Too much secondary air will cool these gases below the ignition point, and prove harmful rather than beneficial.

The amount of secondary air required depends on so many variables, that it is impossible to make a set of rules to fit all cases.

The following suggestions will be helpful: (*a*) In cold weather, with high combustion rates, the secondary air damper should be half open all the time. (*b*) In very mild weather with a very low combustion rate, the secondary air damper should be closed all the time. (*c*) For temperature between very mild and very cold, the secondary air damper should be in an intermediate position. (*d*) For ordinary house operation, secondary air is needed after each firing, for about one hour.

Secondary air, when used with bituminous coal, serves the purpose of preventing smoke as well as increasing the efficiency by burning the gas escaping from the fuel bed. As a guide to the amount of secondary air required, the user should supply just enough secondary air to eliminate the smoke.

BURNING VARIOUS TYPES OF FUEL

It is advantageous to be able to burn several types of fuel. The boiler may be designed for one particular type of fuel, but a knowledge of the method of handling other fuels often makes it possible to obtain satisfactory results with other available fuels.

Anthracite

Anthracite coal has a heat value of from 11,600 to 13,500 B.t.u. per pound and ash content of from 10 to 20 per cent.

An anthracite fire should never be poked as this serves to bring ash to the surface of the fuel bed where it melts into clinker.

Grate size is suitable for large grates and a fuel depth of 20 in. or more. The air spaces are large; the amount of surface in contact with the air is small, and consequently combustion is slow. Lumps of rock or slate, being large, may cause trouble in shaking of the grate. On grates, 25 in. and under, the fire is likely to go out easily with this fuel, unless mixed with small coal for reducing the air spaces.

Egg size is suitable for large firepots (grates 25 in. and over) if the fuel can be fired at least 20 in. deep. The air spaces between the pieces of coal are large and combustion is slower than with the next smaller size, although more rapid than with grate coal. This coal should be clean and high in calorific value. The rock and slate pieces may be large enough to cause some trouble in shaking the grate. For best results this coal should be fired deep. The grate should be shaken before every firing. An anthracite fire should never be poked as this only brings ash to the surface of the fuel bed where it melts into clinker.

Stove size coal is the popular size of anthracite fuel for most sizes of heating boilers. It is small enough to burn well on grates 17 in. and above, but large enough so that the draft loss through the fuel bed is not too great. The refuse in the coal is not large enough to cause any trouble in shaking of the grates. About the only instructions needed for burning this type of fuel are: The grate should be shaken before each firing; the fire should never be poked from the top; the fuel should be fired deep and uniformly.

Chestnut size coal is in demand for firepots up to 20 in., and especially those in which the fuel cannot be fired over 18 in. deep. The percentage of ash is higher than in stove coal, but the pieces of rock and slate are small and do not interfere with the shaking of the grates.

Pea size coal is often an economical fuel to burn. It is low in price. When carefully fired pea coal can be burned on regular grates. It is well to have a small amount of a larger fuel on hand when building new fires, or when filling holes in the fuel bed. Care should be taken to shake the grates only until the first bright coals begin to fall through the grates. The fuel bed, after a new fire has been built, should be built up by addition

of small charges until at least level with the sill of the fire door. This keeps a bed of ignited coal in readiness when a sudden demand for heat is made on the boiler. When firing, the bright fuel should either be pulled forward or pushed to the back of the firepot, leaving a hollow in which to fire the fresh fuel and leaving a portion of the glowing coal exposed, to ignite the gases rising from the fuel, otherwise a gas explosion may occur.

This fuel requires a strong draft and therefore the best results will generally be obtained by keeping the choke damper open, the cold-air check closed and controlling the fire by means of the air-inlet damper only.

Buckwheat size coal requires the same type of attention as pea size. The smaller size of the fuel makes it more difficult to burn on ordinary grates. Even greater care must be taken in shaking than with pea coal, lest the fuel run through the grate. A good draft is required and consequently the fire is best controlled by the air-inlet damper only. Where frequent attention can be given and where there is not a big heat demand on the boiler, this fuel is frequently burned without the aid of any special equipment.

In general it will be found more satisfactory with buckwheat coal to keep a uniform heat output and consequently to keep the system warm all the time, rather than to allow the system to cool off at times and then to attempt to burn the fuel at a high rate while warming up. A uniform low fire will minimize the clinker formation and keep the clinker in an easily broken up condition so that it can be easily shaken through the grate.

Forced draft and special grates or retorts are frequently used with this fuel for best results. (See Chapter VII.)

Coke

Coke is a very desirable fuel and will usually give satisfaction as soon as the user learns how to control the fire. Coke ignites and burns very rapidly with less draft than anthracite. In order to control the air admitted to the fuel it is very important that all openings or leaks into the ashpit be tightly closed. A coke fire responds more rapidly than anthracite to the opening of the dampers. This is an advantage in warming up the system, but it also makes it necessary to watch the dampers more closely in order to prevent the fire from burning too rapidly. A deep bed of coke should always be carried. The grates should be shaken only slightly in mild weather, and should only be shaken until the first red particles drop from grates in cold weather. Since coke only weighs about half as much as anthracite per cubic foot, and therefore only about half as much can be put in the firepot, it will be necessary to fire oftener, but during the greater part of the heating season this will not be an item of importance. The best size of coke for general use will be that which passes over a 1 in. screen and through a 1½ in. screen for small firepots where the fuel depth is not over 20 in. For large firepots where the fuel can be fired over 20 in. deep, coke which passes over a 1 in. screen and through a 3 in. screen will be most satisfactory. Large sizes of coke should either be mixed with fine sizes or should be broken up before using.

Kinds of Bituminous Coal

Solid fuels, excepting anthracite and coke, can be classified, from the standpoint of the user, into four types, as follows: (*a*) caking bituminous coal, (*b*) non-caking bituminous coal, (*c*) semi-bituminous coal and (*d*) lignite.

The characteristics of these coals are as follows:

Bituminous coal generally has a high heat value (from 12,000 to 14,500 B.t.u. per pound) and a percentage of ash of 5 to 15 per cent.

Caking coal forms a cake or crust over the fire as soon as heated. This crust, when broken up, gives a fire that burns like coke. Some types of caking coal are very easily broken up, even in handling, and as a result are very fine when fired, while others are quite strong so that the percentage of lumps is high. The heat value of a fine coal may be even greater than the heat value of the coal containing some lumps, but for general operation, the coal containing the larger percentage of lumps will be most satisfactory. A fine coal forms a blanket over the fire, tending to reduce the rate of combustion and also to increase the loss due to falling of coal through the grate, whereas a coal with a larger percentage of lumps allows the air to pass through the fuel bed more easily and also prevents, to a certain degree, the formation of a solid crust such as produced by the fine coal.

The *non-caking coal* does not form a coke or crust when heated, but burns practically without attention because the air can pass freely through the fuel bed. This coal is best