HISTORY OF PIG IRON MANUFACTURE ON THE PACIFIC COAST

The discovery of gold in California and the consequent immigration and growth of population along the Pacific Coast created not only an interest in other mineral resources but also a demand for manufactured products of the metals. It was natural, therefore, for the early settlers to turn attention to the possibilities of developing iron deposits into producers of ore to supply potential blast furnaces, and to look at the forests and the coal beds as sources of fuel for metallurgical operations. Cast iron, rolled iron, and steel products were in great demand for all the needs of a new country engaged in the development of mines and farms, in the exploitation of the timber and fisheries resources, in building railroads, and in creating shipping activities along both rims of the Pacific. A strong belief in the extent and magnitude of the deposits of raw materials, necessity created by local conditions, the isolation of the western coast from the producing iron and steel centers of the east, and an optimism of creative development—all contributed to the desire and the determination to establish an iron manufacturing industry on the western slope facing the Pacific Ocean.

It must not be inferred that other localities in the line of the western drift of population were inactive. The occurrence of excellent deposits of iron ore in Utah was noted by the first settlers. They soon recognized the necessity and importance of iron production, but the sporadic attempts made to organize an industry failed because of difficulties in securing suitable coke near the iron deposits, and because the principal occupation of the pioneers was directed to agricultural pursuits. The opposition of the Mormon church authorities to industrial activity was also a factor in hindering such development. Utah, however, became a producer of pig iron in 1874. The Great Western Iron Works had built a plant of two small stacks about 1873 at Iron City in Iron County and manufactured 415 tons of iron from 1874 to 1876. This establishment was abandoned in 1883, and the old stacks torn down. However, foundations are reported to have been laid for a coke furnace, 45 feet by 15 feet, to use the local hematite and magnetite ores, but the later project was never carried to completion. The

Equitable Iron and Coal Company of Ogden began the construction of the Laura May furnace at Ogden in Weber County in 1875. This was not completed until 1882 and does not appear to have produced more than 57 tons. The records indicate that Utah produced 472 tons of pig iron in the following years:

1874	200
1875	150
1876	65
1882	57

Manufacture then ceased, and Utah passed out of the list of states producing pig iron until 1924, when a modern blast furnace establishment and by-product coking plant, utilizing the rich resources of iron ore, coal, and limestone, were put into operation near Provo by the Columbia Steel Corporation.

The history of the attempts to manufacture pig iron in California, Oregon, and Washington is given in the pages which follow. Rolling mills had been established as early as 1868 in California and somewhat later in Oregon and Washington, but the story of their development is a separate chapter in the industrial development of the coast and will receive only incidental mention in this narrative. The material for this article was collected during an investigation, made in 1924 and 1925, of the possibilities of establishing a blast furnace industry on Puget Sound. As a part of the study, it was found desirable to secure information regarding previous atempts made along these lines in the Coast states. Interest in the matter was stimulated by the discovery of many facts not generally known, consequently an effort was made to bring together these scattered facts dealing with the early history of pig iron manufacture on the Pacific Coast into a continuous whole. The sources of information are difficult to find, are fragmentary, and contradictory; the available data, recorded largely by non-technical writers, lack the accuracy demanded by the scientific investigator. Because of this, many points of metallurgical and engineering importance are vague and ambiguous; on the other hand, these technical matters are not of great significance to the casual investigator. An attempt has been made here to present the story, as it has been traced out of the various records and sources open to the writer, in the hope that it may be of some interest to the general reader as well as an historical record of the difficulties and problems faced in the former attempts made to

establish this basic industry on the western coast of the United States.

The significant fact to note is that California, Oregon, and Washington did actually produce pig iron over a period of years. The total quantity manufactured during the various cycles of activity is not large. Only incomplete statistics are available, consequently the estimates presented indicate approximations. Oregon produced nearly 95,000 net tons during the period from 1874 to 1894; Washington 25,000 tons in the early years from 1881 to 1889; and California 15,000 tons in the short life of operation from 1881 to 1886. The total reported production to 1894 amounts to 132,845 net tons of charcoal iron;—probably 135,000 tons is a safe round-figure estimate. The production at Irondale, Washington, during the intermittent operations from 1902-1903, 1907-1910, and 1917-1919 was 41,000 tons. The grand total for the Pacific Coast during all the years is estimated to be approximately 175,000 net tons;—not a large amount measured in terms of the modern furnace,—but it is an index of the results actually attained through the earnest efforts of the hopeful adventurers of past days.

Notwithstanding the commercial failure of the early enterprises, the hope still persists of a rebirth of the pig iron industry at some time in the near future. The hope is based on the expectation that changed economic conditions will allow the assembling of raw materials at one or more strategic points along the Pacific and permit the production of pig iron and its direct products on a profitable basis. This is not altogether an idle dream, because some day the industrial necessities of the Coast will justify the erection of local blast furnaces to satisfy the established, existing market as well as to meet future growth. When the time arrives, the development will proceed cautiously along well proven channels, and it will be conducted in a systematic, scientific and technical procedure based on a full comprehension of all the possibilities and limitations of our resources and our markets. Then will the dreams and ambitions of the pioneers be converted into realities.

Oregon

Oregon has the distinction of being the first state on the Pacific Coast to manufacture pig iron in the blast furnace. Interest in the possibility of utilizing iron ores was shown as early as 1841. Wilkes refers to the plans of Major Robert Moore, then living on the west bank of the Willamette overlooking the falls, to erect furnaces for smelting iron. Moore believed that the nearby rock was

iron ore,—an error pointed out to him by Commodore Wilkes, but like many a prospector, Moore did not believe that he was mistaken. Oddly enough, the first iron made, an iron pick and some horseshoe nails, was smelted in a primitive way in 1862 from ore obtained at a deposit farther down the river at Oswego on the west bank a few miles above the city of Portland. As a result, plans were made to exploit this deposit. The Oregon Iron Company, promoted chiefly by W. S. Ladd, H. C. Leonard, and H. D. Green, was organized in February, 1865, with a capital of $500,000 to manufacture pig iron in Oregon. The stock was distributed among twenty stockholders, among whom were San Francisco and New York men as well as Oregonians. On May 13, 1865, the following directors were chosen:—W. S. Ladd, H. C. Leonard, Henry Failing, Addison M. Starr, John Green, and Henry D. Green, the first two acting as president and vice-president. In 1866 the construction of a furnace to utilize the limonite ore at Oswego was begun. This furnace, modelled after the Barnum stack at Lime Rock, Connecticut, was completed under the direction of a Mr. G. D. Wilbur of Connecticut, but did not begin actual operations until Agust 24, 1867, when 6 tons of metal were made.

The stack, constructed of hewn stone obtained in the immediate neighborhood, was 42 feet high, 34 feet square at the base, 26 feet square at the top, and had a hearth diameter of 9 feet 6 inches,—the entire structure supported on solid, dry stone foundations 16 feet deep to bed rock and 36 feet square. Surmounting the stack was a brick chimney 40 feet high containing chambers for heating the air used for blast. This was furnished by two wooden blowing engines, driven by water power, having cylinders 5 feet in diameter and a stroke of 6 feet. The capacity of this furnace was very small, only about 8 tons per day. The cost of the plant was $126,000.

Charcoal for fuel was made from Oregon fir, and limestone for flux was principally obtained from the San Juan islands in Washington. Stone from Santa Cruz, California, was also used. Some attempts were made to use local calcareous material in place of limestone, but without success. Limonite of low grade from deposits near the furnace furnished the supply of ore,—2½ tons being required for each ton of pig iron produced.

By the first of October, 1867, the production had reached 224 long tons costing $29.00 per ton, exclusive of taxes and interest on

capital. The pig iron, consumed locally and in San Francisco and sold at a price varying between $25.00 and $30.00 per ton, was pronounced to be of superior quality. No exact record of the tonnage produced in the years immediately following the beginning of operations is available. It has been stated that between 1867 and 1869 the plant produced 2400 tons of pig iron.

The works were closed in 1869 because of difficulties due to the construction of the furnace, which limited the output to a relatively small amount of iron, and the plant remained idle until March, 1874. During the three following years over 5000 tons of pig iron were made, but the results of operation do not appear to have been satisfactory, for the plant was sold at sheriff's sale in September 1877 to the Oswego Iron Company under whose management it was thought production could be increased. The new owners rebuilt the furnace, began operation in 1878 and continued until 1882, apparently without making the progress expected. The low price of iron also contributed to the difficulties of the new management. On April 22, 1882, the Oregon Iron and Steel Company was incorporated to take over the business. This company was organized by W. S. Ladd, W. M. Ladd, and E. W. Crichton, with a capital of $3,000,000. The officers in 1884 were S. G. Reed, president, William S. Ladd, vice president, E. W. Crichton, secretary and superintendent. Production of iron was resumed and kept up until November, 1885, when the operations were again stopped because of the low price of iron. The difficulties in which the company found itself were adjusted in 1887. Reorganization with a paid up capital of $1,500,000 took place; the old plant was discarded, and a new one constructed in 1888. This was blown in and put into operation in October. Mr. W. S. Ladd became president, Martin Winch, vice president, and J. Frank Watson, secretary.

The new blast furnace of 50 tons daily capacity was 60 feet high, bosh diameter 13 feet, had 6 tuyeres, and water cooled bosh. It was equipped with three Whitwell hot blast stoves 15 feet by 75 feet; a Weimer blowing engine of 800 horsepower furnished blast. Boilers and stoves were fired with waste gas from the furnace. The complete plant represented the latest development in furnace design. Fuel, as before, was charcoal, made in 36 beehive kilns, 30 feet in diameter and 13 feet high, located near the plant. A new mine 2½ miles away was opened to supply local ore, and in addition some magnetite ore from Redonda Island, British Col-

umbia, was later imported for use as a mixture with the limonite. A Davis-Colby kiln was used for calcining and roasting part of the ore. In addition to producing pig iron, the company manufactured cast iron pipe in a foundry having a capacity of 25 tons per day.

This plant received its first charge on October 17, 1888, and produced pig iron until 1894, the banner year being 1890, when 12,305 tons were made. Production then declined. In 1894 the operation was suspended and virtually abandoned, thus closing the record of Oregon's activity as a producer. The total output from 1867 to 1894 was 93,404 net tons, equivalent to 83,400 gross tons of pig iron.

The record of production, so far as can be determined from available sources, is as follows:

1867)	
1868)	2,400 net tons
1869)	
1874	2,500
1875	1,000
1876	1,750
1877	— —
1878	1,310
1879	2,500
1880	5,000
1881	6,100
1882	6,750
1883	7,000
1884	3,640
1885	3,832
1886	— —
1887	— —
1888	2,509
1889	9,426
1890	12,305
1891	10,411
1892	8,543
1893	5,308
1894	1,120
	93,404 net tons
	or 83,400 long tons

During the period of industrial activity following the declaration of war attention was directed to the possibility of reviving the former blast furnace operations at Oswego, at well as at Irondale, Washington. The Oswego furnace was acquired by the Pacific Coast Steel Company on June 22, 1917, but nothing was done to place the plant on an operating basis, probably because of the high cost of assembling the necessary raw materials for pig iron production. Only part of the former installation now remains, and, except for its historical interest, the furnace has no practical value.

A rolling mill for the production of bar, band, and hoop iron was put into operation in September 1892 by the Portland Rolling Mills at Portland. It later passed into the hands of the Pacific Hardware and Steel Company, and subsequently abandoned. The organization was acquired by the Seattle Steel Company of Seattle in 1904, and the plant dismantled about 1917. Later, in 1918, the Pacific Coast Steel Company began the construction of a new steel plant and rolling mill. One open-hearth furnace was installed, but the rest of the construction was halted, and the plant left incompleted.

The history of the various attempts to make iron in Oregon indicates the difficulties, technical and commercial, which the various enterprises faced. The modern requirements of large resources of high grade ore, coking coal, and limestone easily accessible and close to cheap transportation facilities, could not be met by the venture at Oswego. Under these handicaps, no iron plant could long survive.

California

After the furnace at Oswego, Oregon, had been completed and in operation, attention was directed in California to the establishment of an iron plant at Clipper Gap, near Hotaling post office, in Placer County, to utilize the iron deposits at that place. As early as 1868 plans were made for the erection of a furnace to test the ores from this deposit, but no construction appears to have been carried on until 1879 or 1880. The furnace, a stone stack 45 feet high by 10 feet hearth diameter with closed top, employing hot blast, and using charcoal for fuel, was blown in April 24, 1881. Local bog and magnetite ores and limestone were used, and foundry pig iron produced. The furnace was rated at 12,000 net tons annual capacity. The California Iron and Steel Company

under the direction of A. P. Hotaling, Irving M. Scott, and Egbert Judson, managed the enterprise.

In 1882, after producing 987 tons of pig iron, the plant was partially destroyed by fire, but was rebuilt the following year, and produced 5,327 tons. This was the best year of this enterprise as the output declined in 1884. The furnace was shut down from October 1884, to February 1886, then blown in for a small production to utilize accumulated stocks of ore and charcoal, which terminated the activities at this plant.

The total reported production in net tons is given below:

1881	4,414
1882	987
1883	5,327
1884	2,157
1885	— —
1886	1,750
Total	14,635

This iron was all consumed around San Francisco. The record was brief and the production extremely small. The venture failed because of variable markets, the low price of iron, and competition of coke iron brought from the east and from Scotland. An important factor in preventing further development of a blast furnace industry in California was lack of coking coals and the high price of charcoal.

No other attempts were made to revive the pig iron industry until 1906 when the Noble Electric Steel Company contracted to build a furnace of the Heroult type for the direct production of pig iron by eletcric smelting methods in Shasta County, 8 miles from Kennett, to ultilize the magnetite deposits on the Pitt River. This furnace was ready to operate in July, 1907. Experimental work was carried on and a small amount of pig iron was produced, but in 1908 a new type of furnace was built because of difficulties in operating the first type built. This operated over a period of several years until 1914 when the project was abandoned as a pig iron operation and attention focused on the manufacture of ferro-alloys.

In 1924, Mr. D. E. McLaughlin, vice president of the Pacific Coast Steel Company, and some of his associates organized a syndicate to develop a blast furnace plant in Southern California. At

the present time investigations are being carried on, but no decision has yet been made regarding final plans.

The operation of rolling mills was begun very early in California. The Pacific Rolling Mill of San Francisco started on July 25, 1868, and produced bar, angle iron, shafting, spikes, bolts, railroad and ship forgings from puddled iron. Steel rails were later rolled from purchased blooms, and in 1884 a 30-ton open-hearth steel furnace was built, from which steel was produced on July 15, 1884. This was the first steel produced on the Pacific Coast.

Many other organizations built rolling mills in the period from 1881 to 1884, contemporaneous with the Clipper Gap pig iron operation, some of which have continued to this day, but the greater number of these plants did not long survive. In recent years California has seen a great development of plants for the manufacture and the rolling of steel. The state has great potentialities in this activity and is the leader in the production of rolled steel products on the Coast.

Washington

The history of iron and steel development in Washington begins in territorial days with the organization of the Puget Sound Iron Company in 1880. The leading figures were Californians interested in the lumber business and in the steamship trade between Puget Sound and California ports. The principal shareholders were John A. Paxton; J. H. Redington; Hinckley, Spiers, and Hayes; Pope and Talbot; H. L. Dodge; G. W. Prescott; A. Chabot, and J. G. Kellog. Cyrus Walker was president. Some Port Townsend men were also concerned in the inauguration of the enterprise.

The plan seems to have had its origin in the fact that bog iron was known to occur in the Chimacum Valley near Port Townsend; plenty of timber was available for charcoal; the vicinity of Port Townsend was regarded as a logical assembling and shipping point for an iron industry. The backers of the project were engaged in timber, lumber, and in shipping enterprises in the Pacific Northwest, and iron was a logical addition to their interests, particularly in view of the demand for iron and steel products in the growing Coast cities to the south.

The first furnace, built at Irondale, blown in on January 27, 1881, was an open top stone stack, 38 feet by 9 feet, using hot blast, and having a capacity of 4000 tons per year. During 1881 it produced 1200 tons of pig iron, but after operating a few months

the decision was made to tear it down and erect a new furnace. In 1882 a 50-ton furnace was erected; this was remodelled in 1884 after certain difficulties had arisen in its operation because of the refractory nature of the ores used. The dimensions of this furnace were as follows:—height 50 feet; bosh diameter 11 feet; crucible diameter 5 feet; diameter at stock line 8 feet. The furnace was of steel construction representing the latest practice of the time and had an estimated capacity of 30 tons a day or 10,000 tons per year. A Player hot blast stove containing 60 pipes; boilers; blowing engines; charcoal ovens and accessories completed the equipment.

The Chimacum bog ores on which the first furnace started to operate were limited in quantity and of low grade. Because of this, other sources of ore were investigated. A magnetite deposit on the west coast of Texada Island, British Columbia, had been discovered about 1870. This deposit offered great promise of a supply of high grade material, and arrangements were made with the owners of this property to furnish ore to be used as a mixture with the local limonite. A lease was secured and several thousand tons were shipped from the Paxton Mine to Irondale. Later, the property was purchased by the Puget Sound Iron Company, which still retains title to the principal iron holdings in Texada Island. Charcoal made at the plant was used exclusively for fuel.

In 1881 the original company transferred all its interests to a new organization incorporated in California, and the head office was moved to San Francisco. The old name, Puget Sound Iron Company, was retained. The officers from 1882 to 1884 were residents of San Francisco. John A. Paxton, president; John H. Redington, vice-president; C. H. Simpkins, treasurer; and A. Halsey, secretary, were the directing body. No iron was produced in 1882 during the period of construction of the new stack, and only a small quantity in 1884 when the furnace was under reconstruction. Production was very irregular and sporadic during the next few years as the table of production will show. In 1889, the maximum production, 10,371 tons, was reached.

The annual production of charcoal iron in net tons, reported by the United States Geological Survey, is given below:

1881	1,200
1882	— —
1883	2,317
1884	540

1885	1,857
1886	2,842
1887	1,586
1888	4,093
1889	10,371
Total	24,806

The plant was closed in 1889 because the operations, conducted with the crude machinery then available, were not profitable. However, the quality of iron produced was very high. It is reported that the number one grade of Irondale pig iron was as fine as any charcoal iron made in the country. This iron was widely used in foundries and shops in California, and some was used in the construction of parts of the cruisers Charleston and San Francisco and the battleship Oregon, built during the years from 1887 to 1893 at the Union Iron Works in San Francisco.

Although the direct production of pig iron languished during the years from 1889 to 1902, the demand for manufactured material led to the building of a small mill for rolling iron merchant bar at Lakeview, near Tacoma, under the ownership of Richard Brown. The rolling equipment came from a dismantled plant at Burlington, Iowa, formerly operated by the Holcomb-Brown Iron Company. The Lakeview organization, known as the Western Iron and Steel Company, was incorporated in 1894 and began rolling operations in May, 1895, but it was not a success. Judge E. M. Wilson, now president of the Pacific Coast Steel Company, then a resident of Youngstown, Ohio, was sent to Tacoma in 1896 to straighten out the legal difficulties which had arisen. He remained at Lakeview and took charge of the operation as president and general manager.

About this time, 1901 or 1902, Mr. William Pigott had purchased a small mill and had acquired a site on land across from Seattle beyond the west side of the Duwamish River, where the present plant of the Pacific Coast Steel Company is located. He took preliminary steps to erect the mill with the expectation of rolling iron and steel products, but stored the equipment temporarily while negotiating with the Lakeview organization to remove its plant to Seattle. Judge Wilson was induced to do this and consolidated his interests with those of Mr. Pigott. Accordingly, the Seattle Steel Company was incorporated on November 23, 1903, with Mr. Wilson as president and Mr. Pigott as vice-president,

and operations were begun on the site selected by Mr. Pigott, now known as Youngstown.

The further history of this enterprise will be discussed at this point although chronologically it overlaps later developments. The Seattle Steel Company's plant was built in 1904-1905, and was first put into operation on May 6, 1905. The equipment consisted of six iron bushelling furnaces, five heating furnaces, and three trains of rolls, 9-inch, 12-inch, and 16-inch—the 12-inch mill representing the equipment purchased by Mr. Pigott, the 9-inch and the 16-inch mills the installation at Lakeview. In 1904, shortly after its incorporation, the Seattle Steel Company acquired the rolling mill at Portland, Oregon, and ultimately dismantled it. The Pacific Coast Steel Company of California, organized by Dr. D. P. Doak and incorporated on May 13, 1909, had built a new open-hearth steel plant and rolling mill at South San Francisco. This organization entered into negotiations with the Seattle enterprise which led to a merger of the two companies on July 15, 1911,—the consolidation retaining the name Pacific Coast Steel Company. The products made during the earlier years of operation at Youngstown were bar iron, flats, rounds, squares, and rerolled light steel rails. The first open-hearth furnace for the production of steel at this mill was completed in 1915, after the purchase of the Irondale plant and its equipment from the Western Steel Corporation. Subsequently, three additional open-hearth furnaces were built, and the rolling mill equipment increased. Today, this plant produces steel products only.

The Irondale project lay dormant from 1889 to 1900, when Mr. Homer H. Swaney of Pittsburgh became interested in the venture. He made an investigation of the iron smelting situation on the Pacific Coast, and became impressed by its possibilities. The Puget Sound Iron Company plant was taken over; various iron claims in British Columbia at Sechart, Sarita, and Sooke Harbor were acquired; a lease on the Texada Island property was secured; and eastern engineers were called in to pass on various matters connected with the new enterprise. Mr. E. V. D'Invilliers of Philadelphia made an examination of coal, iron, and limestone properties in British Columbia and Washington in May 1900. The Wellman-Seaver Engineering Company of Cleveland, Ohio, was engaged in September in connection with the metallurgical problems involved in rehabilitating the plant. Mr. J. H. Cremer, their engineer, made a study of the furnace plant at Irondale as

well as of several of the iron properties in British Columbia and Coal properties in Washington. In connection with his investigations, Mr. Cremer caused by-product coking tests to be made of Wilkeson coal at the plant of the United Coke and Gas Company at Otto, Pennsylvania. Later, in 1902, Mr. Horace V. Winchell, acting for New York interests, reported on the iron ores of the North Pacific area and their availability for pig iron manufacture.

The organization, formed in 1901 with Mr. Swaney as vice president to take over the Irondale plant, was called the Pacific Steel Company. Under its management the furnace was relined to give a stack height of 60 feet, a bosh 12 feet in diameter, and a 6 feet crucible; an additional stove and boiler were added; various repairs made; and the plant put into operation on December 15, 1901. The changes in the furnace increased its potential capacity to 60 tons of iron per day. Texada Island magnetite ore mixed with a small percentage of ore from Hamilton, Washington, constituted the charge. The limestone used came from Roche Harbor. An attempt was made to use coke from Cokedale in Skagit County, but the fuel did not prove satisfactory. Further tests were made with mixtures of coke and charcoal, but the coke was too poor in quality and its use was abandoned in favor of charcoal alone. This charcoal was made at the plant in a battery of 20 kilns each 30 feet by 30 feet in size. It must be remembered that the entire project was regarded as an experiment to determine whether iron could be successfully produced in the Pacific Northwest.

The results of the trial tests at Irondale, extending over a year, during which time something over 6000 tons of pig iron were made, proved that iron of good quality could be manufactured. Production continued on a small scale until 1903. The product was used by foundries and machine shops along the coast from Alaska to Southern California, and pronounced to be first-class. As a matter of historical interest, some of the iron was used in the engines of the battleship Nebraska built during 1902 to 1904 at the shipyard of Moran Brothers in Seattle. The success of the experimental operation led to ambitious plans for the upbuilding of the iron plant, and expansion into steel production.

The Seattle Iron and Steel Company was projected and incorporated in 1903 to take over the properties and plant of the Pacific Steel Company, enlarge the blast furnace at Irondale, and at a proposed site in Seattle to erect basic open-hearth furnaces,

rolling mills, and a modern 250-ton blast furnace. The authorized capital stock was $6,000,000, in addition to which $2,000,000 were to be raised by the sale of bonds. Mr. Swaney's name headed the new organization, and a board of trustees made up of leading business men of Seattle was created. Mr. Swaney continued his activities in acquiring properties and perfecting plans for the new company, and was engaged in this activity when he lost his life in the wreck of the steamer Clallam on January 9, 1904. His death resulted in the cessation of all the activities of the Pacific Steel Company and of its proposed successor the Seattle Iron and Steel Company. One of the factors or causes which contributed to the failure was an over-ambitious attempt to acquire iron ore properties, real estate, rolling mills and other facilities much in excess of the needs of the project. The time had not arrived for activity on so large a scale; the program was top-heavy, and collapse came with the loss of the prime mover in the enterprise.

Following the failure of the plans of the Pacific Steel Company and the Seattle Iron and Steel Company, other attempts were made to revive the project. In September, 1906, the Irondale plant was bought by Mr. James A. Moore of Seattle for $40,000 at a court sale. After certain alterations and renovations made by the Wellman-Seaver-Morgan Company in 1906, which increased its capacity to 80 tons, the furnace was put in blast in 1907. The operating organization at this time was known as the Irondale Furnace Company. A small amount of pig iron was produced in 1907 and in 1908, but the existing financial depression reduced the market demand, and the furnace was shut down. No iron was produced in 1909.

In the meantime, on October 2, 1909, the Western Steel Corporation, capitalization $20,000,000, was organized with Mr. Moore as president. This company made pretentious plans for steel furnaces and mills as adjuncts to the blast furnace plant; purchased coal properties in Washington and in British Columbia; iron ore deposits in Washington, British Columbia, and Nevada; limestone and dolomite areas in Washington; magnesite in British Columbia; and entered into a very favorable contract with the Han Yeh Ping Iron and Coal Company of Hankow, China, for a supply of iron ore and of pig iron to supplement the supply from its own operations.

The furnace was again blown in during the spring of 1910. The first cargo of Chinese ore and pig iron arrived at Irondale on

July 1, 1910, on the steamship Riverdale under charter by the Robert Dollar Company. A total of 25,000 tons of ore valued at $47,750 was imported during the year. The furnace charges consisted of two-thirds Chinese ore with one-third of local ores from the Northwest. The old charcoal kilns were abandoned, and coke from Pierce County purchased for fuel pending the building of ovens proposed to coke coal from Graham Island, British Columbia, and from Ashford, Washington. The blast furnace operation did not continue after 1910.

The pig iron made locally, together with the Chinese pig iron, was used with scrap in open-hearth furnaces to produce steel, which was subsequently rolled into billets and finished shapes. The pig iron and steel produced were of good quality,—again demonstrating the metallurgical and technical success of the operations. But, history repeated itself. The company became insolvent, and the plant was closed in 1911. Various explanations have been given of the failure; the leading causes involved the acquisition of of too many undeveloped iron and coal properties of uncertain value, ventures into real estate promotion at Irondale, plant construction in excess of existing market demands, and insufficient capital to carry through the pretentious program of the backers of the enterprise.

The Western Steel Corporation passed into the hands of receivers; the various holdings of iron ore, coal, and limestone properties were disposed of, and the physical plant at Irondale was sold to the Pacific Coast Steel Company in 1914. The open-hearth furnace and rolling mill equipment were later removed to the Seattle plant, and the blast furnace was allowed to fall into disrepair. In 1917 the scarcity and the high prices of pig iron on the Pacific Coast led the Pacific Coast Steel Company to rehabilitate the old furnace and undertake the production of pig iron as a war emergency measure. Accordingly, the furnace was blown in on September 10, 1917, and operated fairly continuously until February 27, 1919. The Chinese and other ore remaining from the shipments made in 1910 and 1911 by the Western Steel Corporation, together with additional ore supplies from British Columbia, mill cinder from the rolling mills at Lakeview and Seattle, limestone from Roche Harbor, and coke from the Wilkeson-Carbonado field in Washington were used during this period. The production was 22,316 gross tons of iron, made up largely of basic pig iron for open-hearth operations and a small amount of foundry iron for

special requirements. The operation was costly, and was discontinued when the supplies of old raw material on hand were used up, as no cheap sources of new material from the Northwest had become available on which to continue production even under the stress of war demands.

During the later intermittent operations of the Irondale furnace, it is estimated that 6,000 tons were made during 1902 and 1903 under the regime of the Pacific Steel Company, and 10,000 tons when the plant was running under the diretcion of Mr. James A. Moore in 1907, 1908, and in 1910. The production from September 1917 to February 1919 made by the Pacific Coast Steel Company was practically 25,000 net tons, an amount equal to the total output of the same plant from 1881 to 1889. The total contribution of the Irondale furnaces is approximately 66,000 net tons.

The history of pig iron manufacture in Washington closes with the shut-down of the Irondale furnace in 1919. Nothing now remains of the plant except a shell, a few dilapidated wooden structures, and the slag heaps built up at various periods since 1881.

The possibilities of engaging in the blast furnace industry in Washington have occupied the attention of various individuals and groups over the period covered by the Irondale operations. There is no question that the iron resources of Washington and of the Pacific Coast in general were largely over-estimated in the early days of development and growth in this area. The period of active mining in the Mesabi region, the growth of the size of blast furnace plants, and the great expansion of the steel industry due to industrial demands of the Atlantic seaboard had not yet arrived. The early investigators and promoters based their comparisons on the conditions existing in the Appalachian region, where small furnaces operating on local supplies of ore met the demands of pig iron for the cities near them. Population and industries to absorb a large output of pig iron was lacking on the Pacific Coast; in addition the activities and the interests of the people were largely along other lines than manufacturing. Yet, a demand existed for iron and steel products, obtained largely by shipment from the eastern centers of production. Under these circumstances, it was natural to expect great interest in the potentialities of an iron industry which should be one of the factors in building up the new empires along the Pacific Ocean.

Following the inception of the Irondale project, it was report-

ed in 1882 that an English company under the name of the Tacoma Iron and Steel Company was projecting a blast furnace plant at Tacoma. The iron ores at Hamilton in Skagit County and the coking coals in Pierce County were to supply the plant. Litigation over title to the iron properties, and other difficulties ended this project.

English capital was again reported to be interested in 1886, when announcement was made that the Moss Bay Hematite Iron and Steel Company of Workington, England, had decided to remove its plant to Washington. This was brought about through the activities of Mr. Peter Kirk, a representative of that firm, who had arrived on the Pacific Coast a short time before in connection with the sale of rails to the proposed new railroad from Seattle to Spokane, known as the Seattle, Lake Shore, and Eastern Railway. The initial intent was to build the line from Seattle through to Snoqualmie Pass to secure the freight on the coal, iron, limestone, and timber immediately tributary. The Denny iron mine at Snoqualmei Pass had been investigated and reported upon, and it was the general belief that large tonnages of ore would be available.

Mr. Kirk had become interested in the possibilities of manufacturing iron and steel near Seattle. In this activity he was encouraged by the owners of the Denny and other properties along the western and the eastern slopes of the Cascades near the projected line of the new railroad. Kirk studied the project for two years, and was joined by W. W. Williams who had come over from England to participate in the investigation. The Denny properties were leased to him for 45 years, one of the conditions being that the proposed iron industry should be located in or near Seattle. In 1887, Kirk was working on a possible plant site at Salal Prairie, near North Bend; prospecting iron deposits near the Pass; and investigating coking coal deposits on Snoqualmie Mountain south of Preston, and north of Green river near Kangley. The results of the study of the iron and limestone deposits appears to have been satisfactory, but the matter of the coal supply was not settled, largely because the deposits nearby did not make as good coke as those in Pierce County near Wilkeson.

The Moss Bay Iron and Steel Company of America was finally organized in 1888 with a capital of $5,000,000. Peter Kirk was president, H. A. Noble, treasurer, and W. W. Williams, secretary. The investigations by Peter Kirk of the distribution of the basic resources led to the selection of a site on Lake Washington,

whose plat was filed on November 2, 1888, and which was named Kirkland in his honor. The reported intention of the company was to establish at this place the greatest iron and steel plant on the Pacific Coast. The company failed, however, and was succeeded in May, 1890, by the Great Western Iron and Steel Company, capitalized at $1,000,000 and officered by Seattle men. The leading stockholders were eastern men, among whom were General Russell A. Alger, Detroit; Joshua N. Sears, Boston; Hon. J. B. Fassett, Elmira; H. A. Noble, Des Moines, and the following local representatives: A. A. Denny, Columbus T. Tyler, Edward Blewett, Jacob Furth, L. S. J. Hunt, Bailey Gatzert, and Peter Kirk and W. W. Williams of the original English group.

During this period effort was centered in developing the iron ores and in building a furnace plant at Kirkland. The project of the earlier company had been delayed; the new company now proposed to spend $1,000,000 in construction of the plant. Shops were begun, fire brick was ordered from England, and it was planned to begin construction of the blast furnace as soon as the structural material should arrive from England. On August 10, 1891, the ship Malcolm King reached Seattle from Maryport, England, with the English fire brick, but something had occurred which halted the work, and the bubble burst before construction of the furnace was begun. Thus, the Kirkland boom died.

The name of Mr. James J. Hill of the Great Northern Railway is frequently mentioned in connection with the question of iron ore resources and blast furnace construction in the Pacific Northwest. As nearly as can be learned, Mr. Hill first looked into the situation about 1886 or 1887 because of the interest of English capital in the matter of renewing operations at Irondale or in building a new blast furnace and steel plant to supply steel billets for a demand then existing in Japan. Several engineers were sent to the Coast. They made an extensive survey of the deposits in British Columbia, but were not satisfied that a sufficient tonnage of ore had been developed to justify any continuous basis of operation. The plans of the English group were accordingly given up. Later, when the Great Northern Railway reached Seattle, Mr. Hill's engineers made another survey without favorable results.

Enthusiastic owners of ore deposits and promoters of iron and steel plants arise every few years to keep the issue alive. Most of these have been of little moment except as a source of journalistic

activity. The most important effort was made in 1916 and 1917. A syndicate composed of William H. Crocker, Wellington Gregg, Jr., S. F. B. Morse, and B. L. Thane of San Francisco made extensive surveys and investigations of raw materials, operation cost, and markets. Negotiations leading to the financing of a corporation to construct blast furnaces and steel mills in the Northwest were carried on during the war period, and seemed to be progressing favorably when the armistice was signed. The change in the economic and industrial structure brought about by the close of the war altered the entire situation on the Coast, and caused the project to be abandoned.

In an effort to obtain the fundamental facts regarding the potentialities of the Pacific Northwest as a center for the production of pig iron, Mr. William Pigott of the Pacific Coast Steel Company sponsored an investigation in 1924 and 1925 of the feasibility of establishing a blast furnace plant on Puget Sound. In this study, the coking coal, the possibilities of by-product coking, and the supplies of limestone, in Washington were given careful attention, and the distribution of the resources of iron ore along the Pacific Rim which might be regarded as possible supplies for a local blast furnace plant were investigated. The results of the research bring out the fact that the state of Washington possesses the necessary coking coal and limestone in ample qauntities and of suitable quality for blast furnace operation. On the other hand, as already proved by the facts related in this history, considerable doubt exists regarding the adequacy of a supply of ore in the area immediately tributary to the Northwest Pacific Coast. No large bodies of ore have been developed on which a plant may be constructed with the assurance of continuous supply for operation over a period of years. However, the Orient, portions of the west coast of South America and of Mexico, and possibly California, possess deposits which at some time may become available as raw material for an industry in this state. Certain it appears, in spite of the failures of the past, that some day iron ore will be brought to Washington's deposits of coal and limestone, and a blast furnace plant will be built to yield a stream of pig iron for the hungry needs of industry. The technical and metallurgical phases may be regarded as settled, for the product made in the past was eminently suitable for all requirements and was of high quality. The future day depends on the progress of manufacturing activity and on economic

necessity and law rather than on the vain ambitions of man.

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