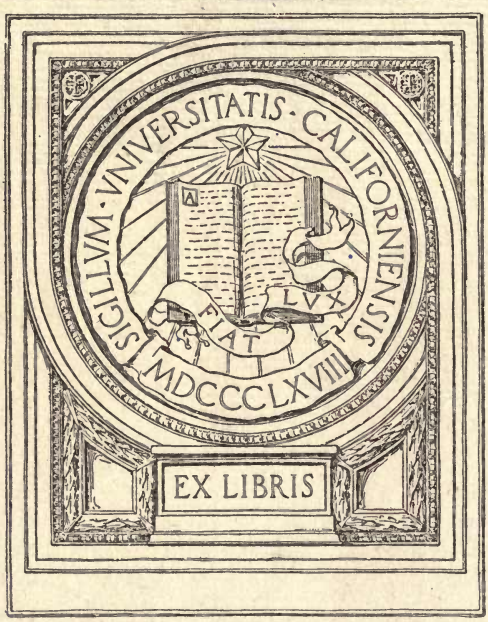
Fifty Years of Iron and Steel

JOSEPH G. BUTLER JR



FIFTY YEARS
OF
IRON AND STEEL

Fifty Years of Iron and Steel

BY

JOSEPH G. BUTLER, JR.

An address delivered at the Thirteenth General Meeting of The American Iron and Steel Institute in Cincinnati, Ohio, October 26, 1917, together with additional data concerning the early use of iron and steel and also a brief historical reference to the formation and organization of the United States Steel Corporation, embellished with portraits of men who have been and are now most distinguished in the development of American Iron and Steel Industries, and interesting reproductions and illustrations depicting the earlier conditions in these industries.

THE PENTON PRESS
CLEVELAND
1918

Two Hundred and Fifty copies of this edition
have been printed of which
this is number
258

Presented to the University
of California with Compliments
of
Leo G. Bullock
Mar 4. 1930

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INTRODUCTION

By JOHN A. PENTON

TO HAVE lived during a period of over sixty years of the world's greatest accomplishment and to have been an eye-witness especially of the great development in this country's iron and steel industry, should be almost glory enough.

To have been, during this period, an active factor in this constructive work, at all times taking a leading part in all of the industry's activities, makes the author of this paper a unique figure among American men of affairs—men who have done things. To have been an eye-witness of iron and steel development from the conversion of the first barrel of Lake Superior ore to a period when over sixty million tons come down the Lakes and other millions are smelted in the Upper Lake region, is something few have experienced.

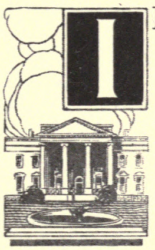
To have been connected with the pig iron industry when only six hundred thousand tons were made a year and be still connected with it when nearly forty million tons have been produced in this same period, is an honor that probably no one else can claim.

And to have been in the industry contemporaneous with Sir Henry Bessemer, Andrew Carnegie, John Fritz, Edgar Thomson, and other great pioneers, and active long before the days of James M. Swank, E. H. Gary, Charles M. Schwab, James A. Farrell, Samuel Mather, W. L. Brown and other leaders of the present, and to be interested still in the steel production in a year when over forty-two million tons have been made, is something to talk about.

But to be able also to look cheerfully and optimistically into the future and expect to be on the job helping to make a hundred million tons of steel a year and to tell about it in a way to charm and hold the reader as these pages do—why what's the use—there is only one "Uncle Joe" in the steel industry.

Fifty Years of Iron and Steel

By Joseph G. Butler, Jr.

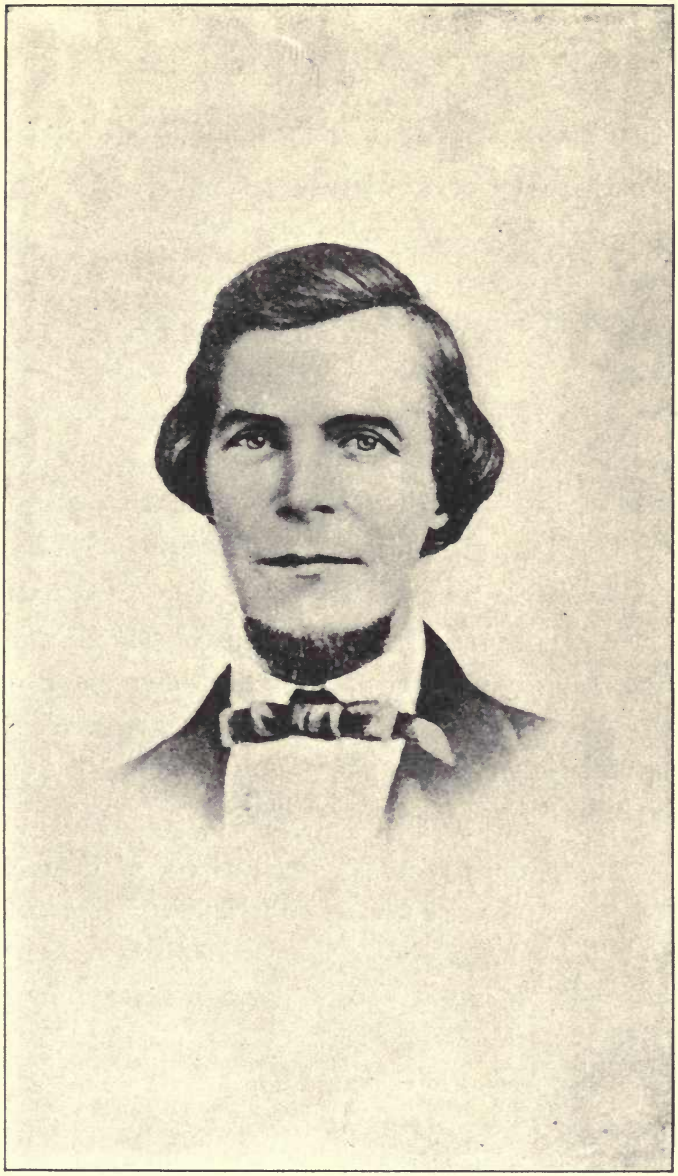


IN HONORING me with a place on your program, the Committee evidently regarded half a century as long enough for any man to be actively engaged in the iron and steel industries. As a matter of fact my experience in them covers a period of sixty years, for I became shipping clerk and assistant manager at the Iron Rolling Mill of James Ward & Company, Niles, Ohio, in 1857, after having spent three years as a clerk in the store connected with that enterprise, during which time I added to my accomplishments the musical art of speaking Welsh and also acquired the ambition to become an ironmaster.

These sixty years cover the greatest progress the world has ever known. They have brought forth so many startling discoveries, so many

striking inventions, so many achievements enriching and broadening human life, that merely to mention all of them would be a tedious task. Most of these were the work of American genius. They are the fruits of individual liberty and just reward for individual effort first known to the world after our forefathers had established freedom in enduring form upon this Continent. The mere contemplation of this progress should serve to remind us of our obligations at this time, when civilization is turning the sharpest corner in its history, and when the right of men to self-government and self-development is threatened as it has never been threatened before.

Sixty years ago there was no such thing as the steel business in America. The trifling production of "blister" steel, amounting to a few thousand tons per year, was not worthy of that designation, but the iron business had already laid the foundations of its future greatness, and this in spite of the fact that we had then comparatively no ores, no efficient fuel, no adequate machinery and very little of the practical and scientific knowledge so widely diffused today.



JAMES WARD

With William Ward and Thomas Russell, he Built at Niles in 1842, the First Rolling Mill in the State of Ohio.

MADE IRON WITHOUT COKE

When I entered the iron business, we made iron without coke—a task resembling that of the Hebrews who were compelled to make bricks without straw. We had what would now be considered no ore, for the chief supply was derived from an occasional pocket in the hills or gathered from swamps or the beds of creeks. We had no furnace tops, no blast stoves, no hot blast as we know it now, no metallurgists, and in the light of the present experience, no markets. We knew nothing of the value of gas, natural or manufactured, a fuel indispensable in the manufacture of iron and steel in large quantities, but we did have grit and energy—the determination to do our best, and the same pride in doing things that we have now.

There were some compensations, of course. The payrolls were not so large and we were not troubled with a shortage of cars to move our product. I recently came across a statement issued by the superintendent of the Ward furnace, operated under lease at Youngstown, about the time of my entrance into the iron business. It reads as follows:

Youngstown, Ohio, August 25, 1853.

Messrs. James Ward & Company,
Gents.

Below you have the furnace proceeds for last week:

		Charges	Coal	Ore	Lime			
Aug.	13	90	400	480	160	7½		
	14	84	"	"	"	7		
	15	87	"	"	"	7½		
	16	87	"	"	"	6½		
	17	84	"	"	"	7		
	18	84	"	"	"	5½	3300	
	19	81	"	"	"	6½	1500	
		597	118½	143	48	47½	metal 4800	casting

Our next payroll will amount to something like $200. We ought to have at least $20 in cash. Yours, etc., etc.

James Cochran, Superintendent.

PAID MEN IN GOODS

The payroll referred to was for one month. The cash was needed to give some of the men a little money for some special purpose. As a rule, they were paid in store goods. Among some other furnace records of these days I have seen an entry reading:

"Paid James Dobson six dollars to git married".

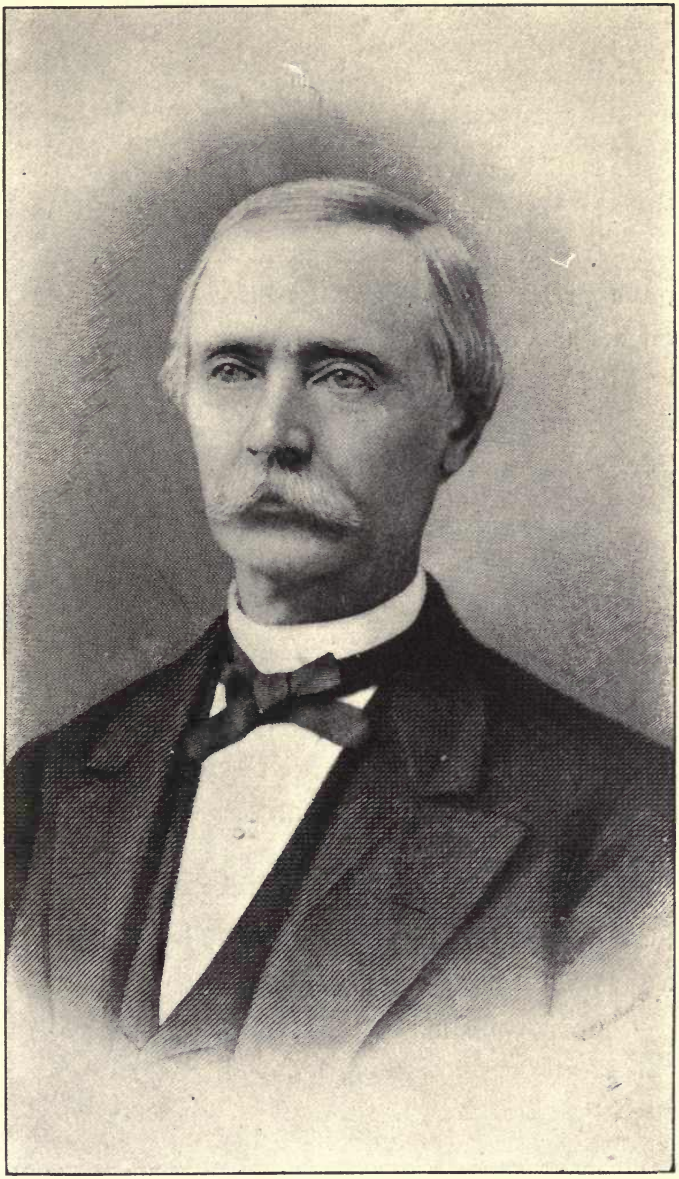
At some of the furnaces in that locality it was the custom to give the men a dollar in cash at Christmas and the Fourth of July. At other times they got along without any money. From

all of which it will be seen that many things, among them getting married and running a blast furnace, were done with less capital than at the present time.

There was at that time no thought of making steel at the ordinary iron works. The equipment consisted of one or more small heating furnaces, one or two trains of rolls, perhaps a forge fire or two, a few puddling furnaces and occasionally some machinery for making cut nails. The product was usually either simply pig iron, or merchant bars, a commodity which, by the way, has not changed its name in the whole 250 years since iron was first formed by forging into that shape.

BESSEMER PROCESS BEGINS ERA OF STEEL

The steel business was really born in America when the Bessemer process came into use here, which was not until about 1864. The idea of removing carbon and silicon from blast furnace iron in this way was undoubtedly first conceived by an American, although he failed to develop the machinery for its use, and, as a consequence, reaped very little benefit from it. When William Kelly, who first decarburized



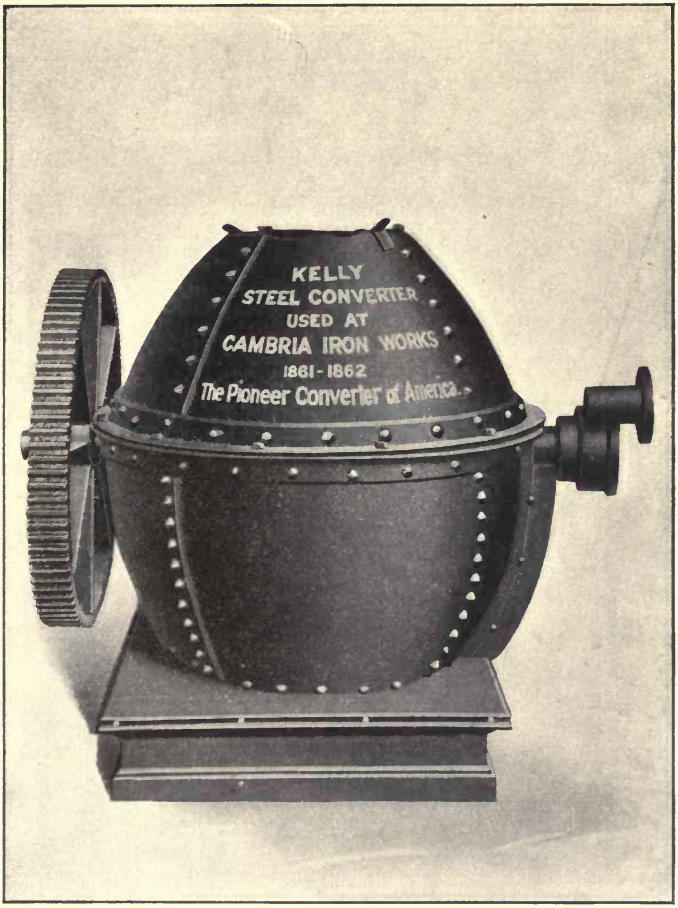
WILLIAM KELLY

Original Discoverer of the Pneumatic Process for Converting Iron Into Steel.

iron by means of an air blast in a furnace he had erected for that purpose at Eddyville, Ky., about 1850, came to file his claim for a patent in 1856 he found that Henry Bessemer had filed similar claims and been granted patents a few days previously. Kelly had worked for years on his scheme, which was identical in principle, but he had not yet made it a commercial success and did not attempt to make steel in that manner. Nevertheless, his use of the pneumatic process first was not disputed and he was granted an interference as against the Bessemer patent.

I can distinctly recall a visit made by this man to Niles while I was a member of the Ward family, being employed in the Ward store, about 1854. He came there to enlist the interest of James Ward, then regarded as an authority on the iron question, in behalf of his experiments, and was a guest at the Ward table on several occasions. How far he succeeded in his errand may be judged by the fact that Mr. Ward said after he left that he was crazy.

The invention of the Bessemer process, or rather its perfection and development, is generally regarded as the longest single step in the march of progress that has brought the iron



The First Pneumatic Converter Used in the United States. Photographed on the Lawn of the Cambria Steel Company Offices in Johnstown, Pa., Where it is Preserved as a Curiosity.

and steel industries to their present stage, but there are other discoveries that seem to me even more important. We cannot make steel without iron, and, therefore, of even more moment than this invention were such things as the discovery of the Lake Superior ore ranges, the invention of the furnace top, the use of coke and its economical manufacture, the development of high blast temperatures, and especially in view of its recent rapid adoption, the Siemens-Martin open-hearth furnace.

All of the various steps in these improvements have been made during the time in which I was greatly interested in them and it has been my pleasure and privilege to follow them closely and to know something of the trials and disappointments undergone by men who conceived and brought them to perfection, or rather to their present state; for it is entirely probable that future generations will continue the work with the same zest and at least part of the success that has attended it so far.

RECALLS MUSHET'S DISCOVERY

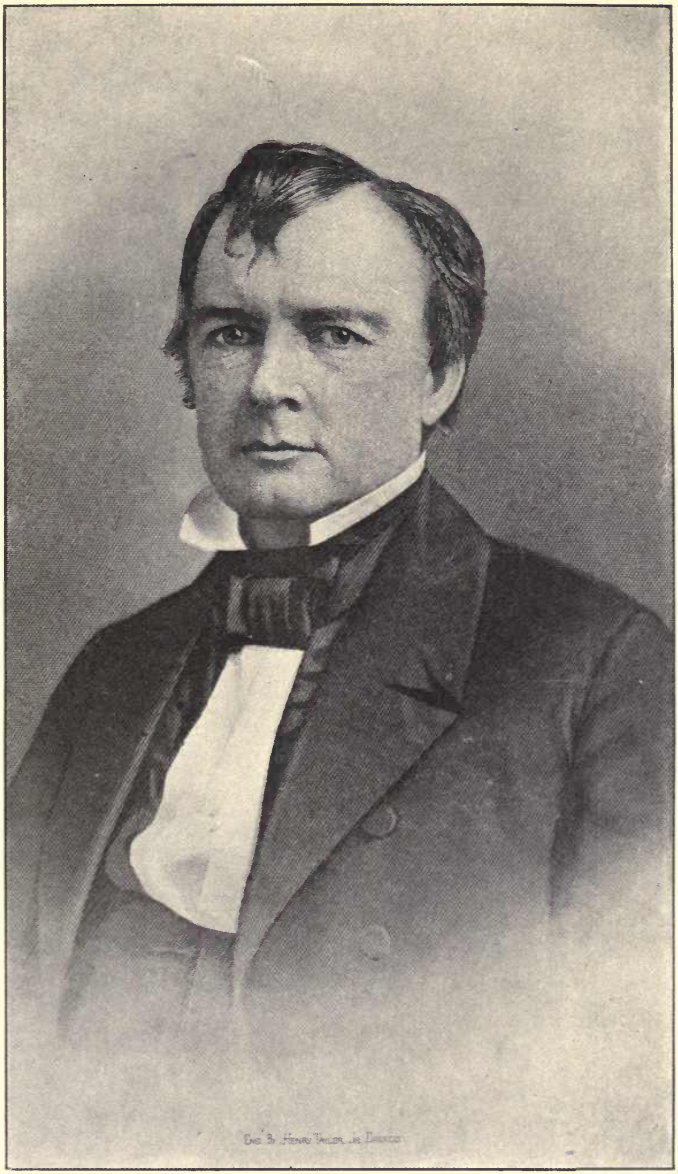
As has been stated, I met Mr. Kelly when he was trying to make his great discovery

SIR HENRY BESSEMER

For Whom the Bessemer Steel Process was Named.

a practical success. I saw him on a number of occasions later, when he was working to unravel the skein of litigation that tied up the Bessemer process and prevented its adoption in this country until ten years after it was patented here. I can recall the announcement in the technical journals of that day of the discovery by Robert Mushet, a Scotchman, that speigeleisen would recarburize iron blown in a converter and thus produce steel. We did not know of this in America for some time after Mushet's patents were granted in England, which was in the latter part of 1856. Up to that time Kelly did not suspect that he had found a new way to make steel, and had urged his process on iron manufacturers only as a cheap and rapid method of purifying iron for rolling mills, claiming that it would take the place of puddling — something it has, by the way, never done.

Likewise I was privileged to watch every step in the development of the hot blast. At the Ward furnace at Niles, and in other furnaces in the Valley, the blast was heated by passing it through cast iron pipes, and these lasted but a short time, their renewal and replacement keeping the local foundries busy and interfering

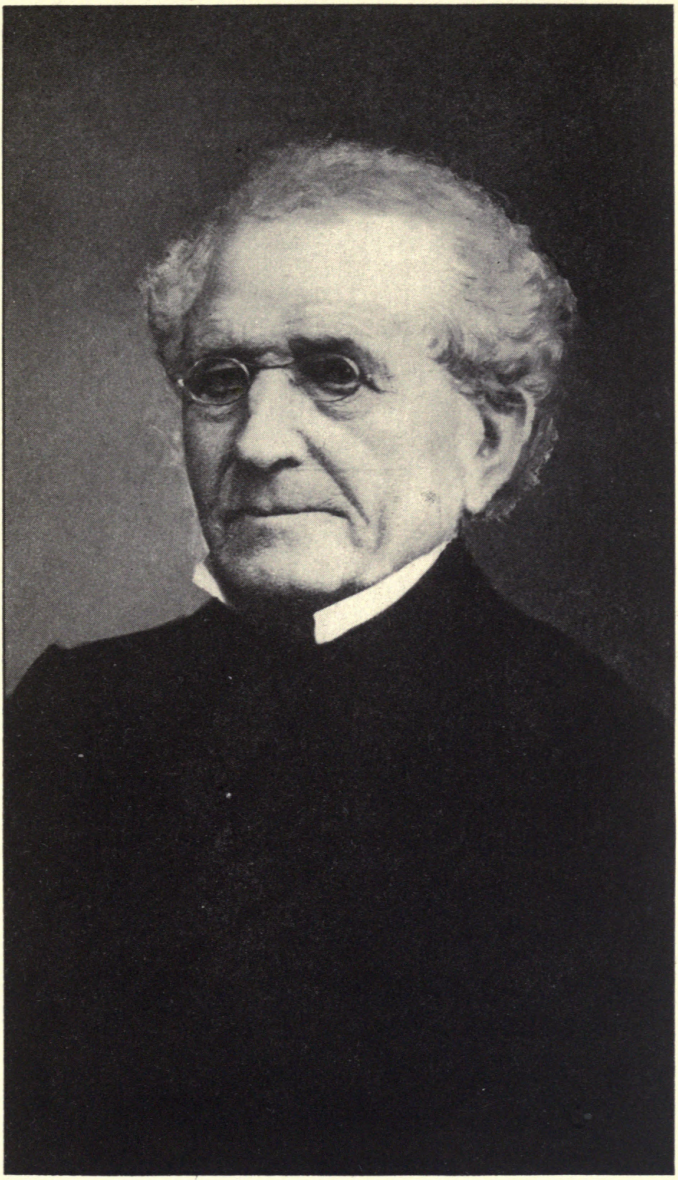


HON. DAVID TOD

Pioneer in the Manufacture of Iron and Mining of Coal in the Mahoning Valley. Pioneer Railroad Builder. Civil War Governor of Ohio.

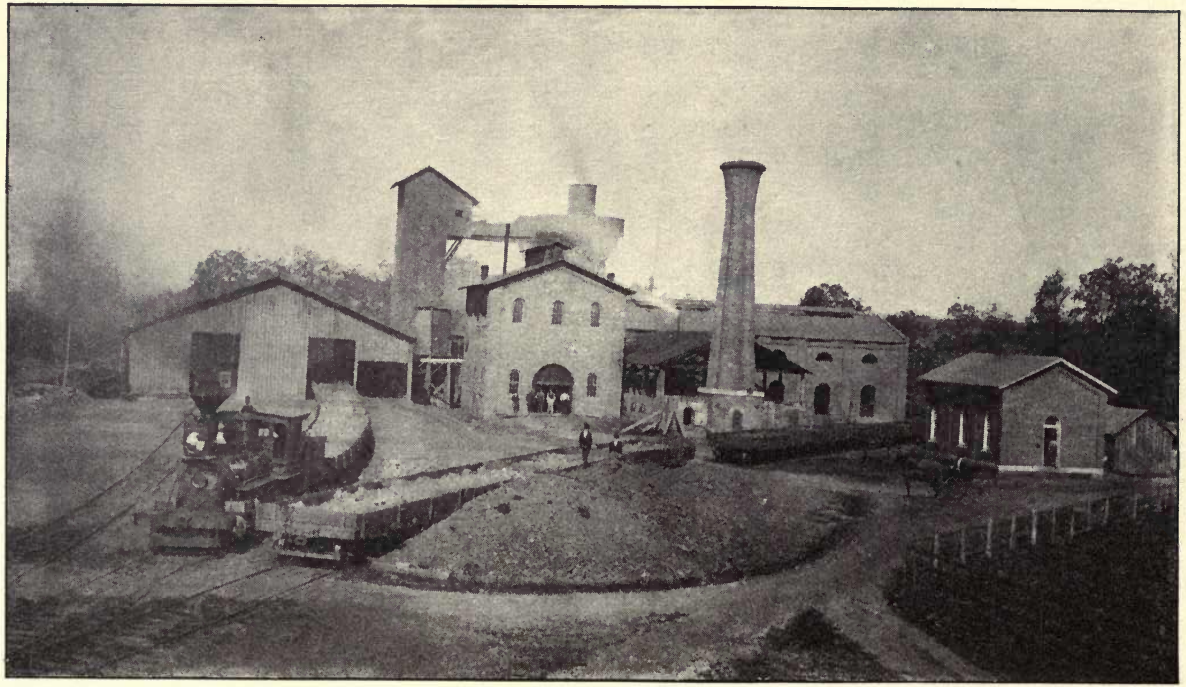
seriously with continuous operation. We had what we called a hot blast, but it was really only warm in comparison with modern practice. The furnaceman tested its temperature with lead and zinc, strips of which were inserted at the point where it entered the furnace. If the blast melted lead it was not quite hot enough, and if it melted zinc it was too hot, so we believed, and would burn the iron. Between the melting point of lead and zinc, as we now know, there is a very considerable difference, so that our wind varied about as much in temperature as it did in pressure. If you reflect that the blast in those days was blown usually by an engine that had been worn out on a Mississippi River steamboat, and that it was the usual thing for the men about a furnace to operate the walking beam when the engine broke down, you will have some light on the strength and steadiness of the hot blast of that day.

It was about 1868 that the Player hot blast stove was brought from England to this country. It was a decided improvement. This stove introduced an innovation in being located on the ground instead of at the tunnel-head. The first stove to employ the regenerative principle was



DAVID THOMAS

Inventor of the Thomas Hot Blast. Made the First Pig Iron with Anthracite Coal as Fuel.



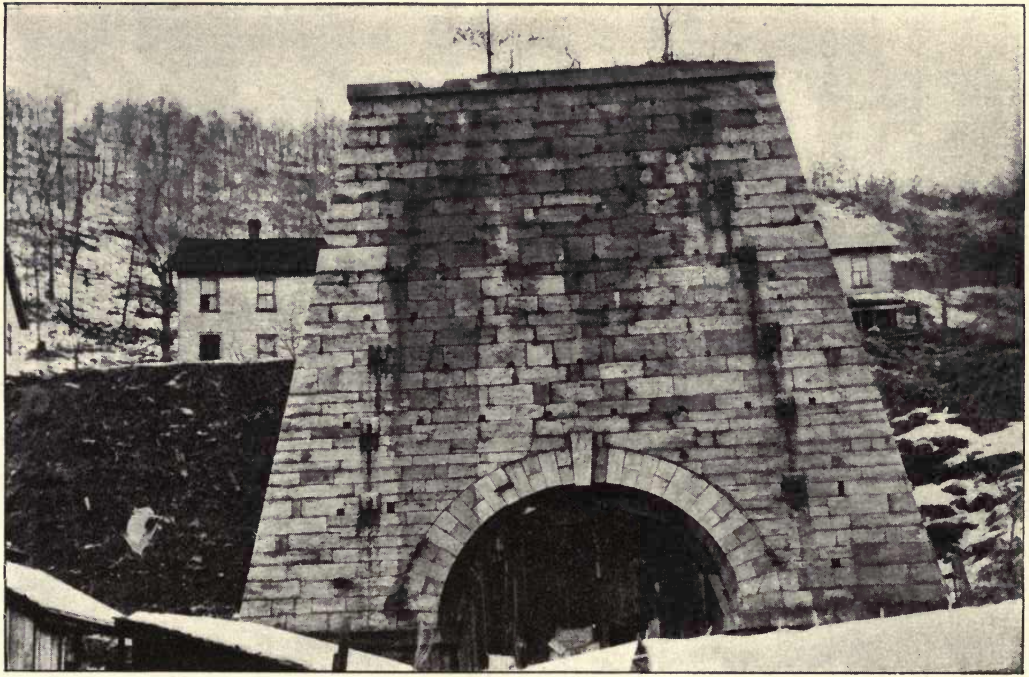
Old Spearman Furnace at Sharpsville, Pa., Now Shenango Valley Furnace Co.

the Whitwell stove, and it was lined with firebrick, also a new idea. Both it and the Player stoves immediately increased the output of furnaces and made larger stacks possible, although it was many years before they supplanted the old Thomas stoves at many American furnaces.

The use of furnace gas for heating the blast in this country we owe to the Germans, the first effort to bring these gases down and burn them under stoves and boilers in America having been made by C. E. Detmold, a German engineer, residing in New York about 1850. The new plan cost a good deal of money and was slowly adopted for that reason. We did not get to it in Ohio for some years after it was used in the East. I recall very distinctly the first furnace top installed at Youngstown. It was thought highly dangerous by the workmen, and there was at first some difficulty in getting them to work around the stack.

FURNACE SETS PRODUCTION MARK

With the use of better stoves and the introduction of more powerful blowing engines, furnaces began to grow in size and more attention



Iron Furnace Erected at Farrandsville, Pa., in 1830.

was paid to their lines. It was realized that much improvement could be made in the output, and progress in this direction was rapid. By 1875 it was known that blast furnaces could be operated successfully up to eighty feet in height, and, with coke for fuel and proper equipment for blowing and heating the blast, could be made to yield much larger product than had been expected up to that time. But it was not until about 1880 that one of these larger furnaces reached an output much above 100 tons per day. This was the Isabella, located at Etna, near Pittsburg. During three years — 1881, 1882 and 1883 — this furnace produced an average of 1090 tons per week — the best ever done by a blast furnace up to that time in this or any other country.

OLD STACKS PICTURESQUE

To those who have had experience only with the present day blast furnace and modern furnace practice, it is impossible to portray the conditions surrounding our industry at the time when I first became interested in it. The old stack of those days with its equipment, would be picturesque in the extreme if it could be set in

the vicinity of a modern steel works. The stack was usually about thirty-five feet in height and built of masonry, lined on the inside with a poor quality of fire-brick. It was square in section, on the outside, the bottom being about twenty-four feet each way and the top somewhat smaller, this depending on the ideas of the man who designed it. The stack was usually located against a bluff, the double purpose being to make construction cheaper by using the hill to reinforce one side and to enable a patient mule to perform the functions of a skip hoist by dragging the ore to the top of the hill. A short bridge connected the stockhouse with the stack and the material charged was wheeled from this point and dumped in at the open top.

Only one or two tuyeres were used, and these were often on the same side of the stack, next to the blowing engine. In front was the sand bed, into which the iron was run, and to one side the space reserved for roasting the ores. No water cooling devices were used except at the tuyeres and the opening in front. It was a very small proposition compared with what we are used to at this time, but was, nevertheless, a source of general public interest and regarded

SAMUEL M. FELTON

A Pioneer in the Manufacture of Steel. One of the Founders of The Pennsylvania Steel Company.

Old Furnace at Bailey's, in Pennsylvania.

with considerable awe by the uninitiated. I can recall the first furnace in our district whose builders had nerve to locate it away from a hill. They used a hoisting device in which a tank filled with water raised the platform on which two wheelbarrows loaded with ore had been placed. When the barrows were dumped they were wheeled back on the platform, the water was let out of the tank at the other end of the rope, and they came down to be refilled.

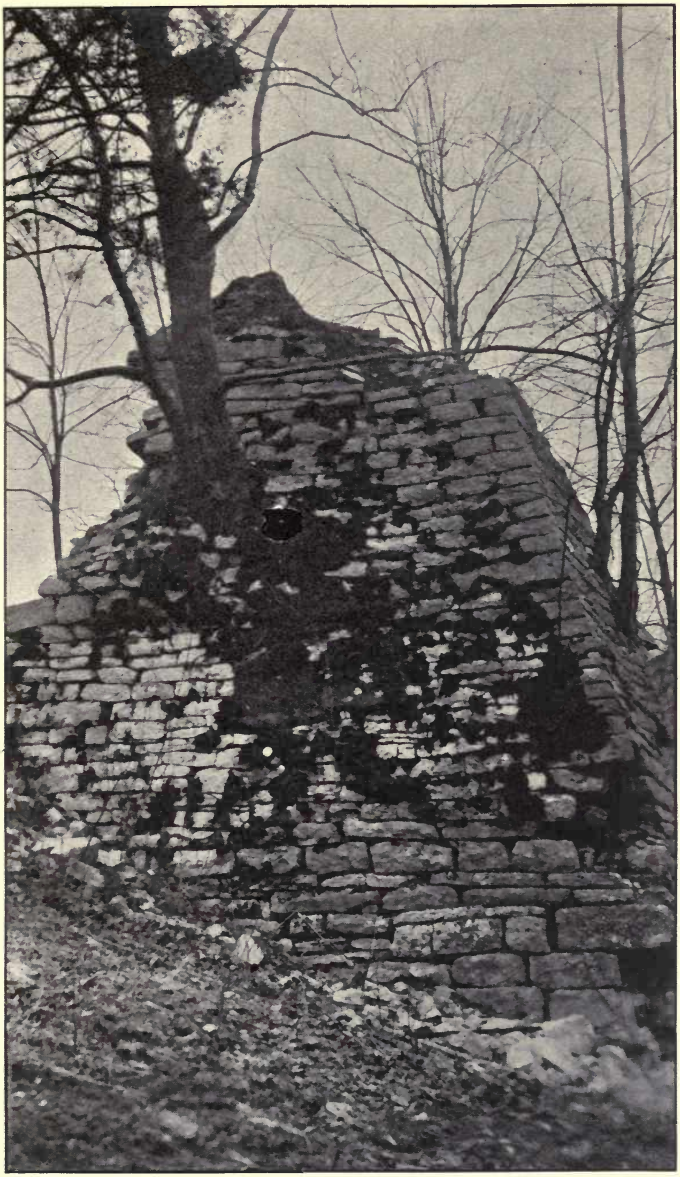
The blowing engines were of the crudest type and had but little power. There was then no method of gauging the pressure accurately and this was one of the cares of the furnace boss. He was expected also to know when the furnace was ready to cast, the proper color of the iron, and a great many other things. As a rule he did know these things better than might be expected, and these old furnaces made good iron even if they did not make much of it.

Even this type of furnace was a great improvement over those in use in that locality forty years earlier, for they used the "trompe" or water blast, which was, you may be sure, somewhat removed from the Gayley Dry Blast. This was a contrivance by which a waterfall was

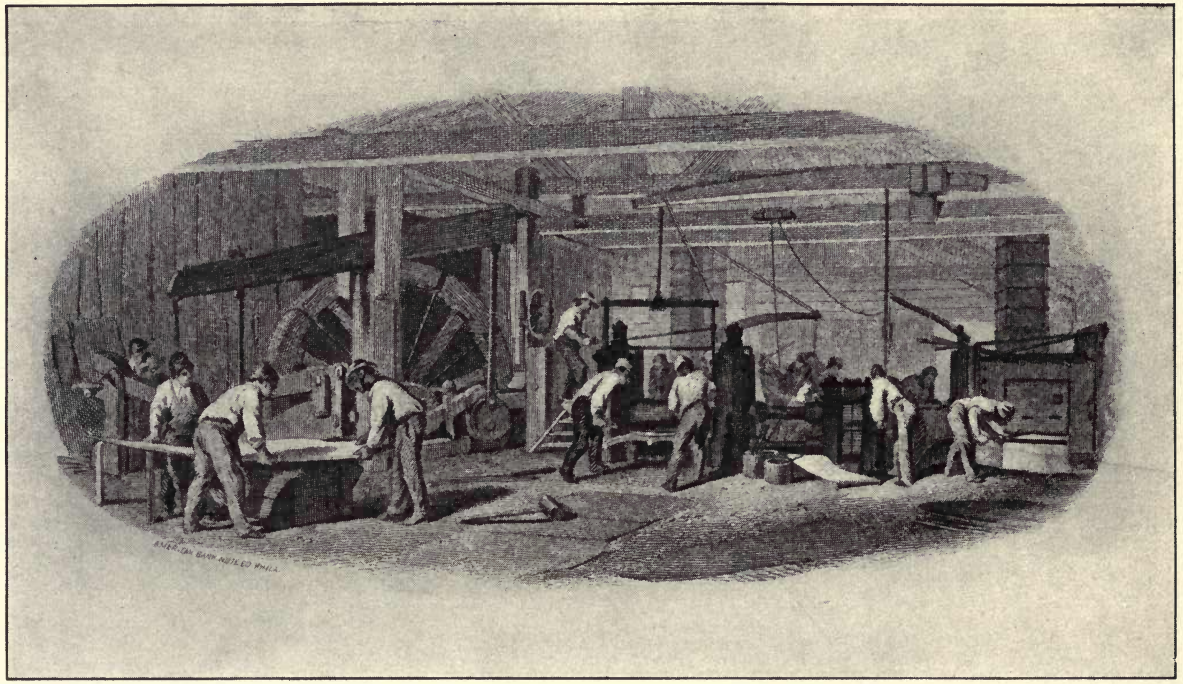
made to carry air into a box, compressing it in the top, from which it was carried to the furnace through a small pipe.

It is a curious circumstance that the first furnace erected by the Carnegie Steel Company was one torn down at Escanaba and taken to Pittsburg. It had been erected in Michigan to be near the ore fields but its owners found that the problems of transportation could not be solved in that way alone.

Scattered all over the Eastern States can be found the ruins of once ambitious efforts to make iron cheaply by locating furnaces close to the ore. Some of the most pathetic failures, however, were furnaces placed, as their builders believed, close to both ore and fuel, and even to transportation. In the Juniata Valley and the Allegheny Mountains are many of these monuments to the realization that the problems of transportation are of great importance in the iron industry. These old stacks, built to defy the ravages of time, were placed where ore had been found and where wood was abundant for the making of charcoal. Most of them were built after the construction of the Pennsylvania Canal and the Old Portage Railroad, both huge



An Abandoned Iron Furnace in Eastern Pennsylvania.
The Tree Growing Out of One Side Best
Indicates the Age of the Stack.



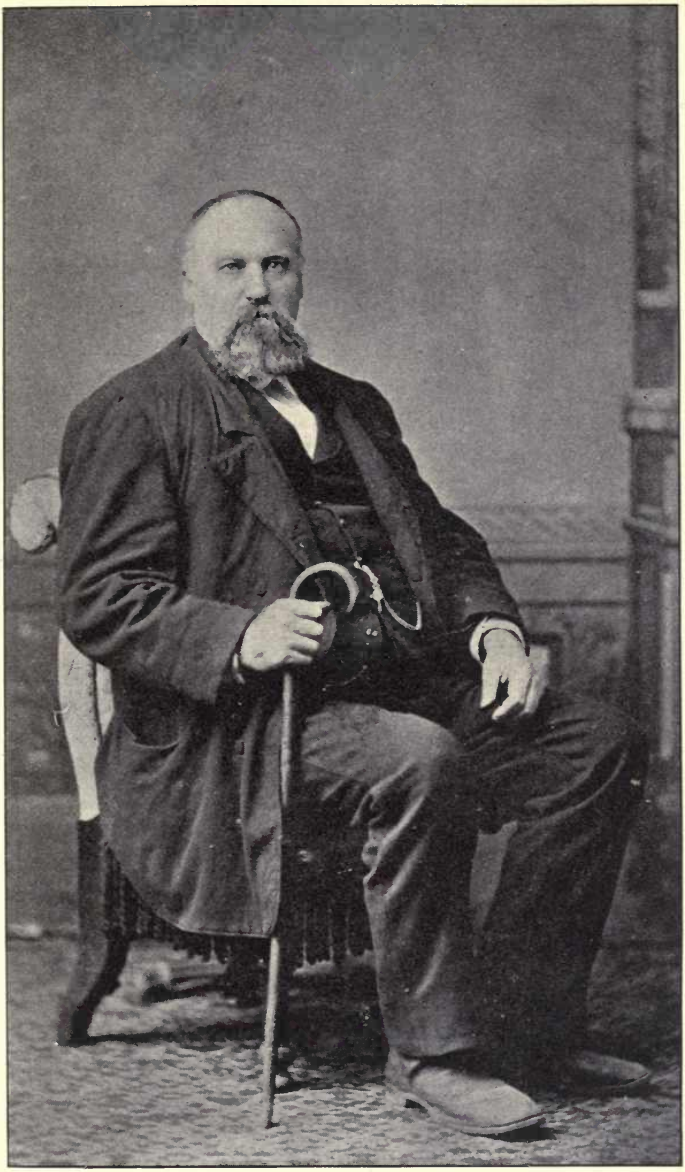
The First Mill for Rolling Boiler Plates in America, built and Operated by the Lukens Iron & Steel Co., Coatesville, Pa.

enterprises for their day. But the canal has disappeared, the famous old railroad is nothing but a memory, and these hollow structures of stone remain as mute witnesses of the fallibility of human calculations and the certainty of that change which is the seed of all progress and which is continually building on the ruins of the best efforts of men better things than those of which they dream. Huge trees may be seen on the tops of some of these old furnaces and around their bases the forest leaves have buried fragments of pig iron, which precious as it was, had to be left behind in the rapid march of progress.

COAL CAUSED VALLEY DEVELOPMENT

About 1860 coke was regularly used as fuel in the Clinton furnace at Pittsburg, and within a few years it proved so efficient that all other fuels were practically eliminated except for making special grades of iron. When I first became interested in the furnace business, all the stacks in the Mahoning Valley, as well as those in Hocking Valley, at Canal Dover and at several other points in Ohio, were using raw coal. It was to a rich deposit of black-band ore found underneath the coal at Mineral Ridge, near

Niles, and the equally important discovery at Brier Hill, in Youngstown, of coal making a fairly good fuel in its raw state, an almost natural coke, that the development of iron business in the Mahoning Valley was due. This coal, very similar to the Scotch coal afterwards found in other parts of Ohio, was rich in carbon and low in ash, and in the hands of those who understood it, made a better blast furnace fuel than had yet been found at its low cost. For years it was mined close to the stacks and hauled by mules. All of the ore, usually a mixture of black-band, kidney and bog ores, had to be roasted before charging, and this was done with wood and coal in great heaps near the furnaces. The output of the four furnaces then in operation in that district was certainly not more than two hundred tons per week. From this has grown a business employing fifty blast furnaces and producing, during 1916, 6,923,938 tons of pig iron. From the few small rolling mill plants then in that neighborhood, have been evolved forty-six modern rolling mills, rolling almost four million tons of steel per year.



BIG JIM KENNEDY

And Old Time Furnaceman.

EARLY DEVELOPMENT OF COKE AS FUEL

Owing to the advantage of this natural fuel, known as "Brier Hill" coal, we did not begin the use of coke in furnaces at Youngstown until 1869, at which time the coal began to grow scarce. An Englishman employed about one of the furnaces had some years previously made coke by covering coal in a heap, and this was used on occasions when a furnace went cold, but the raw fuel, the coal, was the main dependence until about the date mentioned, when we began to use bee hive coke.

The employment of coke as a blast furnace fuel was an advance of such importance that it is worth while to refer to it somewhat more comprehensively. It was known in Germany and England long before its use anywhere in America, where charcoal was at first relatively low in cost. The date and place where coke was first used in this country are not entirely certain, but it was possibly tried in several places at the beginning of the last century. A paragraph in a history of Fayette County, Pa., refers to the use of coke in Alleghany furnace, Blair County, in 1811. William Firmstone used it for a short time in a furnace in Huntington

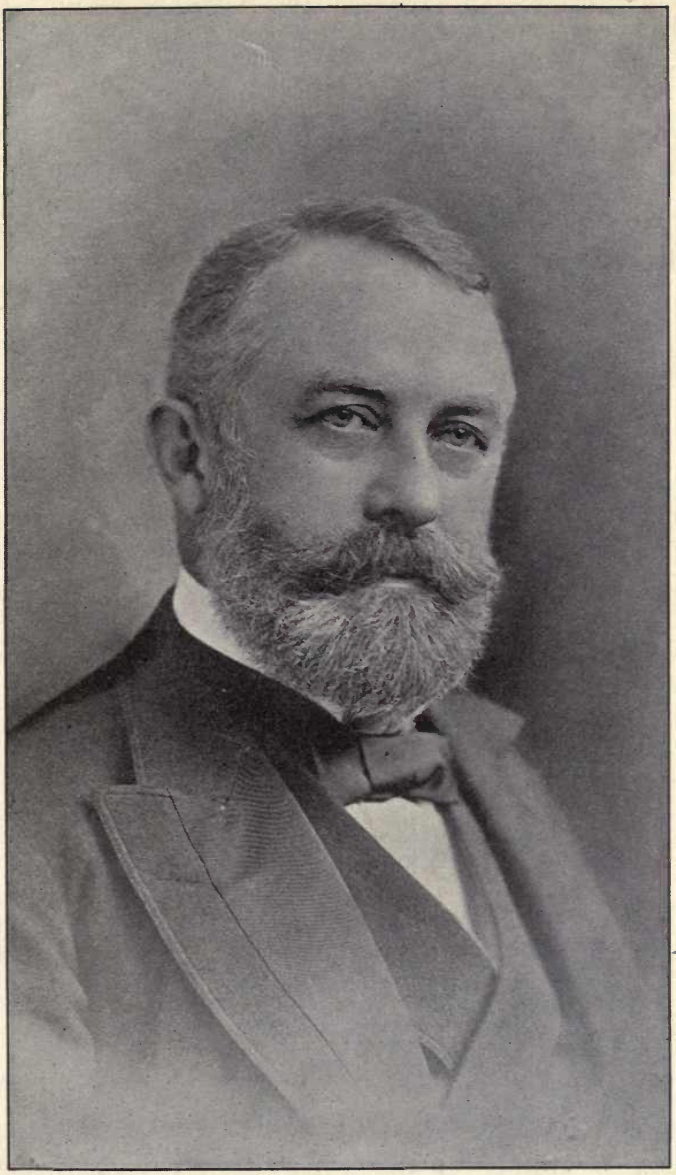
County, Pa., in 1835, but abandoned it later. There seems to be no doubt that he succeeded in making good gray iron with it at the date mentioned, but why he did not continue has never been recorded. In 1856, there were twenty-one furnaces in Pennsylvania and three in Maryland using coke, but, so far as is known, none west of these States. The census of 1850 enumerates four furnaces as burning coke, and 1860 twenty-one reported its use. In the next ten years the census people found only five more plants using coke, but it is probable there were many that did not report its use at that time. At any rate, by 1880, the census reports enumerated 149 stacks blowing on that fuel.

Coke from that time on rapidly supplanted charcoal and all other fuels, including anthracite coal. It is now used almost exclusively. Out of 465 blast furnaces now in operation or building in this country, only forty use charcoal, the others being fired with coke or, in a few instances with coke and coal mixed. The charcoal furnaces are chiefly small and of antiquated type, their output for 1916 having been only 372,411 tons of iron as compared with 39,062,386 tons produced in coke or in coal and coke driven

stacks. No new charcoal furnaces were reported building in 1916, but 17 coke furnaces, with an annual capacity of 3,151,000 tons, were under construction at the close of that year.

It was my privilege to make the first contract for coke entered into by Mr. H. C. Frick, a man whose name must be always inseparable from the history of the coke industry in America, when he began the coke business on his own account, and I would be ashamed to tell you the price, as I think he would also. I bought the first coke used in the Mahoning Valley for a furnace at Girard then under my management. The exact date has escaped my memory, but it was in the late 60's. This coke was used as a mixture with Brier Hill coal, and some coal was still used as a mixture until twenty years later, when we could no longer obtain it in satisfactory quantities. The mixture made what we thought then was a very satisfactory and economical fuel, the coal adding to the surplus gas production.

I have bought many thousands of tons of good beehive coke at eighty-five cents per ton. The average selling price of the entire output of the country in 1880 was $1.99 per ton at ovens.

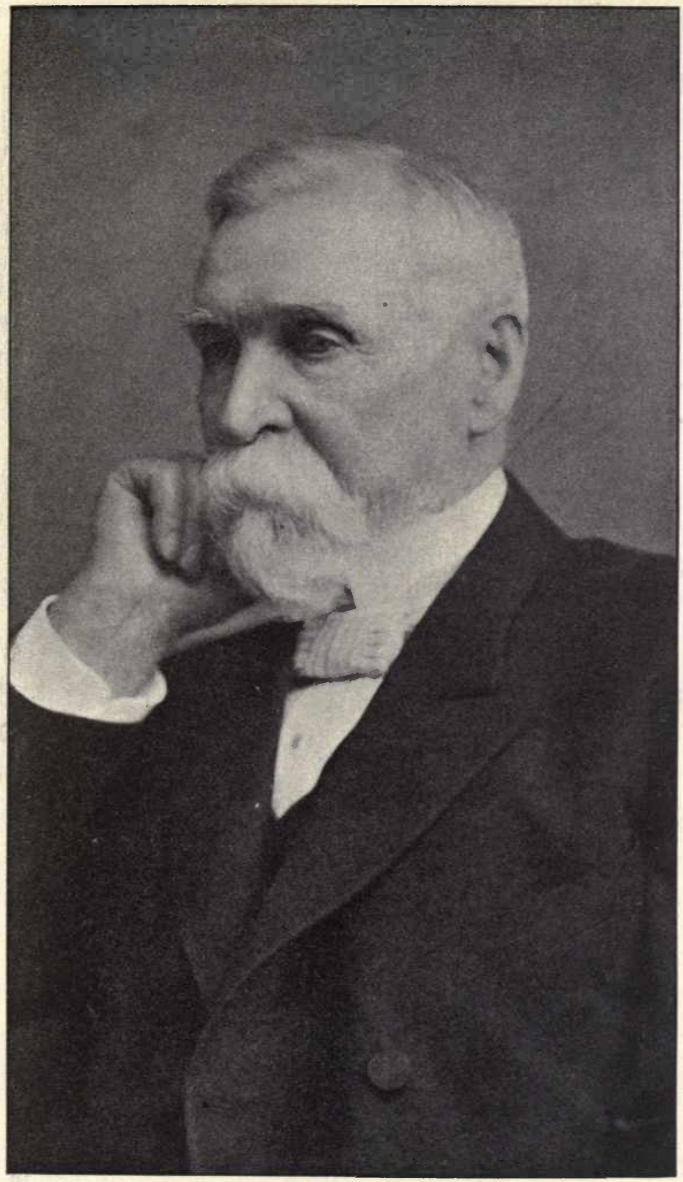


HENRY CLAY FRICK

Whose Strength of Purpose, Integrity and Ability have been Felt Throughout America's Great Industries.

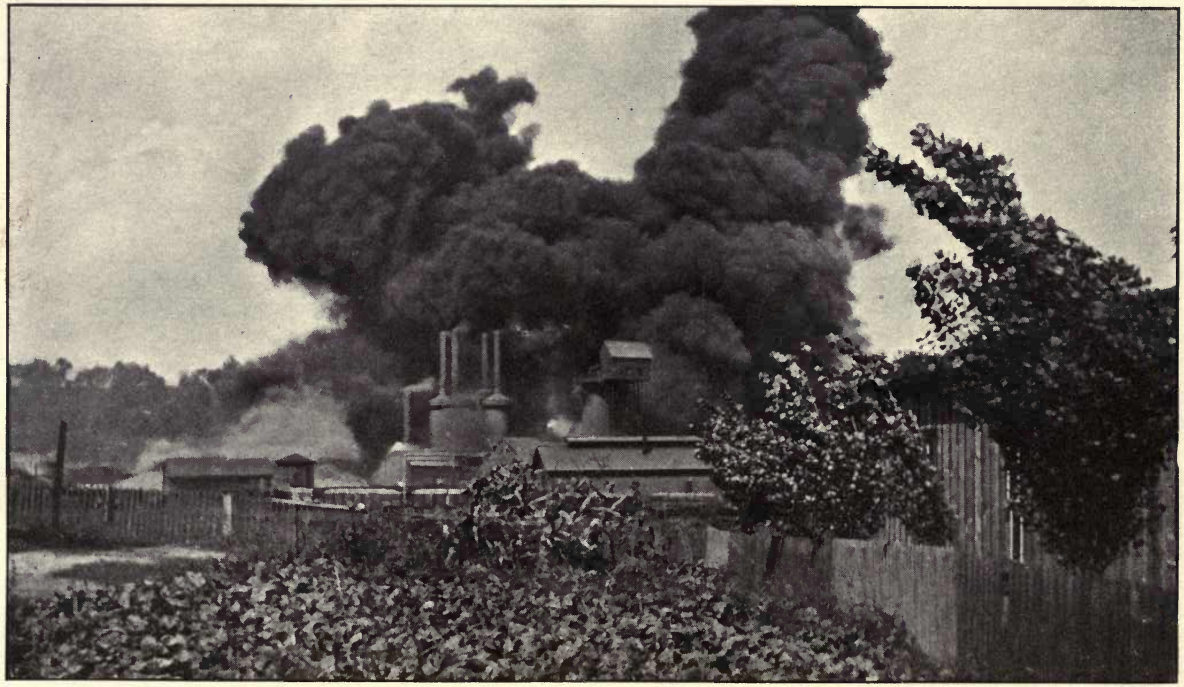
There were then 12,372 beehive ovens in operation, and the production was 3,338,300 tons. During 1916, according to the estimates at hand —the exact figures not being available, the country's entire production of coke was 54,325,000 tons and of this 35.35 per cent was made in by-product ovens. Some coke was sold in 1917 as high as $15 per ton, surely a war price.

Hardly less important for the country than the addition to furnace output resulting from the use of coke is the rapid development of the by-product industry. It has grown from 5.41 per cent in 1901 to 35.35 per cent in 1916. No other single development has done so much to conserve the natural resources of America and none has more effectively indicated the energy, wisdom and public-spirit of the men at the head of our iron and steel plants. The erection of by-product plants involves huge expenditure, but they make large profits and save for future generations incalculable natural wealth. It is safe to predict that the wasteful beehive oven will soon take its place in the limbo of great mistakes, among the dust of ignorance, with many other things that were once hailed as



JOHN FRITZ

Noted Inventor; Practical Worker in Iron and Steel of International Reputation.



A Furnace Explosion at Sharpesville, Pa., Caused by Mesaba Ore in the Early Days of its Use.

great discoveries and thought to be the limit of human knowledge.

LAKE SUPERIOR ORES

The development of the Lake Superior ore deposits has exercised on the iron and steel industries of the world an influence more far-reaching than any other incident in their history. Previous to that time furnaces and iron works had been located in many places where ore and fuel could be found. But the time had come when such resources were inadequate to meet the growing needs of the country. Perhaps it would be more accurate to say that the time had come when the further progress of civilization demanded iron ore in quantities and at a cost hitherto undreamed of. There is no question that, from the time of the discovery of the Mesaba Range, civilization and progress received a tremendous impulse from the cheaper iron and steel it made possible. From this time it became evident that the production of these commodities had to be on an enormous scale, and that the day of the small furnace was at an end. It became evident also, that henceforth the industries must be confined to those

localities where ore and fuel could be assembled in vast tonnages at low cost, and markets reached with the greatest facility. The first effect of this discovery was to practically limit the production of iron and steel in large tonnages to regions most accessible to great ore and fuel deposits. The Pittsburg and Youngstown districts had no rival in this respect except, perhaps, the Atlantic coast district, where the rich ores of Cuba and South America were available at equal distance from the Connellsville coke field. Even this district is now suffering from the accidental dislocation of ocean freight service and is glad to get ores from Lake Superior, which have no equal in low cost and purity.

Unfortunately I am not able to give the cost of ore at the furnaces of early days. The records then kept were imperfect in this respect and the dollar did not mean the same thing as it does now. But it was very high, in spite of the exceedingly low price of other commodities, and must have varied greatly at different furnaces, depending on whether it was mined from rich deposits or from those where it was poor in quality and limited in quantity.

The honor of discovering the ore deposits near Lake Superior is variously claimed. Some

CAPT. EBER B. WARD

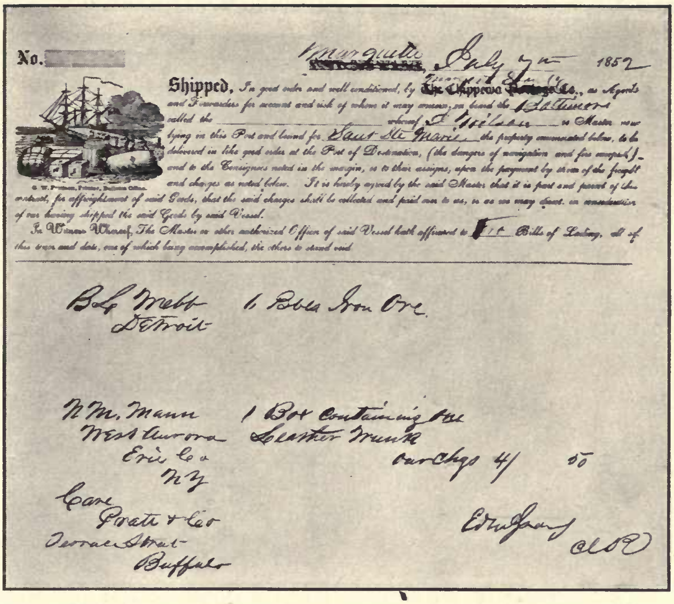
Chief Owner of the Plant at Wyandotte, Mich., and Responsible for the Construction of the First Successful Bessemer Converter in America.

writers credit it to Government engineers who noticed a variation of the magnetic needle and investigated the cause. Others state that the Indians had found the ores and reported large masses of "iron stone" in that locality. I am inclined to think the honor belongs to Philo M. Everett who, in 1845, located the Marquette Range in company with Indian guides.

The various ranges were opened for shipment of ore in the following order:

Marquette	1850
Menominee	1870
Gogebic	1884
Vermilion	1884
Mesaba	1892
Michipicoten	1900
Baraboo	1904
Cuyuna	1911

The first regular shipments in cargo down the lakes began somewhat later than the dates mentioned for all these ranges. That from the Marquette was in 1856, the opening of the Sault Ste. Marie Canal in that year having made possible cargoes large enough for that day, although they would seem insignificant at this time. The total shipments by water from this region in 1856 were only 7,000 tons, about half enough



No.

Marquette, July 7th 1852

Shipped, In good order and well conditioned, by The Chippewa [illegible] Co., as Agents and Forwarders for account and risk of whom it may concern, on board the Baltimore called the ______ whereof J. Wilson is Master now lying in this Port and bound for Saut Ste Marie, the property enumerated below, to be delivered in like good order at the Port of Destination, (the dangers of navigation and fire excepted) and to the Consignees noted in the margin, or to their assigns, upon the payment by them of the freight and charges as noted below. It is hereby agreed by the said Master that it is part and parcel of this contract, for affreightment of said Goods, that the said charges shall be collected and paid over to us, or as we may direct, in consideration of our having shipped the said Goods by said Vessel.

In Witness Whereof, The Master or other authorized Officer of said Vessel hath affirmed to Five Bills of Lading, all of this tenor and date, one of which being accomplished, the others to stand void.

B. L. Webb, Detroit — 6 Bbls Iron Ore.

N. M. Mann, West Aurora, Erie Co., N.Y. — 1 Box containing one Leather Trunk — our chgs 4/ 50

Care Pratt & Co, Terrace Street, Buffalo

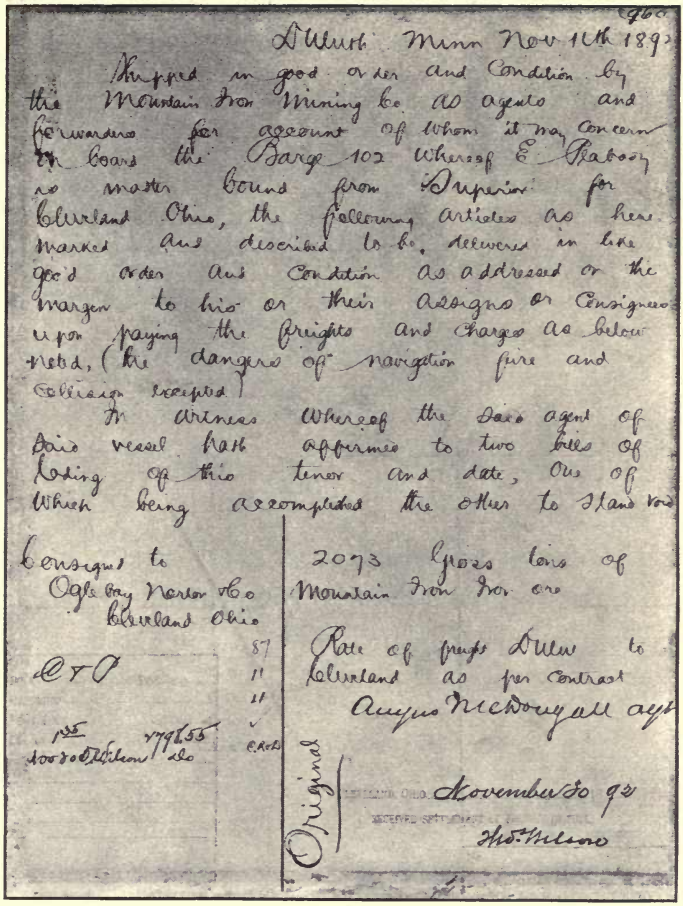
Edw. Gray, Clk

Reproduction of Bill of Lading First Shipment of Lake Superior Ore. Loaned by Oglebay, Norton & Co.

to make a cargo for a modern ore boat. This ore was valued at $28,000. In 1856 first-class "specular" or "hard" ore from the Marquette Range brought $7 per ton on the docks at Cleveland.

Up to 1908 all the ranges in the Lake Superior region had produced a total of 407,060,116 tons of ore. In 1912 their output had increased to 48,221,546 tons for that year alone, and in 1916 it reached the grand total of 66,658,466 tons—or 11,000,000 tons more than the entire production of the United States in 1915, according to the figures of the United States Geological Survey.

In 1916 the Mesaba Range alone produced 42,525,612 tons or almost 64 per cent, achieving a record as the greatest source of iron ore on the globe. The Mesaba Range has led in production since 1895, and its development has revolutionized the iron and steel industries of America. Because the ore on this range can be mined with great economy, and because of its close proximity to the Lakes, it can furnish ore at a lower cost per ton of iron than any other part of the world where there are furnaces to smelt it. Equally rich and accessible deposits may



Duluth Minn Nov 14th 1892

Shipped in good order and Condition by the Mountain Iron Mining Co as agents and forwarders for account of whom it may concern on board the Barge 102 whereof E Pabody is master bound from Superior for Cleveland Ohio, the following articles as here marked and described to be delivered in like good order and condition as addressed or the margen to him or their assigns or Consignees upon paying the freights and charges as below noted, (the dangers of navigation fire and collision excepted)

In witness Whereof the Duluth agent of said vessel hath affirmed to two bills of lading of this tenor and date, One of which being accomplished the other to stand void

Consigned to
Ogle Bay Norton & Co
Cleveland Ohio

O & O

2073 Gross tons of Mountain Iron Iron ore

Rate of freight Duluth to Cleveland as per contract

Amyus McKay all agt

Original

November 30 92

Mountain Iron Mining Co

Reproduction Bill of Lading First Shipment of Mesaba Ore.
Loaned by Oglebay, Norton & Co.

exist in India and South America, but it must be remembered that the tropics are not suited to the manufacture of iron, and it is not likely that anything equal to this range will be found within the temperate zones. Because of the conditions on the Mesaba Range we have learned to mine ore by stripping, even at a depth of 300 feet, and this of itself has been a long step toward economy in the cost of production.

IMPROVEMENT IN HANDLING ORES

Following the development of the Mesaba Range came astounding improvements in the mining and transportation of ore which, together with the tremendous supply of the Lake Superior region, have had much to do with the phenomenal growth of our iron and steel industries.

When we began to use Lake Superior ores the ordinary cargo of a lake boat was 500 tons. It required several days to load and unload this cargo at every point where it had to be handled —four in all. The ore cars then in use carried only ten tons. When their capacity was increased to twenty-five tons and boats were built that would carry 1,000 tons, we thought our problems were solved. Now we have vessels

loading as high as 12,000 tons at the upper ports in one or two hours with one or two men on the dock, and unloading their cargo directly into fifty-ton cars in about the same time, with practically no manual labor.

In the old days men with shovels loaded the ore at the mines into small cars, from which it was transferred to railroad cars. They handled it again the same way four times before it reached the furnace, for even the hopper car had not then been invented. Aside from being the most laborious task to which a human back was ever bent, this was extremely costly and slow beyond your belief. Now we handle this vast tonnage entirely by machinery. Steam shovels mine the ore; it flows by gravity into great vessels; huge unloaders transfer it to railroad cars, and car dumpers empty it under ore bridges—all the work being done by power and at a speed little short of miraculous. These things were all unknown a half-century ago. They are the product of the tireless brains and the unflagging energy of the men who have built our industries to their present colossal proportions.

The improvements in blast furnace construction and practice referred to in previous para-

graphs had much of their inspiration from these changes in the method of handling ores. With them came changes in size, lines and equipment. These changes were most marked during the period between 1860 and 1890. In 1850 there were few furnaces in the country that could produce 150 tons of iron in a week, and the average did not reach that figure until about 1865. In 1890 a furnace at the Edgar Thomson Works built under the design of Julian Kennedy and operated under the direction of Captain Bill Jones, startled the world by yielding 502 tons of iron in one day and 2,462 tons in one week. That was then believed to be the limit of production, but it is now quite usual for stacks to exceed this figure, and there are a few producing 600 tons per day.

In 1860 the total output of pig iron in the United States was 821,223 tons. In 1890 it had risen to 9,202,703 tons. During 1916 there were made in America 45,864,625 tons of furnace iron of all grades.

THE IRON AND STEEL INDUSTRY IN THE SOUTH

The remarkable growth of Iron and Steel manufacture in the South deserves almost a

JULIAN KENNEDY

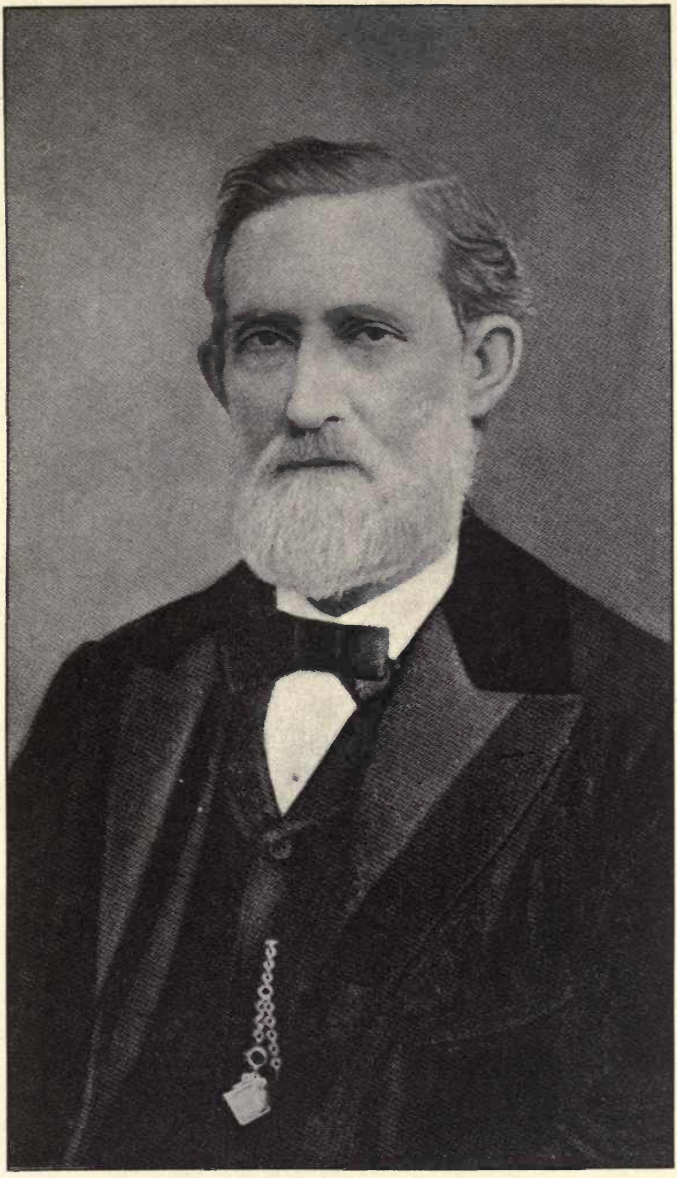
To Whose Engineering Genius the World's
Progress Owes Much.

separate paper, but I understand it must only be a feature of my address.

The subject has been treated by many writers: the late James M. Swank, E. A. Smith, Miss Armes of Birmingham and others. A paper read by James Bowron, at the long to be remembered meeting of the Institute in Birmingham, Alabama, is quite complete and should be read by everyone desiring to be thoroughly familiar with the Southern industry.

It is somewhat difficult to differentiate the South metallurgically. Mason & Dixon's line and all East of the Mississippi, except Florida, Mississippi and Louisiana, would probably include it.

Before the Civil War no iron was made in the South with mineral fuel, but charcoal furnaces were quite common, as well as forges. As early as 1725 a furnace was built in Virginia on property owned by Captain Washington, brother of George Washington. The ruins of this furnace can still be seen. Small furnaces were in operation through the Eighteenth and Nineteenth centuries. Ship-plates of exceptionally good quality were made in the South before the war from charcoal blooms. The war practi-



JAMES M. SWANK

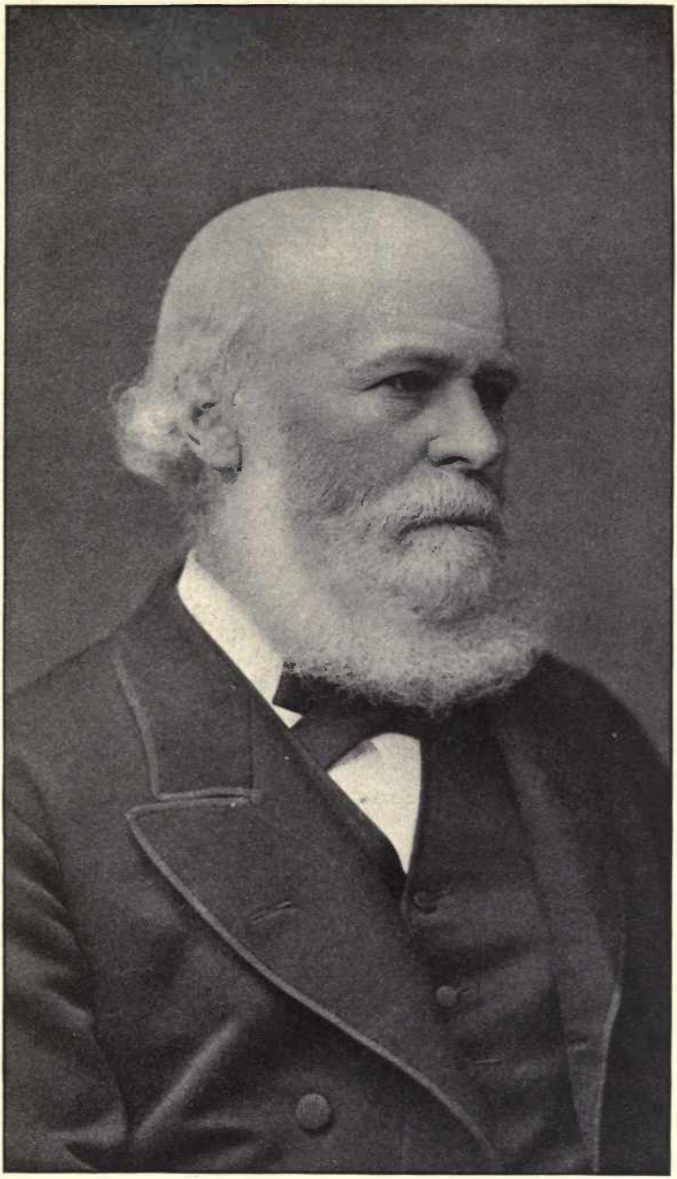
Author and Statistician. For More than Forty Years the Faithful Secretary and Guiding Spirit of The American Iron and Steel Association.

cally stopped all the manufacture of material. Some of the plants were taken over by the Federal Government. Dating from the close of the Civil War a great deal of capital was invested in Alabama and Georgia, principally English money.

Sir Lowthian Bell, a world-wide authority, visited this country with the British Iron and Steel Institute in 1890, and he said: "I will not say that Birmingham will furnish the world with iron, but I will say that she will eventually dictate to the world what the price of iron shall be".

Incidentally I might add that it was my good fortune to know Sir Lowthian Bell, he having visited the United States on several occasions. His work "Chemical Phenomena of Iron Smelting", is a classic and should be in the library of every iron manufacturer today.

To go into details of the developments through the South would occupy too much time. I think it safe to say, however, that the first real prosperity in the Southern industry as a whole, dates from the acquisition of the property of the Tennessee Coal, Iron & Railroad Company by the United States Steel Corporation. It is believed by many in position to know



SIR LOWTHIAN BELL

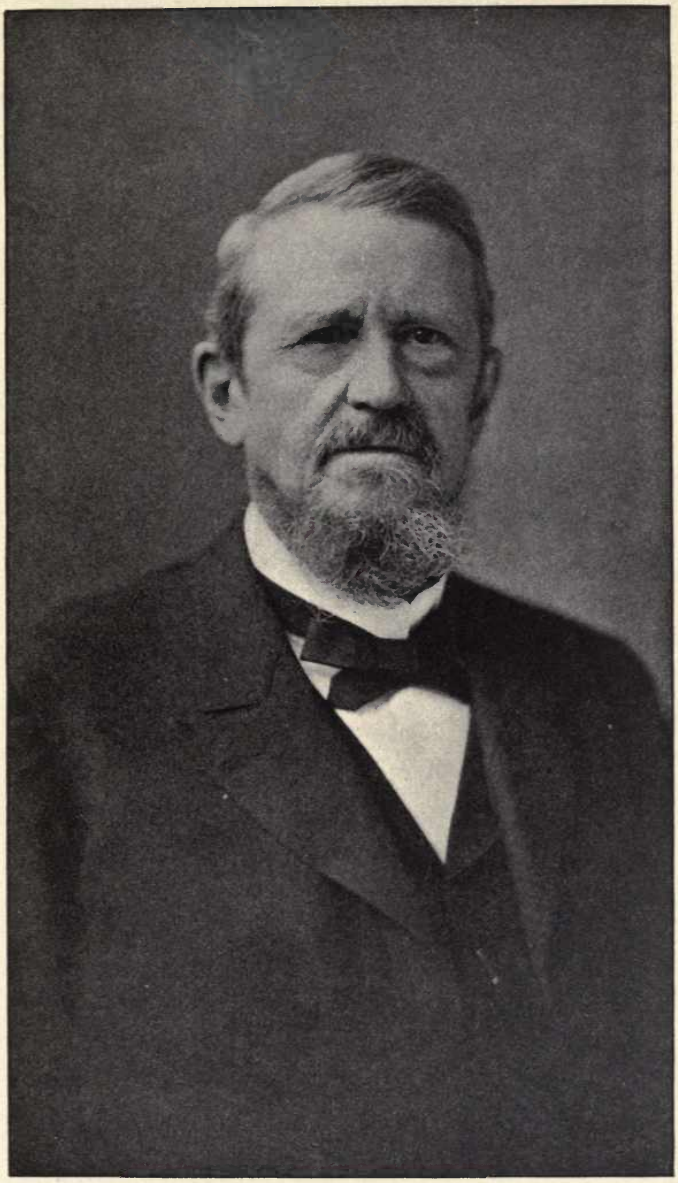
An Eminent English Metallurgical Engineer and Writer. Author of "The Chemical Phenomena of Iron Smelting." Father of Sir Hugh Bell.

that the purchase of this property at the time when it was acquired saved the nation from a most disastrous panic, or rather minimized the panic then in existence and eventually stopped it.

The Roane Iron Co. built blast furnaces at Rockwood, Tenn., fully a half century ago and they are still in successful operation. This same company undertook the manufacture of Bessemer steel rails at Chattanooga but the experiment was a failure. Now that Open-hearth rails have practically supplanted Bessemer steel rails, it is interesting to report that the Tennessee Coal, Iron & Railroad Company is one of the largest manufacturers of Open-hearth steel rails in the United States.

The Southern ore supply is practically without limit. Its iron contents are much lower than the Lake Superior ores but the South has the advantage of the coal, ore and flux being all in close proximity.

It is interesting to note that General Sherman, whose well known characterization of war has become fixed and emphasized in the minds of the whole world, built a rolling mill at Chattanooga in 1864 for the U. S. Government. This was used for rolling iron rails. Steel rails were



JOSEPH WHARTON

A Pioneer in the Manufacture of Iron and Steel in Eastern Pennsylvania and New Jersey. Founder of The Bethlehem Steel Company.

then unknown. Iron rails from all the roads in the South which were accessible to the Northern armies were brought to this mill, cut up and made into piles with new puddle iron for heads, and rerolled into sections of from fifty to sixty-five pounds per yard. The manufacture of iron and open-hearth steel, and more particularly pig iron, is today in a very prosperous condition throughout the South and I predict for the industries in that section increased prosperity.

An additional word about Captain "Bill" Jones will not be out of place in this connection, since he was, in a sense, the South's most notable contribution to the progress of American iron and steel industries. Captain Jones was for a time one of the most important practical men in the Carnegie plants. He was an inventor, and a manager of great ability. When the Civil War broke out he was employed at Chattanooga, Tenn., but on account of his Northern sympathies felt obliged to leave that section. He worked his way to Johnstown, going up the river on a steamboat. He was killed in a gas explosion at one of the Carnegie furnaces. Had it not been for his untimely death he might have become one of

WM. R. JONES (Capt. Bill Jones)

A Genius in Blast Furnace Practice. A Martyr to His Zeal.

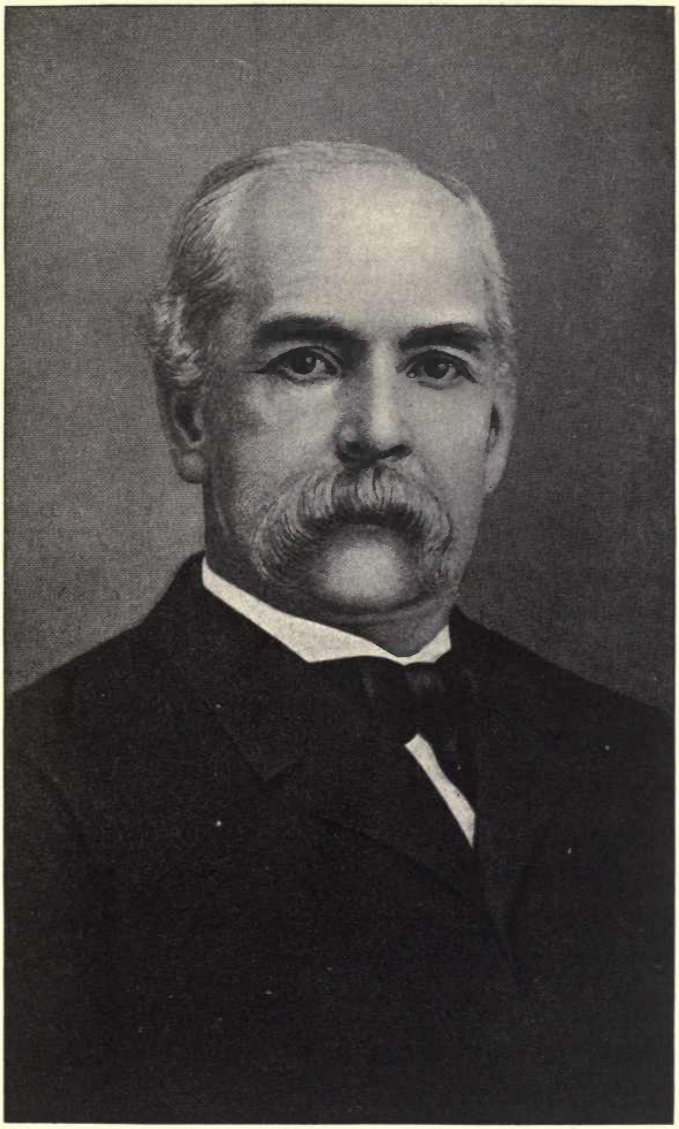
the country's foremost steel men, as negotiations were under way at that time looking to his going to Youngstown as a partner in a steel plant being organized there.

Captain Jones was not only an able practical steel man, but he was also a gallant soldier, having served with distinction in the Civil War, from which he emerged as captain.

DEVELOPMENT OF STEEL

Naturally, the rapid development of the iron industry was closely followed by an equally impressive growth in the production of steel, and this was characterized by the same astonishing increase in the efficiency of machinery and methods for fabricating the product into the countless forms in which it is marketed today.

It is uncertain when the first "blister" steel was made in America, but we know that up to 1831 the annual output had been less than 2,000 tons, and that little crucible steel had been made here. In 1860 we were still dependent on Europe for practically all of our steel requirements. The Bessemer process was then known, but as a dispute had arisen over its invention and an "interference" with the Bessemer patents had been



JAMES PARK JR.

A Pioneer in the Manufacture of Crucible Steel.

granted to William Kelly, the process was not put into general use in this country until after 1860.

I have referred to Mr. Kelly's visits to James Ward at Niles in connection with his invention. These occurred while I was a member of the Ward household, and the matter was discussed at the Ward table. On one of these visits Mr. Kelly was much exorcised over the fact that he had neglected to patent his discovery, but still had great hopes that he would yet be able to reap the rewards of it, in spite of the fact that Bessemer had been granted a patent a few days before his application was filed. I cannot recall the date of this occurrence, but it must have been in 1857, as the patents were granted in this country in 1856.

As a matter of fact, neither Bessemer nor Kelly is entitled to the honor of inventing the Bessemer steel process. Kelly had, years before Bessemer began his experiments, conceived the idea of decarburizing iron by a blast of air, and had actually used the process in the making of iron which he used and sold in place of that produced in the refinery and run out fires then employed. Sir Henry Bessemer conceived the

DANIEL J. MORRELL

Pioneer of the Policy of Protection to American Industries.

same idea and carried it out with a much more efficient mechanical appliance, which has been changed but little in general design to this day; but neither of these men were able to make steel. All they accomplished was to remove from pig iron the silicon and carbon. Robert Mushet was the man who first found out how to make Bessemer steel by recarburizing the iron after it has been blown in a converter. Kelly reaped very little benefit, also, but he will always be regarded by Americans as the actual discoverer of the fundamental element in this great process, and the little converter which he had made at the Cambria Iron Works and used there with more or less success in 1861 and 1862 is an enduring monument to the spirit of discovery and the persistent efforts which have made the steel business what it is.

The manufacture of Bessemer steel did not attain any headway in this country until 1867, but when it did finally start, its results were tremendous. It built the railroads of the United States, as well as most of our sky-scrapers, bridges and ships, yet in spite of this fact, it now seems destined to give place to an older and more expensive process, that of the

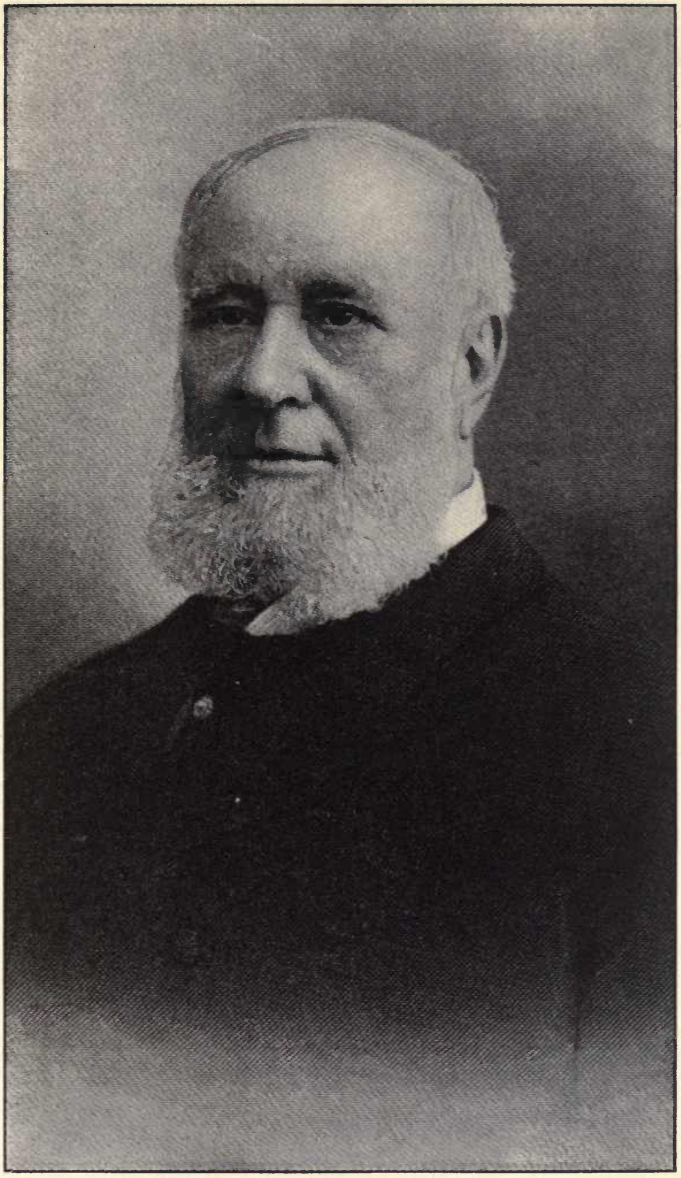
ANDREW WHEELER

Treasurer of The American Iron & Steel Association.

open-hearth; and this in turn, will probably yield supremacy to the electric furnace, so rapid are the changes and so eager the industry to keep pace with modern knowledge and invention.

No less remarkable are the changes that sixty years have witnessed in the fabrication of iron and steel. When I first entered the business the plant of my employer consisted of a small blast furnace, a refinery forge or two, and a mill upon which we rolled iron bars for various purposes. After the pig iron had been refined in the furnace—a process somewhat like that of puddling, it was rolled into muck bar. This was then made up into bundles, reheated and rolled on a primitive form of bar mill. My first contribution to the efficiency of the plant was a plan to regulate the size of these bundles so that they would produce a bar of the size and length desired and thus eliminate excessive waste from scrap as each piece was rolled. It was recognized as a new idea and Mr. Ward complimented me highly.

The first bar iron rolled in the United States was produced at Plumsack, Fayette County, Pa., in 1817. The first puddling in this country was done at the Boston Iron Works in 1825. The



BENJAMIN FRANKLIN JONES

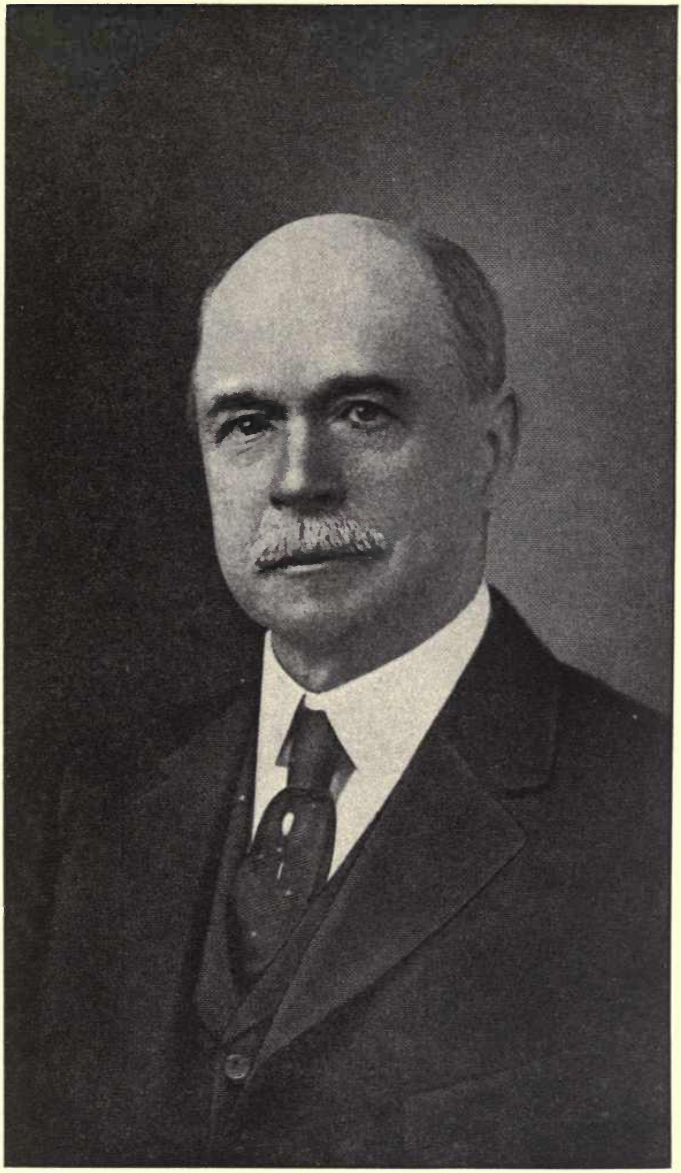
Founder of The Jones & Laughlin Steel Company. A Pioneer in the Development of Iron and Steel Manufacture in Pittsburgh.

first successful American blast furnace of which there is record was built at Lynn, Mass., in 1645.

The first successful iron working plant in America seems to have been established at Lynn about the same time the first furnace was built. Only cast iron articles were produced at first, but a forge was started in 1648, or three years later.

The first iron works in New York State were built at Ancram Creek about 1740. Soon afterwards a blast furnace was erected in the Ramapo Mountains, and before the Revolution this had been consolidated with a forge and operated under the name of the Sterling Iron Works. It was here that the anchors were forged for the first ships to fly the American flag, and here also that a great chain was made and stretched across the Hudson River to prevent British gunboats from passing West Point, in 1788. That chain still holds the honor of being the largest ever forged, a fact which shows that our ancestors could rise to great efforts when inspired by patriotism, even as we are doing today.

I occasionally go into the blooming mills at the Brier Hill plant, where we break down a steel ingot in less than a minute, and mentally



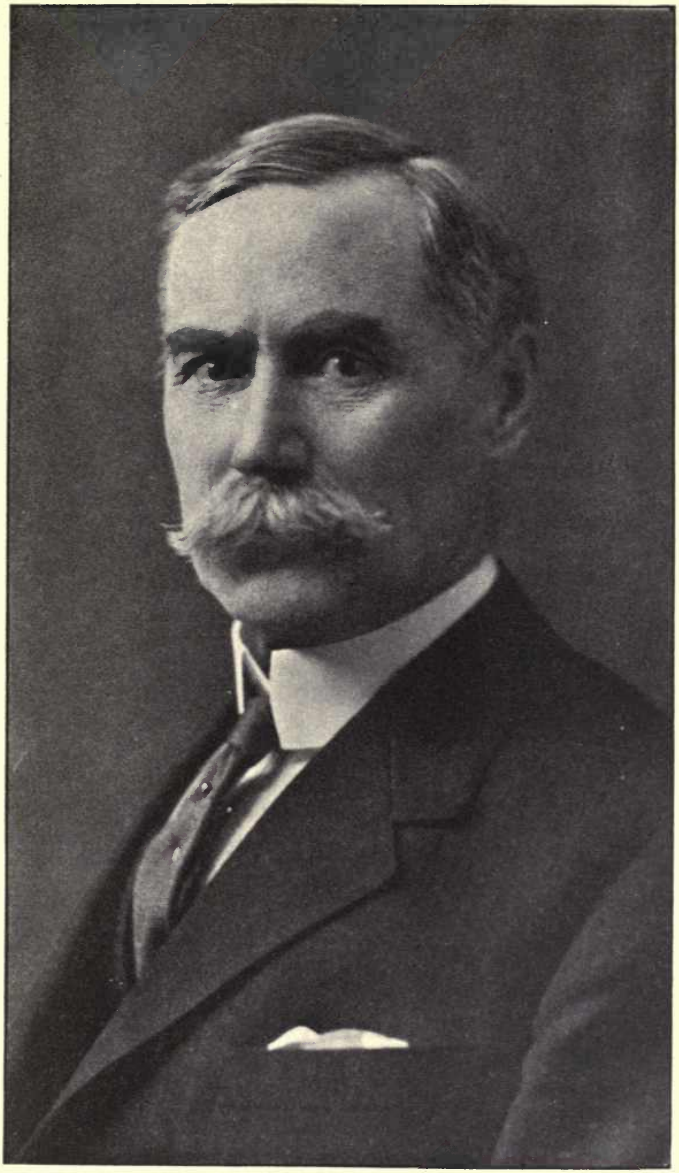
ROBERT W. HUNT

A Noted Mechanical Engineer, who Rolled the First Commercial Order of Steel Rails Filled in this Country at Johnstown, Pennsylvania.

compare the massive machinery in use in modern steel plants with the equipment of those days. Still we had achieved a good deal even then. The first successful rolling mill in this country was about as primitive compared with the equipment of sixty years ago as was the old Ward mill when compared with a modern rolling mill.

The pioneers started with nothing. We had at least something to work with. Both they and we of this generation have made the best of our opportunities, and the result is the majestic industry which today stands without a rival in the efficiency of its processes, in the zeal of its operatives, and in its far-reaching effect on human happiness and welfare.

Much of this great progress has been undoubtedly due to the men who have been engaged in the iron and steel business. In justice they must be given credit with a degree of enterprise found in no other industry. They have been willing at all times to face ruin for the sake of adventure into new and more promising fields. They have rewarded courage, vision and genius as no other industry has rewarded these things. They have constantly



J. A. CAMPBELL

President of The Youngstown Sheet & Tube Company. A Commanding Figure Among Executives who Have More Recently Achieved National Reputation.

looked forward to higher achievements, scorning the contentment that sometimes brings stagnation to a great industry.

All of this progress, however, cannot be credited to the men of the industry. Some of it was undoubtedly due to the greatness of the country, the magnificence of our natural resources, and the enterprise of our people as a whole. In no other country, in the world, for instance, could there have been a demand for railroad expansion such as to require 500,000 miles of steel rails in less than twenty years, as was the case in this country between 1865 and 1885.

The first steel rail rolled in America from American steel was made at the North Chicago Rolling Mill on May 24, 1865, from steel ingots made at Wyandotte, Mich. The ingots were made under the direction of William F. Durfee, who had built the first successful Bessemer converter at Wyandotte. Steel made in this converter was used in rolling the rail referred to. I was attending a meeting of the American Iron and Steel Association in Chicago at the time and went with the party that visited the works to see the operation repeated the following day.

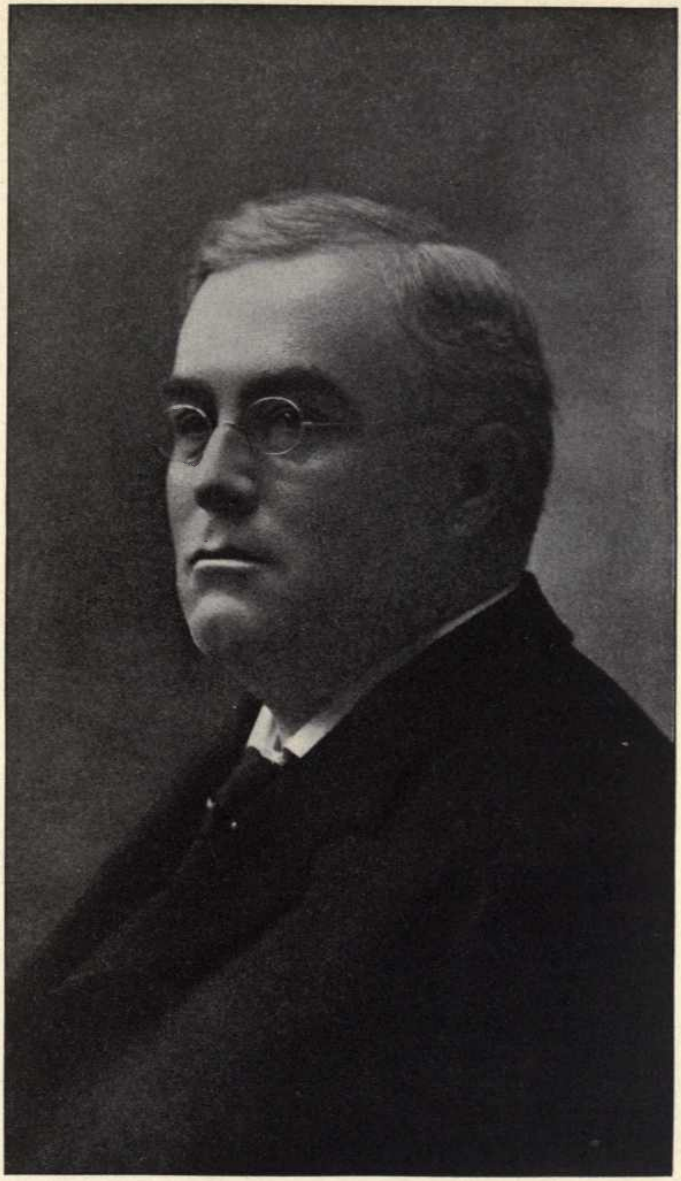
Three rails were rolled on each occasion, and a part of one of them was cut off and sent to the meeting, where it naturally attracted much attention. By 1890 more than 19,000,000 tons of steel rails had been rolled in this country, practically all of them from Bessemer steel. In 1916, which, as you all know, was not a good year for the rail business, the output was 2,854,518 tons. Of this production in 1916, 2,269,600 tons were rolled from open-hearth steel, showing the great development of that process during the intervening years.

Although Mr. Durfee deserves the honor of having built the first successful Bessemer converter in this country, the steel made in it was actually an infringement on the Bessemer patents, which were then in dispute. These patents were afterward bought by the firm of Winslow, Griswold and Holley, who built the first commercial plant for making Bessemer steel at Troy. Mr. Holley helped to develop the original converter at Wyandotte until it was on a commercial basis. He later assisted in the building of a plant at the Cambria Iron Works and next built the Bessemer plant at the Pennsylvania Steel Works, which was erected and operated

under the combined patents of Bessemer and Kelly, who had in the meantime, reached an agreement. There were only thirteen plants built in this country down to 1881, but from that time the growth of the manufacture of Bessemer Steel in America was very rapid. The first commercial order of steel rails filled in this country was rolled by the Cambria Iron Company in 1867, under the direction of Mr. Robert W. Hunt.

WELLMAN DEVELOPED THE OPEN-HEARTH

There has been an impression that William F. Durfee had much to do with the early development of the open-hearth process in this country, but this seems to be an error. He was largely occupied with the Bessemer process, but the credit of building the first successful open-hearth of the Siemens-Martin type is due to Mr. Samuel T. Wellman, of the Wellman-Seaver-Morgan Company. Mr. Wellman built the first really successful American open-hearth furnace at the Bay State Iron Works, South Boston, in the latter part of 1869. He had been assistant engineer for Mr. J. T. Potts, who had been sent to this country by C. W. Siemens to assist in the starting of an open-hearth furnace at Trenton for Cooper, Hewitt & Company, who



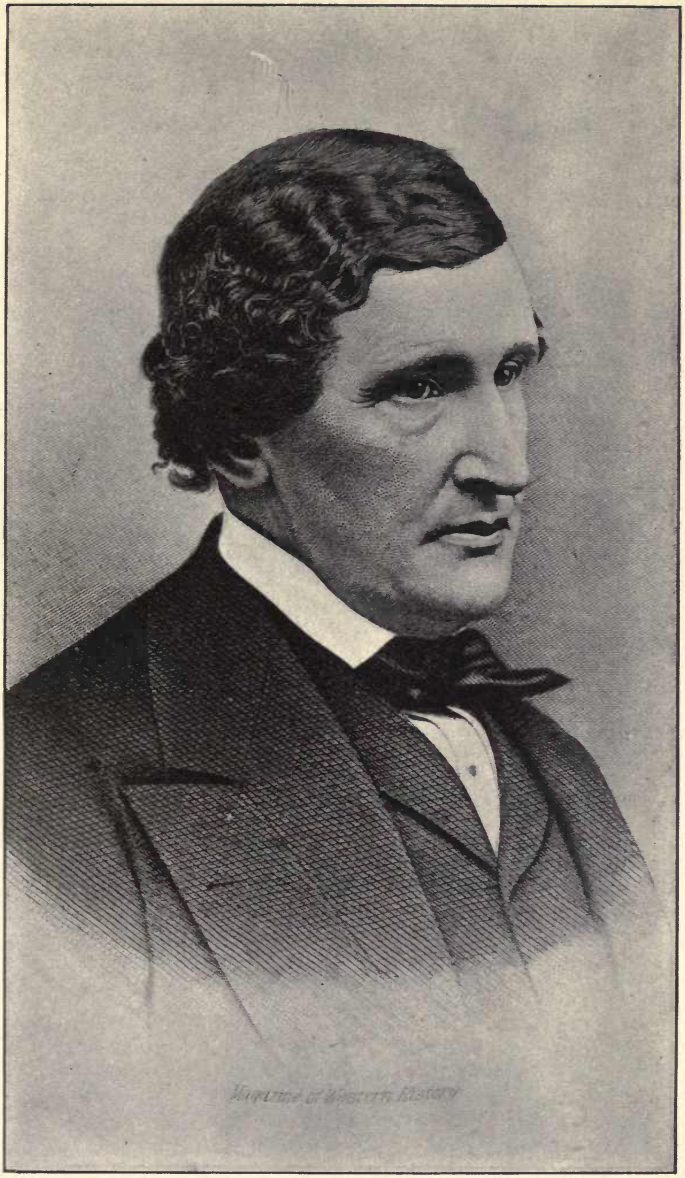
SAMUEL T. WELLMAN

Pioneer in Steel Manufacture. First to Successfully Operate the Open-Hearth Furnace in America.

had bought the Siemens rights. This furnace had not been successful, owing to trouble with the gas producers and other difficulties, and was finally abandoned. In working on this furnace Mr. Wellman acquired experience that made it possible for him to correct errors in design that had proven fatal to the Cooper-Hewitt experiment. It was at South Boston that the first ferro-manganese was made in this country. A full account of this interesting stage in the development of the Siemens-Martin regenerative furnace was given by Mr. Wellman in a paper read before the American Society of Mechanical Engineers in 1901, at which time he was President of that body. Like almost all great improvements the open-hearth furnace involved much costly experiment and many heart-breaking failures. The first open-hearth furnaces had a capacity of only five or six tons at a heat, and they had none of the mechanical appliances for pouring or for casting ingots now in use. Development both as to size and mechanical operation, has been gradual, and but little change has been made in the method of pre-heating the fuel gases.

TARIFF PLAYS AN IMPORTANT PART

To one who can recall the early years of iron and steel manufacture there is nothing more



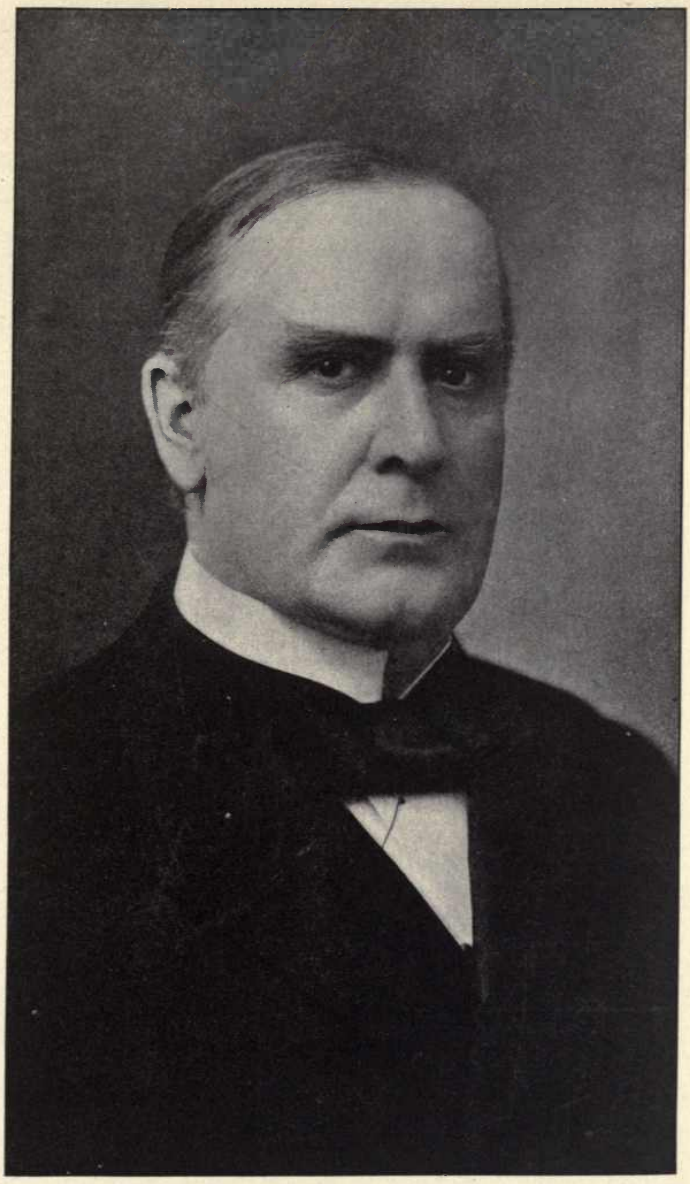
CHARLES E. SMITH

First Statistician of the American Iron Trade.

inspiring than the ceaseless effort of men engaged in the industry to find better and more economical methods of producing iron and steel. To this must be ascribed in large part the phenomenal advances made in America, which has led the world in the perfection of metallurgical processes and the adaptation of mechanical appliances for these processes.

In like manner there is no question that a part of the development was due to the tariff policy which for a great portion of this period encouraged enterprise by protecting the struggling iron and steel industries against competition from abroad and assuring reward for energy and ability expended in this direction.

You will pardon me if I claim a small part in this, for it was my privilege to be consulted freely by William McKinley during the period in which he labored so faithfully and effectively for wise tariff-legislation, as well as to enjoy his personal friendship and confidence during his lifetime as well as during his administration. One of the most gratifying tasks of my life has been the effort to repay in some small measure the debt owed by the industries of America to this statesman, whose broad vision had so much

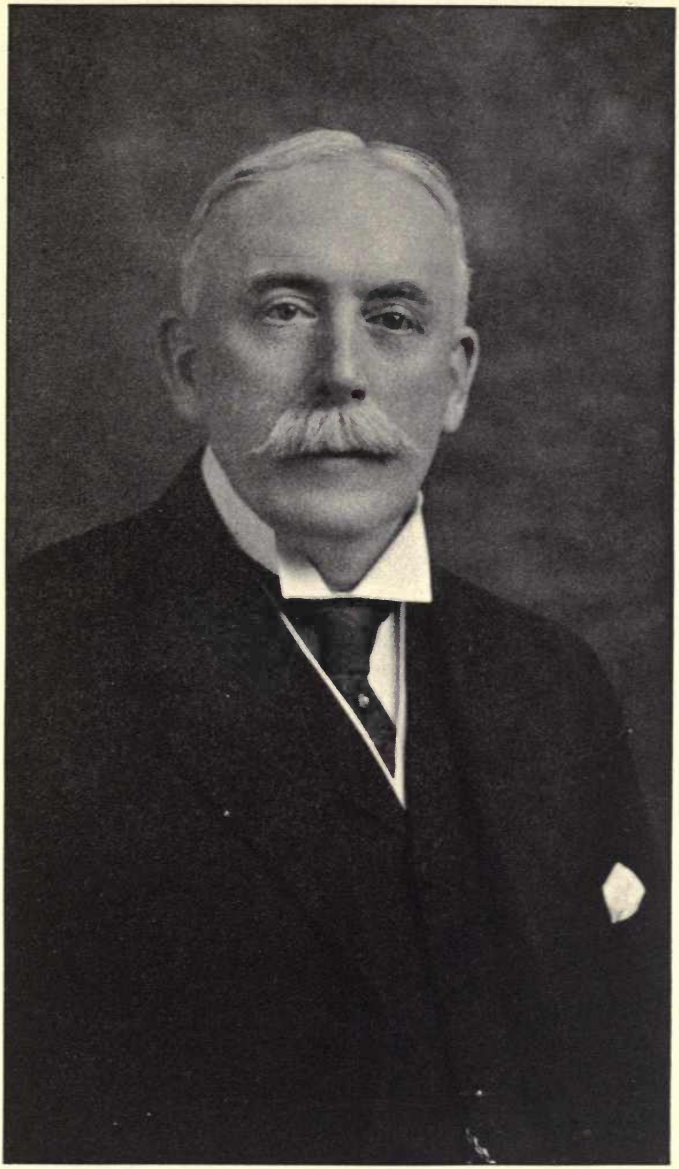


WILLIAM McKINLEY

The Most Prominent Advocate of the Policy of Protection to American Industries. Twenty-fifth President of the United States.

to do with our national growth, by conceiving, planning, and, with the help of my friends in these industries, erecting to his memory at Niles, Ohio, on the spot where he was born and where we played together as boys, one of the noblest and most beautiful memorials on the American continent. This structure was dedicated on October 5th, 1917, and I hope you will permit me at this time, although it may seem foreign to my subject, to extend to every member of the Institute an invitation to visit it. It has cost approximately half a million dollars and is artistically worthy of its purpose.

I have had the honor to be consulted by the men who framed every tariff bill passed by a Republican Congress since 1875, and have tried to consult with the framers of every Democratic tariff bill during the same period. In preparing data for this paper I came across a voluminous report on industrial conditions prepared by me in 1912 at the special request of William H. Taft, then President of the United States, for the use of the Ways and Means committee at work on the tariff changes contemplated at that time. This document, was submitted to Mr. James A. Farrell, and it was thor-



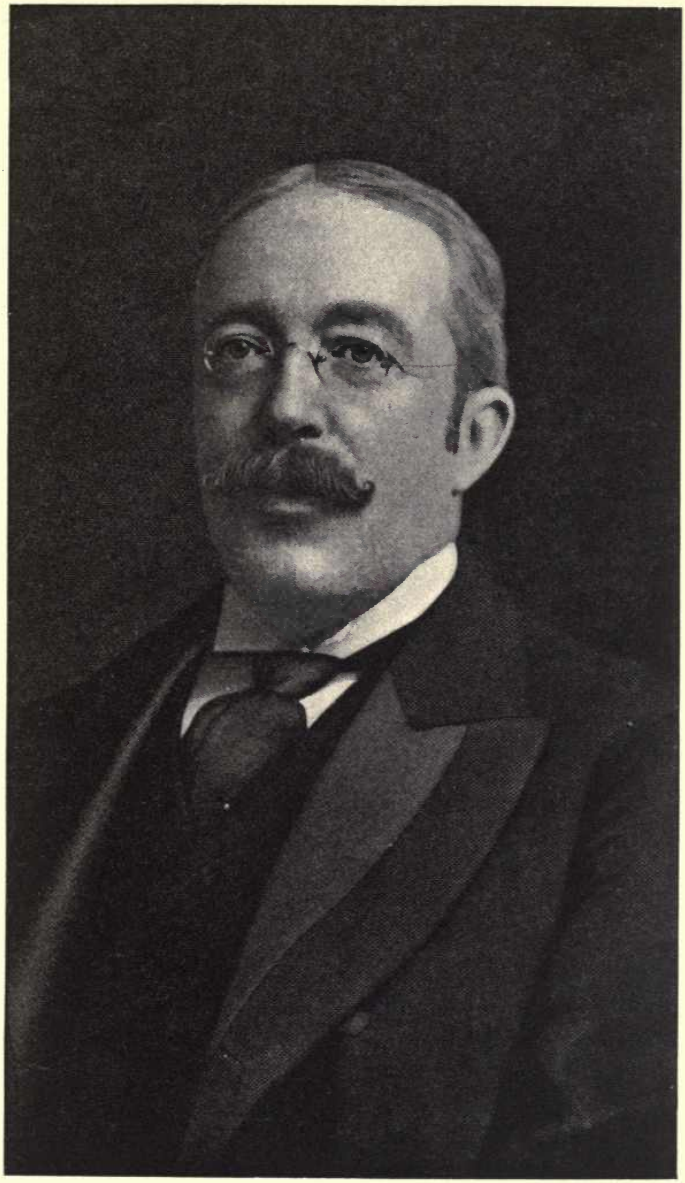
JAMES A. FARRELL

President of The United States Steel Corporation. An American Who Thinks in International Terms.

oughly endorsed by him, so it must have had some merit. You may rest assured that in these activities, whether they were solicited, or, as was sometimes the case, not over-enthusiastically received, I always had in mind the welfare of the country through its industries, and I am sure that these did not suffer from anything I said or wrote upon the subject.

BROAD VISION OF LEADERSHIP

Still more helpful was the influence of the organizations created and fostered by men of vision in the two industries. These men saw, long before it came to be generally realized, that the true basis of success in manufacturing enterprises was not so much unreasoning competition as sensible co-operation, and they early put their views into effect by the organization of such associations as the American Pig Iron Association and the Bessemer Pig Iron Association, both of which it was my privilege for many years to serve as president, together with The American Iron and Steel Association and our own great Association, The American Iron and Steel Institute. It would be hard for anyone to estimate what has been accomplished by these organizations toward the stimulation of progress and the conservation of resources in these two lines.



SAMUEL MATHER

Director and one of the Founders of The United States Steel Corporation. Leading Spirit in the Development of Lake Superior Ore Industry.

Even those least friendly to the iron and steel interests must acknowledge that they have led all others in this country in the way of advanced ideas along sociological lines. This has been particularly true of The American Iron and Steel Institute under the able administration of Judge Gary. We have been the first to realize the great truth that business success depends upon co-operation rather than upon competition, a truth now generally admitted. We have been the most generous of all the industries in dividing with labor the rewards of business. We have led all other industries in the matter of safety, sanitation and welfare work, and we have done more than any other to establish in the public mind the fact that the interests of labor and capital are identical, the prosperity of one involving the prosperity of the other, and that both owe to the public duties equal to those they owe to themselves.

THE UNITED STATES STEEL CORPORATION

The history of the American iron and steel industry has known no incident of more far-reaching importance than the organization of the United States Steel Corporation. It is the

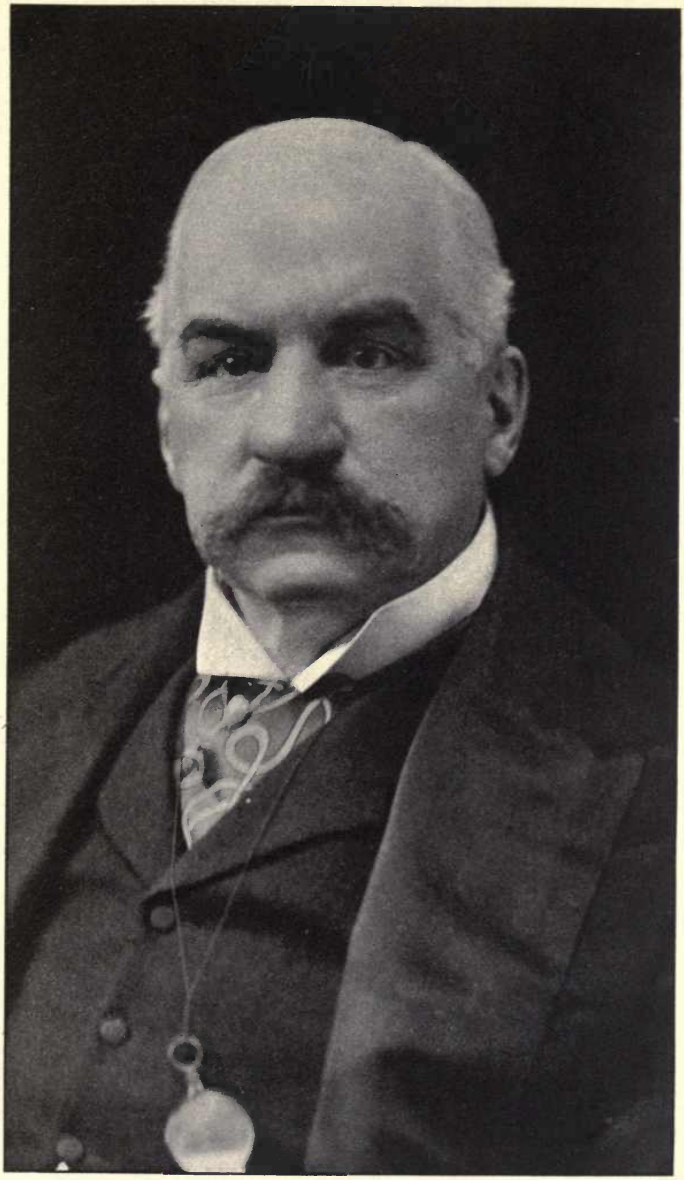
HON. ELBERT H. GARY

The Foremost Figure in the Iron and Steel World of Today.

greatest industrial and financial aggregation in the world, producing a larger tonnage of steel and iron than any single country on the globe except the United States.

The United States Steel Corporation was formed as the result of a growing conviction among men engaged in the manufacture of iron and steel that some method would have to be devised whereby greater efficiency could be obtained as well as more stable market conditions secured if the remarkable progress of this country along these lines was to be maintained and the competition of foreign countries successfully met. History relates it was conceived in the brain of Elbert H. Gary, who was then President of the Federal Steel Company, but it was a long time in being born.

As production mounted during the years between 1870 and 1890, conditions became exceedingly bad. Ruthless competition was the order of the day. Price-cutting, unfair methods of business, and all the evils attendant on the desire to secure markets became so prevalent that an effort was made to reach some sort of stability by the famous "pools", which many of you will remember with amusement, because their only effect was to show that agreements of

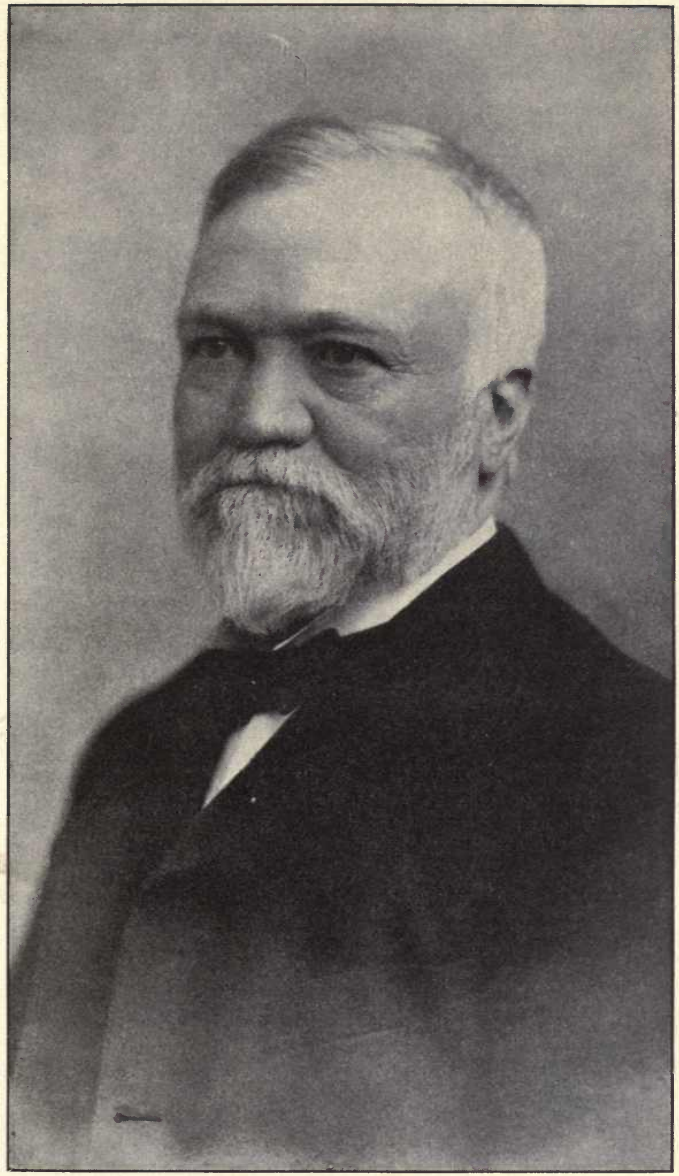


J. P. MORGAN

The Most Eminent Financier of the Nineteenth Century.
Prominent in the Formation of The United
States Steel Corporation.

this kind without the proper spirit behind them are even less than "scraps of paper". The first serious effort to improve conditions was the combination of a number of companies producing different lines of finished steel. Several of these came into being in the late nineties, but they went after one another in precisely the same spirit that the original companies manifested, and the only result was competition fiercer and more relentless than before.

Judge Gary had tried to organize a great combination, and had turned for financial assistance to the late J. P. Morgan, then the only man in the United States who could influence the necessary capital. Morgan was unresponsive and nothing was done. Finally, however Judge Gary succeeded in interesting Andrew Carnegie, then a commanding figure in the steel world. Carnegie doubtless realized the fact that the policies followed up to that time were unwholesome, and he was willing to sell out to such a combination, because he felt that, sooner or later, his great company would find a rival, or combination of rivals that would be its equal, and then would come a battle royal in which he might suffer with the rest.



ANDREW CARNEGIE

For Many Years a Dominant Figure in the Iron and Steel Industries.

On the evening of December 12, 1900, two New York men, both warm friends of Carnegie, arranged a dinner in New York. To this they invited Morgan and others among whom was Charles M. Schwab, then President of the Carnegie Steel Company. Schwab made at that dinner the speech of his life. He painted the possibilities of such a corporation as Judge Gary had been trying to form, and painted them in such vivid colors that, after the dinner was over, Morgan took him to one side and spent the greater part of the evening in talking over the matter. The result was that the financier's hesitation vanished and he asked Schwab to learn Carnegie's price. This price was slightly more than $492,000,000 the largest sum that had ever been paid for anything bought in the world up to that time.

The Steel Corporation was chartered early in 1901. It began business with ten of the largest companies then in existence. It had a capital of $1,404,000,000. Its properties consisted of 161 separate plants, comprising 73 blast furnaces, steel works and rolling mills, vast holdings of ore lands, coal and limestone, 112 steamships, and 1,000 miles of railroads. Its productive

CHARLES M. SCHWAB

A Most Interesting Figure in the American Steel and Iron Industries. Author, Orator, Musician—A Genius in Steel.

capacity was estimated at 7,400,000 tons of pig iron, 9,400,000 tons of steel ingots, and 7,900,000 tons of finished steel per annum. Its board of directors included practically all of the very wealthy men then in the United States, and it had on its hands the biggest problem of industrial operation ever undertaken by any set of men.

The Steel Corporation was regarded pessimistically by most of the practical steel men of that time. It was believed to be top-heavy and in the light of our experience and methods of business, most of the independents were much afraid of it. We did not then appreciate the high ideals of the man who first conceived it. Nor did we understand that part of his dream, now realized, was an entirely new principle in business conduct. The idea of co-operation, rather than competition, in business was then untried and most of us thought that it was impractical. We have seen it worked out, and we now know that this idea is basically sound. We have had opportunity to learn by experience that the United States Steel Corporation, managed as it has been, has been a most excellent thing for the iron and steel industries in this country and the world, and, so far as I am aware,

there is not an independent steel company which has not benefited by the broad policy it inaugurated and made possible for all of us.

The effect of the corporation's activities and its policy has been good from every point of view. It has benefited its workingmen, the public and its stockholders. Many new companies which have been started since it began business have found it an actual aid toward their success.

So far as results are concerned, the Steel Corporation must be regarded as one of the most successful enterprises in American history. It has decreased the number of steel works under its management by dismantling several that were unprofitable in operation, so that it now operates 146 plants, instead of 149, as at the beginning; but it has increased its productive capacity fully 100 per cent. At the same time, owing to the phenomenal growth of the industry during this period, it now controls a far less proportion of production in this country than at the time of its entrance into the business, its production being only about 45 per cent of the whole of 1916.

Perhaps the greatest service rendered to the steel industry of America by this great corporation has been the extension of our export trade. Under the able direction of President Farrell this branch of the market, formerly neglected, has been studiously cultivated, with marked advantage to the reputation of American iron and steel products in all parts of the world.

The story of the United States Steel Corporation forms one of the most interesting chapters in the history of the iron and steel business of America and will always be one of the important happenings in the industrial and financial history of the world. It has established the fame of Elbert H. Gary, Chairman of its Board of Directors, since the beginning; J. P. Morgan, whose financial genius and power made it possible; Geo. W. Perkins, who, as chairman of its finance committee, found arduous tasks in its first years; Chas. M. Schwab, who, as its first president, piloted it through the troublesome period of its organization; William Ellis Corey, who was its president for years; James A. Farrell, now occupying that responsible position; and many others.

Among those who have done most to make it a success without any effort to claim credit is Henry Clay Frick. Even before Mr. Frick began to actively devote his attention to the corporation he was on its board of directors and was recognized as the most forceful individual in the trade. He had, in his relations with Andrew Carnegie, done inestimable service in blazing the way for a better understanding of business honor and rectitude. These relations and their outcome form an incident so striking that I should like to say something further concerning them. However, to those familiar with the matter it will be sufficient to say that they probably had indirectly a good deal to do with the formation of the Steel Corporation, and that their outcome illustrates the fact that, in the steel business, as in other walks of life, ability usually wins. Mr. Frick remains one of the most important figures in the industry, and his work on the Finance Committee of the Corporation has added to the universal esteem and respect in which he is held by all who are familiar with the industrial and financial history of our country.

One of the things of which the iron and steel industries have a just right to be proud is the present attitude of our government toward them. In times of peace Washington has shown a disposition to amuse itself and entertain the public with efforts to regulate these corporations, but in time of war it turns to them without hesitation, finding them eager to render every service. At this time the government, through the War Industries Board, has prescribed certain basic prices for steel products, but at the same time it has shown its faith in the manufacturers themselves by asking them, through the Iron and Steel Institute, to arrange the details by which these prices may be made an actual fact. Under these circumstances, the fixing of prices has actually been done by patriotic manufacturers themselves, rather than by the government, and the manner in which the interests of the nation have been given preference is a striking testimonial to the high ideals existing among these men.

FRIENDS WHO HAVE MADE GOOD

It has been my privilege to enjoy the personal acquaintance and friendship of almost every man who has been prominent in iron

and steel in America, as well as of many of those who have achieved fame abroad. Among these are some who have closed long and honorable careers, and others who are still in the heyday of their usefulness; but, even more gratifying to me is the fact that in my experience it has been my pleasure to have in a certain sense been tutor and friend to many young men who have since proven their ability and energy by reaching positions of high usefulness and reputation. Julian Kennedy, whose career as an engineer has benefited the iron and steel industries in all parts of the world, came to the Mahoning Valley as a young man just out of college, and, while we thought he was rather too fond of rowing a boat on the little river there, he was evidently not wasting his time in fishing while doing so. Mr. C. A. Meissner, who is known to most of you as chairman of the coke committee of the corporation, was our first chemist at Brier Hill, and the first chemist, for that matter, employed at any of the furnaces in that locality. While with us he distinguished himself by making first-class "Scotch" pig iron out of Lake Superior ores, and while we had at first to keep a little imported Scotch pig around for the

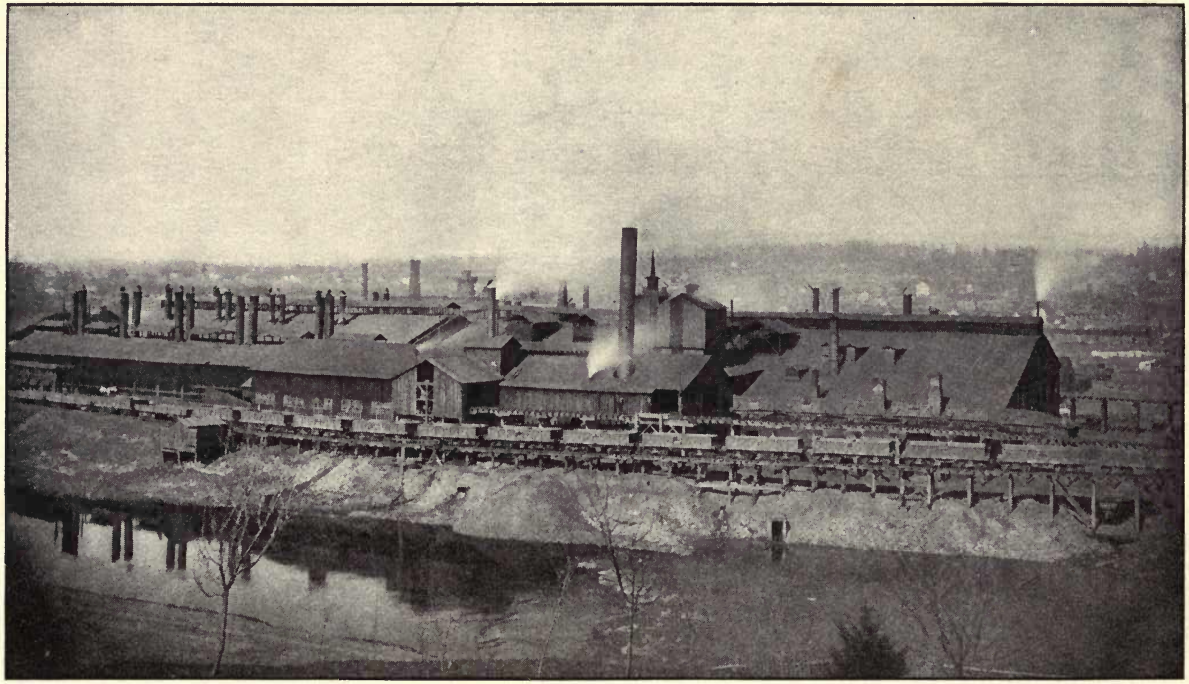
benefit of doubting Thomases, it was not long until "Brier Hill Scotch" was in strong demand all over the country. Mr. W. B. Schiller, Mr. F. B. Richards and the late Jasper Sheadle, are also Brier Hill by-products.

I would like, also, to claim credit for our young friend, Charlie Schwab, but Carnegie got hold of him first, and Andy always knew a good thing when he found it. Nevertheless, I wish to pay the compliment to Mr. Schwab of saying that he could hardly have done very much better had he been educated at Brier Hill. He has built up in the Bethlehem Steel Company, an institution which is a Krupp and a Creusot combined, with some advantages over both. So long as we have young men coming on with the brains and energy of those who are to be found in the various iron and steel organizations, the future of these industries in America is safe, and the country is safe also.

It has been said that: "Youth longs and manhood strives, but age remembers", and this is my excuse for indulging in reminiscences before a body of busy men intensely interested in the present and the future. To me it seems that this future can be gauged accurately from the

present and the past. The early days of iron making in this country are radiant with the spirit of progress and of patriotism. This spirit had no small part in making America monarch of all the forges, and it has not died out. We can depend on it to still preserve the wonderful lead we have attained in production, and to maintain the institutions to which we owe so much of all that is good for us and for the world.

It is as true today as it ever was that the civilization of a people may be told by their progress in the use of iron and steel, and I hope the time will never come when America will no longer lead all other nations in this respect. I hope also that the time will never come when men in our industry will show less public spirit or less patriotism than in the past. In the present crisis of our national life we need the high purpose and the unselfish devotion to country that our members have shown. We need the courage and vision of Judge Gary, our President, and we need the energy and ability of our younger manufacturers as never before.



Westerman Iron Co.'s Rolling Mills, Sharon, Pa., About 1895.

THE KAISER MISCALCULATED

In 1916 I spent six weeks in France and England with the American Industrial Commission. Had not what I saw there been sufficient to impress upon me the importance of the American Iron and Steel Industries in the world's struggle against despotism and scientific barbarism, the statements made to me by the leaders of the French and English people would have done so. Without the magnificent resources of our mines and mills the Allied cause would have been lost long ago. The genius, the energy, and the rectitude of purpose that made possible the splendid industrial development of America will also make possible the preservation of democracy. There can be no doubt whatever on this point. Our Government was not ready, but our mills were prepared. The biggest thing the Kaiser overlooked in his calculations was the American Iron and Steel industry.

It has been our great privilege, gentlemen of the Institute, to render aid on behalf of the world in the supreme hour of history. We are now called upon to make sacrifices in the same great cause, recently brought more directly home

to America, but scarcely more ours now than it was at the beginning of the war. That we shall do so with energy and devotion characteristic of our history and in keeping with our traditions I have not the slightest doubt.

Aside from the duty to aid our country in every way possible by the efficient operation of our properties and the ready co-operation with the Government already shown, our chief duty, as I see it, is to preserve the traditions and to continue the splendid record of the industries in our care. There is still much to be done. The limit of advancement has not been reached. In the future lies opportunity as great as that of the past. It must be grasped by younger men, for we older ones have reached the summit from which the prospect most alluring lies behind us. If the facts and reminiscences to which you have so patiently listened today give you inspiration to carry out the traditions and to emulate past performance of the great industries in which you are fortunate to be engaged, they will have accomplished their purpose and I shall have my reward.

SUPPLEMENT — (APPENDIX)

Because of the very general interest in the organization of the United States Steel Corporation, as well as because of the large part in the industries taken by many of those connected with the Corporation in official capacities, I have deemed it proper to include the following information concerning that organization.

From the statistics given herewith it will be seen that there have been numerous changes, combinations and additions made from time to time among the constituent companies, so that at this date (October, 1917), these companies number sixteen, as against twelve at the time the Steel Corporation was chartered (February 25, 1901).

It is a striking tribute to the growth of iron and steel production in this country that, while the Corporation originally controlled about sixty per cent. of American output, its total annual capacity at this time is somewhat less than fifty per cent. of the aggregate production of American mills and furnaces.

This information is given here, rather than in the body of this paper, because it was thought

best to avoid an excess of facts and figures which it would be difficult, if not impossible, for those who heard the paper read to assimilate and remember from merely hearing them, as well as because the paper itself was so largely a matter of personal reminiscence and personal experience.

APPROXIMATE ANNUAL CAPACITY
United States Steel Corporation

	TONS
Pig Iron	18,344,000
Steel Ingots	22,686,000
Finished Steel Products, for sale	16,500,000
Cement, Bbls	13,500,000

United States Steel Corporation

Manufacturing Companies in Organization

When Organized		*November, 1917*
Carnegie Steel Co. National Steel Co. American Steel Hoop Co.	Merged..	Carnegie Steel Co.
		Clairton Steel Co.
National Tube Co. Shelby Steel Tube Co.	Merged..	National Tube Co.
		The National Tube Co.
American Tin Plate Co. American Sheet Steel Co.	Merged..	American Sheet & Tin Plate Co.
American Steel & Wire Co.		American Steel & Wire Co.
		~~Union Steel Co.~~
American Bridge Co.		American Bridge Co.
Federal Steel Co.		Federal Steel Co.
Illinois Steel Co.		Illinois Steel Co.
Lorain Steel Co.		Lorain Steel Co.
		Indiana Steel Co.
		Minnesota Steel Co.
		U. S. Steel Products Co.
		Universal Portland Cement Co.
		Tennessee Coal, Iron & R. R. Co.

United States Steel Corporation

DATE ORGANIZED: {Incorporated February 25, 1901. Began Business April 1, 1901.

FIRST OFFICIALS: DIRECTORS

Class 1—Term Expires 1902		*Class 2—Term Expires 1903*		*Class 3—Term Expires 1904*	
Marshall Field,	William E. Dodge,	Francis H. Peabody,	Peter A. B. Widener,	J. Pierpont Morgan,	Elbert H. Gary,
Daniel G. Reid,	Nathaniel Thayer,	Charles Steele,	James H. Reed,	John D. Rockefeller,	George H. Perkins,
John D. Rockefeller, Jr.,	Abram S. Hewitt,	William H. Moore,	Henry C. Frick,	Henry H. Rogers,	Edmund C. Converse,
Alfred Clifford,	Clement A. Griscom.	Norman B. Ream,	William Edenborn.	Charles M. Schwab,	Percival Roberts, Jr.

EXECUTIVE ORGANIZATION: { The organization as below is given as of the several dates when important changes were made, the organization of the respective earlier dates continuing practically unchanged until date the later organization is shown.

At Date Organization, 1901	1903	1906	1911	1914 to 1917	DIRECTORS, 1917
EXECUTIVE COMMITTEE Elbert H. Gary, *Chairman.* Daniel G. Reid, William Edenborn, Edmund C. Converse, Percival Roberts, Jr., Charles Steele, Charles M. Schwab, *Ex-officio.* George W. Perkins, *Ex-officio.*	EXECUTIVE COMMITTEE was abandoned in 1903				*Term Expires 1918* Henry C. Frick, James H. Reed, Percival Roberts, Jr., Robert Winsor, *Term Expires 1919* George F. Baker, James A. Farrell, Elbert H. Gary, *Chairman,* J. P. Morgan, George W. Perkins, *Term Expires 1920* Robert Bacon, Samuel Mather, Thomas Morrison, John S. Phipps, Daniel G. Reid,
FINANCE COMMITTEE Robert Bacon, *Chairman,* Henry H. Rogers, Norman B. Ream, P. A. B. Widener, Elbert H. Gary, *Ex-officio,* Charles M. Schwab, *Ex-officio,*	FINANCE COMMITTEE Geo. W. Perkins, *Chairman,* Henry H. Rogers, Norman B. Ream, P. A. B. Widener, Henry C. Frick, Robert Bacon, Chas. M. Schwab, E. H. Gary, *Ex-officio,* W. E. Corey, *Ex-officio,*	FINANCE COMMITTEE E. H. Gary, *Chairman,* Henry H. Rogers, Norman B. Ream, P. A. B. Widener, Henry C. Frick, Geo. F. Baker, Geo. W. Perkins, Henry Phipps, W. E. Corey,	FINANCE COMMITTEE E. H. Gary, *Chairman,* H. C. Frick, Geo. F. Baker, J. P. Morgan, Jr., Geo. W. Perkins, Henry Phipps, Norman B. Ream, Percival Roberts, Jr., P. A. B. Widener,	FINANCE COMMITTEE E. H. Gary, *Chairman,* H. C. Frick, Geo. F. Baker, J. P. Morgan, Geo. W. Perkins, Percival Roberts, Jr., J. A. Farrell,	The By-Laws provide that the Chairman of the Board shall be the chief executive officer in general charge of the affairs of the Corporation. They also provide that the Chairman of the Board and the Chairman of the Finance Committee shall have all the power of the Finance Committee when it is not in session and that the Finance Committee shall have all the power of the Board of Directors when it is not in session. E. H. Gary since 1908 has been Chairman of the Finance Committee as well as Chairman of the Board of Directors.
OFFICERS *Chairman of Board*..... *President*.....C. M. Schwab *Vice President*....Jas. Gayley *Vice President*..... *Vice President*..... *Treasurer*.....A. F. Luke *Secretary*....Richard Trimble *Comptroller*...Edw. Shearson *Gen'l Counsel*....F. L. Stetson	OFFICERS E. H. Gary, W. E. Corey, Jas. Gayley, W. B. Dickson, Richard Trimble, W. J. Filbert, F. L. Stetson.	No Change from 1903 *Gayley retired Jan. 1, '09 and succeeded by D. G. Kerr.	E. H. Gary, J. A. Farrell, D. G. Kerr, John Reis, Richard Trimble, W. J. Filbert, F. L. Stetson,	No Change except as below R. V. Lindabury,	

HISTORICAL

Interesting Facts Concerning the Early History of the Use and Manufacture of Iron and Steel.

In response to numerous requests, the following historical data concerning the early use and manufacture of iron and steel is given herewith in order that it may be found in convenient form for reference. This information has been gathered from various sources, including most of the authoritative literature on the subject. The writer claims for it no originality. Nor can he claim for it absolute accuracy, since on many points the facts are somewhat in doubt and it has been necessary to give from a mass of conflicting statements those which seemed to be favored by the weight of the evidence.

The first use of iron probably antedates all human records and even the oldest traditions. The place at which it was first discovered, as well as the manner in which it was first worked, are lost in the mists of antiquity. There seems to be little reason to doubt that it was among the first of the metals to be used, in spite of a common impression that the use of bronze is older.

This impression seems to have grown out of reference to bronze in the earliest chronicles; but since it was more difficult to make bronze than iron, the latter was probably used in various ways before it was discovered that copper and tin could be combined to form a workable metal.

So far as is known, iron was first used in Western Asia and soon afterward in Northern Africa, although a few writers lean to the belief that the Chinese deserve credit for this discovery, as they do for a number of others made early in the known history of the race. The first reliable evidence of the employment of iron in weapons and tools comes from that part of the world in which man has left, through history and tradition, the first record of his existence and his activities. There is reason to believe that the first iron devoted to useful purposes was obtained from meteorites, and that the first iron ore taken from the earth was mined in Algeria, where ore deposits of unusual richness are found at this day.

The art of working iron seems to have reached very early in history a stage which would indicate that its source must have depended on

something more dependable than the finding of fragments from other worlds. Tubal Cain, described in Genesis as "the forger of every cutting instrument of brass and iron," was born in the seventh generation from Adam, and he must have had some method of securing the raw materials for his trade easily accessible and within reasonable distance from the cradle of the race. The Egyptians, whose existence as a people is believed to have begun two generations after Noah and whose civilization is the earliest of which we have authentic records, made considerable use of iron, which they most likely obtained from Algeria. An inscription found among the ruins of Karnak, in Upper Egypt, relates that Thothmes, who reigned about seventeen centuries before the Christian era, had received from the tributary kings of Lower Egypt presents of wrought metal, with vessels of copper, bronze and iron. The iron probably came from Algeria, and may have been worked before the Egyptians learned to fashion a cutting edge, otherwise they would probably have brought gifts in the form of weapons, which at that period of the world's history, were deemed the most important of all implements.

Steel seems to have been first made in Chalybia, a district in what is now Armenia, although it may have been known in other parts of the East at an earlier date. Steel and iron tools found in India and said to be three thousand years old are in the British Museum. They must have been made from steel formed by a process similar to the crucible process, for their quality is excellent, but of this there is no record. The famous pillar at Delhi is believed to have been erected six centuries before Christ, and if this supposition, which depends chiefly on an inscription in Sanscrit, is correct, the art of working iron in large masses was known in India at a very early date. The Delhi pillar is of wrought iron, almost entirely pure. It is 23 feet 8 inches in height and cylindrical in form, except that its diameter at the base is somewhat larger than at the top, the former being 16.4 inches. An ornamental capital surmounts the column. The pillar has been highly polished and is covered with inscriptions, although the metal is so hard that modern tools mark it only with the greatest difficulty. It has defied the elements for twenty-six centuries and is an object of great interest to metallurgists.

The inscriptions give no information as to why it was erected or by what method the iron was brought to that form.

Iron is mentioned in a Chinese record believed to have been written 2000 years before Christ. In this ancient land of mystery very little advancement has been made in the production of iron, and whether the metal was discovered first there or in Western Asia, the fact remains that at this time practically none of it is now produced on that continent.

The first authentic record of the use of iron in Europe indicates that this occurred about 700 B.C. although Greek mythology refers to it in chronicles far antedating that period. The Greeks are said to have used iron during the Trojan War, although their opponents were not acquainted with the metal, a fact which seems to be established by the failure to find any trace of iron among the ruins of ancient Troy. As in other instances, this use of the metal is a matter of tradition, and the first authentic reference to it in Grecian history is about 700 B.C.

The Romans learned that art of working iron from the Greeks, and at the beginning of

the Christian era it was extensively employed by them in the form of weapons, ornaments and in other ways. When Vespasian built the Coliseum with the labor of slaves brought from Jerusalem by Titus, about A.D. 32, he used iron ties to hold the great stones in place.

Abundance of rich ores in Spain led to that country becoming early one of the chief sources of iron and one of the earliest sources of steel in Europe. There the first advances were made in the smelting of ore by the invention of the Catalonian forge, which was later used in every country in Europe and even in this country. This primitive furnace may still be found in use in many parts of the world. The forges of Aragon and Catalonia acquired high fame in the production of steel, and the swords of Toledo have never been excelled in beauty and quality. Here, as in Asia and China, development of efficient methods never made much progress, and Spain is now among the inconsequential producers of iron and steel.

The Belgians were among the first European peoples to make much progress in these industries, and they have always been relatively large producers of iron and steel, as well as among

the most skillful artificers in these metals. They made iron before the invasion of the Romans, and have been known as the most accomplished artists in certain lines of its manufacture since that time. The pathetic fate of their great factories under the heel of the Prussian invader is one of the features of the present European war.

The Germans were among the last peoples in Europe to be civilized and among the last to learn the art of manufacturing iron. They have, however, made greater progress in this line than most other nations. At a time when the Roman soldiers were equipped with iron swords and lances and even iron armor, the Germans fought them through their dark forests with wooden spears, bows and arrows. Not until 1,000 years after the beginning of the Christian era did these Germans begin to make iron in any quantity. They then invented the "stuckhofen" an improvement on the Catalan forge, and later they devised the "blauofen" which was the progenitor of the modern blast furnace. The "blauofen" was gradually developed until 1450 A.D. a furnace of this type 24 feet in height was operated in the Thuringian mountains. This furnace was equipped with a wooden bellows,

which a church organist had invented to supersede the leather bellows. At the beginning of the present war, Germany stood second in the list of the world's producers of pig iron, with a tonnage of almost 12,000,000 as compared with 30,000,000 in the United States and 9,000,000 for England.

France has never been a great producer of iron and steel, and the history of those industries on Gallic soil has been about the same as in other parts of Europe. In none of the old world nations was much progress made in the ten centuries preceding the Nineteenth, but since that time the growth of iron and steel manufacture has been rapid. The Krupp Works at Essen, Germany, and the Creusot Works in France were founded about the beginning of the last century and since that time both countries have advanced rapidly in the use of improved methods. France produced about 4,000,000 tons of pig iron in 1915. Her great steel works are now almost exclusively devoted to the manufacture of munitions of war.

The blast furnace made its first appearance in England in the Fifteenth Century and there, as everywhere else, the result was an astonishing

development of the industry. The great problem of previous ages had been to secure temperatures high enough to melt iron ore rapidly, and when this was solved by the use of an effective blast, other improvements followed immediately. England was the first country to feel the shortage of wood caused by the consumption of whole forests in making charcoal for blast furnace fuel, and in the middle of the Seventeenth Century the iron industry suffered a severe check because of a popular uprising against the further use of wood for this purpose. It was feared that if the blast furnaces kept on demanding charcoal not enough timber could be found to maintain the royal navy. This agitation led to the discovery of coke about 1750, and with it came almost a revolution in the manufacture of iron.

Crucible steel was first made in England in 1740, the process having been discovered by Benjamin Huntsman, who was not an iron worker, but a maker of clocks.

The art of working iron was brought to this hemisphere from the Old World. The North American Indians had absolutely no knowledge of it, and there has been found no evidence that

the Mound Builders ever smelted iron, although it is probable they knew its value, for they used a few weapons and tools fashioned from meteoric iron by hammering. In Mexico and South America the Spaniards found the natives familiar with the process of smelting and working silver and gold, but they apparently knew nothing of the use of iron.

It was in quest of gold, too, that the first discovery of iron ore on this continent was made by the English. They were, of course, disappointed that the more precious metal could not be found, but events have proved the iron deposits of North America to exceed in wealth the most fabled dreams of the original gold seekers.

Iron was first discovered in North Carolina in 1585. Ore was shipped to England from Jamestown in 1608. Ten years later a bloomary and forge were erected at Falling Creek, Va., but before they were put in operation the Indians descended on the workmen, slaying them and destroying their enterprise. Thus Virginia lost the honor of producing the first iron in America. This went to Massachusetts, where, in May, 1645, the first successful smelting of

iron ore on this side of the world took place, three tons being made at Lynn during May of that year.

Little progress in the manufacture of iron or steel was made in this country, from this time until the early years of 1800, the colonies having been encouraged to depend on the mother country for their supplies and many difficulties being encountered in the then new and thinly settled regions where the first iron enterprises had been established. At the close of the Eighteenth Century the Napoleonic wars distracted the attention of the English from American markets and required all the product of their furnaces, so that by 1812 the iron industry in the United States had attained some headway, furnaces being erected in many parts of the country where ore could be found and where wood for charcoal was abundant.

Then came the downfall of Napoleon, and soon after the revival of the export trade of Britain, which had a disastrous effect on these new enterprises as well as on all manufactures in this country. Many of the furnaces were unable to compete and went out of commission. But little progress was made from 1820 until

the opening of the Civil War, which created an immediate demand for iron and steel. Many new furnaces were erected, every method of increasing production was eagerly seized, and from that time forward the growth of the industries has been phenomenal.

Developments following the Civil War period have been discussed at length in the paper, "Sixty Years of Iron and Steel," which immediately precedes this chapter.