enlargement of this plant to 160 ovens in 1899 that probably exercised a considerable influence in convincing furnace men that the luster and ring of beehive coke were not essential qualities in the manufacture of iron.

During the last two or three years the progress in the manufacture of by-product coke has been marked, not only in the number of ovens built and under construction but in the size and capacity of the ovens themselves. The original Semet-Solvay ovens at Syracuse, N.Y., were 30 feet long, 16 inches wide at one end, 17 inches wide at the other, and 5 feet 8 inches high. They had a charging capacity of 4.4 short tons of coal. The original Otto-Hoffmann ovens at Johnstown were 33 ft. 6 in. long, 6 ft. high, and 17 to 21 in. wide, with a charging capacity of 5.5 tons. Many of the retort ovens constructed at the present time are over 36 ft. long and nearly 12 ft. high but without much additional width, and they have a charging capacity of from 12 to 16 tons.

The number of retort ovens in the United States in 1902, the end of the first decade in the era of by-product coke manufacture, was 1,663; in 1912, at the end of the second decade, there were 5,211 such ovens, and in 1913 they numbered 5,688. The increase in the number of retort ovens from 1912 to 1913 was 477, whereas the total number of ovens increased 420, from 102,230 to 102,650. As will be shown later, however, many thousands of the beehive ovens were idle in 1913, more than half of them probably for the whole time, whereas all but 157 of the completed retort ovens were in operation. There were 1,321 new ovens building at the close of 1913, of which 504 were of the by-product type. The output of the by-product ovens in 1913 represented 27.5 per cent. of the total coke production of the United States. In 1912 it represented a little more than 25 per cent., and in 1911 22.1 per cent.

The evolution in coke making is not only in the steady substitution of the retort oven, and its recovery of the valuable contents of the coal other than coke, for the wasteful beehive; it means also the shifting of the coke-making industry from the vicinity of the mines to the centers of manufacture and population, where the gas may be utilized and the other by-products disposed of at a profit. The extent to which this shifting of the coke-making industry has already taken place is evinced by the statistics of production in West Virginia where there are few coke consuming enterprises. From the time the industry was first started in that State the larger part of the product has been shipped to furnaces in other States. The production of coke in West Virginia in 1913 showed an insignificant gain over 1912, and the industry has not only shown no progress during the last 10 years but has materially declined. The quantity of West Virginia coal used in the manufacture of coke, however, has materially increased, but the ovens at which the coal is used are at points in other States, and most of them are of the by-product or retort type. Returns to the U. S. Survey for 1913 show that the quantity of West Virginia coal made into coke outside of the State in that year was 7,546,674 tons, or nearly twice as much as the coal made into coke at ovens within the State. Another evidence of this marked change is that of the 17,826 ovens in West Virginia in 1913, 9,129 were idle the entire year and many others for a portion of the year.

In spite of the progress made in the last few years in the manufacture of coke in by-product ovens the United States is still much behind some European countries in this regard. In Germany and Belgium the retort oven is the only one used, the beehive having been discarded years ago. One of the reasons for the somewhat tardy development in the United States is peculiar, being nothing less than the well-grounded apprehension as to the early exhaustion of the Connellsville coal. Because of the limited span of life yet remaining to the Connellsville region, the owners and operators in that district have not felt disposed to throw away the capital already invested in the beehive ovens that have made the Connellsville district notorious and the coke famous.

THE ORIGIN OF COAL.

According to David White and Reinhardt Thiessen in a bulletin published by the U. S. Geological Survey the fact is almost universally accepted that beds of coal represent accumulations of vegetal matter in varying stages of preservation, with, as a rule, very small proportions of the remains of animal life. Mingled with the organic substances are different inorganic mineral sediments, which, together with the mineral matter originally contained in the plants themselves, constitute the "ash" of coal. The examination of coal shows that the kinds of ingredient plants range all the way from algæ and fungi to large trees of various orders, and that these in turn vary in their own groups according to the depth and the nature of the water in which they grew and according to the other conditions of growth, such as moisture, temperature, soil, light, climate, and the competition of individuals. The species or kinds of plants and the numbers of each kind also differ greatly among themselves, not only during any one geologic period because of the changes of environment, but also from one geologic period to another, and it will be remembered that well-developed coal has been found in the strata of every period since the Silurian.

Most geologists now agree that coal is transformed peat. True there is wide difference of opinion as to how the transformation has been accomplished and even as to whether coal started as such peat as is now found. Some writers insist that the higher grade coal, in its process of development, never passed through geologic stages of existence as peat, lignite, etc., but these writers are relatively few. At all events there is scarcely anyone who does not admit that some peat has been converted to coal in the normal geologic processes. In the following pages the term "peat" is used in its broad sense, to include lowland swamp and salt-marsh or estuarine peats, as well as inland-bog peats. Ordinary or typical coal beds were formed from plant remains in vast lowland or coastal swamps and deltas.

The plant materials composing coal differ both in kind and in degree of preservation, or, rather, of decomposition, for it will be recalled that all the organisms forming the deposit undergo more or less decay, the extent of which depends on climate, water table, and other conditions of deposition, just as in the peat swamps of the present day. The rate and the extent of the decay are controlled largely by the oxygen supply, which is chiefly affected by the rate of plant growth, temperature, the exposure to the air, the drainage, and so forth. Obviously the growth of the peat accumulation requires that the rate of contribution of the plant material shall, on the whole, exceed the rate of decay, the putrefaction being finally smothered by exclusion of oxygen from the buried debris or stopped by the influence of the toxic products of decay accumulating beneath the surface of the bog.