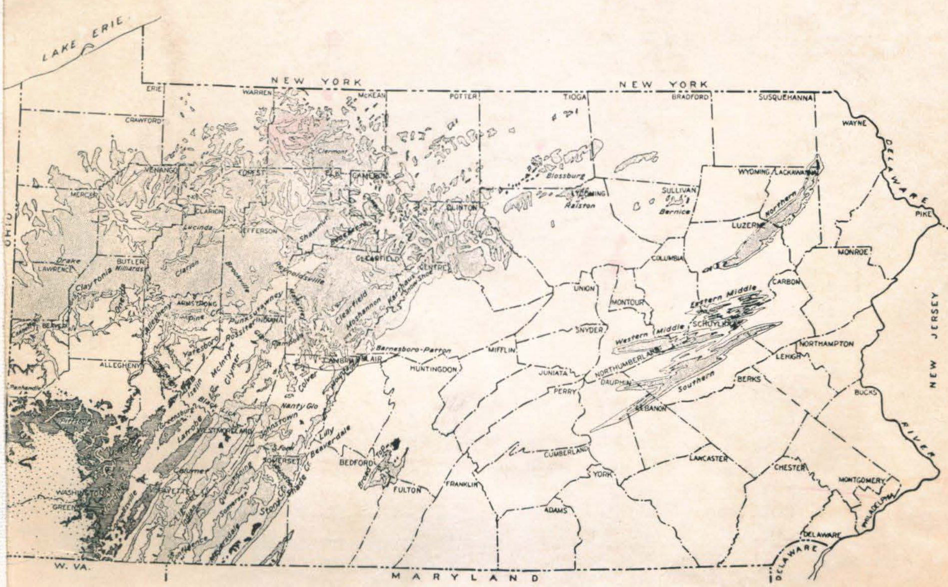
PENNSYLVANIA'S COAL INDUSTRY



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The map on the front cover shows the location of anthracite and bituminous coal fields in Pennsylvania. This map is a reproduction of the one found on page 78, *Pennsylvania's Mineral Heritage*, 1944. In that publication of the Pennsylvania Department of Internal Affairs the map includes explanatory legends. Through the courtesy of State Geologist Carlyle Gray, an exceptionally good copy of the map was made available for reproduction here.

FOREWORD

How important will Pennsylvania's coal industry be a century hence? No one knows. Experts would differ widely in their answer to this question. Nevertheless, the coal industry of Pennsylvania has made a highly significant contribution in the history of the United States. America's economic greatness is to a considerable extent due to Pennsylvania's deposits of anthracite and bituminous coal and to the way in which these deposits have been put to use.

The coal industry has been a prime factor in Pennsylvania's amazing economic development, its growth of population, and its wealth. The State has mined as much as a billion dollars worth of coal in a single year. At Pittsburgh's latitude a train of coal cars carrying this output for twelve months would reach more than twice around the world. The State's coal industry made possible the enormous expansion of the iron and steel industry at Pittsburgh, Johnstown, Steelton, Bethlehem, and a number of other Pennsylvania cities.

In this pamphlet Dr. Robert D. Billinger has compressed the history of a two-part industry—that of anthracite coal in Eastern Pennsylvania and of bituminous coal, chiefly in the Southwestern quarter of the State.

Dr. Billinger grew up in Shenandoah, Schuylkill County, in the anthracite region. As a youth he was employed for a few months to help a mining surveyor. This brought to him first-hand impressions of underground and strip mining. As a member of the chemistry faculty at Lehigh University for more than twenty-five years, he has had numerous contacts with mining engineers and administrators. In 1953, to secure up-to-date material concerning the bituminous industry, he visited two of the largest and most modern mines in the Monongahela Valley. He is the author of numerous writings on early Pennsylvania industries and on inorganic chemistry.

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I. COAL—SOURCE OF POWER

1. Origin of Coal

Pennsylvania has been richly endowed with coal, the great source of heat and power. Almost one hundred billion tons of this condensed energy from the sun were formed here in Pennsylvania's original underground storehouse. Recent estimates place the original stores of bituminous coal in Pennsylvania at 75,093,000,000 tons and the anthracite deposits at 22,008,050,000 tons.

Coal is of vegetable origin, millions of years old. Scientific evidence indicates that before the dawn of history there existed giant ferns and rushes tall as modern trees. They grew lush and thick in the warm, moist climate that existed in the Carboniferous Age. Plants grew, decayed, were crushed, and buried. Through countless eons of time (beginning some 250 million years ago), layer upon layer of vegetable debris was deposited. These masses were transformed by heat and pressure in nature's giant caldron, through the several stages of coal formation from wood to peat, to lignite, to bituminous coal, and finally to anthracite. Geologists tell us that deposits like the Pittsburgh coal bed may have taken from 2,700 to 10,000 years to form. Then for untold ages the deposits lay until discovered by man. Condensation and decomposition took place with release of water and gases. The covering layers excluded oxygen and stopped the final stage which would have converted the carbon into carbon dioxide.

In some places in Pennsylvania there are one hundred superimposed beds, which may have a total thickness of 3,500 feet. These beds of coal are separated by sandstone, shale, clay, and limestone. In the central and western parts of the State they are fairly horizontal, and the best seams of bituminous coal generally lie about five hundred feet deep. Where there has been greater upheaval, as in the eastern sections, the resultant pressures have produced coal with a greater proportion of fixed carbon, known as anthracite coal.

2. First Uses of Coal

Aristotle and Pliny mention coal, and so we learn that western civilization knew something of its nature at least by 400 B. C. The Chinese are supposed to have used it much earlier in the reduction of copper ores. In Europe it came into use as a fuel in the thirteenth century.

The Saxon "col" is the original of our word coal. Early known as kohle, later cole, it was finally changed to coal. For years this name signified charcoal. As long as wood was abundant in both Europe and America the use of charcoal in metallurgy was preferred. This is still true in Sweden.

There is a certain romantic mystery about any mining operation. Medieval miners in Europe associated the presence of little gnomes or spirits with their dark, subterranean pits. The very names of some metals, like nickel and cobalt, are derived from words which denote the evil or the treacherous.

Coal with its dark lustre and its combustibility truly belongs in the history of ideas to the realm of black magic. Although this term is usually reserved for the alchemical origins of modern chemistry, it might easily include many phases of coal history. Certainly the formation of coal from vegetable sources, ages ago, under tremendous pressure and through mysterious metamorphosis, distillation, and synthesis, involved great chemical forces.

3. Coal in America

In North America coal was first discovered on Cape Breton Island, off the eastern coast of Canada, in 1672, although the island had been discovered almost two hundred years before (1498) by Sebastian Cabot. Joliet's map of 1673-74 records "Charbon de terra" on the Illinois River, which was the first allusion to bituminous coal in what is now the United States. Although a map by the Jesuit Father Hennepin, Chaplain with LaSalle's Expedition in 1680, showed a "cole mine" above Fort Crèvecoeur (Peoria), his narrative simply stated that "we had not time enough to look for Mines; but we found in several Places some Pit-Coal."

Certainly the red men must have seen it in outcroppings along the streams and no doubt knew that it could burn. The natives probably also used some coal as pigment, but there is no definite indication of other utilization except that the Hopi Indians in Arizona are credited with using lignite in burning pottery, perhaps as early as A. D. 1000. Unnamed white hunters and trappers must also have come in contact with it.

The first mining of coal in the American colonies was probably in the James River coal field of Virginia. It was described in a letter (May 10, 1701) by Colonel William Byrd, F.R.S., as having been found by a hunter on a tract of land allotted to some French Huguenots near Manokin, about fourteen miles above Richmond. For half a century it was used only locally, mainly by blacksmiths, but records show that in 1758, six hundred bushels of this coal were shipped to England.

The first reference to coal in the Appalachian region appeared in 1736 on a map made by Benjamin Winslow. This chart covered the upper Potomac River. As early as 1742 coal was found in what is now southern West Virginia by John Howard, who had a commission from the Virginia governor to explore the country westward to the Mississippi.

Although the presence of coal in Pennsylvania was indicated a few years after the land was given to William Penn in 1681, its actual discovery in the several fields and the earliest efforts at organized mining came almost a century later. For the period 1800-1950 there are fairly accurate records of production statistics, which show that the peak of output was in the first quarter of the present century.

4. Classification of Pennsylvania Coal

The discovery of coal in various localities in Pennsylvania and elsewhere in America was often accidental. Each region has its own legend. Here some pioneer was directed to coal by Indians; there a hunter was smoking out a ground hog and set a fire which burned overlong because of coal deposits. But once coal mining was introduced more advanced steps were taken. Welsh and English coal miners brought with them the knowledge and experience of their ancient craft. Organized search by state geologists occurred after Henry Darwin Rogers made the first Pennsylvania Geology survey in 1858. It was much too early to expect any regular chemical analysis by mining companies, but samples could be sent to a few consulting chemists in the larger cities and in existing universities and colleges. Practical testing by the industrial customer was the accepted order.

Eventually, a statewide classification of coals was made. Comparisons of the products from the chief mining centers provided a picture much like the following report of a much later date:

Department of Interior,
United States Geological Survey
State of Pennsylvania Coal Fields and Producing Districts
C. E. Lesher, September 1919.

	District	*Volatile Matter*	*Fixed Carbon*
Bituminous (high volatile)	Pittsburgh, Allegheny County	39.3%	60.7%
" "	Irwin Basin, Westmoreland Co.	37.1	62.9
" "	Greensburg	34.4	65.6
" (medium volatile)	Punxsutawney, Indiana Co.	28.5	71.5
Semi-Bituminous (low volatile)	Huntingdon, Bedford Co.	16.1	83.9
" " "	Moshannon, Clearfield Co.	26.6	73.4
" " "	Snowshoe, Clearfield Co.	26.4	73.6
" " "	Blossburg, Tioga Co.	24.5	75.5
Semi-Anthracite "	Forksville, Sullivan Co.	13.0	87.0
" "	Rock Run, Sullivan Co.	11.0	89.0
" "	Bernice Basin	9.5	90.5
Anthracite	Northern, Luzerne Co.	6.1	93.9
"	Middle Luzerne & Carbon Co.	3.7	96.3
"	Southern, Schuylkill Co.	4.3	95.7
"	Shamokin, Northumberland Co.	9.0	91.0
"	Lykens Valley, Schuylkill Co.	10.0	90.0
"	Fishtail, Dauphin Co.	7.3	92.7

In the given list the specified towns are not always in the counties mentioned, but are in neighboring districts through which the same coal seams run. The analyses are on dry coal and reported on an ash-free basis. Actually "fixed carbon" represents both the combustible carbon which contributes heat and the mineral ash which furnishes none. The ash content of anthracite coal should run slightly more than nine per cent for the larger sizes of egg, stove, and chestnut and from eleven to thirteen plus per cent for the finer sizes. The ash content of bituminous could be lower or higher than that of anthracite, and varies widely in different localities. Again, the specific gravity of bituminous coal ranges from 1.15 to 1.5, while that of anthracite is 1.40 to 1.70. Finally, the fuel values, represented in terms of British thermal units, range from 13,400 to 14,650 for low volatile bituminous coals (the so-called "smokeless" varieties, recommended as steam coals) to slightly over 15,000 B.T.U. for large sizes of anthracite.

The properties and classification of coal have been inserted here to explain to the reader the several products and their production sources. In general we can say that anthracite comes from the eastern section of the State, while bituminous coal is mined in the central and southwestern areas.

Since industry developed as settlement of lands advanced, we shall discuss the anthracite mines first. Actually the discovery of coal in Pennsylvania seems to have been first made in the bituminous regions, but commercial development of anthracite came earlier.

II. HISTORY AND DEVELOPMENT OF PENNSYLVANIA ANTHRACITE

1. Discovery and Early Uses

Pennsylvania in the past one hundred and fifty years has produced over five billion tons of hard coal. This treasure, anthracite coal, had its greatest concentration in a five hundred square mile area in nine counties of northeastern Pennsylvania.

Although small quantities of nature's end product in the transition from prehistoric vegetation to fixed carbon exist in various localities—a trace in Rhode Island, Washington, and Colorado, some in Scotland, and in Wales; perhaps more in Russia and China—the major supply comes from the anthracite fields of Pennsylvania. In this region the active mines and strippings might be concentrated in a twenty-two square mile working area, if they were all adjacent.

Anthracite coal is characterized by its black luster and hardness. It is often referred to as hard coal or "black diamond." Actually it has a rating of 2.75 to 3 in Mohs' scale, where ten selected minerals are compared. Talc being very soft has a hardness of 1.0; the diamond's value is 10. Anthracite can be scratched with a knife, but it is much harder than other varieties of coal. With an average fixed carbon content of 86.0 per cent and volatile matter of only 4.3 per cent, it is the most desirable domestic coal, for it burns longer than bituminous coal and gives off no choking fumes.

It has been established that five to eight feet of the compressed ancient forest matter were required to form one foot of coal. Why this coal formation process occurred at its optimum in eastern Pennsylvania is a matter for geological explanation, the record of which is told in the deposits from lakes, rivers and oceans, the mighty upheavals and changes in the earth's crust, and climatic changes during the glacial periods, and other factors. Suffice it to say that it happened here more fully than anywhere else. At Nesquehoning, along the Lehigh River above Mauch Chunk (now Jim Thorpe), a coal seam 114 feet thick was found. This is an extreme case. Sometimes workable seams run only one foot to three feet thick in the anthracite regions. From these Pennsylvania deposits come 99 per cent of the anthracite coal mined in the United States.

Who discovered anthracite? Probably it was game hunters, who came upon hard coal, without leaving a record of their find. Long before the coming of the white man, the Indians must have seen outcroppings of coal. We have little or no authenticated record of its utilization by the red men.

In 1762 John Jenkins, one of a party from Connecticut which had camped for ten days along the Susquehanna River, made a report of discovery of iron ore and anthracite coal at Wyoming. Thomas Penn in London received a piece of this Wyoming Valley coal in 1766 when James Tilghman of Philadelphia sent a sample collected by his brother-in-law, Colonel Francis. The latter reported a very great fund of coal in the hills of the region, where he went to remove settlers from some of the Indian lands. Tilghman modestly wrote: "This bed of coal . . . may sometime or other be a thing of great value."

Blacksmiths in the valley were the first to utilize the black stones in their forges. At several points (Plymouth and Pittston, for instance) exposed veins of coal along the smaller creeks which flowed into the Susquehanna were quite open to view. Local historians think that the Indians had some knowledge of the fuel, and perhaps even worked the veins to some extent. Two early smiths who applied coal to forges were the Gore brothers, Obadiah and Daniel, emigrants from Plainfield, Connecticut, who came to Wyoming in 1769.

During the American Revolution Durham boats were loaded with coal at Mill Creek, above Wilkes-Barre, and floated down the river to Harris Ferry. From there the coal was drawn by wagons to Carlisle, where it is reported to have been used in furnaces and forges which made arms for the colonial forces.

Another pair of brothers, John and Abijah Smith, also from Connecticut, were the first active miners and marketers of coal. From Plymouth in the Wyoming Valley in 1807 they sent their first ark of coal to Columbia, Pennsylvania. Here and at nearby points they sold fifty-five tons of the new product, after demonstrating its use in the grates of public houses and homes. Hitherto it had been burned chiefly with a forced draft in forges. The Smith brothers employed a mason to build grates in which anthracite could be burned with natural draft. Slowly the public learned how to use the new fuel and the coal shipments continued from the Wyoming region in steadily increasing amounts. In 1820 some 2,500 tons were sent to market. The Susquehanna coal arks that carried it down this treacherous river were ninety feet long, sixteen feet wide, four feet deep and held about sixty tons of coal. The capacity cannot be calculated from the dimensions, because each end terminated in an acute angle and the depth of coal varied. They were manned by four men, who worked in pairs with thirty-foot oars mounted on stem posts at bow and stern. Despite their efforts, only about two out of three arks reached their tide water destination after seven days of navigating rocks and rapids.

Public acceptance of hard coal came only after men like Oliver Evans, the well-known inventor of Philadelphia (1802), and Judge Jesse Fell of Wilkes-Barre (1808), showed that a blast was not needed to burn anthracite in open grates or stoves. True it is that many of the first vendors of coal had to give away their product in some localities, but once the value of the "black diamonds" was realized a new industry was born. George B. Kulp claims that the Yankees of the Wyoming district were able to sell all their coal, but pioneers in coal selling from other regions were not always that fortunate. Well-known is the story of Colonel George Shoemaker of Pottsville who in 1812 drove nine wagon loads of coal to Philadelphia, where he could sell only two. Even after giving away seven loads of this product which cost him $28.00 a ton he was denounced as a "cheat and swindler."

In the Lehigh region a hunter named Philip Ginter discovered coal near Mauch Chunk Mountain in 1791. In the Schuylkill region, southernmost field of largest anthracite reserves, coal deposits were marked on local maps as early at 1770, but real discovery at the foot of Broad Mountain is credited to the observation of another hunter, Nicho Allen, in 1790. The same year (1790) coal was discovered by Isaac Tomlinson on his farm at Shamokin. This was in Northumberland County in the Western Middle Field.

Another coal discoverer, again a hunter, was John Charles, who found coal near Hazleton in the Eastern Middle Field in 1826.

The accidental discoveries of coal make interesting stories. One night while camping out in the hills near Pottsville, Nicho Allen built a fire under a ledge of protecting stone. To his astonishment he awoke during the night to see a blinding light from the ledge where apparently "the mountain was on fire." John Charles in the Hazleton region claims to have made his discovery of the black, shiny stones while digging in a woodchuck's hole. Philip Ginter thus describes his find in the Lehigh region:

> One day, after a poor season [of hunting], when we were on short allowance, I had had unusually bad luck and was on my way empty-handed and disheartened, tired and wet from the rain which had commenced falling, when I struck my foot against a stone and drove it on before me. It was nearly dusk, but light enough remained to show me that it was black and shiny. I had heard of "stone coal" over in Wyoming, and had frequently pried into rocks in hope of finding it. When I saw black rock I knew it must be stone coal, and on looking around I discovered black dirt and a great many pieces of stone coal under the roots of a tree that had been blown down. I took pieces of this coal home with me, and the next day carried them to Colonel Jacob Weiss at Fort Allen.

Why had not other intrepid explorers made these discoveries much earlier? Perhaps some had. The real discoverer of anthracite in Pennsylvania seems to be lost in history, unless we credit the Jenkins report of 1762 as the first of the discoveries. Manifestly, Allen, Tomlinson, Ginter, and Charles had been impressed when they observed the Wyoming Valley coal stones. They passed on their findings, and other men soon followed the discoveries with the first primitive mining operations.

Very little profit, if any, came to these sharp-eyed finders of stone coal. Ginter complained that the small tract of land which Colonel Weiss had given him in payment for his discovery was later "taken from me by a man who said he owned it before I did," whereas "in a few years the discovery made hundreds of fortunes." In the Pottsville region also, Nicho Allen soon became discouraged with the slow public acceptance of anthracite and gave up his partnership with Colonel Shoemaker.

2. Industrial Beginnings

Although Ginter was wrong in his statement about the fortunes made from coal in a few years after its presence was generally known, there were repeated efforts made by several companies in the Lehigh Valley before successful operations started about 1820. Success came after Josiah White and Erskine Hazard of Philadelphia sought to develop an anthracite coal supply. These ambitious industrialists had learned how to use anthracite in a wire mill which they operated at the Falls of the Schuylkill. After one of Colonel Shoemaker's wagon loads of coal had been sold to them in 1812, a discouraged furnace man at their plant accidentally learned the secret of burning the new fuel by leaving it alone with proper draft and by giving it a chance to burn.

The Lehigh Coal Mine Company, founded in 1792 by Colonel Weiss, Robert Morris, the celebrated financier, and others, had produced coal; but the novelty of the product and the problems of transportation over forbidding trails or down the rocky Lehigh militated against success. Again in 1813 a new group, led by Charles Miner, Jacob Cist, John Robinson, and Stephen Tuttle, leased the coal lands for ten years. The rising price of charcoal favored their product, but again transportation by wooden arks on the Lehigh River was so great a problem that they soon forfeited their leases.

In this field, between Mauch Chunk and Tamaqua, White and Hazard were able to obtain a lease, in association with a partner named Hauto, for a period of twenty years. The terms required only that: "After a given time for preparation, they should deliver for their own benefit at least forty thousand bushels of coal annually at Philadelphia and the districts, and should pay, upon demand, one ear of corn as an annual rent for the property." In

August 1818 they formed the Lehigh Navigation Company, and in October of that year their Lehigh Coal Company began to mine and deliver coal. One of their first accomplishments was to build a road from the mines to the river, over almost impossible terrain. By 1820 both companies were merged into The Lehigh Navigation and Coal Company. This is one of the oldest companies in continuous service, and exists today as one of the six major anthracite producing companies.

Messrs. White and Hazard surveyed the Lehigh River, and developed a series of dams to provide "artificial freshets" during the season of navigation. Rafts and coal arks were employed. They were made for one trip only and, when they arrived at their destination, were broken up and sold for any salvageable timber. Many of them were wrecked en route, but those which were navigated successfully brought cargoes that were receiving increasing utilization.

Anyone who has attempted a trip by boat or canoe down the Lehigh and Delaware Rivers can understand how difficult was the journey even under good conditions of stream flow.

3. The Canal Era

Canals were an essential step in the transportation of coal to city markets. Indeed the late Professor F. V. Larkin maintained that "the first attempts in the United States to establish anything approaching a system of inland navigation had their origin in efforts to get to market the 'stone coal' of the Schuylkill, Lehigh, Wyoming and Lackawanna Valleys." Whether or not this statement is totally correct it would seem to apply to Pennsylvania, at least. By 1825 the Schuylkill River canal was officially opened, although its planning and inception date back to 1760. Not originally planned for coal transport, its chief business soon became the carrying of this product. Its success was due largely to the financial backing of Stephen Girard, then one of America's wealthiest men, whose land holdings in the anthracite regions were most extensive. In the first five years of operation, coal shipments from the Schuylkill region by canal increased from 6,500 tons to 79,973 tons.

In June 1829 the Lehigh canal was opened to navigation. This work was the natural outgrowth of Josiah White's efforts to make the Lehigh River navigable. His canal served the ever increasing market for anthracite; and the mule and horse drawn boats returned with cargoes of produce and commodities from Philadelphia. A small traffic in passengers arose from individuals or groups who desired to travel over the new route. Early in January 1841 a great flood swept away much of the canal bank and destroyed many locks and bridges. But Josiah White and his sturdy followers repaired the canal, and he lived to see its tonnage increase to more than 700,000 tons per year.

The Lehigh Canal had been extended from Mauch Chunk upstream to White Haven. This section was destroyed by another disastrous flood in 1869, and was never rebuilt. Coal transport on the Lehigh Canal decreased as the railroads were built, but some boats were still in use as late as the middle 1920's.

In 1832 the connecting link along the Delaware, known as the Delaware Division Canal, was opened, with the result that coal could be transported from Mauch Chunk to Easton and thence to Philadelphia. At Easton the Morris Canal, completed in 1831, could also be used to transport coal by canal and inclined planes to Newark, New Jersey.

In 1828 the Delaware and Hudson Canal was completed. This route was used to carry coal from the northern Wyoming field at Carbondale, Pennsylvania, by road (shortly afterward by rail) to Honesdale on the Lackawaxen where the canal began, then on to the Delaware, and across country to Rondout on the Hudson River. From this point the anthracite was transported to New York City by boat. The conception of this project was due to a Philadelphian, William Wurts, who with his brothers Charles and Maurice, began as early as 1812 to trace the locations and outlines of the great northern and eastern anthracite fields. They purchased extensive tracts of land and tried to float coal by rafts down the Delaware to Philadelphia. After ten years of work and study they saw an outlet for their coal in the closer and larget market of New York City if an overland canal could be constructed from the Delaware to the Hudson. They were authorized in 1823 by the State of Pennsylvania to improve the navigation of the Lackawaxen River and by the State of New York to construct a canal from tidewater on the Hudson to the Delaware River and up the Delaware to the mouth of the Lackawaxen. There were many doubts as to its success, but with engineers of experience from the Erie Canal—Judge Benjamin Wright, Colonel John L. Sullivan and John B. Mills—and an authorized capital stock of half a million dollars promptly subscribed, the work went forward from July 13, 1825.

Thus in a little over three years was constructed "the largest private enterprise undertaken on the American continent up to that time." The Delaware and Hudson Canal was one hundred and eight miles long, thirty-two to thirty-six feet wide at the water line, with a minimum depth of four feet. Ascending from tidewater it rose, with some intervening descents, to its terminus at Honesdale where the altitude was nine hundred and seventy-two feet. It employed one hundred and ten locks and was spanned by one hundred and thirty-seven bridges. For seventy years it was a major highway for anthracite from the Lackawanna and Wyoming Valleys to the great New York metropolitan area.

To bring coal from the Wyoming Valley to markets by water transportation the North Branch Canal was constructed along the Susquehanna River. Ground was broken on July 4, 1828, at Berwick and by 1834 it was possible for boats to make the complete round trip from Wilkes-Barre to Philadelphia. The North Branch canal extended for sixty-seven miles from Nanticoke to Northumberland. The remainder of the trip was made on the Union and Essex Canal to Philadelphia.

4. The Advent of Railroads

The first railroad locomotive to operate in the United States was employed in connection with the anthracite coal industry. This was the Stourbridge Lion, purchased in England by the Delaware and Hudson Canal Company. It was first operated by Horatio Allen on August 8, 1829, at Honesdale in Pennsylvania and its first attempt was a three-mile run over hemlock rails protected by wrought iron strips of half-inch thickness. The locomotive was one of four brought to this country for early use. They were never actually used to transport coal, because the roadbed and rail construction at the time were considered unsafe. However, their introduction, trial, and display served as a prophetic symbol of the advent of the railroad.

The Mauch Chunk Railroad is claimed to have been the first steam railroad to be constructed in Pennsylvania and the second in the United States. It was completed in 1827 by the Lehigh Coal and Navigation Company to haul coal from the mines to the Lehigh River. At first mules were used to haul the empty cars up the inclined plane, but soon steam hoisting engines were employed. Cars, loaded with both coal and mules, came down the nine mile road by gravity. This switchback railroad was operated for many years after its initial use for coal hauling was abandoned. Up until 1934 tourists to this famed scenic region were thrilled by the ride on the historic gravity railroad at Mauch Chunk.

Almost as soon as the canals were constructed, railroads began to appear. Many of them were short lines of but a few miles. At first a number used horses to haul coal cars from mines to the canals. During this period and up until 1861 some twenty roads of various sizes had been constructed; many were single track roads built over low trestles of rickety construction. Out of these, however, grew some of the larger railroad companies which now control well-known major lines.

The Philadelphia and Reading Railroad Company, which helped to develop the anthracite industry in the Schuylkill region, was chartered on April 4, 1833. By January 1, 1842, its first engine and passenger train traveled from Philadelphia to Mount Carbon, one mile below Pottsville. This was a distance of ninety-two miles. The Reading Company, which in former years was the target of considerable opprobrium because of the "hands-off" policy of some of its officials, it may be noted in passing, has staged a return to strength recently. It now carries about 39 per cent of the total production of anthracite coal. In 1929 it carried only 19 per cent.

The Lehigh Valley Railroad ran its first train from Easton to Mauch Chunk on September 12, 1855. Its guiding genius was Asa Packer, canalboat builder, merchant, and mine operator. Packer had been the first to take coal directly to metropolitan New York from the Lehigh region via canals, rivers and bays. He and his brother owned a firm which, under the title A. & B. W. Packer, built boats for both the Lehigh and Schuylkill canals. The original railroad charter was given to the Delaware, Lehigh, Schuylkill and Susquehanna Railroad in 1846. When the project languished, Packer became "promoter, contractor and engineer." At the time of his death in 1879 the Lehigh Valley Railroad extended for 658 miles into New Jersey and New York. That it served a highly useful purpose is indicated by the fact that in one year 4,360,000 tons of coal were carried in its cars.

Asa Packer made his contributions not only as a businessman and engineer, but as public servant and benefactor. He served as a member of the Pennsylvania Legislature, as Associate Judge of Carbon County, and as Representative for two terms in the Federal Congress; he was also the founder of Lehigh University and a major benefactor of various hospitals and other institutions.

At this point it would be well to refer to the Mahanoy Plane, a major piece of engineering construction which was used to raise cars of anthracite coal from Mahanoy Valley in Schuylkill County to the top of a nearby hill, located some twelve miles from Pottsville. The plane was 2,410 feet long and 354 feet high. From its top, at an elevation of 1,478 feet above sea level, the coal cars ran down grade to the Schuylkill River. It was operating as late as 1931, when approximately fifteen thousand cars were raised during one month. This plane was erected about 1863 by the Girard estate. Stephen Girard, previously mentioned as a financial backer of the Schuylkill Canal, had acquired land tracts which constituted about eight per cent of the acreage of the Middle Atlantic hard coal fields. These lands in Schuylkill and Columbia Counties had been purchased from the Bank of the United States for $30,100. In time they became sources of great revenue to the Girard estate. Coal lands were leased to operating companies on a tonnage royalty basis. The income has gone chiefly to the endowment of such institutions as Girard College in Philadelphia.

Stephen Girard, it should be made clear, not only aided during his lifetime the development of canal transportation in the Schuylkill anthracite field but subscribed $200,000 toward the construction of the Danville and Pottsville Railroad. This was, in fact, one of his major interests at the time of his death in 1831.

The Delaware, Lackawanna and Western Railroad began traffic operations on October 20, 1851. It arose from a plan drawn up by Henry Drinker as early as 1819 for a railroad connecting Pittston on the Susquehanna River with the Water Gap on the Delaware. Through various charters, mergers, and agreements the line was extended not only from Scranton to the Delaware, but by arrangement with the Central Railroad of New Jersey also to the Atlantic coast. In 1869 an outlet to the Great Lakes was likewise obtained, and connections were made with the Erie Railroad for shipments east and west. Anthracite coal operations were begun in 1851 by the Lackawanna Company, which soon developed into one of the major producers. It continued in business until September 1, 1921, after which its coal mining interests were transferred to the Glen Alden Coal Company, the present operating body.

5. Early Miners and Mining Methods

The first coal miners in the Pennsylvania anthracite fields were natives of the British Isles—Welsh, Irish, Scots, and English. In later years came the Poles, Lithuanians, Slavs, and some Italians. The region has had more than its share of strife because of racial, religious, and industrial problems.

A colorful era in early anthracite labor history was that of the reign of the "Molly Maguires." This secret society of miners was named for a similar organization in Ireland. Justified as some of the grievances against management may have been, the introduction of class hate, threats, and extreme violence aroused the public against this local uprising. The period was 1862-1877 and the center was in Schuylkill County. After scores of murders, attributed by some to the instigation of the "Mollies," the coal managers and civil authorities took vigorous action. A Pinkerton detective, James McParlan, who had been a member of the society for two years, turned in enough evidence to round up the chief offenders. Ten leaders were hanged and fourteen sent to prison.

Labor organizations were generally unpopular until the turn of the century when John Mitchell emerged as champion of the United Mine Workers. The place which he occupies in the memories of the miners can be estimated as one observes the statue in Courthouse Square in Scranton. An impressive monument and life-size figure of the great organizer put him in the class of others so honored by this city: Christopher Columbus, George Washington, and General Philip Sheridan.

Historically, mining is sometimes considered to have been the earliest cooperative industry. Mining methods were well-defined and beautifully illustrated in the sixteenth-century text of George Bauer, generally known as Agricola's *De Re Metallica.* In Britain it is believed that coal there was first brought into use by the Romans. Certainly the art developed from the time of the first charter for the license to dig coal granted by King Henry III in 1239.

The simplest and oldest forms of extracting coal from the ground are quarrying and strip mining. So in the earliest days of procuring anthracite, when the existence of coal was evident only at exposed outcrops, the quickest and easiest methods were used. The tools were the pick, shovel, sledge, wedge, barrow, and cart. The latter was either hand-drawn or hauled by horses, mules, or oxen. When pits of thirty or more feet were dug, buckets or barrels were lowered on a windlass to hoist the coal to the surface. Tunnels on an incline, to provide drainage for water, were driven wherever possible. If too much water accumulated, the pit was left for a time or abandoned entirely.

In the historical and general survey to which this pamphlet is limited, only an outline of the advances can be enumerated. Some developments in coal transportation have been related. Another phase would be the growth of the modern motor highways which began with the early turnpikes. With hard-surfaced roads came modern trucking which carries an increasing proportion of coal.

To aid muscle and brawn in prying coal loose from its underground caverns explosives were employed almost from the beginning of anthracite mining. Abijah Smith brought John Flannigan, a man experienced in powder blasting, from Milford, Connecticut, to Plymouth in 1818 to experiment in loosening coal. The attempts were successful and so began a peacetime use in Pennsylvania for explosives in ever increasing amounts. Today about 0.3 pound of explosive is used per ton of coal mined underground, whereas the average may be three pounds per ton of coal obtained in stripping operations. The progress in this field from Alfred Nobel's dynamite to more modern, effective, and "permissive" explosives might fill a sizable tome.

As anthracite coal became known to the public it also became the subject for scientific study. Scientists, such as James Woodhouse at the University of Pennsylvania, John Griscom in New York, and Benjamin Silliman at Yale, examined it in the laboratory and in the field. The geological surveys by private companies and by the State of Pennsylvania outlined the several important fields.

6. Geographical Areas of Anthracite

The Northern or Wyoming field runs northeasterly through Luzerne and Lackawanna Counties, overlapping slightly into Wayne and Susquehanna. The principal cities and towns therein are Nanticoke, Wilkes-Barre, Pittston, Scranton, and Carbondale. This area covers 176 square miles. In this field the coal beds are characteristically flat until the veins outcrop on the mountain sides, where the beds may pitch from 10 to 47 degrees. Some of the deepest mines are sunk in this area. Two shafts of the Glen Alden Coal Company exceed two thousand feet in depth.

The Eastern Middle Field, which spreads about Hazleton as a center, is broken into nine parallel, elongated basins. This area, also called the Upper Lehigh Field, is chiefly in Luzerne County between the Lehigh River and Catawissa Creek. Its size is thirty-three square miles.

The Western Middle Field comprises some ninety-four square miles of coal lands lying between the Susquehanna River and the small tributaries of the Schuylkill River. It covers portions of Schuylkill, Columbia, and Northumberland Counties. Its chief centers of population are Shenandoah, Shamokin, Mt. Carmel, Mahanoy City, and Ashland.

The Southern Field, with an area of 181 square miles, is the largest. This region, also known as the Schuylkill Field, has the most steeply pitched beds. It stretches for about seventy miles from Mauch Chunk on the Lehigh River to Dauphin on the Susquehanna. Pottsville, Tamaqua, and Mauch Chunk are the chief centers of the region.

7. Progress in Mining

Modern mining employs highly developed techniques of engineering. Not all of these were initiated in the anthracite field, but the coal industry as a whole has been credited with making "more progress in the last two decades than any other American industry." One would hesitate to defend that statement, but there are many evidences of renewed activity and interest in the technical aspects of coal mining. Some 80,000 men are employed by the anthracite industry, but only about 25,000 of these are actually miners. The relationship is somewhat akin to that of an army in which many of the men are not actual fighters.

Getting the coal from underground is accomplished by following certain patterns determined by the nature of the coal veins. These methods have been established by the practical miner and engineer, and involve principles of safety, economy, and common sense. For example, drift openings were used in the early days of the industry when the coal bed outcropped on the hillside and may have extended horizontally through the hill. The drift was made to follow a slight upward incline to allow for water drainage. Most of the top beds have been worked out long ago, and so drift mining is no longer common.

If the coal does not lie deeper than a few hundred feet it may be reached by a slope. A slope is driven through rock or coal so as to contact one vein or several veins. A plane is similar to a slope, but it is usually a larger avenue of transport. Loaded cars go down a plane but up a slope, and are hauled by cables which are mechanically controlled.

Tunnels or gangways are driven horizontally through rock or coal. Rock driving is slow and costly. It involves problems of dust control to safeguard the workmen's health, of timbering to guard against falling rock fragments (not to support the total earth mass), and of moving great masses of rock and earth, a task which nowadays means the installation of tracks and the use of electric locomotives, as well as other equipment. All of these problems are subsequent to preliminary planning, surveying, drilling, and blasting along the course to be followed.

Most of the extensive coal deposits are reached by shafts driven vertically to penetrate one or several coal beds. In anthracite mines, these shafts are generally less than 2,000 feet in depth, but a few may be deeper. The shaft must be large enough to provide for two rugged elevators or "cages," one rising as the other descends. Men and coal cars travel the same route. Shafts, as well as tunnels, must be timbered or otherwise lined.

Keeping fresh air circulating in mines is a major problem. Indeed, the largest commodity handled in a mining operation is air. Huge ventilating fans are needed to draw out the foul air. A system of suction for old air and atmospheric pressure to force the fresh air down the mine shaft is usually adequate. Sometimes at deeper and more winding passageways pressure fans are employed. Legal requirements of two hundred cubic feet of air per minute per man are more than attained by large power-driven fans.

In some mines dangerous gases form. They may be harmful to respiration and are also combustible. A mine may be ignited by carelessness or accident and become a giant furnace, producing smoke and deadly gases. There is one instance of a burning mine in the Summit Hill area, Carbon County, which has been smoldering since 1859. Ever since the British chemist Sir Humphry Davy invented his safety lamp for miners in 1817, continuous efforts have been made to safeguard against mine fires and explosions. Davy's lamp used an oil cup and cloth wick, with the flame surrounded by a wire gauze which kept the temperature below the ignition point of the mine gases. Now electric battery lamps are widely used in mines, but for many years the carbide water lamp was, and still is, used where there is no danger from mine gases. This acetylene-generating device owes its existence to the synthesis of calcium carbide by another chemist, Friedrich Wöhler of Germany. Robert Hare, one of the University of Pennsylvania's early teachers of chemistry, operated the first electric furnace to prepare calcium carbide.

The pumping and removal of ground water on a huge scale is another challenge to the mining engineer. On the average, about twelve tons of water are handled for every ton of coal. Rains and contact with underground streams cause deluges which not only involve the movement of vast quantities of water but also result in loosened earth and cave-ins. The Hudson Coal Company maintains a pumping plant capable of raising two hundred million gallons of water per day.

Mechanization in the anthracite industry is steady, but has always been somewhat behind that of the bituminous industry. One chief reason for this fact has been the natural reluctance of the miner to be displaced by a machine; another reason is a difference in the nature of the hard and the soft coal. The latter is more friable and generally is easier to pry loose. Machine mining has a definite place where coal beds are thin and difficult to exploit by hand operations. Undercutting machines, which employ hard steel picks attached to a continuous chain, are electrically powered. They are used to make a cut or "kerf" about five inches high and as deep as desired to assist the fall of coal when explosives are employed. Various types of mechanical loaders have been developed: scrapers, shakers, steel conveyors, and to a limited extent some mechanical shovels where space permits.

Progress in coal hauling has been marked. The old days of the picturesque mine mule are gone. He has been replaced by modern, electrically motorized trains which speedily haul long strings of coal cars underground.

In the United States the first application of electricity to mine haulage was made in July 1887 by the Union Electric Company at the Lykens Valley Coal Company, a branch of the Pennsylvania Coal Company. The mine was at Wiconisco, about fifteen miles from Millersburg, Pennsylvania. The dynamo or generator, designed by the inventor, W. W. Schlesinger, had fifty horsepower rating; it was run by an old horizontal type of steam, hoisting engine. The "Pioneer" locomotive which employed a chain drive to the car wheels was able to pull thirty-one cars, totalling 150 tons. This early electric locomotive is preserved in the Ford Museum at Dearborn, Michigan. Today one of the largest producers of anthracite employs 340 electric locomotives and maintains 350 miles of railway track underground.

8. Coal Preparation

From the mine, coal is conveyed to a breaker or colliery where it is prepared for the market.

The first United States patent for a "coal breaking machine" (U. S. Patent No. 3292) was obtained in 1843 by Joseph Battin, a Pennsylvania Quaker. The breaker was set up at the colliery of Gideon Bast on Wolf Creek near Minersville. By April 1844 this device, which consisted of a hopper, of rolls covered with cast-iron teeth for crushing, and of screens for sizing, was in operation. It operated with a ten horsepower stationary engine and saved the labor of sixty men. It is claimed to have prepared two hundred tons of coal a day. Battin's patents (the original one and others which followed) were infringed and contested for years. This fact, states Edward Pinkowski, involved Battin in legal battles which reportedly cost him $100,000; his claims, however, were eventually sustained. The noted inventor became an engineer and designer of many municipal projects, such as gas works, water works, and tunnels.

A modern breaker (or preparation plant) is a huge manufacturing plant which crushes, sizes, and cleans the coal. One of the largest breakers in the anthracite field is the Locust Summit Central Breaker of the Philadelphia and Reading Coal & Iron Company. It is located near Mt. Carmel and was erected about twenty years ago at a cost of four and a half million dollars. Serving four mines and strips, it was designed to prepare three hundred carloads (15,000 tons) of coal per day. In 1944 it produced 3,036,431 tons of coal. The Reading Company also built a plant of similar capacity, the St. Nicholas Breaker, which is located between Shenandoah and Mahanoy City.

In the field of coal preparation the anthracite industry has shown its greatest advances in recent years. As the coal comes from the mines by car or conveyor, it contains various amounts of rock, slate, and "bone." The object is to crush the coal, clean it, and separate it into the commercial sizes of grate, egg, stove, chestnut, pea, buckwheat, rice, and barley. Specifications adopted in 1941 designate an allowable minimum and maximum per cent of impurities and variations in size.

Many of the modern breakers employ a sand flotation system to separate the coal from its impurities. An agitated sand-and-water mixture is used which will permit the coal to float off the surface while the impurities, of higher density, sink.

The Chance Cone system, developed by Dr. Henry M. Chance of Philadelphia, employs giant cones which vary in size from fifteen feet (or larger) in diameter at the top to two and a half feet at the bottom. A central shaft, provided with agitator arms, keeps the mixture in motion. A preliminary rolling and crushing of the larger pieces of coal are first undertaken; then the coal, along with the rock, is treated in the cone, where the coal is floated to chutes and screens while the discarded matter of greater specific gravity sinks to the bottom and is sent to the dump. Actually the process is somewhat more complicated than it has been outlined here, because some screening has been done before the mixture enters the cone separator and because the different sizes enter at different levels.

The Chance process was first introduced commercially in 1921, and it has been widely adopted in new installations.

For years a jig method for the separation of coal from impurities has been standard practice. By agitation in water-tight boxes the crude coal is shaken until the lighter clean coal rises to the top of the wet, moving mixture. Subsequent scraping can accomplish a removal of the coal. Jigging was introduced about 1872, prior to which time dry methods of separation were used.

Another coal separation process, imported from Belgium, is the Rheolaveur system. It was invented by Antoine France-Focquet. Its principle is to secure a separation of the coal impurities in a moving stream of water passing over a series of troughs. An upward current of water keeps the coal from escaping with the refuse. Still another scientific application of a gravity flotation process was used at the Locust Mountain Coal Company in Shenandoah. This Dupont Sink and Float Process employed solutions of halogenated hydrocarbon oils of sufficiently high specific gravity to produce the desired separations. It was used for a number of years during the 1930 decade, but some troublesome problems of corrosion and loss of solution caused its abandonment in that area.

9. Emphasis on Safety

With respect to the hazards involved in the coal industry, the Bureau of Mines figures on fatalities in anthracite mines show that in 1870 when 15,664,275 tons of coal were produced there were 221 deaths from accidents. In 1946 when 60,685,000 tons of coal were produced the fatalities were only 170. Thus, whereas there were 13.47 men killed per million tons of anthracite mined in 1870, this figure had dropped in 1946 to 2.8. The reduction in fatalities and the reasons for better safety records have been reported by a Committee of Anthracite Operators under the chairmanship of Cadwallader Evans, Jr. First-aid training of men in industry is claimed to have been begun on the continent in the Northern anthracite field in 1899. Dr. Mathew J. Shields is credited with starting this systematic training at Jermyn in

Lackawanna County. The Red Cross subsequently took over the work, with Dr. Shields as director. In 1913 he assisted the United States Bureau of Mines in writing its original *First Aid Manual.* The stimulation of the safety incentive has been encouraged by state and company regulations and suggestions in the use of safety equipment. Safety lamps and other devices for gas testing, the use of electrical detonators instead of fuses for explosives, hard hats to protect miners from head injuries, safety goggles, hard-toed shoes, and water sprays for dust control are but part of an intensive program which has steadily lowered the accident toll.

As an illustration of a recent improvement in roof testing one may mention an adaptation of electronic principles and equipment as a substitute for the old standard method of hammer tapping. Since falls of roof and face lead the list of causes of mine fatalities the mine inspector or "fire boss" must regularly determine whether the overhead rock or roof is sound. By practice he can generally tell from the sound produced by hammer tapping whether conditions are safe. In 1946 C. G. Brennecke and R. T. Gallagher, working at Lehigh University in cooperation with the General Reinsurance Corporation, developed portable equipment which produces regular taps on the roof and then with the aid of electronic devices examines the sound waves produced. The apparatus has been favorably tested in the mines and should prove to be another important contribution to accident prevention.

10. Outlook for Anthracite

The coal industry as a whole has been described by some authorities as "a very sick industry." It has suffered considerably from labor troubles ever since the turn of the century. Many articles and books—some by serious students but many by hasty observers or writers with a vitriolic pen—have been written on the social and labor problems of the anthracite region. Epithets have been bandied back and forth by both labor and management. Having grown up in Schuylkill County, the writer has some concept of the problems but would not venture to pose as an authority. He regards most of the extreme expressions as examples of the cookpot calling the kettle black.

Anthracite production reached its peak of 89,598,249 tons in 1920 and its maximum number of employees, 150,804 persons, in

1930. Since then it has suffered from the use of competitive fuels and labor troubles; by 1949 production was not much over 40,000,000 tons.

Since coal's chief use has been as a fuel and since anthracite was long regarded as king of fuels because of its high calorific value and clean smoke, the public was glad to get it—almost at any reasonable price. But when its quality varied because of the poor preparation methods of some producers and "bootleg" operators, many consumers were lost. These facts have been corrected in large measure by closer inspection, improved preparation practices, and elimination of most of the bootleggers. In order to benefit both the consumers and the producers of anthracite, organized research and study have been undertaken in recent years. The Anthracite Institute has maintained a laboratory for analysis and research for some twenty-five years. This was located at Primos, not far from Philadelphia, until several years ago when it was transferred to Wilkes-Barre. From it have come, among other important contributions, new designs for anthracite furnaces. Thus, a novel type of continuously operating, automatic fuel burner called the "Anthratube" was announced in 1945. Built in a compact unit, two by two by three feet, the new device will burn from fifty to sixty pounds of coal per square foot per hour, liberating more than 500,000 B.T.U. per cubic foot as compared to about 50,000 B.T.U. liberated in most household furnaces.

Independent investigations by coal companies have been maintained or initiated at intervals by consultants and university laboratories. For example, a product known as "Anthracoal" was developed some thirty years ago as the result of researches in the chemical laboratory of Lehigh University. It was prepared from small particles of anthracite coal heated with coal tar pitch to form a product which was harder, tougher, and stronger than coke. By this process of supplying a binder to culm and by coking the mixture a new domestic and metallurgical fuel was formed. Again, H. G. Turner became interested in the microscopical structure of anthracite coal in 1925 and in conjunction with the Anthracite Institute did researches at Lehigh University and later at the Pennsylvania State College (now University). In developing new uses for anthracite he helped to market "Anthrafilt," a carefully prepared fine size coal used in water filtration systems.

The loss of much coal in the waters flowing from the breakers has constituted a source of waste and stream pollution. For years studies of this problem have been made by the United States Bureau of Mines; and in 1928 a triangular cooperative study and report were made by this body, working with the Pennsylvania Topographic and Geologic Survey and with the Water and Power Resources Board of the Department of Forests and Waters. As a result of this study and of investigations carried on by the Institute and by individual companies, a number of modern installations have been made recently. At its Tamaqua Colliery, the Lehigh Navigation and Coal Company placed in operation a froth flotation plant to recover fine anthracite discharged from the breaker waste water. This operation, begun in 1945, handles feeds ranging from forty to sixty tons per hour and produces thirty to forty-five tons per hour of marketable coal. The reagents used, pine and fuel oils, cost $0.061 per ton of coal, and the total cost is given at $0.31 per ton of product.

Another oil flotation plant was installed in 1947 at Number 7 Colliery of the Susquehanna Collieries Company at Nanticoke. It treats twenty-eight mesh anthracite from breaker waste water and delivers the water to a settling pond to comply with Pennsylvania requirements. The fine size anthracite recovered is sold to the Luzerne County Gas and Electric Company.

Anthracite will always find its major market as a quality fuel for home and commercial uses. Still there are a number of other important consumers and potential markets. Steam power plants, for example, used 13,251,106 tons of the 1945 production of 54,400,000 tons.

In early anthracite history many of the blast furnaces of the day used anthracite coal during the transition period between charcoal and coke. Dr. Frederick W. Geissenhainer, a Lutheran clergyman, had a patent claim granted in 1833 for "a new and useful improvement in the manufacture of iron and steel by the application of anthracite coal." However, David Thomas, of Catasauqua, Pennsylvania, is credited with the first successful and commercial utilization of anthracite in smelting iron ore. In 1871 the annual production of pig iron smelted by anthracite was 957,000 tons, compared to 570,000 tons of iron made by using soft coal and coke, and to 385,000 tons of iron smelted with charcoal.

Today the iron industry no longer uses anthracite coal as a reducing agent, but the zinc industry still employs it in that capacity. Its wider use has also been suggested for power plants, foundry cupolas, and tobacco-curing barns. The Anthracite Institute has also announced researches on a fluidized bed gas producer using anthracite silt as a fuel. Another method involves a slagging gas producer, in which the melted ash flows out and is converted into mineral wool. Further evidence of active interest on the part of leaders of the coal industry in its problems and also in its potentialities is the fact that for a number of years annual anthracite conferences of a technical nature have been held at Lehigh University. These were instituted in 1938 by the late Professor Howard Eckfeldt, director of the Eckley B. Coxe Mining Laboratory at the university. It may be added in passing that Mr. Coxe, in honor of whom the laboratory was named, was manager of large mine operations and a founder of the American Institute of Mining and Metallurgical Engineers, which was established in 1871 as the result of interest by anthracite men.

To aid the Pennsylvania anthracite industry in further research a new $450,000 laboratory has just been opened at Schuylkill Haven. It will be under the direction of the United States Bureau of Mines, which for years maintained a successful laboratory in Pittsburgh. Mr. John W. Buch, the supervising engineer, has stated:

> The laboratory is to serve as a center of information in matters pertaining to conservation of anthracite reserves; efficient mining preparation, and utilization; developing new uses for anthracite; promoting safety, health, and sanitation in anthracite mining operations; and solving special problems that may eventually be assigned to the Bureau of Mines, such as mine flooding and dewatering.

This is quite an ambitious statement of aims. Its fulfillment will require continued funds, investigation, and research.

How much coal do we really have? This question was raised by A. B. Crichton in 1948 when he criticized the optimistic estimates of various geological surveys. A. C. Fieldner, Chief of the Fuels Division of the United States Bureau of Mines, stated (1948) that the anthracite deposits of Pennsylvania were perhaps 29 per cent depleted and that the industry has already entered the stage of increasing costs.

To meet these increasing costs, operators have sought more economical methods of extracting coal from the earth. Whenever feasible, stripping methods are being used on an increasing scale. In 1952 some 26 per cent of the total tonnage of anthracite was produced by stripping. Giant power shovels with buckets of thirty-cubic-yard capacity are employed in some operations, and much larger buckets are being planned. However, owing to the fact that this method of attack would denude an already scarred landscape, the Commonwealth has passed an anthracite strip mining law which requires a permit costing twenty-five dollars per acre of stripping area and a deposit bond of two hundred dollars an acre.

The anthracite region of Pennsylvania, up to 1869 (except 1865), produced more coal than all the remainder of the United States. In 1869 the production was 17,083,134 tons. Since then, the tonnage of anthracite has increased, but the mining of bituminous coal and lignite has so greatly developed that now anthracite tonnage is only about ten per cent of the total.

Nevertheless, the following quotation from the office of the Secretary of Mines at Harrisburg summarizes the present economic contributions of anthracite coal:

> The value of the annual production of Pennsylvania Anthracite today is more than that of all the gold, silver, lead and aluminum produced in Amercia. Its value is over three times that of all the copper; two and one-half times that of all the iron ore; and nearly six times that of all the zinc produced in America.

Anthracite was produced between 1945 and 1949 at the rate of about 58,000,000 tons per year. Today the industry provides, as already indicated, about one-tenth of all the coal mined in America and pays annually in wages more than $170,000,000. Moreover, the railroads receive a revenue of about $100,000,000 therefrom. There are about 9,000 retail coal dealers, with 40,000 employees, in the anthracite-burning territory. The capital invested by these dealers in plants and equipment is more than $375,000,000, and their total retail sales amount to about $425,000,000 annually. However, at the moment of the writing of this pamphlet (June 1954), the anthracite industry is suffering a new low in production. Companies have shut down many old mines and have reorganized operations to curb continued losses. Attempts to open mines of the Lehigh Navigation and Coal Company for some 2,500 miners, have been met with a picket line of one hundred men who claim that there is a violation of a 1952 contract. This occurred despite the advice of the national labor leader Mr. John L. Lewis.

In the Panther Valley area, as in other anthracite sections, continued efforts are being made by local groups toward inducing new industries to open factories in order to absorb the unemployed. It has been pointed out, however, by Frank W. Earnest, president of the Anthracite Institute, that it would require about two hundred enterprises with each one earning a million dollars a year to supplant the present anthracite economy.

As more publicity depicts the problems of the district, more aid will come. An aroused local pride will undoubtedly develop greater cooperation among folks who want to live among their barren, rocky hills. If determination, loyalty, and friendliness are sufficient, these people will succeed.

III. THE BITUMINOUS STORY

1. Beginnings of Bituminous Coal Mining

Bituminous coal occurs in about one-third of the area of the forty-five thousand square miles comprising the Keystone State. This region is chiefly in five counties in the southwestern section: Allegheny, Fayette, Greene, Washington, and Westmoreland. However, there are some twenty-four additional active bituminous counties in central and western Pennsylvania. In fact, Cambria County, with 12,072,089 tons in 1952, was next to the highest producer, according to statistics of the Pennsylvania Department of Mines.

Going back to the earliest reports of coal in western Pennsylvania we can consult Howard N. Eavenson, an eminent mining engineer who was America's most diligent historian of the coal industry. Eavenson credits John Pattin, an Indian trader, with the first record of coal in this area. Pattin's map of travels in Pennsylvania and Ohio in 1750 shows "sea coal" along the

Kiskiminitas River. In his "Analysis of travels and explorations in the middle British Colonies," published in 1755, Lewis Evans stated that Licking Creek, a few miles below Venango, "has plenty of Coals" and that there were beds of coal and salt along the Kiskiminitas River. The coal was a few miles below the present town of Saltsburg. Evans also learned from Indians that as early as 1748 there was a burning coal mine at Lamenoshikola Creek, at the head of the Muskingum River.

By 1760 a coal mine was opened opposite Fort Pitt for use of the garrison stationed there.

The earliest record of the Pittsburgh coal bed and of probably the first coal mine in Pennsylvania is found on a "Plan of Fort Pitt and Parts Adjacent" by B. Raber. The map is dated 1761. Inasmuch as it shows a road from the mine on Coal Hill to the river, the mine was probably in use.

Captain Adam Stephen, who was one of Washington's officers during the 1754 expedition in western Pennsylvania, wrote that he had "seen a deal of Limestone, Coal, and rich Iron Ore, all convenient for Water Carriage."

Eavenson has recorded the comments of many early travelers, military commanders, and others who observed coal outcrops and workings in western Pennsylvania before 1780. Some of the army leaders employed their men at various times in procuring coal, but in general the production was on a small scale and merely for the purpose of obtaining fuel for local blacksmiths.

George Washington recorded a visit, October 14, 1770, to the home of a Captain Crawford in the heart of the Connellsville region. His journal noted: "Went to see a coal-mine not far from his house on the banks of the river. The coal seemed to be of the very best kind, burning freely, and abundance of it."

By November 1768, the Indians had sold the southwestern corner of the state to the proprietors of Pennsylvania. Penn's heirs knew about coal in the Pittsburgh region and really began the coal trade when they sold lots, for thirty pounds sterling each, with the privilege of mining coal in the "Great Seam."

In southwestern Pennsylvania, beneath beautiful rolling hills, traversed by the Youghiogheny ("the river which flows roundabout") and by the Monongahela ("the river with sliding banks"), lay the choicest bituminous coal fields—the source of future riches and development, toil and trouble. Who could envision the transition from the days of the Indian paddling his canoe, with perhaps a sack full of black pigment for decorating his lodge or person, to the era of multiple coal barges pushed by stern-wheeled steamboats or more swiftly driven by boats equipped with Diesel engines?

2. First Years of the Soft Coal Industry

As settlers moved west of the Appalachians after the Revolution, the growing population created a need for more coal. Distinguished foreign visitors and domestic leaders described the advantages and extent of the Pennsylvania coal deposits. A German observer, Dr. Johann David Schoepf, who visited Pittsburgh in 1788, wrote: "The great supply [of coal] will be uncommonly advantageous in the future settlement of this region. . . . Also the use of the minerals here will be facilitated, and these coals will even form a considerable article of export." Benjamin Smith Barton, a member of a commission working on the southern boundary line of Pennsylvania, noted in his journal: "I observed considerable quantities of Stone Coal in the neighborhood of the town, and even in the town [Beesontown or Uniontown]. It appears it forms the bed of the country."

River transportation of coal was employed very early. It is recorded that in 1789 a large keel boat, laden with coal and moving down the Monongahela, was sunk and four persons were drowned. On January 27, 1793, Isaac Craig, Acting Deputy Quartermaster, sent "50 bushels (2 tons) of coal on a small keel boat" to Fort Washington, located where Cincinnati now stands. Subsequent shipments of coal came from Pittsburgh while General Anthony Wayne was in charge of Fort Washington in 1793-94. Coal in 1791 sold for twelve cents a bushel. By 1794 it could be obtained at four cents per bushel, or $0.96 per ton. For those who carried their own coal from the pits it could be had for a penny a bushel.

Tench Coxe, brilliant early Philadelphia economist and Assistant Secretary of the Treasury, wrote in *A View of the United States of America,* 1794:

> *The plenty of pit-coal in Pennsylvania will very soon give it an immense advantage over all the interior country*

north and east of it and it results that Pennsylvania, and the United States in general, are well suited to all manufactories which are effected by fire, such as furnaces, foundries, forges, glasshouses, breweries, distilleries, steel works, smith's shops, and all other manufactories in metal, soap-boiling, chandler's shops, pot ash works, sugar and other refineries.

Connellsville, chartered in 1798 by Zachariah Connell, could offer free coal and quarry stone as an inducement to settlers. The charter, recorded in Fayette County, stated that Connell "doth hereby grant unto the inhabitants of the said Town, their heirs, and assigns forever, the free and full privilege of digging and removing from said Stone Coal Bank and Stone Quarry to their habitation or place of abode within said town only, any quantity of Coal and Stone necessary for their own particular use." This right, Eavenson stated, was used very seldom because of the cheapness of the products. The right ceased without opposition when an operating company bought the tract and began making coke. In later years Connellsville coke was known far and wide for its excellence in foundry use.

Primitive industries, forerunners of the giants of the present era, were in evidence before the close of the eighteenth century. In 1794, the first iron furnace in Allegheny County was put in blast. This operation near Shadyside was short-lived because it was thought too costly to bring ore thirty miles from a deposit on the Kiskiminitas River—a telling commentary on the means of transportation then available when we consider the great distances over which furnace raw materials are now carried. In 1797 another one of Pittsburgh's great industries, the manufacture of glass, was started. The promoters were Colonel James O'Hara and Major Isaac Craig, who employed William Eichbaum to build and conduct a glass works. The accessibility of near-by coal was one of the chief factors in locating this infant industry.

The first glass industry west of the Allegheny Mountains is, however, credited to Albert Gallatin and three partners. Begun in 1797, it was located on the east bank of the Monongahela at George Creek in New Geneva.

A French engineer, Victor Collot, visited the area in 1796 and made a creditable map of Pittsburgh, which shows "the first actual location of the workings along Coal Hill." Writing for the French government, Collot predicted: "This town, when the Indian frontier is thrown back, and the roads are rendered practicable, will certainly become one of the first inland cities of the United States." Although he stated that the quality of its coal "is equal to the best kind in England . . . , this town has made little effort to establish manufactures."

Sometimes both iron ore and coal occurred conveniently adjacent. On January 6, 1816, an advertisement in the *Pittsburgh Gazette* announced that Isaac Meason of Mount Braddock, Fayette County, wanted to sell his iron works "to which is attached an excellent Stone Coal Bank." Eavenson thought that this was "probably the first captive coal mine in this country." The term "captive" refers to mines from which all of the coal goes directly to the owners' iron furnaces or whatever industries they may operate, rather than to the open market.

3. Early Coal Records

Authorities searching old deeds in the several county seats of western Pennsylvania have found practically no references to coal rights prior to 1829. The location of lots was sometimes referred to in relation to "Coal Hill," but specific statements as to rights to coal mines and collieries were not included. However, early newspaper advertisements gave more information about activities in coal lands. In the first two decades of the nineteenth century more than thirty such references appeared. Most of these appeared in Pittsburgh newspapers, but there were also several in publications from Uniontown, Washington, and Greensburg. Such features as limestone, sugar camps, and apple orchards were often mentioned before the inclusion of "an excellent coal bank" in the description of the lands advertised for sale.

It is interesting that on January 1, 1802, Pittsburgh had an "ordinance respecting coal" which required that all wagons and carts used in delivering coal be branded "with their capacities in bushels." The act is thought to be the first legislation of its type in any American coal region and the beginning of regulations regarding weights and measures involving coal.

4. Smoky City

Early observations on the sooty pallor of the atmosphere about Pittsburgh, as a result of the use of soft coal in homes and industries, are to be found. An English visitor, John Bernard, wrote in 1800: "On approaching Pittsburgh, we were struck with a peculiarity nowhere else to be observed in the States; a cloud of smoke hung over it in an exceedingly clear sky, recalling to me many choking recollections of London." The smoke nuisance which later earned Pittsburgh the title of "Smoky City" was soon enough decried. For a century and a half the deluge of black particles continued, with increasingly vigorous attempts made to legislate against this problem. Not until 1952 were restrictive regulations passed to curb the discharge of "solidified darkness," which resulted in air pollution and property destruction. Now it is unlawful to burn bituminous coal except with certain prescribed stoker type furnaces. That is a long step to take in a community which owes much of its development to coal, and it may be even more difficult to maintain.

5. Growth of the Soft Coal Market

Coal's first important customer came with the steam engine which was introduced early in the nineteenth century. By 1808 a steam engine was operating in Pittsburgh to furnish power in a grist mill, and the fuel—twenty bushels per day, at a total cost of one dollar—was "stone coal." A few years before in Philadelphia, Oliver Evans had made use of the steam engine for driving mill machinery; in fact, he was one of the early engineers who used anthracite coal successfully. By 1832 it was reported that there were over one hundred steam engines employed by various industries in the soft coal area.

Another outlet for bituminous was in salt making, an important early industry in western Pennsylvania. Near Butler a small salt plant was begun in 1809. Two coal furnaces supplied the heat to evaporate the salt liquor from a near-by well. The operation employed forty-eight kettles of thirty gallons each to dry a product exceedingly important to man and beast. As the salt industry developed, new wells were drilled at a number of other points along the Conemaugh, Kiskiminitas, and Mahoning Creeks, as well as along the Allegheny and Monongahela Rivers. The demand for coal increased. At its peak salt-making used one hundred thousand tons of coal per year. The industry flourished in this area from 1815 to 1870, after which it receded because of competition from larger salt-making developments in adjoining states. This fact, however, had no effect upon the consumption of bituminous coal.

Zadock Cramer, publisher of an early almanac known as *The Navigator,* wrote in 1814:

> Little short of a million bushels [of coal] are now consumed annually; the price formerly six cents, has now risen to twelve cents keeping pace with the increased price of provisions, labor & c. . . . There are forty or fifty pits opened, [on Coal Hill], including those on both sides of the river. They are worked into the hill horizontally, the coal is wheeled to the mouth of the pit in a wheelbarrow, thrown upon a platform, and from thence loaded into wagons. After digging in some distance, rooms are formed on each side, pillars being left at intervals to support the roof. The coal is in the first instance separated in solid masses (the veins being generally, from six to eight feet in thickness) and is afterwards broken into smaller pieces for the purpose of transportation. A laborer is able to dig upwards of one hundred bushels per day.

Cramer described the evil and inconvenience of the city's smoke, but suggested that "all this might be prevented by some additional expense on the construction of the chimnies." He predicted that because of its cheap fuel and favorable location Pittsburgh would become "at some period or another, the first inland town in America."

With respect to the financial situation of the men who worked in the coal mines, we get some idea of the comparative income of American and British miners in this period from the pen of Thomas Hulme, an English traveler. In 1819 he wrote about his observations at Wheeling:

> The coals are principally in one long ridge, about ten feet wide; much as they are in Pittsburgh, in point of quality and situation. They cost 3 cents per bushel to be got out of the mines. This price, as nearly as I can calculate enables the American collier to earn upon an average, double the number of cents for the same labor

> that the collier in England, can earn; so that as the American collier can, upon an average buy his flour for one third the price that the English collier pays for his flour, he receives six times the quantity of flour for the same labour.

Glowing accounts such as this one no doubt increased the westward migration, which was already growing yearly.

6. Coke

The making of coke for foundries and for iron smelting became general sometime after the middle of the nineteenth century. However, the first use of coke occurred much earlier. For example, the Plumpsock Iron Works in Fayette County were described in 1818 as having "an inexhaustible pit . . . [of stone coal] within one hundred yards of the forge. Three men with a horse and cart are sufficient to raise, coke and haul to the forge all the coal necessary for keeping the works in full operation." Perhaps the first efforts in coke-making in western Pennsylvania were even earlier because about 1814 an iron founder, John Beal, offered his services to instruct blast furnace operators how to convert "stone coal into coak." This early coke was made in piles, rather than in the ovens of later production methods. It may be mentioned here that coke, by whatever process made, is a porous substance resulting from the slow heating of soft coal out of contact with air. Because the volatile gases have been removed, it is essentially carbon along with a little mineral ash. As such it can be used by householders, or by smiths and foundry men. However, its greatest value is in reducing iron ores in the blast furnace. It is "strong enough" to support the ore and limestone, and yet sufficiently porous to be affected quickly by the air blast. As coke is converted to carbon monoxide it serves as a reducing agent and a source of heat.

Everyone has heard much about the use of by-product ovens in the production of coke. It was thought by many that the older beehive oven batteries with their colorful but wasteful display of flame had ceased to exist. With the rise of the modern by-product ovens, which not only conserve gas, benzene, ammonia, naphthalene, and toluene but also provide a source for hundreds of by-products, there has been a gradual decrease in the proportion of coke made by the older beehive ovens. However, when steel mills are working at one hundred-plus capacity, the old beehives are put back into use and are able to produce ten per cent or more of the total coke needed. At one time (1909) there were some 579 plants with a total of well over 100,000 beehive ovens making coke.

By 1832 Pittsburgh alone was using ten thousand bushels (four hundred tons) of coal a day. Other western Pennsylvania towns, such as Connellsville, Brownsville, and Washington, were consuming increasing amounts locally and beginning to transport it by river boats. The supply at this period was so great and accessible that soft coal could be bought at the mine in Connellsville for thirty-eight cents a ton. There was no excuse for folks in the area to be cold when anyone could haul or carry his fuel for household use. Kitchen cooks, nevertheless, still insisted on wood for their stoves and fireplaces because of the ease of kindling and the freedom from odors.

7. Transportation of Bituminous Coal

During the early period of its development, western Pennsylvania relied largely on the rivers for coal transport, a condition still true today wherever river traffic is possible. Highways in the early days were few and poor.

The canal era for the bituminous coal fields arrived in the 1830's, with the first boat reaching Pittsburgh over the Pennsylvania Canal in 1834. Such a boat would start at Columbia on the Susquehanna River, continue on the canal through the Juniata River valley to Hollidaysburg, then travel by rail and inclined planes to Johnstown. The route from Johnstown to Pittsburgh was along a canal which coursed the valleys of the Conemaugh, Kiskiminitas, and Allegheny Rivers. This engineering feat was an outlet to the East for coal from the Counties of Huntingdon, Bedford, Blair, and Centre; but very little was shipped all the way from Pittsburgh. Some Monongahela River coal was, however, carried east in 1835 and tested for gas purposes. Although the report was favorable, Philadelphia continued to use chiefly Virginia or English coal until the advent of speedier carriage by railroad several decades later.

The inadequacy of the canal system from Harrisburg to Pittsburgh led to the formation of the Pennsylvania Railroad Company in 1846 to build a line over the 249 miles of wilderness between the two cities. In the course of the next century the Pennsylvania Railroad grew from a local line of but several hundred miles into an interstate system of over 10,000 miles. As coal revenues to the railroads increased, the enormous volume (and dollar income) of this traffic became apparent. It was not, however, until after the Civil War that some railroads were built almost entirely with an eye to coal carrying. How important this business was becoming is indicated in a report by the Secretary of the Commonwealth of Pennsylvania on January 9, 1840. It contained production statistics of bituminous coal for the year 1838. Of a total of 2,046,874 tons, Allegheny County accounted for 1,862,000 tons; next in order came Washington County with 71,200 tons, Indiana County with 30,500 tons, Greene County with 18,800 tons, Butler County with 15,240 tons, and Clearfield County with 13,083 tons. Some seventeen counties reported, but those not mentioned here listed fewer than ten thousand tons each. In 1853 the first important shipment of coal to the East was sent from Westmoreland County. Nine-ton box cars were used for its transport. The same year saw a small quantity of anthracite reach Pittsburgh. It was placed on sale for $5.50 a ton.

An English visitor to the bituminous coal fields, Prof. D. T. Ansted of Cambridge, recorded many of the facts of the coal industry of one hundred years ago. Describing the drift mines worked along the river banks near Pittsburgh, he stated that the yield from the five-foot seam was between 3,000 to 4,000 tons per acre. The coal was obtained from a great number of openings on the hillside that were about seven yards wide and of variable length. After the coal was brought to the hillside it was sent down an incline to the river where it was screened and loaded on flat boats. Even though these boats were crudely made of rough boards, they were 100 to 130 feet long and about twenty feet wide and had a capacity of 500 tons or less. They were assembled for a one-way trip and sold for lumber at their destination. The costs prevalent at this period were given: the mining of coal cost three cents per bushel and loading it one-half to one cent per bushel; boatmen received from one to one and a half dollars per day; mineral rights, within six miles of Pittsburgh, cost five hundred dollars per acre, with land valued at thirty to forty dollars per acre. The report also stated that Pittsburgh was lighted with gas from local coal; the gas yield was 336 cubic feet per bushel of 76 pounds (or 9903 cubic feet per ton of coal). In the winter of 1852-53, gas production was 180,000 cubic feet per day. The resulting coke was sold for four cents a bushel; as for other by-products, there was little use for the tar and none for the ammonia.

8. Increases in Soft Coal Production

From Eavenson's studies we find that by the year 1800 some 87,000 tons of bituminous coal were mined in Pennsylvania and only two hundred and fifty tons of anthracite. The production of anthracite grew slowly but steadily and by 1832 was larger than that of bituminous. Probably because of the new Schuylkill River Canal (1825) and the Lehigh Canal (1829), the anthracite regions marketed in that year 501,951 tons in comparison to 450,940 tons from bituminous sources.

Inspection of some selected figures from production tables for the past century shows how the picture has changed in the last fifty years:

PENNSYLVANIA COAL MINED—NET TONS

	Anthracite	Bituminous	
1850	4,326,969	2,147,500	
1875	23,120,730	12,443,860	
1900	57,367,915	79,842,326	
1917	99,611,811		Peak
1918		178,000,000	Years
1924	87,277,449	135,266,612	(1925)
1944	64,112,589		Highest
1947		144,761,964	recent year
1952	40,067,130	87,308,999	

As the table shows, bituminous production by 1900 had surpassed in tonnage that of anthracite, though the money value of the anthracite was greater. The decreases shown in 1952 were due largely to work stoppages from labor troubles. Appendix 1 shows some of these figures.

9. Problems in the Bituminous Industry

The coal industry has had more than its share of difficulties, some of which were common to all business enterprises, others unique to coal mining. Coal operators despaired, with modest restraint, over the National Recovery Administration, the New Deal, and the Coal Conservation Act of 1937. The latter was the so-called Guffey Bill. Glen L. Parker in his book, *The Coal Industry,* states that "the Bituminous Coal Code under the National Industrial Recovery Act represents the first serious and far-reaching attempt in peace-time on the part of the Federal Government to regulate an industry that had been so thoroughly committed to laissez-faire." The object of the code was to prevent constant price cutting and wage-juggling as a result of competition between unionized northern areas and non-union southern fields. Some idea of the aroused feelings of operators in the Appalachian group, the source of seventy per cent of all coal, can be imagined when under the terms of government regulations it was proposed to give them only one representative on a board of ten. After about four years of study, bitter discussion, haggling, and changing labor provisions to make the Bituminous Coal Act constitutional the Guffey Act was passed in 1937 after further revision. Designed for a four-year period but extended during the war, this complicated system finally became unworkable. Price controls were then fixed by the Office of Price Administration to prevent wartime inflation.

Like many another industry, that of coal has been bothered by an excess of labor strife and union tangles. Miners may look upon their organizer, John L. Lewis, as labor's champion and dub him "Old King Coal," but management more often would like to see his throne topple. Usually a radical, Lewis has on occasion been quite conservative. Many of the gains in wages and benefits to the miner have been credited to him. The coal miner is now considered to be one of the highest paid workers, although he has lost much of his gains in time out for strikes and dictated holidays. A daily wage of twenty odd dollars per day does not produce a high monthly income when the miner may be working only three days per week.

Coal mining is one of the most competitive industries. In addition to competition within the industry itself, recent years have shown tremendous competition from the outside, chiefly from the oil and natural gas interests. The decline in production since the first World War has been due partly to public demand for a fuel whose delivery will not be interrupted by frequent shutdowns of mines, but also to the appeal which oil and gas have made because of their ease of handling and their freedom from ash. In spite of a differential in price, which frequently favors the use of coal, the American public (for home use especially) wants ease and convenience and is willing to pay for it.

Another very important factor affecting coal consumption is the increased efficiency of electric power plants, which are the major customers in the use of coal. In 1919 it required 3.2 pounds of coal to produce one kilowatt-hour. In 1937 only 1.42 pounds of coal per kilowatt-hour were used, and now in some cases only 0.8 pound. Nonetheless, the manifold increase in use of electric power has raised the consumption of bituminous coal by electric utilities from ten per cent of total production in 1920 to 18.4 per cent in 1951.

IV. PRESENT STATUS OF THE COAL INDUSTRY

1. Coal, a Big Business

Since 1800 Pennsylvania has furnished more than forty per cent of all the coal mined in the United States. Its total output has been almost thirteen billion tons, of which five billion tons were anthracite coal. The value of Pennsylvania's mined coal has been estimated at twenty-nine billion dollars. The black treasure removed from Penn's hills would constitute a pile ten miles square and three quarters of a mile high. Is it any wonder that there are ground settlings of a serious nature in sections where preventive precautions have been neglected? This condition has become a real problem in older areas of the anthracite region where mine pillars have been robbed.

The cost of coal to consumers depends on a number of variables. Distance from the mine is the chief factor, but there is also a seasonal price which varies slightly. Dealers reduce prices in summer to induce sales. The retail cash price (weighted average) of chestnut size anthracite coal in December 1953 was $26.34 per ton. Ten years ago (Dec. 1943) this size brought only $13.91. Yet despite the charges in the past of monopolistic profits by some famous labor counselors such as Clarence Darrow—it is widely known that, except during wartime production, the bituminous coal companies for many years have commonly shown a deficit.

In 1950 Richard Maize, then Secretary of Mines for Pennsylvania, stated that five million American homes, housing more than thirty million people, were heated with anthracite coal. At that time there were 75,231 employees in the Pennsylvania anthracite fields. In 1953 this number decreased to 56,500. Employees of the Keystone State's bituminous industry in 1950 numbered 94,514, but in 1952 only 76,676. The decline in production and employment in the coal industry constitutes what the State Historian of Pennsylvania, S. K. Stevens, says, "has been one of the major economic problems of contemporary Pennsylvania."

For years the mining of bituminous coal was done by a great sprawling network of producers, using primitive methods and having little association among themselves. Even in 1929 there were 4,600 soft coal producers throughout the nation, of which some 3,300 each produced fewer than fifty thousand tons annually. In 1946 western Pennsylvania alone had 677 mines. On the other hand, many of the steel companies, needing soft coal for coke manufacture, went into the mining business. These "captive" mines may produce twenty-five per cent or more of the total bituminous coal, depending on the capacity of steel production. The Robena Mine of the United States Steel Company in Greene County is the largest coal mine in the world. It produced 4,439,439 tons in 1953. The second largest in Pennsylvania is Jones and Laughlin's Vesta Number 5 Mine which reported two and a quarter million tons in 1951. Both mines utilize modern preparation plants located along the Monongahela River. In some instances the coal is hauled underground by electric motor power for twelve or more miles to the blending and cleaning plant, where the coal is separated from rock, slate, and other materials by sink and float processes. Next it is washed and then chuted into 900-ton barges for its trip to Clairton or Pittsburgh, some eighty miles north by river route. Several other major steel producers obtain large supplies of coal from southwestern Pennsylvania and near-by West Virginia. For example, the Youngstown Sheet and Tube Company draws from Nemacolin, the Crucible Steel Company from Crucible Mine, and the Republic Steel Company from Clyde Mines. Wherever possible, shipment is made by water to the by-product coking plants and iron furnaces. Some, like Bethlehem Steel Company, transport by rail.

The largest coal company operating in Pennsylvania resulted from the gradual merging of many smaller independent groups. About the beginning of this century the Monongahela River Consolidated Coal and Coke Company emerged from an association of mine operators who chiefly employed river transport. There was also a union of one hundred and twenty so-called rail companies into the Pittsburgh Coal Company. In 1916 these two groups were merged into what is probably the world's largest coal mining enterprise. The present organization, resulting from a union of the Pittsburgh Coal Company and the Consolidated Coal Company in 1945, has thirty-eight deep coal mines and fourteen stripping operations. About twenty-five per cent of the Pittsburgh Coal Company had been owned by the Mellon interests, whereas the Rockefellers had a large share in Consolidated Coal. In 1946 the production of the new Pittsburgh Consolidation Coal Company was twenty-six million tons. The chairman of the board of directors of the organization—a subsidiary of the M. A. Hanna interests—was Mr. George Humphreys, whom President Eisenhower chose as Secretary of the Treasury of the United States. The chief reason for this pooling of interests is to eliminate losses and to put the coal business on a sound financial basis. Northern companies had keen competition from those in West Virginia and farther South; in fact some of the northern mines were more costly to operate. This was due to the following factors:

(1) dwindling coal sources in the older mines,
(2) the opening of new mines, and
(3) greater unionization with resulting higher wages in the northern coal fields.

In the decade after World War I the Pittsburgh Company showed a deficit for seven years. Financial losses plagued almost the entire coal industry during the late twenties and the thirties of the present century. The 1940-50 period showed a brighter picture. Of the 1,800 coal companies in the nation in 1947, some 1,400 showed a total net income aggregating 265 million dollars, but four hundred still showed a deficit totalling six millions. The 1951 *Coal Annual* reported that in the eight years ending with 1947 the industry's profit after the payment of taxes was 414 million dollars. This is certainly much smaller than returns of other major industries.

2. The Trend Towards Mechanization

All of the mining companies have tended towards mechanization to save costs. Prior to 1885 mining was almost entirely a pick and shovel operation, with hand drills, primitive explosive techniques, wheelbarrows, mules and small cars—a dirty, hazardous operation with a high accident toll. Production rates and wages were low, whereas hours underground were long and tedious.

Within the past fifty years have come many changes, such as the gradual introduction of power machines for drilling, cutting, loading; electric trolley locomotives, not only for hauling coal but also for transporting men underground to save the long, tiresome drag to and from the coal face; improved and safer explosives; adequate fans to provide fresh air in all areas; rock dusting to eliminate coal dust explosions (the walls are now kept white with powdered limestone); electric battery lamps for better illumination; and adequate inspection of mines by company, State and Federal mining inspectors. Pennsylvania in 1953 had thirty bituminous mine inspectors and twenty-five anthracite inspectors, all appointed by the Commonwealth Government.

Some of these steps in the direction of improved mining techniques and conditions had their beginnings prior to 1900. For example, in 1868 the first law relating to coal mines in Pennsylvania was passed. It applied to the draining of mines in Westmoreland County. By 1869 the anthracite region had its first law pertaining to ventilation, safety lamps, and mine inspectors.

It is impossible here to list all of the improvements in technique which have tended to raise production and better the workman's conditions. For example, approximately nine tons of air must be circulated during the mining of one ton of coal, and in some districts as much as fifteen to twenty tons of water are pumped per ton of coal. There are some mines so gassy that six million cubic feet of methane (which mixed with air in certain proportions creates fire damp, a combustible and explosive gas) form in twenty-four hours, but proper ventilation keeps the amount down to less than 0.5 per cent.

Ever since the United States Bureau of Mines was established in 1910, continuous efforts have been made to study, control, and minimize mine disasters. Besides the continued investigations at the Bureau's Pittsburgh laboratories, the nature and cause of explosions have been analyzed in an experimental mine at Bruceton, thirteen miles away. The management, with the assistance of Federal and State authorities, has trained mine personnel and rescue crews in the best-known methods of combating underground dangers. Moreover, the stress on safety practice as a preventive measure against accidents is constant, and is continuously advanced by legislation, education, and engineering technique.

The results of the trend towards mechanization may be seen by comparison of the average production of a British and an American miner. In the United States it required, as figures in 1940 revealed, 1.7 man hours per ton of coal; in Britain it was seven and a half man hours for the same amount. Mining conditions, of course, accounted for most of the difference. Abroad, the miner may have to walk several miles underground from the shaft pit to his work; further, the coal seams may be too thin for the effective use of machinery.

The decreases in fatalities per million tons of coal mined in 1951 over the 1935-39 average amounted to 48.6 per cent. Deaths caused by explosions have decreased by eighty per cent in the past thirty years because of greater safety precautions. Among mineral industries the coal miner in recent decades won most of the safety awards and citations. Back in the period 1910-1914 the total number of fatalities averaged 2,004 per year in the United States coal industry; in 1950 the fatalities were but five hundred and fifty, of which fifty-eight per cent were due to roof falling in the mines and only 0.55 per cent to explosions. The Bureau of Mines, it may be added, calls an accident a "disaster" when five or more men lose their lives. In the years 1949 and 1950 there was no such loss on record.

3. Impact of the Coal Business Upon Society

It has been claimed that more mineral wealth has come from the Pittsburgh coal seams than from any other mining venture in the world. Because about two-thirds of the cost of coal goes into wages, one can see that most of this wealth has gone to labor. An overmanned industry means less in wages per man. In the coal industry during the past twenty years there has been a decrease of about twenty-eight per cent in the number of employees. The coal they have mined and processed has increased Pennsylvania's heavy industry, such as power, transportation, steel, glass, coke with its multitudinous by-products, and hundreds of manufacturing enterprises. The wealth resulting therefrom far surpasses that made immediately from coal itself. Furthermore, it has brought warmth and comfort into countless homes and places of business.

Directly influenced by and also influencing the coal industry are the rail, water, and automotive systems of transport. Then there is the production of the massive and powerful machines (many of which are made in Pennsylvania) for digging, drilling, cutting, loading, and refining coal, and of the many special safety devices, besides head lamps, helmets, and safety goggles, which are developed and manufactured by private industry. Moreover, coal's earnings have built up the private fortunes which have frequently founded and funded great colleges, universities, institutes of research (such as the Mellon Institute), and hospitals. The taxes from coal have also helped to maintain education, from elementary schools to large universities.

Art and literature have been inspired by the theme of coal mining and by the people who make it their life-work. Nowhere else will one find a friendlier people than those who live in both the anthracite and bituminous coal regions. Here America's melting pot has done a leveling which brooks no class differences. Their respect for man's life and pleasure does not always adhere to law's restrictions. Liquor and gambling are not recent innovations. Whole communities play the illegal "pools." Bootleggers in the anthracite field (in the 1930's) appropriated coal and undermined highways, but they kept coal moving to markets which in some instances might have been lost to the industry.

The traveler through the coal regions will no doubt be awed by the extensive stripping operations, the stream pollution, the "cave-ins" and crooked houses, the burning mine in Scranton (publicized in 1953), or the soot and cinders of western Pennsylvania. These are evils, however, to which public opinion and legislation are alert. The scars of gutted hills may take years to eliminate, but a gradual program of reforestation will be followed as has already taken place in some sections. Streams are slowly being restored to a reasonable clarity, and eventually the smoke problem will get more attention. Natives of a coal region say, however, that they would rather see smoke and full dinner pails than neither one of them.

4. The Future of Coal

In spite of a trend to decreased production of coal in recent years, engineers who are studying the future energy needs of the nation predict that coal will again assume a larger role than at present. In an analytical article in the *Bituminous Coal Annual* for 1952 Messrs. Lamb, McElroy, and Pursglove develop this theme under the title, "There's Coal in Your Future." They estimate that the over-all energy demand in 1975 will be double that supplied at mid-century. This is probably a conservative figure in view of the fact that the energy output of the United States doubled in the 1925-1950 period. Based on this estimate, a fifty per cent increase in the coal requirements is assumed.

In 1951 the distribution of bituminous coal was:

To electric utilities	105	million tons
For coke and steel production	125	" "
To railroads	55	" "
Other domestic markets	225	" "
Exports	60	" "
Total	570	" "

If this coal tonnage is to increase fifty per cent, then the 1975 demand will be 855 million tons. The authorities quoted believe that the greatest increase will come from the electric energy requirements for more coal—perhaps more than triple the present demand. Coke and steel will almost double their needs; railroads, on the other hand, will probably decrease their use of coal as more Diesel engines are employed. Other domestic markets will increase somewhat but exports may drop.

Advanced coal mining practice at present consists of four major steps: to cut, drill, shoot, and load the coal. Although many mines are now equipped to do these separate operations mechanically, those in the vanguard have installed or are planning to use an ultra-modern piece of power machinery known as the "continuous miner." In 1951 one hundred and seventy continuous mining machines were in use, and there were some operations in which the entire production was thus obtained. These industrial robots operating on tank-type treads move up to a coal seam and, after chipping off the coal, throw it back on a waiting car or other transport unit. This continuous process can mine coal at the rate of two tons per minute.

The object of mechanization is the saving of high-priced labor. Mr. G. B. Harrington stresses however that the industry needs, even more than power machinery, improved labor relationships which will result in continuous mining. The United States Coal Commission in 1925 studied the cost of mining when operations were only part-time. On the basis of a month of twenty-five days as a standard, the Commission found that a loss of five days per month raised costs five per cent; with half-time operation, costs increased twenty per cent, and if only five working days per month were scheduled the costs doubled. It is almost certain that these costs are much higher, now that more expensive machinery is used.

Future mining will see greater application of roof bolting for safety. Since most of the underground accidents are due to falls of the overhanging rock, the recent plan of using long, expanding-end, flanged bolts to support the mine roof will increase safety. It will also eliminate timbering and improve efficiency. There will be a wider use of the new giant augurs which can increase production to thirty or more tons of coal a man per day. These ingenious motor-driven bits, three feet or more in diameter, chew out coal like a mammoth boring-mole.

To carry coal there will be various new types of conveyors. Up some slopes there are already literally miles of heavily reinforced rubber belting, four to five feet in width, utilized now in transporting raw coal from mine to cleaning plant or later in removing the waste to a man-made mountain. There are also new types of conveyors made of stainless steel, which simply vibrate and shake the coal along its route. There have been experiments even with pipeline transport, which soon may be used more extensively. As to surface mining or stripping, which now provides about one-fourth of the coal production, this will undoubtedly increase in districts where coal is close enough to the surface to be removed economically.

Advocates of a super-power system, in which coal is burned at the mines and electric power generated in the process, were presenting general plans thirty years ago. This concept will be perfected as studies and applications of underground gasification, *i.e.*, controlled burning in the mine, are completed. The process has several advantages: (1) a tremendous saving in cost of coal transport; (2) the ability to utilize seams of coal so thin that they cannot be mined by conventional methods; (3) a first step in synthetic fuel manufacture, namely the conversion of coal to oil.

Coal will always be vitally important because it contains the most versatile element, carbon. The hydrocarbons which issue from bituminous coal upon distillation are raw materials for the ever growing organic chemical industry. There are thousands of compounds so obtained which have direct uses or which serve as intermediates for the preparation of drugs, vitamins, fibers, flavors, perfumes, dyes, fertilizers, insecticides, and paints. We have heard so much about the "wizardry of modern chemistry" that we may assume this development to be a form of magic. Nothing could be farther from the truth. The time, work, and money which have gone into research are tremendous but the resultant increase in technical knowledge will pay off in future rewards.

The story of the by-product coke industry is beyond the scope of this pamphlet. Its history is closely associated with Pennsylvania. Shortly after the Solvay Process Company built twelve Semet-Solvay ovens in New York in 1893, the second by-product plant in the country was built at Johnstown, Pennsylvania. This unit of sixty ovens was erected in 1895 by the Cambria Steel Company (now the Bethlehem Steel Corporation) to make metallurgical coke. Four years later, when one hundred Otto-Hoffman ovens were built, even skeptical steel men saw the trend. By 1915 the Koppers Company—largest coke oven builders and also big coal and coke producers—moved from Chicago to Pittsburgh to offer its engineers a larger field of development. Its origin dates back to 1906 when the United States Steel Corporation brought Dr. Heinrich Koppers from Essen, Germany, to design ovens for the Illinois Steel Company at Joliet, Illinois.

Research, such as that inaugurated by the Pittsburgh Consolidated Coal Company in association with the Standard Oil Company of New Jersey, to study new processes for utilizing our coal resources and to develop liquid fuels by improved conversion processes will insure us that there will be increasing demands for coal in the future. A study of possible conversion techniques indicates that a partial conversion of coal into liquid fuels will be best. The bituminous coal will be heated to distill the volatile liquids and release some of the gas of higher calorific power. The process itself will be fueled by some of this gas. A solid char, suitable for use in heating boilers, will be formed, and the liquids will be used by the chemical industry. By a process of hydrogenation (*i.e.,* chemical addition of hydrogen gas), the distillation liquids can be converted to liquid fuels. The step in which the synthetic gas is catalytically transformed into liquid fuels is known as the Fischer-Tropsch Process. With American refinements it will provide fuels for future industrial needs. Thus coal, which resulted from chemical and physical changes in nature ages ago, will be subjected to additional man-made changes to suit man's requirements. Although it is true that atomic energy transformations may alter future plans for energy sources, coal will undoubtedly play a large role in any future developments of power production.

APPENDIX 1: ANTHRACITE

1952 STATISTICS OF THE DEPARTMENT OF MINES
COMMONWEALTH OF PENNSYLVANIA

County	*Production Net Tons of Anthracite*	*Employees*	*Average Days Worked*	*Fatalities*
Luzerne	13,774,952	28,512	238	37
Schuylkill	12,977,572(a)	17,937	215	22
Northumberland	5,326,146	5,538	210	10
Lackawanna	5,303,545	9,717	240	10
Carbon	1,899,297	3,279	213	8
Columbia	760,695	1,352	222	5
Sullivan	24,055	63	206	—
Dauphin	868	40	224	—
Region	40,067,130	66,438	221	92

(a) Tons included from Lebanon County.

APPENDIX 2: BITUMINOUS

1952 STATISTICS OF THE DEPARTMENT OF MINES
COMMONWEALTH OF PENNSYLVANIA

County	*Production Net Tons Bituminous Coal*	*Employees*	*Days Worked*	*Fatalities*
Washington	13,656,583	11,871	168	6
Cambria	12,072,089	12,172	153	15
Greene	9,592,879	8,488	174	9
Allegheny	8,230,420	7,184	176	1
Fayette	7,523,581	9,154	126	3
Indiana	6,245,535	5,248	183	5
Clearfield	5,781,289	4,091	217	3
Westmoreland	5,252,229	4,906	165	13
Somerset	4,982,002	5,159	149	4
Armstrong	3,262,566	2,078	237	1
Clarion	2,231,809	975	254	—
Butler	1,963,063	1,044	210	2
Jefferson	1,560,065	1,298	175	—
Centre	1,009,024	590	214	—
Clinton	617,027	160	257	—
Elk	589,588	479	176	—
Mercer	534,666	287	207	—
Venango	447,516	108	295	—
Beaver	445,807	191	205	1
Huntingdon	268,772	354	117	—
Lawrence	262,626	92	237	—
Blair	208,099	168	191	—
Bedford	206,764	327	97	—
Fulton	157,614	50	165	—
Tioga	62,761	130	74	—
McKean	43,847	29	168	—
Lycoming	27,034	19	177	—
Bradford	7,538	5	232	—
Region Total	87,308,999	76,676	5,199 (Av.) 186	62

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