smoke; but it resembles anthracite also in being but ill adapted for use in open grates on account of the difficulty of ignition and the absence of flame.

One of the most notable features of the smoke abatement movement in recent years has been the manufacture of smokeless fuels capable of being readily and satisfactorily burnt in ordinary household grates. The use of such fuels is growing and will, in conjunction with the enormous expansion in the use of gas­cookers and heating appliances, do much to eliminate smoke nuisances from private houses. Over 750,000 gas-cookers are in use in the metropolis alone, and their aggregate effect in preventing the emission of smoke from kitchen chimneys must be very great.

Liquid fuel or natural petroleum, which has come into excep­tional prominence during recent years as a heating agent, owes its success to its relatively smokeless combustion and. high efficiency. The same applies to gaseous fuel, which includes in addition to ordinary coal gas other mixtures of gases which burn with a high heating value and with no deleterious vapours or smoke (see Fuel: *Liquid* and *Gaseous).* Electricity is now also being largely utilized in factories for power purposes, and is thus bearing its share in solving the problem of smoke abatement.

See *Official Report of the Smoke Abatement Committee* (London, 1882); W. C. Popplewell, *The Prevention of Smoke* (1901); W. Nicholson, *Smoke Abatement* (1905); also the publications of the London Coal Smoke Abatement Society; Booth and Kershaw, *Smoke Prevention and Fuel Economy* (1904); *Reports of the Laws in certain Foreign Countries in regard to Emission of Smoke from Chimneys* (Foreign Office Return),Cd. 2347 (1905) ; *London Foginquiry* (1901-1902) (Reports to and by the Meteorological Council).

(O. Μ.; L. W. Ch.)

**SMOLENSK,** a government of middle Russia, belonging partly to Great Russia and partly to White Russia, bounded by the governments of Moscow and Kaluga on the E., Orel and Cherni­gov on the S., Mogilev and Vitebsk on the W., and Pskov and Tver on the N. It covers an area of 21,632 sq. m. in the W. of the great central plateau, its N. districts extending towards the hilly region of the Valdai. The rivers being deeply cut in the plateau, the surface is also hilly in the W. districts (Smolensk, Doro- gobuzh), whence it slopes away gently towards vast plains on the E. and S. Carboniferous limestones, containing a few deposits of coal (in Yukhnov) and quarried for building purposes, occupy the E. of Smolensk; chalk appears in the S. extremity; while tertiary sands, marls and ferruginous clays cover all the W. The whole is overlain with a thick sheet of boulder clay, with irregular extensions to the N.; post-tertiary sands are spread over wide surfaces; and peat-bogs fill the marshy depressions. The soil, mostly clay, is generally unfertile, and stony and sandy in several districts. The rivers Vazuza and 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 Dvina—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 drains it for more than 300 m.; 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 N.W. More than one-third of the area is under forests. The climate is like that of middle Russia generally, although the moderating influence of the damp climate of. W. Europe is felt to some extent. The average yearly temperature at the city of Smolensk is 45∙5° Fahr. (January, 13-5°; July, 67∙2°).

The estimated population in 1906 was 1,762,400. It is chiefly composed of White Russians (55%) in the W., and Great Russians (43%) in the E. Most of the inhabitants (98%) belong to the Orthodox Greek Church; the rest are Noncon­formists. The government is divided into twelve districts, the chief towns of which are Smolensk, Byelyi, Dorogobuzh, Dukhov - shina, Elnya, Gzhatsk, Krasnyi, Poryechie, Roslavl, Sychevka, Vyazma and Yukhnov.

Notwithstanding the unproductive soil and the frequent failures of crops (especially in the N.W.), the chief occupation is agriculture. Out of the total area 38½% is held by the village communities, 52% by private persons and 2½% by the crown; 7 % is uncultivable. Nearly 30% of the surface is arable land, and over 20% is under meadows. The principal crops are rye, wheat, oats, barley, buck­wheat and potatoes. Grain has to be imported. Improved agri­cultural implements are beginning to be manufactured within the government, and to be used by the landlords, and partly also by the peasants. Flax and hemp are important crops, and some tobacco is grown. The live stock of the peasantry suffer from a want of meadow and pasture land, which is chiefly in private ownership. The peasantry are mostly very poor, in consequence not only of the French invasion in 1812, the effects of which are still felt, but also of insufficient allotments and want of meadows. In the way of mining phosphorite only is extracted. The most important industries are cotton, oil and paper mills, distilleries and breweries. The timber trade and boat-building are important sources of income, but 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. A lively traffic is carried on on the rivers, principally the Kasplya, the Obzha and the Ugra, corn, hemp, hempseed, linseed and especially timber being shipped. A considerable quantity of corn is imported into the W. districts.