B

A SHORT DESCRIPTION

OF THE

Pennsylvania

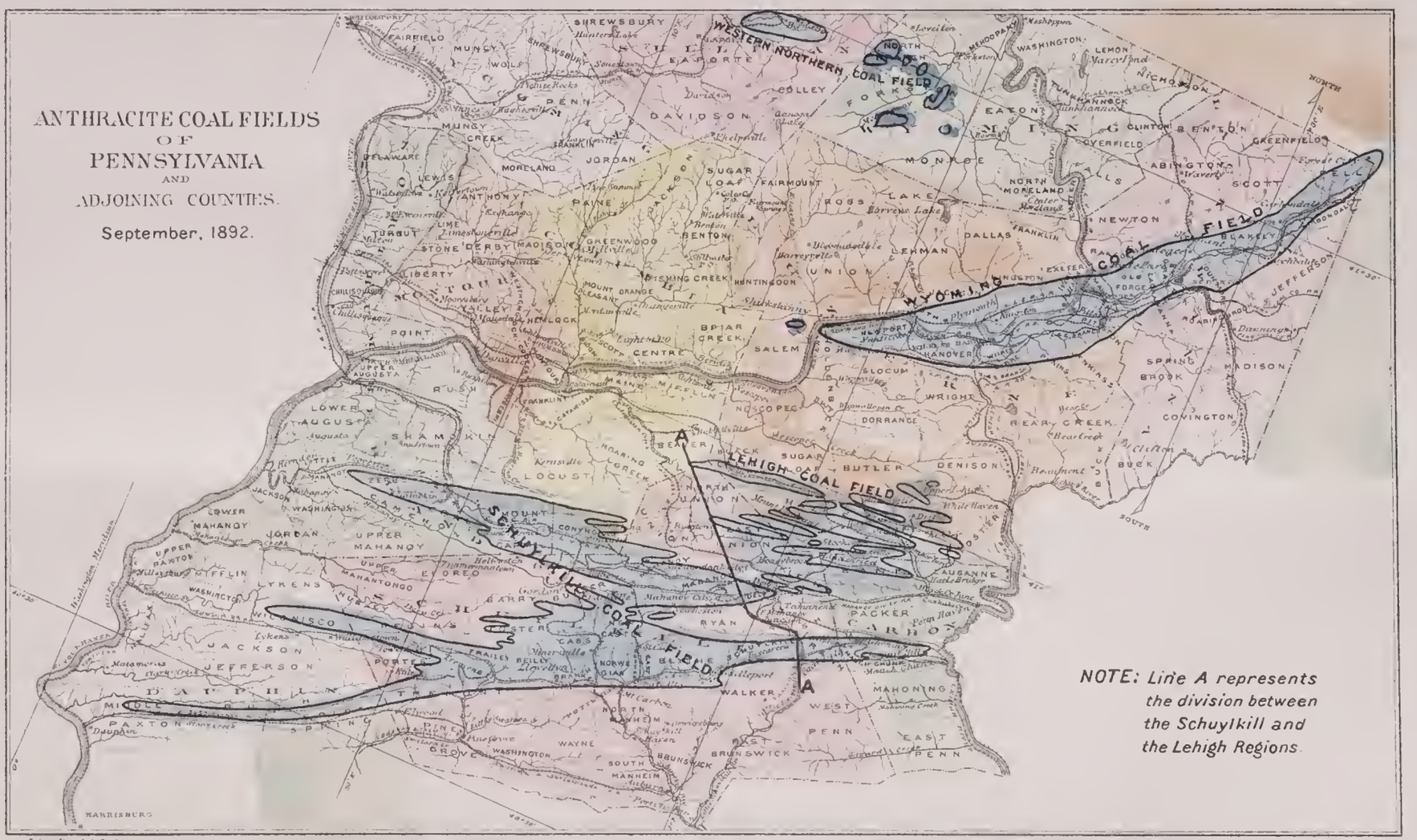
Anthracite Coal Field.

Its Extent, Capacity, Value, Progress, Duration of Progress, Its Economic Importance, and Its Early History.

BY

JAMES F. JONES, M. E.

PHILADELPHIA.


ANTHRACITE COAL FIELDS
OF
PENNSYLVANIA
AND
ADJOINING COUNTIES.
September, 1892.
WESTERN NORTHERN COAL FIELD
WYOMING COAL FIELD
LEHIGH COAL FIELD
SCHUYLKILL COAL FIELD
A
A
NOTE: Line A represents the division between the Schuylkill and the Lehigh Regions.
Julius Bien & Co. Lith.
Scale of Miles
Scale of Kilometers

B

A SHORT DESCRIPTION

OF THE

Pennsylvania

Anthracite Coal Field.

Its Extent, Capacity, Value, Progress, Duration of Progress, Its Economic Importance, and Its Early History.

BY

JAMES F. JONES, M. E.

PHILADELPHIA.

BRIEF SYNOPSIS.

The Pennsylvania Anthracite Coal Field.

A short description of the extent, capacity, value, duration of progress and the economic importance of the Anthracite Coal Field of Pennsylvania.

The following are some of the important summaries:

Number of Acres, 312,000—square miles, 487½.
Tonnage of Marketable Coal remaining, 12,000,000,000 tons.
Time required to exhaust the first one fourth, forty-four years.
Annual out-put at the end of forty-four years, estimated to be 100,000,000 tons.
Out-put in 1891, 40½ million tons.

Average cost per ton, on cars,—labor and material, . . .	$1 34
Average cost per ton, on cars, including all charges for improvements, depreciation, land exhausted, taxes and insurance, .	1.58
Average cost per ton, on cars, including interest on the value of the coal lands, ...	1.90
Approximate average cost per ton, on cars, for the Wyoming Region, ...	1.20
Approximate average cost per ton, on cars, for the Lehigh Region,	1.34
Approximate average cost per ton, on cars, for the Schuylkill Region, ...	1.46
Value of Coal Lands and Collieries, about	$300,000,000.00

Loss in the Iron Manufacturing Division of the Anthracite Market, nearly 3,000,000 tons.
Gain in the Western Division of the market, for the same period, is nearly equal to the loss in the Iron Manufacturing Division.

INDEX.

THE PENNSYLVANIA ANTHRACITE COAL FIELD.

TABULAR STATEMENTS.

PLATES.

A SHORT DESCRIPTION

OF THE

PENNSYLVANIA ANTHRACITE COAL FIELD,

ITS EXTENT, CAPACITY, VALUE, AND ITS ECONOMIC IMPORTANCE, WITH AN ESTIMATE OF THE DURATION OF THE PROGRESS OF THE BUSINESS.

Anthracite coal is to be found in the Rocky Mountains, in the Alps, in Wales, in Southern Russia, in China, and perhaps in other known places, as well as in the State of Pennsylvania.

No anthracite field has been developed to the extent of that of Pennsylvania, and based upon the present knowledge of the coal fields of the world, and the geology in general, it may be stated that the Pennsylvania deposit is remarkable for its extent, quality and value.

The deposit lies to the east of the centre of the State;* practically between the rivers Delaware and Susquehanna. It is quite probable that its original boundaries were much more extended, and that the erosive and transporting powers of the two rivers named, reinforced by the Hudson, have performed more mining and transporting of coal than has been left for man. The sporadic character of the coal fields of the country, as represented by a recently made Coal Development Government Map, would indicate to some degree, that the whole country had been at one time, to a great extent, if not entirely, covered with coal.

Boundaries of field.

The entire field under consideration is within the State lines: its extreme length is 115 miles, and its greatest width, on a slightly oblique line across the basin is fifty-five miles; the northeastern extremity of the field is at the southeastern corner of Susquehanna County, and the southwestern is near the banks of the Susquehanna River, nine miles above Harrisburg, in Dauphin County. The total distance between the extreme points named is 118 miles. The course of the general trend of the main synclinal axis of the Southern Basin is N. 65 East.

* See map on front page.

Limit of coal measures.

The coal measures crop to the surface and disappear at the northeastern end of the Wyoming Basin and at a point nine miles above Harrisburg: at the northern point, permanently, within the United States; but at the southern, after a lapse of some seventy miles to the southwest, it reappears, bearing this time bituminous coal as its economic product; and this begins the Bituminous Coal Fields of Western Pennsylvania, which extend also into the Western and Southern States. There may be no ascertained proof to determine that the Anthracite and Bituminous Fields of Pennsylvania were at one time connected: their relative position and the character of the anthracite coal in the western part of the field make such a theory somewhat probable. The Bituminous Coal Field of Wales passes from one form of bituminous, at the eastern end, into another near the centre, then into anthracite at the western end of the same basin; in Russia the bituminous coal within the same basin also passes into anthracite.

Differences between the three chief varieties of coal.

Several theories have already been advanced as to the origin of coal and the cause of the difference between anthracite, bituminous and lignite, but none seem to be free from objections. The one most popularly accepted about the origin is: that it is the product of vegetation, produced in the form of a dense forest of trees; proof of the wood origin is to be found within the structure of the coal, and in its analyses. The fact that the Anthracite Coal Basin, and coal veins in Wales produce both anthracite and bituminous, as well also the different grades of bituminous, and that the Russian Anthracite Coal Veins pass into bituminous in the same basin, is strong proof that anthracite and bituminous are the product of the same vegetation and of the same period, but by what process the different conditions have been produced is not satisfactorily solved, the theory of corrugations and pressure is inadequate, and the one of distillation of the hydro-carbon fails to meet the objections. Some coal veins are more than 200 feet in thickness, and it has been determined that such a thickness of coal vein requires a sheet of vegetation more than 2000 feet in thickness to produce it.

The characteristic differences in the three coals are to be found in the percentages of fuel matter in the form of fixed and hydrocarbon in the percentage of ash, and in the percentage of moisture. Anthracite contains the larger percentage of fuel matter, and the less of ash and moisture. Lignite contains the less amount of fuel matter and the greater of ash and moisture. Each of the three kinds will vary materially within the range of its own percentages, and yield kinds of coal varying in quality and commercial value. The density, hardness, and lustre of the different coals add materially

to their saleable condition. Lignite is the most readily ignited of the coals, and the one most liable to ignite spontaneously, and this fact detracts from its value for shipping for long distances.

As a rule the eastern and western extremities of the anthracite field produce the softer kind of coal, and the more central portion yields the harder. The difference in the market value of the different kinds is largely due to the peculiarities of the market, rather than to the chemistry of the coal. The product of the same vein is more difficult to prepare for market at some localities than at others, and none of the veins would seem to be exempt from these varying conditions; on this account additional cost is incurred in the preparation for market. The different systems of mining practiced and imposed by the varying angles of dip, or inclination of the veins adds additional cost to the preparation of the coal, on account of the larger quantity of refuse matter, necessarily brought out of the mines, inter-mixed with the coal, and discharged into the breaker; but this additional cost is sometimes more than balanced by the less cost in mining and loading of the material in the mines.

SURFACE AREA.

The surface area of the Pennsylvania Anthracite Coal Field is estimated at 312,000* acres, or 487½ square miles.

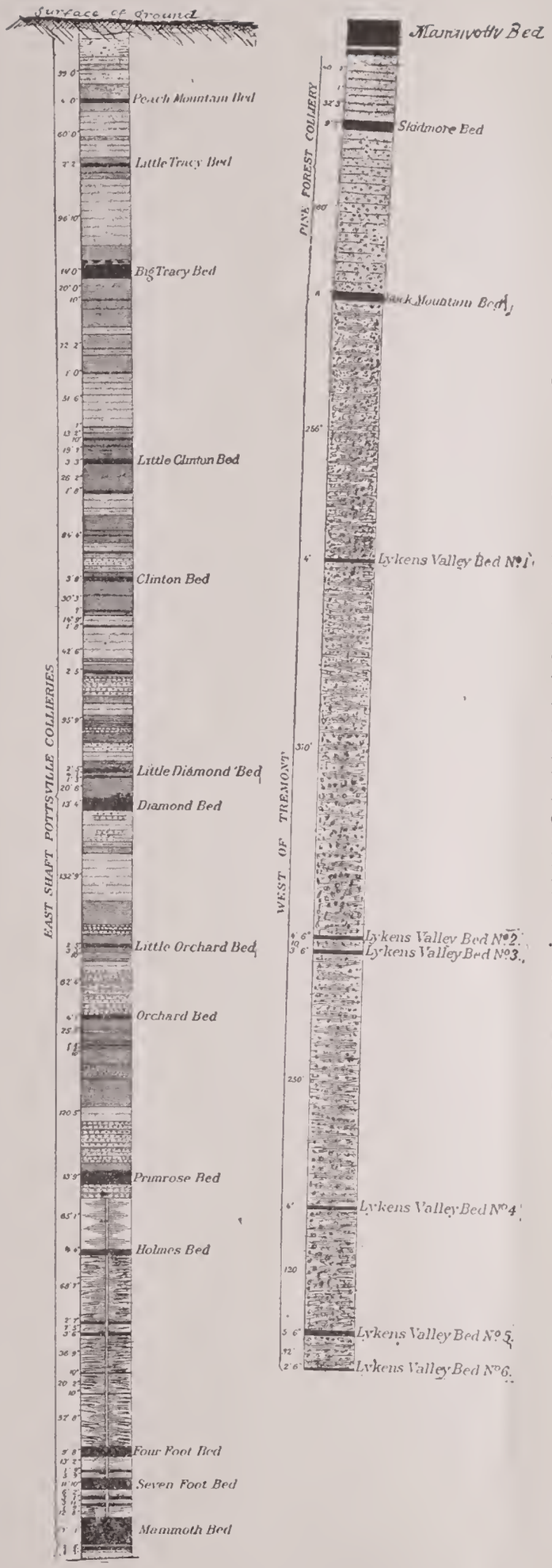
DIVISIONS OF THE FIELD.

Extent of Basins.

The field is divided into basins, geologically known as the Wyoming, or Northern; Lehigh, or Middle; the Mahanoy and Shamokin, or Western Middle, and the Schuylkill and Panther Creek. The former is a well defined single basin fifty-five and one-half miles in length by a varying breadth, from six to nothing, and of nearly 174 square miles; the Lehigh is composed of several small disconnected basins of various lengths and breadths; the Mahanoy and Shamokin Division is composed of one general basin forty-two miles long by four and one-half miles at its greatest breadth; and the Schuylkill and Panther Creek has a length of sixty-nine miles by a maximum breadth of nine miles. It is seldom that Nature has been found in any coal field to be so liberal as she has been in this, in the quantity of coal deposited for an equal thickness of strata.

Upon the following two pages will be found a columnar and cross sections of the coal veins in the Schuylkill Valley Division of the field. The sections are more ideal than representative of any

*This area covers all the Lykens Valley outcrop in the Schuylkill, Panther Creek, Mahanoy and Shamokin Valleys, but the estimate of the coal tonnage does not include the Lykens Valley Vein beyond where it is supposed to be productive.



PENNSYLVANIA ANTHRACITE COAL FIELD.

PHILADELPHIA, SEPT., 1892.

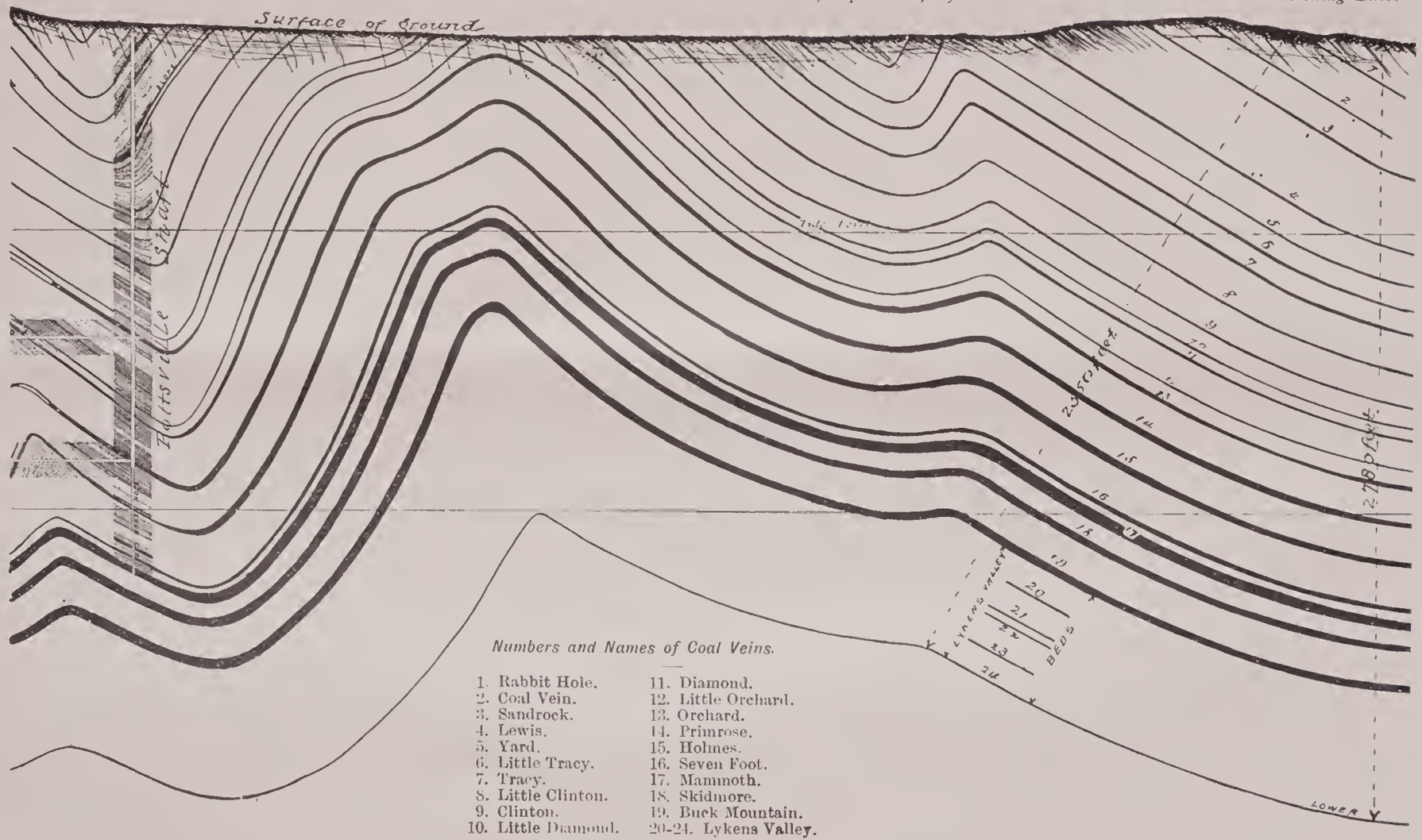
Columnar Section of the Coal Measures in Schuylkill Valley.

NAMES OF THE COAL VEINS AND THEIR THICKNESS.

Peach Mountain,	4 ft.	0 in.
Little Tracy,	2 "	2 "
Big Tracy,	14 "	0 "
Little Clinton,	3 "	3 "
Clinton,	3 "	8 "
Vein,	2 "	5 "
Vein,	2 "	5 "
Little Diamond,	2 "	5 "
Diamond,	13 "	4 "
Little Orchard,	2 "	5 "
Orchard,	4 "	1 "
Primrose,	13 "	9 "
Holmes,	6 "	4 "
Vein,	2 "	7 "
Vein,	3 "	6 "
Four Foot,	9 "	8 "
Seven Foot,	11 "	10 "
Vein,	3 "	1 "
Mammoth,	27 "	1 "
Vein,	2 "	6 "
Skidmore,	9 "	6 "
Buck Mountain,	8 "	0 "
Lykens Valley, No. 1,	4 "	0 "
" " " 2,	4 "	6 "
" " " 3,	3 "	6 "
" " " 4,	4 "	0 "
" " " 5,	5 "	6 "
" " " 6,	2 "	6 "
Total,	178 ft.	0 in.

CROSS SECTION OF THE COAL MEASURES FROM THE SURFACE TO THE LOWEST COAL VEIN IN SCHUYLKILL VALLEY.

PENNSYLVANIA ANTHRACITE COAL FIELD, September, 1892. *Looking East.*



Numbers and Names of Coal Veins.

1. Rabbit Hole.
2. Coal Vein.
3. Sandrock.
4. Lewis.
5. Yard.
6. Little Tracy.
7. Tracy.
8. Little Clinton.
9. Clinton.
10. Little Diamond.
11. Diamond.
12. Little Orchard.
13. Orchard.
14. Primrose.
15. Holmes.
16. Seven Foot.
17. Mammoth.
18. Skidmore.
19. Buck Mountain.
20-24. Lykens Valley.

one locality. The information is taken from the recently published report of the Pennsylvania Geological Survey—in part.

Thickness of coal bearing measures.

The coal bearing measures have their greatest thickness in the Wyoming Basin, at Wilkes-Barre and Scranton; in the Mahanoy and Shamokin, at Ashland, and in the Schuylkill and Panther Creek, at Tamaqua, Pottsville, Minersville and Tremont. The greatest depth from the surface to the Lykens Valley, or lowest vein, is in the Schuylkill Basin, in the vicinity of Pottsville, where it will approach 1100 yards, and bearing from eighteen to twenty-two coal veins, yielding from thirty-five to fifty yards of coal. To reach the Lykens Valley Vein in the lowest part of the basin, a vertical shaft seven-eighths of a mile will be necessary.

Thickness of coal measures.

The thickness of the coal bearing measures at Ashland is 600 yards, carrying some twelve coal veins, yielding twenty to twenty-five yards of coal; to reach the lowest vein, in the deepest part of the basin, a vertical shaft half a mile long will be required. The greatest thickness of the coal bearing measures near Wilkes-Barre is 600 yards, the number of workable coal veins is ten to fourteen, and the total thickness of coal is from thirty to forty yards. A vertical shaft nearly 600 yards deep will be required to reach the lower vein in the deepest part of the basin.

Interconglomerate coals.

The coal veins vary in thickness from a few inches to upwards of 100 feet. The Lykens Valley Vein occurs within the conglomerate rock forming generally the base of the coal measures. Being an intereonglomerate coal and formed at a period preceding and anteceding those when the waters were turbulent—having sufficient current to carry and deposit pebbles of the size of small eggs—as is supposed to be the case while forming the conglomerate rocks, making the table upon which the bed lies, and the roof covering it. Much of the vein matter has been displaced and carried away by erosion, leaving its several members in a very irregular and unreliable thickness.

During the formation of the conglomerate rock bed, some six or seven coal veins were formed, the largest of which is about ten feet in thickness. The conglomerate series are generally known as the Lykens Valley or Intereonglomerate Veins; and eight yards of coal are given as their aggregate thickness in the most favorable localities.

The Interconglomerate coal veins* are in their best and most profitable condition at the western extremity of the Schuylkill and

Current Anthracite selling prices showing superior value of Lykens Valley vein.

*The wholesale price per ton the product of the Lykens Valley Vein commands in New York at the present time is $5.00 for Broken, $5.50 for Egg, $6.00 for Stove, and $5.00 for Chestnut sizes, as against $4.00, $4.45, $4.85 and $4.65 for the same sizes and in the same order for the highest price commanded by the other veins.

Shamokin basins; they have been found at the outcrops at intervals throughout the said basins, and may develop to a great thickness at any unproven point; but past experience in the most eastern developments has discouraged owners for the time being, and directed their attention to veins less irregular and more profitable. The Lehigh and Wyoming Sections of the field do not contain the Lykens Valley Veins.

Buck Mountain and other veins.

The Buck Mountain, bearing also other names, is the next vein of the series, and it varies from three to thirty feet at different points; it is found in its greatest thickness near Wilkes-Barre.

The Mammoth, the "King Vein" of the field, and the next vein above the Buck Mountain, attaining a thickness of upwards of sixty* feet, with a general thickness of from twenty to forty-five feet. It is found in its greatest thickness, as one member, in the eastern end of Schuylkill and Panther Creek Basins, in the vicinity of Hazleton and at Shenandoah City; and it is frequently found in two, three and perhaps four members, all passing under different names at different points.

The veins above the Mammoth vary in thickness from a few inches to about sixteen feet. All of the veins vary in thickness and condition at short intervals.

ESTIMATE OF TONNAGE.

With any known thickness and area of a vein of coal, it is not difficult to make a close estimate of the tonnage contained in it. The many changes of thickness and condition through which the veins passes throughout the field, make it difficult to determine the tonnage contained within the field—the vein thickness factor is to some extent empirical under all conditions. Ocular knowledge and personal acquaintance with the character of each vein, in the different localities, as well as an independent and untrammeled mind, and we may perhaps add, some degree of courage, are necessities to approach accuracy in the estimate of the tonnage.

The common source of the error or differences in the tonnage estimates is to be found in the vein thickness factor used. It would be a remarkable coincident for any two persons to produce like results and it would scarcely be possible for the same person to produce like results in two estimates of the same section. There is, however, a reasonable limit for this personal error. When approximate estimates have a greater difference than from ten to fifteen per cent., the probability is that some other cause than personal error has produced it.

*Given by the Geological Survey at 103 feet near Hazleton.

Estimates by other authors.

Three estimates of the tonnage in the Pennsylvania Anthracite Coal Field have already been made and published, and before proceeding any further, notice of them had better be made here. To fail to notice them, coming as they do from such eminent sources, may, perhaps, be considered presumptive.

The three estimates are given in the appended statement on the last page. The first was issued in 1879 by P. W. Shaeffer, Esq., of Pottsville, now deceased; the second was published in 1880 by Mr. Joseph S. Harris, and the third by the last author in May, 1892. The tonnage results of the estimates are given as under:

Mr. Shaeffer's	26,360,576,000 tons.
Mr. Harris's of 1880 . .	13,250,392,100 tons.
Mr. Harris's of 1892 . .	14,453,397,600 tons.

The authors of, and the purposes of their estimates.

The first two estimates are so grossly at variance as to need some explanation, which has not been given; the third is a slight advance on the second. Mr. Shaeffer assumed two-thirds of the product as waste. Mr. Harris, in the 1880 estimate, assumed seventy-three per cent.; in the 1892 estimate, Mr. Harris states that he is hopeful that fifty per cent. will be realized. In 1878 he informed the Lehigh Coal and Navigation Company that they were realizing 34.4 per cent. A few years later he advanced to about thirty-nine per cent. Mr. P. W. Shaeffer was a Geologist and Mining Engineer professionally, and a great portion of his life was devoted to the practical coal geology of the field under consideration and the developments of coal properties, and as a result, he became the peer of his profession in wealth. His estimate under consideration was made in the interest of science, and was read before the American Association for the Advancement of Science, in September, 1879. Outside of any consideration for the high character of the author, there is every reason to believe that he was free from the influence of friendly or unfriendly interest, and in search only of accurate, scientific knowledge while making his estimate.

Vein yield.

Mr. Joseph S. Harris made his estimate of 1880 for the Philadelphia and Reading Coal and Iron Company's Receivers, while he was engaged as Engineer and Superintendent of Mines at Lansford, Pa., for the Lehigh Coal and Navigation Company. The estimate was the basis upon which he determined the valuation of the Philadelphia and Reading Coal and Iron Company's property. The third estimate was published by the author of the second in the *Forum*, in May of this year; Mr. Harris, in his 1880 estimate and in the prognostication of the future, says:* "The tonnages are spoken of as

Future tonnage.

*See Mr. Harris's report, pages 18 and 19, also 12, 13 and 14, published with the Philadelphia and Reading reports in 1880 and 1881.

shipments here because the demand, which would keep on increasing, is, after 1910, interfered with by the inability of the Anthracite Field to maintain production, which hereafter is limited by what can be shipped. In this statement the maximum annual shipment for the whole field is placed at about thirty-seven millions of tons, and the culminating point at about the year 1915."

Maximum output.

Upon what theory Mr. Harris based his future estimates is not stated; eight years later, 1888, the fixed maximum had been exceeded by over 1,000,000 tons, and eleven years later, 1891, 3,500,000 tons in excess of the estimated maximum had been realized, with the business running in its ordinary course, its progress being normal, In 1892 Mr. Harris prophesies the maximum output at 60,000,000, but this propheey is only an assertion in a newspaper article, yet coming from the president of an important Anthracite Coal Company, it is entitled to considerable weight and importance.

Method of estimating.

In making the following estimate of the original tonnage within the Anthracite Coal Field of Pennsylvania, the veins have been separated into five divisions:

1. Lykens Valley Veins, all below the Buck Mountain.
2. Buck Mountain Vein and its leaders*, up to the Skidmore.
3. Mammoth Vein and its splits and leaders, from, and including the Skidmore to the Holmes.
4. Holmes and Primrose with their leaders.
5. All above the Primrose.

The lowest thickness of vein included in the estimate is two and one-half feet.

Subdivisions of the field.

The several divisions of the field were treated separately and each divided into a number of subdivisions with a thickness used for each division or group of veins, based upon a general knowledge of the field, and reinforced by the data collected by the Geological Survey of the State.

Percentage of marketable coal.

An estimate of the marketable portion of the cubical contents of the veins in the ground is as important as the one determining the total product in the field. The condition of the anthracite mining of Pennsylvania to-day may be compared with that of the virgin forest's first attack by the woodman, who cuts down the most choice and profitable trees and takes away only the choice log cuts, leaving the balance as waste. Later on, when stumpage advances, and the choice trees are less plentiful, or located at points more difficult to reach, the woodman finds it to his advantage to return to the refused

Basis of past estimates misleading.

*The term, "leader," in the Anthracite Field, is the name given to a small coal vein, usually accompanying an ordinary vein, and located some feet apart, below or above.

cuts of the first felled trees. It is hardly necessary to state that to estimate the output of the forest, based upon the past result, before the refused log cuts and the culled timber have been marketed, would be misleading, yet this, to a great extent, has been the rule for making general estimates of the total marketable product in the Anthracite Coal Field.

There is another feature, which the illustration fails to represent: the thicker coal veins, yield the lowest percentages of the cubical contents, yet, being the most profitable to mine, they have yielded the bulk of the tonnage, perhaps eighty-five per cent. up to the present time. Some of the exploited large veins in the early experience of mining, have yielded perhaps no more than twenty per cent. of their tonnage, and in some cases the second exploitation has already taken place with considerable immediate increase in the vein yield. The conditions of the present day as to the necessity for exhaustive mining are not very far advanced from those of forty or fifty years ago, and the improvement is not likely to extend rapidly. So long as new openings, in accessible large veins are in abundance, the efforts of the managers are not likely to be intense in the direction of thorough exhaustion, and many of the present and future openings will no doubt, be re-exploited in a future day. To attack old workings at the present day carries with it the risk of much greater loss in ultimate tonnage than if left to the remote future. The careless or inefficient mining of the past and present is due to the superabundance of choice veins, yielding less costly and more accessible coal. These conditions are but slightly improved at the present, and the results can only be a trifle better. The mining of the smaller veins, which will necessarily be deferred to the future, will afford better opportunities for a more thorough exhaustion of the large veins generally. All of the workings, with rare exceptions, will be as accessible fifty or a hundred years hence, as at present, and the coal will keep.

Cause of low percentages in vein product.

A large percentage of the product is wasted on the culm banks at the collieries, but not so much to-day as in former years. In the early experience all sizes smaller than Chestnut coal were wasted. Pea coal, Buckwheat, Numbers 1 and 2, and Rice sizes are now being marketed, and they form about twenty-five per cent. of the present tonnage. This improvement has largely occurred within the last decade, and there is yet a large percentage of excellent fuel wasted which the continued improvements will ultimately prevent. Much of that which was formerly wasted on the culm banks is to-day being recovered and marketed. This coal displaces, to a more or less degree, some of the larger sizes, and to that extent, lessens the

output of a more profitable tonnage, thus injuring in the same measure, at the present, the business of some of the larger interests, which control large acreage of coal land and tonnage that will extend in its supply into the remote future. The small coal also rivals the bituminous coal, which has now become to the principal anthracite coal owners and transporters, a dividend earning factor. The smaller estates, which are less willing to waste their product on the culm piles, are pressing the smaller sizes on the market, thus compelling the larger companies in a measure, to meet the competition, and this hastens the improvement in the percentage of yield of the vein.

Experience has proved that the bituminous coal veins, from two and one-half to five feet in thickness, have yielded upwards of ninety per cent. as a marketable product. Ninety-five per cent. has been observed as the highest, but in estimating, the quantity contained in coal fields from seventy-five to eighty per cent. have been used for the marketable product. Such percentages are no doubt possible with a favorable roof and floor to the veins.

Control of roof of veins by the miners.

With a vein thickness of ten feet, or less, the roof may be stated to be under control by means of gobbing and timbering; from ten to eighteen feet it is only partially under control by timbering, and above eighteen feet it is practically beyond control by timbering, and the miner can only win as much of the coal as the condition of the roof and floor permits. In the latter cases, and under the present efforts and systems of mining the quantity varies with the dip and various other conditions and is less than forty per cent., but in all such cases the unmined coal will form sites for future collieries, when more profitable sites are less available. The time for such occurrences, is likely to be remote, however.

There is no system of mining in the large veins by which all of the coal can be won, excepting one that was adopted years ago by the French people and which is too expensive for adoption in this country at the present time; its chief features consist of filling the excavated portions of the vein, made in the day, by rock and earth excavated in the day on the surface and placed by night. The ownership of the minerals being invested in the French Government makes such a system practicable in France.

After the coal has been brought out of the mines there is a loss to account for in sizing and preparing for market, which is at present more than ten per cent. Passing coal from one railroad car, over shutes, into another, has been determined to result in from one to two per cent. of "waste," but this is usually pure coal reduced to dust and it is sold in some cases at a reduced cost; it, therefore, to that extent, becomes a part of the marketable product.

Method used in determining percentage of marketable tonnage.

In estimating the ultimate marketable coal tonnage of the Pennsylvania Anthracite Field, it was decided to give eighty per cent. as a maximum ultimate yield for the small veins, from two and a half to four and a half feet thickness, and forty per cent. for the large Mammoth Vein with a varying percentage ranging between these extremes, according to thickness, for the intermediate vein thicknesses. Each of the main divisions of the field were subdivided into a number of smaller divisions with the aggregate resulting in a general average slightly above sixty per cent. Sixty per cent. is used in the estimate as the portion of the total tonnage in the ground that will be marketed, and this leaves forty per cent. to be considered as waste, irrecoverably lost.

The forty per cent. waste means about 9000 million tons of coal, and with nearly all of this tonnage remaining in the field, it remains for the future to determine, if the people of Pennsylvania at the more exhaustive period of the business, when fuel is scarce and supplied from long distances, will not reduce that waste much lower than forty per cent.; while the fuel supplied from elsewhere is likely to be much inferior to the one they have been accustomed to.

Since the Mammoth Vein is split, or divided into two or more members throughout the greatest portion of the field, the percentages of the total product, yielding only forty per cent., is very low.

The result of the estimate in round numbers is as follows:

Product of the field by regions.

	Total Product.	Marketable Product.
Schuylkill	9,500,000,000	5,700,000,000
Mahanoy and Shamokin .	5,000,000,000	3,000,000,000
Lehigh	500,000,000	300,000,000
Wyoming	6,500,000,000	3,900,000,000
Total tons, 2,240 lbs . . .	21,500,000,000*	12,900,000,000

Allowance for faults in the veins.

In the above estimate extremely liberal allowance has been made for faults or wants in the veins.

Estimate placed within grasp of the layman.

To place the estimate within the grasp of the layman and student miner, it may be stated that the tonnage of the total product within the field is equal to a sheet of coal a little in excess of twenty-nine feet, spread over the entire coal vein area, and sixty per cent. of this, which is the assumed marketable product, is equal to a sheet of coal over the same area, seventeen and a half feet in thickness, a little more than half the thickness of the lowest or Buck Mountain Vein in portions of the Wyoming Region.

* Another estimate is in progress of preparation and it will be published at an early day. I am informed that the work on it is so far advanced as to enable those in position to know, to state that the result will give a total product in the vicinity of twenty-five billion tons. This information was received after the above estimate was made.

The coal formation is crimped or corrugated into basins of the form of a boat, and the area of the coal vein is greater in proportion to the steepness of the sides of the basin and its depth, than its surface area. The lower veins will average about a fifth greater.

Area of surface compared with area of veins.

A vein three feet in thickness of equal area to that of the lower coal vein and yielding 100 per cent. marketable coal would give a marketable tonnage a trifle greater than 2000 million tons, and a vein six feet, a trifle greater than 4000 million tons.

The area of the field extends only to the outcrops of the coal of the lowest workable vein. The Buck Mountain Vein is the lowest for a large percentage of the area, and it has a varying thickness of from three to thirty feet. The Mammoth Vein, which has a thickness ranging from about eight to fifty feet,* with an ordinary thickness, of from twenty to forty feet, is next in area to the Buck Mountain, and it, with its splits and leaders, will yield more than half of the coal of the field. The formation in the deepest portion contains from 105 to 150 feet of coal veins. When the above facts are borne in mind, it is scarcely necessary to use any professional skill in order to determine that an estimate giving a thickness of seventeen feet of coal for the entire field is low.

Estimate of marketable tonnage simplified.

The question, "As to what depth can coal be won economically" has engrossed considerable thought and discussion among the English people for several years, and it is one that should not be entirely ignored in the estimates of the field under consideration.

For several years 3000 feet were held as the greatest possible depth for mining coal. It was well known that the rock strata increased in temperature at an average of about two degrees in every 100 to 120 feet. With a rock temperature of fifty degrees at the surface, the temperature of the rock at the bottom of the shaft 3000 feet deep would be about 105 degrees. Later observation has shown that the temperature of the air current of the mines in deep workings is several degrees lower than that of the strata. The result of the investigation and views of the people of Great Britain on the subject will be found on page 25.

Maximum mining depth.

It is now considered, and this is based on the increased skill in mining, that the improved mechanical appliances and devices for ventilating coal cutting and coal hauling, places a depth of 4000 feet within the range of possibility of mining coal.

The Pottsville Shafts,† located in the Schuylkill Basin, have a depth of 1700 feet. They are the deepest in the anthracite field as yet. Observations of the temperature of the rock strata were

Deepest shafts in the field.

* The Geological Survey report it at 103 feet at Hazleton.

† See plate on page 8.

made, while sinking at intervals of fifty or 100 feet in these shafts, and the result agrees closely with that given above.

The percentage of the anthracite coal of the field under consideration lying below the depth of 4000 feet, is as yet problematic, and the quantity is likely to be insignificant.

After passing a depth from the surface of, say 1500 feet, the deeper coals are likely to be found dry and dusty, and in a less firm condition, owing to the greater weight of the superincumbent rock. The anthracite coal has to pass through the breaker crushers in the course of its preparation for market, its value is not likely to be impaired in consequence of the greater depth, but rather, in some cases and especially with the use of coal cutting machines, will be improved. At present the greatest depth reached is less than 2000 feet, and it is scarcely necessary to exceed this in supplying the market for the next forty years.

Losses in vein product.

Some loss in the total product of the field will result from the overlying silt and quicksand; but fortunately only the Wyoming section of the field is likely to suffer from this cause to any extent. The Susquehanna and Lackawanna Rivers traverse the field for almost its entire length, and together, have covered about one-sixth of the coal area with quicksand, gravel and boulders to a depth ranging as high as 225 feet. It is a source of cost and menacing danger to the miner, and already, (1885,) it has entombed beyond recovery twenty-eight workmen. The vein loss from this source will be confined to the upper veins, lying in the centre of the basin. It may be stated that while the presence of the rivers will ultimately rob the miner of some of his coal, it has, perhaps, more than compensated for that loss by supplying him with an abundance of fresh water for all his needs for mining, manufacturing and domestic uses—the want of which has been, and is a source of great cost in other sections of the field—besides, it has given him a most beautiful, fertile and well irrigated valley for his home and garden. Mine fires and town sites will also claim some of the tonnage. Ample allowance has been made in the estimate of the marketable product for all sources of loss in vein yield.

EARLY HISTORY.

The history of the anthracite coal business is practically contained within this century, although few references have been made in the preceding one.

Obadiah Gore, a blacksmith and an early settler in Wyoming, in the Northern or Wyoming Coal Field, is reported to have made the first use of anthracite as a fuel, in 1768. Other blacksmiths

followed his example, and Judge Fell, of the same valley, began, in 1788, to make a domestic fuel of it; it having previously been used in the manufacture of nails.

An organization known as the Lehigh Coal Company was formed in 1773. It purchased a tract of land at Summit Hill, near Mauch Chunk; but no practical results were had for the first thirty-six years.

Some anthracite coal was brought to Philadelphia in the year 1800. Oliver Evans, of Philadelphia, patented a grate in 1800 to burn "Mineral Coal," and Dr. Thomas James of the same city, is said to be the first to use anthracite as a domestic fuel habitually. He began in 1804 and used it continuously for twenty-two years.

The introduction of anthracite as a domestic fuel does not seem to have been successful up to this time, and the fact that it is now in common use in this country, within the range of the anthracite coal field, is no doubt due to the fact that no soft bituminous coal was discovered in the same vicinity, and that the people were forced through necessity to exercise their ingenuity in its preparation for domestic use. These efforts produced the breakers for crushing and sizing, with the stoves and ranges adapted to its consumption. It is a noted fact that the Welsh people, who are among the greatest producers and consumers of coal, and who have the bituminous and anthracite in abundance, within the same basin, were never driven to use anthracite for domestic purposes, as a rule. Bituminous is their domestic fuel—they have no breakers for preparing anthracite, nor have they stoves and ranges for consuming it, unless it be of recent introduction.

The Provincial Map of 1770 showed coal-pit locations on Mahanoy Creek. Mining began in Mahanoy region about 1834, and shipments from Shamokin began about 1839. In 1806, William Turnbull sent an ark load of anthracite to the Philadelphia Water Works, but want of experience in its use condemned it; it doubtless came from Summit Hill.

Effect of War, 1812.

The war of 1812 advanced the price of the Virginia and British coals and this gave the prospector new hope and energy, and he again attacks the anthracite field with greater earnestness, but the effect of the war was short in duration. In that year nine horse wagon loads were sent from Schuylkill County to Philadelphia by George Shoemaker and a Philadelphian. Two of the loads were sold and the venture was unprofitable to those directly interested. Later, this coal was tested in a furnace in Delaware County and pronounced a success, notices of which were published in the Philadelphia papers. Successful tests followed in other iron works near the said city shortly afterwards.

An attempt was made to ship five large boat loads of the Summit Hill coal to Philadelphia in 1813—influenced, doubtless, by the war—two reached their destination and three were wrecked.

In 1818, the present existing Lehigh Coal and Navigation Company was formed and it absorbed the company named above, as well also the Lehigh Navigation Company, and from this date became rapid, permanent progress in the anthracite business.

In 1820, 365 tons of anthracite were brought to Philadelphia at a cost of fourteen dollars a ton. In 1824, 9541 tons were sold in the same city.

From the last-named date begins the history of the various canals and railroads connecting the different centres of consumption with the various sections of the anthracite coal field.

The Delaware and Hudson Canal Company, chartered in 1823, completed the construction of its canal from the Hudson River to Honesdale in 1828, and its gravity road from the canal to the mines in the Wyoming Coal Field in the following year. The Wyoming Valley is reported to have yielded 7000 tons in 1829.

Several efforts were made to use anthracite in the manufacture of iron in the early history of its introduction as a domestic fuel, and premiums are reported as paid for encouragement. Mr. David Thomas, with his knowledge of its use in Wales, is entitled to the credit of first introducing anthracite in a blast furnace successfully in this country, at Catasauqua, in 1840.

Beginning of permanent progress in the Anthracite business.

The Schuylkill Region coal entered the market as a regular supply in 1822, and gave a tonnage for that year of nearly 1500 tons. The subsequent growth from the three regions is given below:

Tonnage progress by regions with aggregates.

YEAR.	SCHUYLKILL.	LEHIGH.	WYOMING.	TOTAL.
1830	89,984	41,750	43,000	174,734
1840	490,596	225,313	148,470	864,379
1850	1,840,620	690,456	827,223	3,358,899
1860	3,749,632	1,821,674	2,941,817	8,513,123
1870	4,968,157	3,239,374	7,974,660	16,182,191
1880	7,554,742	4,463,221	11,419 279	23,431,242
1890	10,867,822	6,329,648	18,657,695	35,855,175
1891	12,741,258	6,381,838	21,325,240	40,448,336

Total product of field.

The above figures give the tonnage marketed, and it aggregates to 856,316,625 tons. Adding to this the coal consumed at the mines and allowing for some imperfect statistics, the grand total will reach about 900,000,000 tons for a period of some seventy years.

Time required to introduce the Anthracite as a new commodity.

Several years would be required to introduce the coal as a new commodity, and to bring the business to a mature standard so that

its future growth would keep pace only with that of the surrounding country forming its field of consumption. Basing this standard upon an annual tonnage of 1,000,000 tons, we find that it took twenty-one years to attain it; and this practically occurred in the year 1841, fifty years ago, and about the time it began to be consumed in blast and other furnaces. The growth of the business for the last half century, 1840 to 1891, averaged annually 789,771 tons. At present the annual growth is about 1,000,000 tons on an average.

The decadal increase from 1840 to 1891 is below stated:

Decade.	Total Decadal Tonnage.	Per cent. of increase above preceding decade.	Increase over previous decade. Tonnage.	Annual Average Tonnage.
1840 to 1851	21,893,063			2,189,306
1850 to 1861	63,981,677	192	42,088,614	6,398,167
1860 to 1871	114,761,986	79	50,780,309	11,476,198
1870 to 1881	202,968,727	77	88,206,741	20,296,873
1880 to 1891	327,940,946	61	124,972,219	32,794,095

Tonnage growth by decades, and by years averaged.

DISTRIBUTION OF THE PRODUCT.

The approximate distribution of the product of the field at the present is as follows:

Pennsylvania, New York and New Jersey	70 per cent.
New England States	10 per cent.
Western States, near and adjacent to the great lakes .	13 per cent.
Southern and far Western States	4 per cent.
Canada	3 per cent.
	100 per cent.

Market divisions and percentages of the product.

The above shows that the bulk of the consumption of the anthracite is in the immediate vicinity of the coal field.

The following figures will show that an important change in the consumption of anthracite, in the manufacturing of iron, has recently been inaugurated, and that it is yet in progress. The same figures also show, in a measure, the great progress made in the iron business within the anthracite market and in the United States.

In 1870, 2,233,410 tons of anthracite were consumed in the manufacture of iron in the United States, and in 1880, 3,322,498 tons.

Anthracite consumed in the manufacture of iron.

The pig-iron production in the United States is given for three census years below:

For 1870	2,052,821 tons.
For 1880	3,781,021 tons.
For 1890	9,579,779 tons.

Number of furnaces and gain in yield.

The number of furnaces in the United States decreased from 1880 to 1890, 119—from 681 to 562. The average annual production for each furnace in 1880 was 5552 tons; in 1890, 17,046 tons, a gain in furnace yield of 207 per cent.

The pig-iron production in Pennsylvania, New York and New Jersey, the principal field of anthracite consumption, is given below:

In 1870	1,921,649 tons.
In 1880	2,401,093 tons.
In 1890	5,216,591 tons.

The number of furnaces, in the same States, in 1880, was 346, and in 1890, 279, a decrease of seven in the latter year. The average production per furnace in 1880 was 6940 tons; in 1890, 18,697 tons, a gain in furnace yield of 169 per cent.

The production of pig-iron in the United States for 1880 and 1890 as to fuel consumed is as follows:

Kinds of coal used in furnaces.

Kinds of Fuel.	Tons of Pig-iron in 1880.	Tons of Pig-iron in 1890.
Anthracite alone	1,112,735	323,258
Mixed Anthracite and Coke	713,932	1,879,098
Coke and Bituminous Coal	1,515,107	6,711,974
Charcoal	435,018	655,520
Castings direct from furnace	4,229	9,929
U. S. Pig-iron Production. Total	3,781,021	9,579,779

In 1880, of the total number of furnaces in the United States, 229 were anthracite, or anthracite and coke furnaces; in 1890, 169 were anthracite, or anthracite and coke furnaces, a decrease of about twenty-seven per cent.

Less Anthracite used in iron manufacturing.

From the above it is found that the consumption of anthracite in the manufacture of iron, in 1870, was 13.8 per cent. of the total anthracite production of Pennsylvania, and in 1880 it was 14.2 per cent. At the latter rate of percentage, the consumption for the same purposes in 1890 would amount to 5,091,434; but the above figures given for 1890, for the iron produced from anthracite alone and from mixed anthracite and coke does not assure much, if any, in excess of 2,000,000 tons. We thus arrive, approximately, in the absence of census figures, not yet prepared, at the decreased consumption in this branch of the anthracite coal market. The decrease is, no doubt, destined to continue at a more or less rate into the future; but it is apparent that the effect will be less serious than

in the past upon the anthracite business, since the effect of the tonnage loss has already spent its force.

The furnace owner has discovered that, by the use of the other known good, but less refractory or a more rapidly consumed fuel, and by an increase in the temperature he is able to produce better results; and this, as is shown by the above figures, he has accomplished to a very satisfactory degree during the last decade, having increased the producing furnace capacity more than 200 per cent. While this remarkably good result has been achieved by the furnace-man, a loss has been caused in the anthracite consumption, and a gain to the bituminous and coke consumption, and this loss has not only occurred in the coke and bituminous producing fields, but it has extended into the iron manufacturing institutions located in the anthracite coal field.

The results, however, in the iron manufacturing divisions of the anthracite market have been, perhaps, fully compensated by an improvement in another single division in the same market, to wit:

Western Market growing.

In 1882, the Western States took 2,231,107 tons, and in 1889, 4,996,420 tons, an increase of 2,783,313 tons, or 125 per cent. in seven years. The increase of tonnage is only a little below the above estimated deficiency in the iron manufacturing division. The western division of the market is comparatively new; the settlements are quite young, the manufacturing institutions are in the early stages of their existence and the population is rapidly growing: it is therefore not unlikely that this branch will in the future attain a high percentage as a domestic fuel. The progress, however, will be strenuously opposed by the excellent domestic fuel of a number of the States entered.

Anthracite rivals.

The bituminous of western Pennsylvania, eastern Ohio and West Virginia are the greatest rivals to the anthracite in Pennsylvania, New York, New Jersey and the New England States. Were it not for the seventy-five cents tariff, Canada would lend strong reinforcement in the New England as well as in some of the other near States. The contest between them has been in progress for many years: the comparative merits of the different coals for the different purposes used are to-day well understood, and in a measure appreciated, and the geology of the country tributary to the Atlantic Sea Board is sufficiently developed to warrant the statement that there is no new coal field to be opened that can affect these markets, therefore the loss or gain in the consumption of anthracite will depend upon the energy and skill exercised in marketing and the rates of freight charged by the different companies from the various competitive fields, with the growth of manufacturing institutions and population.

No new fields to develop to interfere.

The increase in the anthracite output in the last decade, 1880-1890, is, as already stated, from 23,438,242 tons to 35,855,175 tons 12,416,933 tons, or fifty-two and nine-tenths per cent.

Percentages of sizes of coal produced.

The proportional division of the tonnage for the years 1880 and 1890 is, as to sizes, approximately as follows:

	TONS.
All sizes above and including Chestnut, 1890, 72%, .	24,815,726
" " " " 1880, 85%, .	19,912,506
Increase in 1890, 24.6%, .	4,903,220
All sizes below Chestnut, ... 1890, 38%, .	11,039,449
" " " . . . . 1880, 15%, .	3,526,185
Increase in 1890, 213.1%,	7,513,264

Net increase in colliery output.

The above figures show approximately that the larger sizes of coal only increased 26.6 per cent., which percentage is the proper measure of the growth of the colliery output, and that the smaller sizes increased 213.1 per cent. This increase in the smaller sizes represents a saving in the year's output of coal formerly wasted on the culm banks, and the recovery of some of that which had been wasted in former years. The smaller sizes are chiefly used for steam purposes in competition with the bituminous coal.

The ordinary draft used for the consumption of domestic coal is inadequate for the smaller sizes of the anthracite coal to produce the necessary heat. The grates are also adapted, both as to heating surface and construction, to the larger sizes. An improvement in these conditions would instantly expand the market for the smaller sizes; but, of course, at the cost of reducing the market for the larger sizes. This would seem to be the proper direction to look to for an improved market for the smaller sizes wasted now and in the past for the want of a market. The conversion of culm and small coal into patent fuel is unavoidably attended, to a prohibitory extent, with cost for labor and material.

The anthracite is daily becoming a greater favorite as a domestic fuel; it is, no doubt, the best known for that purpose. It is clean to handle, and it contains, as already stated, the greater amount of fuel constituents; it is almost free from the objectionable black smoke so much complained of by the people, and it has none of the unpleasant odors usually accompanying the consuming of some of the varieties of bituminous

DURATION AND PROGRESS OF THE PENNSYLVANIA ANTHRACITE BUSINESS.

The past a guide for the future.

The past experience in the anthracite business is undoubtedly a reliable criterion as to the future regarding the progress of its market. Slight variations can be expected in the percentages consumed in the divisions of the market from time to time, but there is no apparent prospect for any great or extraordinary increase in any of the divisions, excepting, perhaps, the Western States, near the Lakes. An export business is also within the range of possibilities, and it would seem that this is the only uncanvassed field open, unless we add to it the uncanvassed export iron business, both of which bear on the anthracite consumption. The percentage of the smaller sizes of coal will go on increasing until the present waste is reduced to a minimum, but policy may retard its progress for a time.

Duration of the progress in the Anthracite business.

The duration of the progress in the anthracite business is a matter that has already been discussed—one published answer has been given to it—and it has already been referred to. It is by no means a new question; it has been pondered over in other coal fields and in one instance with success. Several elements of uncertainty enter the solution of the answer, making it quite difficult to arrive at anything but an approximation, and with the vast tonnage remaining it would seem almost unnecessary to attempt an answer at the present time, excepting for scientific purposes.*

The principal factors in the problem are:—

Factors in the problem.

First.—The quantity of coal contained in the field and the portion that can be marketed.

Second.—The maximum producing capacity of the field.

Third.—The capacity of the market in its future growth and expansion.

The tonnage of marketable coal within the field has already been discussed in former pages, and the amount given in round numbers, at 12,000 million tons. This tonnage is about equal to a sheet

Duration of coal business and tonnage progress, Great Britain.

*The people of Great Britain manifested some anxiety about the duration of the coal supply in their country several decades ago, and a number of estimates have been made. In 1870 a Royal Commission was appointed by the Government to examine and report on the subject. The maximum depth from which coal could be mined was taken at 4000 feet. The Commissioners reported 48,868 million tons. This tonnage will last at the rate of 200 million tons annually, 734 years,—say 600 years, allowing for small unminable veins. Between the depth of 4000 and 10,000 feet the tonnage is estimated at 48,465 millions; at this point the heat is estimated to be above that of the ability of man to withstand.

Deep mining.

The improvement made in Mine Ventilation enabled the Commissioners to increase the previously accepted ultimate mining depth from 3000 to about 4000 feet.

The coal exportation from Great Britain at present is approaching 40,000,000 tons annually, which is proof of the practically unlimited supply as far as the care of the people of the present generation is concerned for the remote future.

of coal a trifle less than five and a-half yards in thickness over the entire coal vein area, as already stated.

Number of breakers, and their capacity.

The maximum producing capacity of the field, depends upon the number and capacity of collieries that can be economically located within its geological limits. There are at present* about 360 breakers within the anthracite field, and each breaker ordinarily represents one colliery, although occasionally a breaker will receive its coal from several mine openings. The production of 1891 gives for the 360 breakers, an average breaker yield, of 112,300 tons. The average surface acreage, of coal, occupied by each breaker, is 867 acres.

Various capacities of breakers.

The highest annual output from any one breaker, in any one year is 622,000 tons. The greatest tonnage from any one breaker, depending upon one mine opening, is 530,000 tons. Eight of the present breakers produce from 400,000 to 622,000 tons, seven from 300,000 to 400,000 tons, and thirty-two, from 200,000 to 300,000.

Theoretical capacity of breakers.

To produce the output of 1891, it would require, of the first-class breakers, say, of a capacity of 500,000 tons,—eighty-one; of a capacity of 400,000 tons,—101, and of a capacity of 300,000 tons, 135.

Tendency to increase breaker capacity.

In the interest of economy the growing tendency is to increase the capacity of the collieries. The ideal capacity at the present time would seem to be from 300,000 to 400,000 tons. If the present average capacity,—112,300 tons, be brought up to 224,600 tons the present number of collieries would give an annual output of nearly 81,000,000 tons; but at 350,000 tons, it would be 126,000,000.

Life of a colliery.

Few collieries within the annals of the history of this business have aggregated a tonnage of 3,000,000. If, for illustration, the life of a colliery be assumed at thirty years, its tonnage would aggregate, at the present average rate of breaker output, to 3,359,000 tons, and it would require 3562 such collieries to exhaust the remaining tonnage, and to increase the average annual output to 224,600, for the same length of life it would require 1781 such collieries. Each of the former class of collieries would exhaust eighty-seven and one-third acres of the surface coal area, and of the latter 174⅔ acres of the average yield. There are other ways to look at this proposition, and all are equally promising, and it may be stated, that if the mettle of the present Pennsylvanian does not deteriorate in his grand and great-grandsons, it is not probable that the market will lack in its supply though the demand exceed 150,000,000 a year.

Acres occupied by colliery.

Attacking small veins.

The smaller coal veins have already been attacked in some sections of the field by small owners, who have exhausted their larger

*1889

veins and are driven without choice to the smaller, rather than permit their mining plants decay into a loss. Such cases are likely to occur in the future, but they will be exceptions to the general rule, until a remote period. The smaller veins, which extend throughout the entire field, will be left unmined until the larger veins are generally exhausted, or have failed to produce the required output, and this fact tends to, and we may say, practically assures a large area of coal veins, up to the remotest period of the business; thus allowing large acreage for colliery territory.

Low shipping collieries.

A large number of collieries to-day are producing less than 100,000 tons, and some of them are up to the maximum producing capacity of the vein or veins, within their special economic limits; a very large majority of them, however, are held down in their production, for causes other than want of coal, and many of the sites can be brought up to the highest capacity. Low shipping collieries will be continued to the end of the business in greater or less numbers, but the modern and improved colliery will go on advancing and a very much smaller number will be required than is now in use for a much larger output. Were it not for the desire to avoid losses resulting from the abandonment of the improvements and the dependent towns, of some of the old, but yet active mining institutions, the progress of the modern colliery would be more rapid.

Possible maximum output capacity of field.

In order to have an idea of what the maximum output of the field may be, it will be assumed that it is produced by 500 collieries. Giving to each colliery a life of thirty years, and an aggregate life tonnage of 3,359,000 tons, the grand total for the 500 collieries would amount to 1,679,500,000 tons, for the thirty years. The output of the several divisions of the collieries has already been given, and it shows that 500 collieries have a capacity of producing easily from 100,000,000 to 160,000,000 tons annually. In the above we have assumed that the maximum output has been attained by the 500 collieries and that these collieries are then beginning the exhaustion of their life tonnages at the apex of the business which is the beginning of the decadent period. But in place of giving the amount due to the 500 collieries during their existence, we will increase it to 3,000,000,000 tons. This amount is more than three times the total output of the field for the last seventy years, and if it be deducted out of the total tonnage of marketable coal remaining in the ground it will leave 9,000,000,000 tons as a quantity that can be delivered to the market in such amounts as it will require every year. The amount used can be varied to produce other results, but they will, no doubt, serve as given for the necessary illustration.

ANTHRACITE MARKET.

The capacity of the market in its future growth and expansion is foreshadowed by its past history, which has already been given in former pages.

No visible changes in market

There is no prospect, and scarcely any possibility under ordinary conditions for any sudden change either in increase or decrease in the growth of any of the branches of the market, and there is no new division at present visible that is possible of development unless it be, as already referred to, the export division. Some of the present branches are capable of expansion.

The discovery of natural gas some years ago carried with it serious results to the consumption of bituminous coal and coke in some of the Eastern States; but it does not seem to have produced any reduction in the consumption of anthracite.

The Pochohontas Coal Field when first developed, some ten or twelve years ago, created a disturbance in the Atlantic Coast Coal Market by very sharp competition and low figures, but it had little or no effect upon the anthracite trade.

The introduction of electricity, which is progressing with rapid strides, is tending to multiply power and is thus lending aid to the consumption of coal, anthracite included.

Anthracite capable of meeting its rivals, and consumers will continue to want it.

The anthracite coal has already withstood severe tests with its rivals and especially within the last decade, and it is not probable that it will be called upon to meet as severe tests in the future and it shows a strong growth. The people have been trained to consume it and there is no visible reason why they should not continue to want it in growing quantities, proportionate to the increase in population and manufacturing institutions, and the development and extension of railroads. These States would seem to be capable of centuries of growth in each of the departments named if compared with other sections of the world not better equipped with the necessary elements to make progressive and prosperous countries.

Coal output of the world.

Ninety six per cent. of the present coal output of the world is produced by six nations, to wit: Great Britain,* United States, Germany, France, Belgium and Austria.

Great Britain produced thirty-seven per cent. of this tonnage; the United States twenty-nine per cent.; Germany, eighteen per cent., and the Pennsylvania Anthracite Coal Field eight and one-half per cent.

*The tonnage mined by Great Britain in the three centuries prior to 1800 is reported at 850,000,000 tons, and for the present century up to 1890, 10 151,637,778 tons, making a total of 11,001,637,778 tons.

Percentages supplied by different nations.

The aggregate output for the passing half century for the six countries is approximately 11,000 million tons, and that of the world perhaps 1000 million tons more. Great Britain supplied, of the aggregate for the six countries, about fifty per cent.; the United States, twenty per cent.; Germany, sixteen per cent., and the Pennsylvania Anthracite Field, nine per cent.

Active coal mining period of the world.

The active coal mining period of the world is represented by this last half century; it began with the practical introduction into general use of steam power, steam ships and of railroad construction, it was near the dawn of modern progress, back of this, the tonnage is meagre and comparatively insignificant, yet spreading over several centuries.

Gross tonnage of the world for the last half century, with its decadal progress.

Fifty years ago the combined annual tonnage of the six nations was less than 50,000,000 tons. At present it is about 528,000,000. The growth for the said period has been at the average rate of 9,500,000 tons annually; during the last decade it averaged an annual increase of 14,000,000 tons, and in the decade immediately preceding 10,750,000 tons. The percentages of growth for the fifty years, compounded, is 4.67 per cent.

The growth of the United States coal business for the last fifty years was at the rate of 2,500,000 tons annually; for the last decade it was 6,200,000 annually, and the decade preceding 3,400,000 tons.

Growth of the Penna. Anthracite business in percentages.

The anthracite coal business of Pennsylvania grew in the last half century from less than 1,000,000 tons a year to 40,000,000, and the annual output in the last decade advanced from 23,500,000 tons to 36,000,000 tons, and that of the adjoining preceding decade from 16,000,000 to 23,500,000. For the fifty years the annual output grew at the rate of 7.7 per cent., compounded. For the same period the United States coal business advanced at the rate of 8.6 per cent., compounded. Tabular Statement "A" on next page gives the comparative growth for all of the countries named for different periods during the last five decades.

The following figures show more strikingly the comparative growth and they have been extended into last year, with some of the figures that were wanting approximated:

Growth of the world's tonnage, fifty years, by nations.

	1840. Tons.	1890. Tons.
Great Britain, annual coal output	34,000,000	186,000,000
Germany, " " "	2,000,000	81,000,000
Belgium, " " "	4,000,000	20,000,000
France, " " "	3,000,000	26,000,000
Austria, " " "	500,000	24,000,000
United States, " " "	2,000,000	130,000,000
Penna. Anth., " " "	1,000,000	41,000,000
Total	46,500,000	508,000,000
Other nations	1,500,000	20,000,000
Output of the world	48,000,000	528,000,000

STATEMENT "A."—Coal Production. Growth in different Periods, for the extreme Dates given.

COUNTRY AND GROUPS OF COUNTRIES.	COMPOUND PERCENTAGES OF GROWTH.									PERCENTAGES OF GROWTH. DECADAL PERIODS.			
	1840 to 1850, ten years.	1850 to 1860, ten years.	1850 to 1870, twenty years.	1850 to 1880, thirty years.	1860 to 1890, thirty years.	1870 to 1890, twenty years	1880 to 1890, ten years.	1850 to 1890, forty years.	1840 to 1890, fifty years.	1840 to 1850 compared with 1850 to 1860.	1850 to 1860 compared with 1860 to 1870.	1860 to 1870 compared with 1870 to 1880.	1870 to 1880 compared with 1880 to 1890.
Pennsylvania Anthracite	4.54	9.74	9 40	6.79	4.91	4.06	4.38	6.10	7.74	219.6	82.1	82.8	61.2
United States	4.63	5.55	5.83	7.60	7.01	7.57	7.05	6.84	8.64	169.9	92.3	114.1	97.6
Great Britain		4.38	3.62	3.19	2.60	2.52	2.14	2.91			46.6	34.3	25.7
Germany		7.80	8.10	7.02	5.40	4.20	4.04	6.08				66.2	58.3
Belgium	5.09	5.14	4.30	3.62	2.52	2.08	1.89	3.18	3.66	66.7	41.1	31.2	14.8
France	3.80	6.58	5.57	5.11	3.95	3.47	3 00	4 58	4.44	68.1	73.9	46.6	29.1
Austria	8.91	12 03	10.57	9.38	6.55	5.42	3.82	7.98	8.19	204.4	146.3	143.7	46.1
Average for the above five foreign countries	5.0	5.31	4.65	4.35	3.33	3.18	2.69	3.86	4.08	62.6	62.3	42.5	33.7
All of the above countries combined	5.76	5.33	4.84	4.63	4.07	3.97	3.71	4.40	4.67	66.9	59.3	49.3	50.5

	Tons.
The world's coal output for fifty years, 12,000,000,000	
Great Britain's coal output for fifty years . . .	5,050,000,000
Germany's coal output for fifty years	1,620,000,000
France's coal output for fifty years	580,000,000
Belgium's coal output for fifty years	560,000,000
Austria's coal output for fifty years	380,000,000
United States's coal output for last fifty years . .	2,000,000,000
Pennsylvania anthracite output for last fifty years	784,000,000
	10,974,000,000
Other countries	1,000,000,000
	11,974,000,000

World's aggregate tonnage by nations, fifty years.

The above historical figures cover so broad an area of territory and so long a period of time, as to establish beyond a doubt, if such be necessary, the character of the growth and permanency of the coal business, and this is not without some importance in the formation of an estimate of large tonnages, extending so remotely into the future. So rapid a progress running up to so great and colossal proportions cannot extend without limit into the future, although it may proceed in its course even at an increased ratio for centuries, the end will come; but that end is too remote for contemplation in the question under consideration.

Conclusions.

It has already been assumed, from the foregoing estimate, and given above, that the anthracite coal field of Pennsylvania, will yield about 9,000,000,000 tons before it has reached its maximum output, and this tonnage is estimated to be required by the market as follows:

Estimate of future Anthracite tonnage

The first one-third in forty-four years, 1935, and the other two-thirds in forty-five more years, 1980. The first period is estimated to end with a tonnage of an annual output of 100,000,000 tons. An average tonnage of 280,000 tons for each of the present 360 breakers, will yield 100,000,000 tons; or say a smaller tonnage with a greater number of breakers. The improvement or growth in the annual output from the present 40,450,000 tons to the 100,000,000 tons will be at the rate of two per cent. compounded as against 7.7 per cent. for the past fifty years; 6.1 per cent. for the past forty years; 4.9 per cent. for the past thirty years; 4.1 per cent. for the past twenty years, and 4.4 per cent. for the past ten years. The improvement in the annual output to exhaust the other two-thirds in the period stated, will be at the rate of about one per cent.

Future progress compared with past

The balance of the tonnage remaining in the field will be exhausted more slowly, and it may extend over a century or more.

While it is not likely that any of the preceding figures will be exactly realized, they are no doubt close enough to show the capabilities and the present possibilities of the Anthracite Coal Business of Pennsylvania as to tonnage and output. To presume that the Anthracite Coal Business will advance less rapidly than the figures indicate, is to presume that some new rival or antagonist to the business is to appear—which is as yet invisible—or that the general progress of the business of the country is to move at a much slower pace than that shown by the figures, representing practically the world's coal business, embracing the most important of the European countries for the past fifty years.

The progress of large enterprises at present are influenced by the commercial progress of the enlightened world, the lines of the former limits are being erased by the more common intercourse, and the world is practically becoming a general mart, both as to product and labor.

The business progress of the United States compares favorably with the progress of that of the most prosperous of the countries referred to, and its unlimited resources, with the energy and skill of its people, are sufficient warrant for the statement that the future business of the anthracite coal field will be no less progressive than that of the past, in which case the estimates given as to progress will be greatly exceeded, and there can be no doubt but that future computers of the tonnage will greatly exceed the estimate given in the preceding pages when the further development of the field will warrant it.

COLLIERY IMPROVEMENTS, EQUIPMENTS, MINE OPENINGS AND CUT COAL.

To produce the present forty and a-half million tons output, it requires a stupendous outlay of money, for machinery, breakers, tunnels, shafts, slopes, mine openings for various purposes, railroad tracks, mules, horses, etc., which are usually classed as Colliery Plants, or Improvements, Personal Property, Dead Work, Cut Coal, etc.

Formerly, such investments were made by the lessees almost exclusively; but the lessor became the ultimate owner invariably, and frequently unwillingly, either through judicial settlements or by virtue of limitation of contracts.

At present few collieries are possessed by individual owners and lessees, and very few lessees own colliery plants.

The bulk of the outlay is in breakers and their machinery, hoisting, pumping and ventilating machinery, and in the sections of the

field where the coal formation lies on a high degree of inclination there is quite an outlay necessary in the stock of cut coal in the mines, and the same sections also yield the largest amount of refuse at the breakers, necessitating a larger and more costly breaker, to produce an equal output; on this account the Southern and Western Middle Basins Collieries have a greater colliery outlay per ton output than those of the other basins. This rule, however, is not without some exceptions.

Southern and Western Basins require greater breaker capacity per ton output.

To approximate the valuation of the colliery outlay of the field published figures covering a period of ten years, and embracing an approach to 140,000,000 tons output,* have been used. The tonnage represents forty per cent. of the entire output of the field for the same period, and it is well distributed throughout the Northern and Southern Divisions. For the ten years the average estimated colliery outlay from these figures was $1.50 per ton output,—for the first five years it was $1.70, and for the second, $1.34—showing a decrease of twenty-one per cent. in the last five years as compared with the first. Some of the figures are extremely high, approaching $2.50 in the first five years, and for the same property nearly $2.60 in the second five.

Value per ton output of improvements, etc.

Using the above resulting figures ($1.50) for the entire field's production the ten years' out-put—340,000,000 tons—was produced by a colliery outlay, of an annual average value, of $51,000,000,† and for the tonnage of the first five years, 155.4 millions, $52,830,000, and for the last five years' output, 164.5 millions, $49,550,000, and for the last year's output, using the $1.50 per ton $60,672,000.

Amount of expenditures in colliery improvements.

Every year's output increases the depth from which the coal has to be won, and this calls for deeper mine openings, greater steam-power, longer tracks and longer and stronger wire ropes, etc., yet the colliery outlay has been decreasing per ton output, and the figures as to this phase can be accepted as being near the actual result. The favorable result is to be accounted for by the increased output per colliery. The machinery and structures, mules and cars and mine openings, in fact all of the mining outfit are made to perform greater service, and to produce better economic results.

Increased depth of mining and cost per ton.

The mine drainage of the field in the future is a problem not without considerable interest in this connection. The quantity of water to be drained out of some of the collieries during the wet seasons is enormous, approaching, perhaps exceeding, 10,000 tons in twenty-four hours, and if the output is low at such an operation, the

Mine drainage.

* Compiled from the State and United States Government Reports, from Financial publication, and from the published reports of several of the companies interested.

† The amount for the Census of 1889 was $50,844,265 for buildings, tools, fixtures; implements, live stock, machinery and supplies—$1.36 per ton output.

average drainage cost will be necessarily high. Such unfavorable conditions occur generally when the operation is a centre of drainage for a large area. The best measure of the importance of the question is in the average cost per ton which it entails, and which in the absence of more exact figures, may be taken at four to six cents a ton. The measures yield but little water below a depth of from 200 to 250 feet, and if it were only possible to retain it at that depth the problem would be very much more simple; this, however, has not been successfully done so far. The water finds its way down to the lower depth in brief periods after the openings are made. The bulk of the flood water comes from the surface, and as the depth increases from which it has to be elevated, greater efforts are being made to perfect the surface drainage so as to arrest its entrance into the workings, and as this is improved less water will enter the mines, and the quantity now handled per ton will be materially lessened in the future for the same openings. The mines underlying a river, such as those in the Wyoming field, are liable at any time to be visited by large influxes from rents or crevasses under the river. The mining business has not yet advanced far enough to make necessary the concentration of pumping for large areas as it is in Great Britain. Large pumping stations are there established in accordance with recently made laws, by Government direction, and each operator affected is taxed the average cost per ton output, for the cost of establishing and maintaining such pumping stations, and this amounts to about four or five cents a ton product.

Cost per ton for drainage.

Mining under river.

Pumping Plant.

The drainage problem analyzed is about as follows:

First.— Improvements, which mean boilers, pumping engines, steam and column pipes, sumps or underground reservoirs, etc.

Second.—Fuel.

Third.—Feed water.

Fourth.—Labor.

Regarding the first it may be stated that improvements are always in progress in the direction of economy, tending to reduce the cost of the plant as well as to decrease the cost of maintenance. When the mine water is charged strongly with sulphuric acid the pumping machinery suffers rapid corrosion of some of the parts, which makes the annual repair charges high. As to the second element, fuel, we may state that while it is an important factor in the power, it being taken from the waste fuel which is thrown away on the culm banks, it has at the present time but little or no bearing on the cost of drainage in the anthracite field. Third, feed water is a necessity for all steam purposes beside that used for pumping

Mine water charged with acids.

at the mines, and the proportional cost chargeable to pumping is rarely of much importance. The fourth, labor does not usually increase in proportion to quantity, as the same engineer employed to run a small pump, will run at the same or a slight advance cost, a large one. The cost of maintenance, however, will increase.

Future cost of drainage.

It is very evident that the cost of pumping in the aggregate will increase with the greater depth and greater developed areas, to a certain extent; but if we take into consideration the increased tonnage that the future will demand from these areas, the prospect for the concentration of pumping, with the progress in the mining skill and plant improvement, the average cost per ton for mine drainage for the future will have a promising aspect; it may advance at some points but generally it promises not to go above what it is until the remote future if at all.

Differences between Bituminous and Anthracite mines.

The prospect for greater improvements in the direction of mine economies are not unfavorable. There is a slight difference between the bituminous and anthracite mines, and the machines invented for coal cutting and coal hauling in the mines were produced to meet the necessities of the bituminous mines. The haulage system has been adapted to the anthracite business, but no coal cutting machines have yet been invented for, or adapted to the anthracite field. The necessity for such inventions will become more pressing as the larger veins become less plentiful, and coal hauling, which is now in its infancy in the field, will become more general. From $20,000,000 to $25,000,000 are expended at the present time annually for coal cutting and coal hauling; how much of this can be saved by the more general application of machinery remains for the future to develop; the amount will go on advancing with the increased tonnage, and the higher the wages paid the greater will be the saving by the application of machinery. All of these conditions are favorable to a reduction in the cost of mining in the future, and it is reasonable to expect that such results will be realized; otherwise it would be out of harmony with the experience of other coal fields. The necessity for mining the smaller veins in Europe, with perhaps some sharper competition, was the mother of the mechanical inventions in coal mining. The same mother will appear in the anthracite field of Pennsylvania later on.

Coal cutting and underground haulage.

Future prospects for cost per ton favorable.

Value per ton output and aggregate value of improvements.

The average amount per ton output representing the value of the collieries is $1.50, as shown by figures produced from two reliable sources; but, for example, and to be liberal, $1.75 will be used for the present purpose. This based upon last year's output will aggregate in round numbers, to, say, $70,000,000. Now this $70,000,000 is taken as the amount invested by the operator on the land at the

present time, and independent of the value of the land, to produce the present output, this amount at six per cent. interest gives $4,200,000, and at four per cent. $2,800,000. This class of property deteriorates and perishes to a greater extent than improvements generally; many of the parts are under constant repairs and renewals. After the colliery construction is completed and set in full operation, only extraordinary charges are made to the improvement account.

Depreciation of colliery improvements.

Assuming the life of a colliery plant and outfit to be twenty years, the annual loss on this account would be one-twentieth of seventy millions—$3,500,000—this is equal to five per cent. interest on the $70,000,000. Adding the interest to the previously mentioned six per cent. will make eleven per cent., or a total amount of $7,700,000, an average of nineteen cents per ton on the last year's tonnage. Giving the colliery a life of fifteen years, the average per ton would be 21.9 cents; for twenty-five years it would be 17.3 cents, and for thirty years 16.1 cents. It would be safe to say that this item in the cost of mining will range below twenty cents a ton on the annual output.

Life of a colliery.

Value of plant and depreciation.

VALUE OF COAL LANDS.

First coal land purchased in field.

The first purchase of any portion of the Pennsylvania Anthracite Coal Field, as coal land recorded, is that made by the Lehigh Coal Company in 1773; it was a tract purchased from Jacob Weiss at Summit Hill. Later it is reported that the same company owned 10,000 acres, which must necessarily include the meat and bone.

State of Penna. never sold coal lands.

The State of Pennsylvania, it is stated, never sold coal lands, no distinction has been made between its coal and other lands. In the latter part of the last century, and in the early part of this, the proprietors and the State sold the vacant land at from twenty-six and two-third cents to fifty-three and one-third cents an acre. Some of the lands have been sold as low as six and two-thirds cents an acre. Six townships in Luzerne County, part of the anthracite coal field, were sold for prices per acre, fixed by the Commissioners, at $2.00 for first-class, $1.20 second-class, fifty cents third, and eight and one-quarter cents fourth class.

William Penn's method of buying lands, and his payments.

Such prices for land may perhaps have been excelled in 1685 by Thomas Holme, the President of the Council, in the absence of William Penn, in his negotiations with the Tangoras and other Indians, under the historic Elm Tree, when he purchased the Indians' relinquishment of the land from near the Delaware River to the Susquehanna River. The distance west from the vicinity of Philadelphia, was to be determined by a man's two days' walk, usually

known as "the Indian walk," and the payments were made in axes, knives, guns, beads, red lead, bar lead, etc., perhaps as many in the aggregate as would fill a couple of good size packing cases.

The present State prices per acre for lands are twenty-six and two-third cents, twenty cents, thirteen and one-third cents and six and two-thirds cents in different sections of the State. The Government price in the Western States for coal lands is $10.00 an acre outside and $20.00 an acre inside of a radius of fifteen miles from a railroad

No standard price for coal lands.

There never has, therefore, been a standard for the price of the Pennsylvania anthracite coal field, and we may add that there is to-day scarcely any necessity for such a standard price, since the coal land has almost exclusively passed into the hands of those who need it and will not sell it; the land is out of the market and there is scarcely any possibility for it ever returning.

Coal lands held in reserve.

Much of the land is now held in reserve like the gold in the Government treasury, earning no interest, yet not exempt from taxes. It is kept there for the purpose of meeting a future demand. It is an investment indirectly in the interest of the coal business, but directly in the interest of freight for the railroad companies. Such a vast storage of freight, the output from which can be increased or decreased almost at will and located so conveniently to the centre of the commercial progress and population, is to be equalled only in rare cases.

To attempt to place a valuation upon an estate containing a large tonnage that will extend into the remote future in its exhaustion, and basing it upon the present earnings of the investment in the coal land by any rule or method, carries with it the liability of placing an extreme high or an extreme low valuation upon the same coal vein in a like condition in different properties, for no other reason than that there is an imaginary line or fence on the surface separating the properties; or it may place a high valuation on an inferior property, and a low on a superior. Coal land is like any other real estate property, it is worth what it can be purchased for. But if a block of coal land is purchased, like a block of specie, to be stowed away, or reserved for some future day, it is of no less value after such purchase than before, nor does the change of ownership alter the comparative value compared with that of its neighbor.

Change in ownership of coal lands.

A large area of the coal field under consideration changed ownership in the decade next succeeding the war, owing, in some degree at least, to the high prices realized for coal on account of the war, and on account also of the consolidation of railroads, canals and coal interests resulting about the same time. Sales of coal lands about this period realized from $250 to $600 an acre; perhaps $800

Amount paid for land with present cost.

for choice tracts. These figures prevailed throughout the different basins. The matter of coal tonnage contained in the ground was then of less importance than it became later. Some of the properties purchased at that time are yet lying dormant, and the money invested was generally borrowed at from six to seven per cent. interest. One hundred dollars at six per cent. interest for twenty-five years, amounts to $250, and at seven per cent., to $275; at the same rate of interest, compounded, the amounts would be respectively, $429.19 and $542.74. From these figures it is quite evident that much of the coal land has cost the present owners amounts ranging from say $600 to $2000 and upwards an acre, and it is safe to say that a considerable percentage of it could not be purchased to-day for the highest amount. It is known, however, that several small lots and tracts in an undesirable part of the field have changed ownership within recent years at extremely low figures.

Yield per acre.

The average acre of the field contains, according to the above estimate, 38,500 tons of marketable coal. Some of the coal veins are worth more than others, and the same vein in one locality is of greater value than in another.

Coal leases and royalties.

Leases on coal properties, two or three decades ago, were made at a royalty of from twenty to thirty cents a ton for the larger sizes of coal, with no charge for the smaller sizes. Large estates are quoted to have been leased at still lower figures, with the term perpetual. The royalty has been advancing and the leases made within recent years, charge from forty-five to fifty cents; in rare cases, perhaps sixty for the larger sizes; fifteen cents, ten cents and five cents for the smaller, resulting in an average price of from thirty to thirty-five cents. Leases at thirty-five cents a ton would find ready takers to-day for any number.

Value of land based upon royalty.

Assuming thirty cents to be the land owners' estimate of the present value of the coal, some idea may be had as to the value of the total tonnage within the field. The output for 1891 amounted to 40,448,400 tons, which at thirty cents a ton, is $12,134,500. The tonnage exhaustion for the same year was equal to an average of 1050 acres of the land, which, if divided into the last mentioned amount, gives an average of $11,557 an acre.

According to the foregoing, the output of 1891, at thirty cents a ton, produced an amount sufficient to pay $577.50 an acre for the land exhausted during the year, besides providing an amount sufficient to pay interest at the rate of 6.32 per centum on the value, $180,607,000, of the remaining, and unexhausted field area at the rate, $577.5 per acre. The figures given for the value of the land are used for illustration only, the results obtained by them are not

realized; royalties are only paid on a small percentage of the output, the figures, however, are sufficiently potent to establish an idea of the value of the coal field upon the theory of current royalties.

An output of 1,000,000 tons exhausts 25.82 acres of the average acre yield. This at thirty cents per ton, yields a sufficient amount to pay $577.50 per acre for the exhausted area, and five per cent. on the value at the same rate of nearly 10,000 acres. The tonnage decreases with every year's output, but the coal lands will enhance in value for many years to come.

Cost of coal lands.

The cost of the coal lands to the present owners, adding interest and contingencies, will not be less than $800 an acre, and this is equal to an average of 2.08 cents a ton on the average estimated product per acre. At two cents a ton the value of the field would be $240,000,000; interest upon which at six per cent. is $14,400,000—an amount equal to thirty-six cents a ton on last year's product. Four per cent. interest would be equal to about 23.7 cents a ton on the same product.

Value of coal lands and collieries.

Adding the $240,000,000 to the $70,000,000, previously referred to, as representing the value of improvements and colliery outfits, makes a total of $310,000,000. The interest on this amount we find as follows:

$240,000,000 at six per cent. interest . . .	$14,400,000
70,000,000 at six per cent. interest . . .	4,200,000
70,000,000 at five per cent. depreciation .	3,500,000
Total	$22,100,000

Interest and depreciation.

The interest and depreciation distributed over the last year's tonnage is equal to 54.63 cents. This represents the measure of the approximate cost, exclusive of profit, entailed by the ownership of coal lands and the construction, both inside and outside, of the collieries, with their equipments, in placing a ton of 2240 pounds of coal on the railroad car at the colliery in a marketable condition, additional to taxes, the cost of labor, and the ordinary colliery material supply. Using four per cent., instead of the six per cent., for the first two items—$14,400,000 and $4,200,000—the amount per ton would be 39.3 cents.

COST PER TON ON CARS.

Items constituting cost per ton.

The term, "Cost per ton," as applied by the Colliery Manager, generally means the total cost of labor, including that of the officers, and the supplies necessary to place a ton of coal in a marketable condition on the railroad car at the colliery. The amount usually

includes the cost of the ordinary repairs and additions to the mine equipments and improvements. Extraordinary charges for improvements and equipments are generally charged to the Capital Account. Perhaps no two managers take the same view of all the items of cost making up this charge, and it is not often that the same view is taken by the same person at the end of prosperous and unprosperous years; and on this account it is difficult to obtain the exact cost per ton for the tonnage produced even where published figures are available; there is invariably some degree of uncertainty where explanations are not given as to what the exact cost is. The inaccuracy arising from this source, however, cannot be serious in the general average of so large a tonnage.

Tonnages used to obtain averages.

Figures extending over the last ten years, and covering nearly 145,000,000 tons, forty three per cent. of the total output, and distributed, in good proportions, through the northern and southern sections of the field, yielded an average cost per ton of nearly $1.34. The highest cost was upwards of $1.50. For a tonnage a trifle less than a million—the cost was $2.90. The lowest cost, and this is for a large percentage of the tonnage, was only a few cents above a dollar; and it may be added, here, that considerable of the percentage of the output, not included in the above figures, is produced for less than a dollar, when all of the small coals are included in the tonnage.

Average cost per ton.

The average cost per ton for the first five years of the decade was $1.38, and for the second $1.31, showing an improvement of seven cents a ton, or five per centum in the last decade. The figures used are largely those referred to in a preceding page and used in determining the value of the collieries.

Misleading effect on cost per ton by increased tonnage of small coals.

In comparing the cost per ton of the present with the past, it is necessary to take into consideration the comparative percentages of the small coal constituting the total output. As already stated, the small coals in the early history of the business were wasted on the culm banks, and to place this material on the railroad car generally, not only adds no cost, but saves the expense of hauling and unloading: to load it on the railroad car for the market increases the colliery output without adding cost. The colliery tonnage has been increased considerably during the last twelve or fifteen years in this manner. An increase of five per cent. would account for the seven cents improvement in the cost per ton, and more than this quantity was in all probabilities realized.

Since making the above statements my attention has been directed to more extensive data, published and available on this subject which will in subsequent pages be used in extension of its consideration.

The output of 1891—40,448,400 tons—at $1.34 per ton amounts to $54,201,000. This amount we take to represent approximately the "cost per ton on cars" for the entire anthracite coal field, of this $36,134,000 is approximately the amount expended under ground, and $18,067,000 above ground.

Relative cost of labor and material.

The relation of the cost of labor to that of the material is about as four is to one—See Statement "D," page 47,—and at this ratio the labor cost was $43,609,000, or $1.072 a ton, and the material cost was $10,849,000, or $0.268 per ton.

Census figures compared with the others.

Comparing the above figures, which cover a period of ten years, with those prepared by the Government officers for the census year of 1889, covering only one year, of a low output and the first, following a high tide year in the business, we find that the amount for labor was $1.07, and for material $0.30, making a total cost per ton of $1.37. It shows that the results are remarkably close, coming, as they do, from independent methods and sources, and for dissimilar periods.

Taxes.

The amount of taxes paid during the last ten years for a tonnage exceeding 130,000,000 tons resulted in a trifle less than four cents a ton. Four cents is, perhaps, a good measure of this cost.

Insurance.

The insurance is an item of very little importance as a factor in the cost of mining. Charges that have been made for this account will, perhaps, average half a cent a ton. The larger corporations do not insure their mining properties, at the present time, as a rule. The item in the former pages, providing for the renewal of improvements, will be considered as liberal enough to cover this charge.

The following is a recapitulation of the total cost of the coal placed on the railroad car at the mines, based upon the tonnage of 1891:

Recapitulation cost per ton.

Coal lands, valuation	$240,000,000 at six per cent.	$14,400,000
Colliery improvements, equipments, dead work and cut coal	70,000,000 at six per cent.	4,200,000
Renewal of collieries or annual depreciation	70,000,000 at five per cent.	3,500,000
Taxes at four cents a ton product		1,618,000
Labor cost		43,609,000
Material		10,840,000
Total		$78,167,000

The total amount, $78,167,000, is equal to $1.93[2] per ton for the 1891 output. From this should be deducted the amount realized for rents of houses and the surface of the land, timber, etc., which will range, perhaps, from two to four cents per ton product. If it be taken at 3.2 cents a ton, it leaves a net average cost per ton of $1.90

in round numbers; the extreme averages will range from $1.60 to $2.10. Divesting the business of the surplus coal land and charging it with the number of acres exhausted during the year as indicated by the tonnage, at $800 an acre, with six per cent. interest on the amount added, the cost per ton, $1.90, would be reduced to $1.56⁷, which is approximately the actual cost per ton for placing a ton of marketable coal on the cars at the mines.

In confirmation of the above resulting cost for mining, the subject will be extended into the following pages, based upon data collected by the Government officers and covering the entire coal field for the last four census years.

COST PER TON, EXTENDED, LABOR, MATERIAL.

The most important of the charges entering into the cost per ton, as has already been shown, is that of the cost of labor. A division of the mine labor is given in the Census Report for the year 1889 for the Anthracite Coal Fields of Pennsylvania as follows:

Division of labor and wages.

	Average number employed.	Average Wages per day.
Above ground—Foremen	564	$2.71
" " Mechanics	4,720	1.92
" " Laborers	23,779	1.29
" " Boys, under sixteen years	17,091	0.62
Below ground—Foremen	737	3.05
" " Miners	36,639	2 40
" " Laborers	35,376	1.63
" " Boys, under sixteen years	4,770	0.89
Office force—Males	526	$410,774
" " Females*	1	$250
Grand total number of employes	124,203	
" " wages " "	$39,279,355	
Total average number employed above ground	46,154	
" " " " below "	77,522	

Notes on Statement "D."

Statement "D," page 47, gives the results for the Pennsylvania coal fields, including bituminous and anthracite, for the Census Reports. In this statement we find that the cost per ton for labor in the anthracite coal field in 1860 was seventy-six cents, and the cost of material was twenty-three cents; total, ninety-nine cents. In 1870, the same items are, given in the same order, $1.64 and twenty-six cents; total, $1.90. In 1880, ninety-seven cents and twenty-nine cents; total, $1.28. In 1889, $1.06 and twenty-nine cents; total,

*The coal mines of Great Britain had in 1891, 5819 females employed outside; in France in 1888, 3336 females were employed at coal mines, and in Belgium in 1889, 12,134 females were employed at the mines.

$1.35. The result for 1870 is influenced by the effects of the inflated currency and results of the war. The average cost per ton for the four census years for labor and material was, labor, $1.10; material, twenty-eight cents; both, $1.38. Throwing out the abnormal year, 1870, the average for the other three years would be ninety-seven cents and fourteen cents; both, $1.11. The latter figures, no doubt, represent well the average cost for the three periods.

Cost per ton from census figures.

The tons per capita will be found on the last mentioned statement, and it will be observed that the result for the last census year shows a loss of nearly twelve per cent. against a gain for the previous census year. Owing to unexplained statistics, these latter figures are not precise enough to be accepted as an accurate comparison of the average individual labor.

Tons per capita.

The result within the State bituminous field shows that the tons per capita advanced one-fifth in the last nine years, and for the same period the average wages advanced a trifle more than a fifth, and the cost per ton for labor fell from sixty-six cents to sixty-four cents.

Results of Bituminous coal fie'd of Penna.

From Statement "C," page 46, it will be observed that the cost per ton for labor varies in the anthracite field in the different counties for 1889, from ninety-nine cents to $1.59, the average being $1.06; the cost of material used varied from twelve cents to thirty-eight cents, and averaged twenty-nine cents. The lowest cost is in Luzerne and Lackawanna Counties for labor, and the highest is in Dauphin County.

Notes on Statement "C."

Cost by counties.

Statement "B," on page 45, gives the cost per ton, including improvements, dead work, taxes, royalty and insurance, for the anthracite coal field of Pennsylvania, the United States coal field, and for several foreign countries. In this it will be found that the total cost of mining anthracite coal is from $1.60 to $1.65 a ton of 2240 pounds. For a like ton, the cost of bituminous is sixty cents in Pennsylvania and $1.00 in the United States. In Canada it is $1.07; in Great Britain, $1.16; in Belgium, $1.41, and in nine operations in Europe it is seventy-two cents.

Notes on Statement "B."

Domestic and foreign collieries.

The item of colliery supply is chiefly made up as follows:

T rails, sheet and other iron and steel.

Powder and all explosives.	Oil, cotton.
Horse feed.	Wire ropes.
Harness.	Picks, sledges, shovels, etc.
Mules and horses.	Lumber and timber.

Items constituting supplies.

The first item will perhaps run about four cents a ton; the second, explosives, we have given on Statement "C," for 1880, and it runs from one to eight cents in the different counties, averaging 6.9 cents; perhaps six cents will cover it at the present. The other

Cost of supplies.

items, not including lumber and timber, may, perhaps, vary from six to ten cents a ton. The cost of lumber we find on Statement "C," for 1880. It runs from four to nine cents in different counties, and averaged 6.5 cents. It may average to-day a cent higher; some of the operations, however, will run as high as ten to thirteen cents. We find also on the same, Statement "B," the cost per ton for lumber and timber in Canada, Great Britain and in Europe. It amounts to 2.7 cents in Canada, 6.2 cents in Great Britain, and 8.7 cents in nine European collieries.

Economic prospect for supplies

In looking into the above list of mine supplies, in its relation to the future, it is scarcely necessary to consult statistics to be impressed that all of the articles included are likely to fall in their prices with the progress of commerce and population. The item of lumber and mine timber, which amounts to six or eight cents a ton, is perhaps the only one likely to have a claim for an advance in estimates running into the future. The price of lumber and timber delivered at the mines to-day is not high, it is perhaps as low as it ever has been, and so low as to almost preclude the possibility of cutting any on the colliery property by the mining force, though it be in abundance. There has been an increased consumption of timber and this has advanced the cost per ton to some degree.

Cost of mine lumber.

Sources of lumber supply

The greatest lumber supply of the Anthracite Coast, for this country at the present time is in the South; located largely within rail haulage. The facilities of the present large mining and transporting companies, with their railroads extending to the northern lakes, would seem to indicate that the supply of mine lumber and timber of the future would largely be drawn from the lakes, for the anthracite business. The railroad companies carry part of their mine tonnage to the lakes, and can bring in their coal cars,—some of which are adapted for such purposes—mine lumber and timber as return freight at such low cost as to exclude the southern product. There will be no necessity for some time, however, to draw from any other than the present sources.

Probable future source of supply.

With such easy access to a supply, that is practically inexhaustible, as far as the anthracite business of this State is concerned, there can be no reason for anticipating that the cost of mine lumber, in the Anthracite Coal Field, per ton of coal, will be materially affected. The experience given by the older countries, where mining has been in progress for centuries, is also encouraging, since the highest figure given for mine lumber and timber per ton is below nine cents. Great Britain has for the last half century been compelled to build brick and stone arches in its mines to support a number of its main avenues, under a crushing pressure, beyond the ability of

Cost per ton of mine lumber.

STATEMENT "B."—Cost of Mining Anthracite and Bituminous Coal in Detail in Pennsylvania, United States, and Bituminous in Foreign Countries, with Value of Improvements, Equipments and Supplies.

		Pennsylvania Anthracite, based upon the foregoing averages. 1891.	BASED UPON GOVERNMENT REPORTS. UNITED STATES. Pennsylvania Anthracite, 1889.		Pennsylvania Bituminous, 1889.		United States Bituminous, 1889.		FOREIGN. United States, 1888–1889, 1890. Lump Coal.	United States, 1888–1889, 1890. Run of Mines.	Canada, 1889.	Great Britain, 1889.	Belgium, 1888.	Province of Liege, Belgium 1888.	Europe, 1888–1889, 1890.	
	Number of institutions	all	all	all	all	all	all	all	99	47	5	13	all	all	9	
	Number of pou ds in ton	2,240	2,240	2,000	2,240	2,000	2,240	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	
	Number of tons	40,448,400	37,146,400	41,509,300	32,295,400	36,174,100	85,383,000	95,629,000	5,563,547	7,446,253	893,032	3,24?,724	.....	.....	1,732,674	
a	Labor	1.08	1.057	0.949	0.642	0.573	0.817	0.727	0.975	0.665	0.867	0.809	0.849	0.836	0.472	a
b	Timber	0.08	.....	.....	.....	.....	.....	.....	0 026	0.015	0.027	0.062	.....	.....	0.087	b
c	Other supplies and repairs	0.20	.....	.....	.....	.....	.....	.....	0.050	0.042	0.088	0.109	.....	.....	0.078	c
	(b and c)	.....	0.291	0.261	0.074	0.061	0.093	0.083	.....	.....	.....	.....	.....	.....	.....	b&c
	Total labor and supplies	1.34	1.348	1.210	0.716	0.634	0.910	0.810	*1.051	0.722	0.982	0.980	other expenses, 0.562	other expenses, 0.501	0.637	
d	Dead work, etc	included with 1.	0.063	0.056	0.009	0.008	0.010	0.004	0.133	.....	.....	.....			.....	d
e	Insurance	.005							.....	.....	0.002	.....			.....	e
f	Interest	.103														
g	Depreciation of value of plant	.086	0.236	0.209	0.079	0.071	0.079	0.072	0.008	0.010	0.020	.....			0.010	f
h	Royalty	.022							0.009	0.006	.....	0.022			0.037	g
i	Taxes	.04							0.043	0.036	0.062	0.124			0.002	h
									0.007	0.006	.....	0.024			0.035	i
j	Total all charges	1.596	1.647	1.475	0.804	0.713	0.999	0.886	0.985	0.780	1.066	1.150	1.411	1.430	0.721	j
k	Value per ton of buildings and fixtures	.....	0.991	.....	0.199	0.22	0.319	.....	.....	.....	.....	.....	.....	.....	.....	k
l	Value, implements, live stock, machinery, supplies	.....	.0388	.....	0.149	0.155	0.245	.....	.....	.....	.....	.....	.....	.....	.....	l

* Includes 13⅓ cents value of screenings.

STATEMENT "C."—Pennsylvania Anthracite Coal Field, by Counties, Tonnage, Cost of Labor, Supplies, Powder, Lumber, Value of Improvements and Equipments, based upon Government Reports for Census Years 1860, 1870, 1880 and 1889.

COUNTY.	Total Tonnage, exclusive of that cousumed at the Mines. (2,240 Pounds.)			Total Amounts received for the Coal, at the Mines, per Ton.			Total Wages paid per Ton, Product.			Total Value of Materials used.			Amount per Ton received at the Mines for Coal after deducting Cost of Labor and Material.			Cost per Ton of Lumber and Timber.	Cost per Ton for Explosives.	Value of Improvements, Equipments and Coal Lands under Development averaged per Ton output.			Value of Machines, per Ton output.		
	1870.	1880.	1889.	1870.	1880.	1889.	1870.	1880.	1889.	1870.	1880.	1889.	1870.	1880.	1889.	1880.	1880.	1870.	1880.	1889.	1870.	1880.	1889.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Lackawanna	.....	4,839,105	8,412,229	.....	$1.56	$1.70	.....	$0.89	$0.99	.....	$0.27	$0.21	.....	$0.40	$0.50	c. 5.4	c. 9.1	.....	$1.61	$3.54	.....	$0.47	$0.26
Luzerne	8,449,373	9.600.588	15,338,360	$2.63	1.86	1.78	$1.56	.93	1.01	$0.21	.26	.28	$0.86	.67	.49	4.1	6.7	$2.96	1.66	4.44	.....	.46	.39
Lehigh	85,978	.....	.....	4.47	.....	.....	1.38	.....	.....	.30	.....	.....	2.79	.....	.....	.....	.....	2.60	.....	.....	.....	.....	.....
Columbia	357,919	253,152	554,936	3.58	1.81	1.90	2.16	1.01	1.28	.70	.31	.38	.64	.49	.24	7.3	4.4	2.63	1.77	3.84	.....	.91	.49
Northumberland	893,928	1,672,723	2,828,771	2.74	1.77	1.73	1.85	1.04	1.24	.20	.29	.35	.69	.44	.14	10.1	7.0	4.53	1.33	2.30	.....	.53	.22
Carbon	360,163	656,808	1,100,736	2.78	2.08	1.84	1.64	1.09	1.16	.32	.44	.30	.82	.55	.38	8.2	4.3	4.20	2.73	4.92	.....	.67	.74
Schuylkill	3,446,557	5,883,677	8,019,262	2.99	1.89	1.80	1.75	1.04	1.07	.34	.32	.38	.90	.53	.35	9.9	6.0	4.97	2.00	4.94	.....	.94	.47
Dauphin	367,281	325,696	576,816	2.68	2.22	2.18	1.56	1.74	1.59	.19	.35	.36	.93	.13	.23	10.6	3.3	10.50	3.30	2.69	.....	.72	.41
Susquehanna	.....	14.928	.....	.....	1.82	.....	.....	.99	.....	.....	.20	.....	.....	.....	.....	4.6	8.3	.....	4.00	.....	.....	.....	.....
Sullivan	.....	.....	324,946	.....	.....	1.72	.....	.....	1.21	.....	.....	.12	.....	.....	.....	.....	.....	.....	.....	6.48	.....	.....	.92
Totals and averages	14,011,209	23,296,678	37,146,456	$2.76	$1.81	$1.77	$1.64	$0.97	$1.06	$0.26	$0.29	$0.29	$0.86	$0.55	$0.46	c. 6 5	c. 6	$3.64	$1.77	$4.18	.....	$0.60	$0.38
Average 1860, 1870, 1880 and 1889 81,700,000				$1.94			$1.10			$0.28			$0.56										
Average 1860, 1880 and 1889 67,689,000				$1.77			$1.00			$0.28			$0.49										
Average 1880 and 1889 60,443,000				$1.79			$1.02			$0.29			$0.48										
Total, 1860 7,245,400				$1.64			$0.76			$0.23			$0.65										

STATEMENT "D."—Showing the Tons Product, Cost of Labor and Supplies, Percentage of Cost due to Labor, Amount received for the Coal, Number of Employees, and Tons per Capita. Based upon the Government and other published Reports.

	COAL FIELD OF PENNSYLVANIA.							
	ANTHRACITE.				BITUMINOUS.			
	1860.	1870.	1880.	1889.	1860.	1870.	1880.	1889.
Tons, 2240 pounds	7,245,394	14,011,209	23,297,000	37,146,000	2,402,488	6,962,962	16,451,038	32,298,293
Cost of labor	$0.76	$1.64	$0.97	$1.06	$0.71	$1.292	$0.66	$0.642
Cost of supplies	$0.23	$0.26	$0.29	$0.29	$0.19	$0.087	$0.106	$0.071
Total labor and supplies	$0.99	$1.90	$1.26	$1.35	$0.90	$0.379	$0.766	$0.713
Percentage of cost due to labor	78%	86.4%	77.1%	78.4%	79%	93.7%	86.1%	89.6%
Average amount received at the mines for coal per ton	$1.638	$2.76	$1.81	$1.77	$1.20	$1.999	$1.103	$0.865
Total number of employees	25,126	53,021	70,669	124,203	4,651	16,851	33,248	53,780
Tons product per employee	338	286	408	360	516	413	500	600

timber to resist. There is no report that the Anthracite Field has come to this as yet. The future of the mine timber question for the Anthracite Coal Field is providential and auspicious.

Statement "C," previously referred to, gives the result of the cost of mining, etc., by counties for the anthracite field based upon the same source as that of Statement "D," for three census years, with the average result for the fourth; it gives the tonnage, the amount received for the coal at the mines per ton, the average wages per ton, the average value of material per ton, cost of lumber, cost of explosives, value of improvements and equipments; it also gives the amount received for the coal after deducting cost of labor and material. From this statement we find that the Lackawanna and Luzerne Counties combined, have as a residue,—not profit—after paying for labor and material—averaged for the three years—58c., and for the last two years 51.9c. Carbon County had for the three years, 50.8c., and for the two years 44.5c. Northumberland for the three years had 32.1c., and for the two years 24.9c. Schuylkill had for the three years 51.7c., and for the two 42.5c. This shows that Lackawanna and Luzerne had an average advantage of nearly nine and a-half cents for the last two years, and six and three-quarter cents for the three years, over Schuylkill County; and in the same order seventeen and twenty-six cents over Northumberland, and seven and four-tenths cents and seven and three-tenths cents over Carbon County. The figures are supposed to be those resulting after paying freight and all possible charges.

Result compared by counties.

Advantage of one county over the other.

In the above we have the cost per ton on cars by counties, and for the entire field. There is another important division of the field, known as the Wyoming Region, Lehigh Region, and Schuylkill Region; this may be termed as the railroad collecting division. The Wyoming Region includes Sullivan, Susquehanna, Lackawanna, and part of Luzerne Counties. A small portion of the field extends into Wayne County, which belongs to this region, but no coal has been mined from there. Sullivan County section of the field is practically outside of its commercial and geographical limits.

Regional divisions.

The Lehigh Region takes in a part of Luzerne, Carbon and Schuylkill Counties.

Counties producing coal in different regions.

The Schuylkill Region embraces part of Schuylkill and all of Columbia, Northumberland and Dauphin Counties.

The determination of the cost per ton on cars for the different regions is not possible from the available data, but it may be approximately determined. The average cost per ton on cars for the entire field and for the last two census years, is $1.31. This is three cents lower than the amount used in obtaining

Cost per ton on cars by regions.

the results given in the preceding pages, but it is based upon returns having to some degree at least, an official character, rendered in a form, bearing some of the characteristics of an affidavit; it is seven cents lower than the average for the last four census years, which includes the period of war, and three cents above the average for the three census years, 1860, 1880 and 1889. The average cost per ton for the Wyoming Region including that portion of Luzerne County extending into the Lehigh Region, and a tonnage of about 90,000 tons, for Sullivan County, is $1.23. For the southern portion of Carbon County the cost was about $1.61* and for the northern about $1.46; the average for the county is $1.48. The average cost for the counties constituting the Schuylkill Region was $1.46. It is not possible to give the precise figures for either of the regions from the data, but they are approximated, based upon the two census years, 1888, 1889, as follows:—

Cost per ton by regions.

Wyoming Field, cost per ton on cars, . . .	$1.20
Lehigh " " " " . . .	1.34
Schuylkill " " " " . . .	1.46

In the foregoing pages it has been shown that twenty-three cents is about the average cost of all other charges entering into the grand total cost per ton on cars at the mines, for interest on the investments in colliery improvements, equipments, taxes and insurance and all other cost usually entering into the account, and allowing for the value, with interest, of the coal lands exhausted in producing the tonnage. To enter minutely into this charge would show a few cents in favor of the Wyoming Region as against the other two. The result is also the product of no exact statement; it is produced by deduction, and will be taken for the sake of liberality at twenty-five cents for the present use.

Cost per ton, other items than labor and material.

PASSES INTO THE FIELD.

Nature was no less careful in the Pennsylvania Anthracite Coal Field, in its geographical and topographical provisions, than in its mineralogical.

Excepting the Virginia Coal Field, near Richmond, and the Rhode Island Graphitic Coal Field, both comparatively insignificant, the Anthracite Field of Pennsylvania is the nearest to the Atlantic Coast's navigable waters within the United States. The distance, in a straight line, from the eastern extremity of the field to tide water is about sixty-five miles, and while the country through

Closeness of field to tide.

* This is based upon the cost per ton of one firm for the years—not census years—1880 and 1889.

which the field is reached, from the coast, is not entirely free from ridges or mountains, there are none of a very prominent character. While some of the routes baffled the skill of canal engineers, the obstacles were easily overcome by the railroad engineers. Nearly all of the existing mountains have been channeled and divided by nature's elements, so as to admit a more or less easy passage and entrance into the coal fields by the railroads at several points.

The altitudes above tide within the Wyoming Region, along the valley, run from about 550 feet at the southern end, to about 1100 feet at the northern. The altitude in the Lehigh Region, at Hazleton, is 1050 feet above tide. In the Mahanoy and Shamokin Valley it runs from about 850 feet to 1250 feet; the altitude of the Pottsville Valley runs from about 600 feet to about 1250 feet. The passes over the mountain, bordering the southern limit of the different regions are from 400 to 800 feet above the valleys, and to surmount this altitude, stationary engines have been located at the head of steep incline planes, at two points in the Wyoming Region, and at two in the Mahanoy and Shamokin Valleys. For all coal shipped eastwardly from the different fields to Philadelphia and New York, the altitudes given represent the total average gradient, in favor of the load to tide water, and it is almost a continuous descent.

Altitudes.

The shortest distance to New York from the coal field is by the Reading System* from Panther Creek, it being 124 miles. The shortest distance to Philadelphia is from New Boston, by the Pennsylvania Railroad Company Schedule, 105 miles. The distance by the Reading, from Pottsville, is 93 miles. The different routes to New York vary from 124 to 237 miles, and to Philadelphia from 105 miles to 177 miles. The shortest distance to Buffalo is 272 miles, by the Delaware, Lackawanna and Western Railroad. The Buffalo distances vary from the one last given to 330 miles, from the Wyoming Field, and from 310 to 330 miles from Schuylkill and Lehigh Fields.

Distances to market.

The amount of indebtedness carried on part of the coal field, at six per centum interest, amounts in yearly interest, if paid, to an approach of $1.00 a ton, on the present annual product of the land owned. This burden upon the different companies varies from the $1.00 as a maximum down to say twenty cents, and less; the higher amounts bear with them a provisional tonnage, for the future, that will extend into the remotest period of the business.

*The term "Reading System" is intended to include the Lehigh Valley and the Central Railroad of New Jersey Companies' Railroads