Cornwall Iron Furnace

Administered by the Pennsylvania Historical & Museum Commission

National Historic Mechanical Engineering Landmark

The American Society of Mechanical Engineers
Susquehanna Section

Cornwall Iron Furnace
Cornwall, Pennsylvania
June 8, 1985

CORNWALL IRON FURNACE

IRON

"As they gather silver, and brass, and IRON, and lead, and tin, into the midst of the furnace, to blow the fire upon it, to melt it..." Ezek. 22:20.

The factors that gave rise to the Industrial Revolution have been the subject of endless speculation by historians who have concluded variously that these were simple and complex; the result of naturally unfolding events and deliberate design; and furthermore, that if there was a single root circumstance that made possible this most momentous event in the progress of civilization it was the development of: sophisticated mining techniques; or the invention and spread of the steam engine; or the emergence of the factory system of manufacturing; or any one of a number of others. While all of these occurrences indeed were important contributors to the Industrial Revolution, they were underlain by a single crucial one upon which all the others were totally dependent and in the absence of which neither they nor nearly any other element of our industrialized society could have evolved: the large-scale, efficiently organized, wide-spread production of the ferrous metals. Without iron, cheaply and easily available, the machinery of the Industrial Revolution could not have existed. Without the steel into which a certain portion of the iron was converted the tools not only to produce the machinery but to work the mines and fields and to carry out literally every aspect of human endeavor could not have been—could not be—possible. Iron and steel, plentiful and cheap, are the foundation upon which rests practically every aspect of life, from the necessities of food, clothing, and shelter to everything beyond...

IRON IN THE COLONIES

Although American colonial life depended principally on wood for most of its mechanical needs, nearly every wooden structure, vehicle, mill, tool, boat, and domestic appliance required some iron to join, band together, cut, or resist wear. For that reason the iron furnace made an early appearance in the American colonies. An even more compelling reason for this was exploitation by English companies of the rich iron ore deposits and limitless forests that provided the fuel for smelting it into pig iron and forging the pig into bar iron, both products shipped back to the mother country from the earliest period of settlement.

As early as 1619 a group of English investors established a blast furnace at Falling Creek near present-day Richmond, Virginia. But what would have been the first iron making establishment in America failed when the workmen were massacred and the furnace was destroyed by Indians. The first successful venture was in the Massachusetts Bay Colony at Saugus, near Lynn, north of Boston. The Hammersmith Ironworks, as it was known, went into operation in 1647. It was an integrated works, its heart the blast furnace that produced pig iron and a line of cast-iron goods made by pouring the molten iron directly from the furnace into moulds. There also was a forge, in which a portion of the pig was reheated and worked under a tilt hammer to convert it into malleable wrought-iron blooms which in turn were rolled out and slit in the rolling mill to form that eminently useful item of commerce, nail rod. From that blacksmiths and other craftsmen produced an infinite variety of finished products, from nails and builders' hardware to plowshares and hoes to rifles and tools; the myriad iron objects so vital to life, both in the colony and "at home."

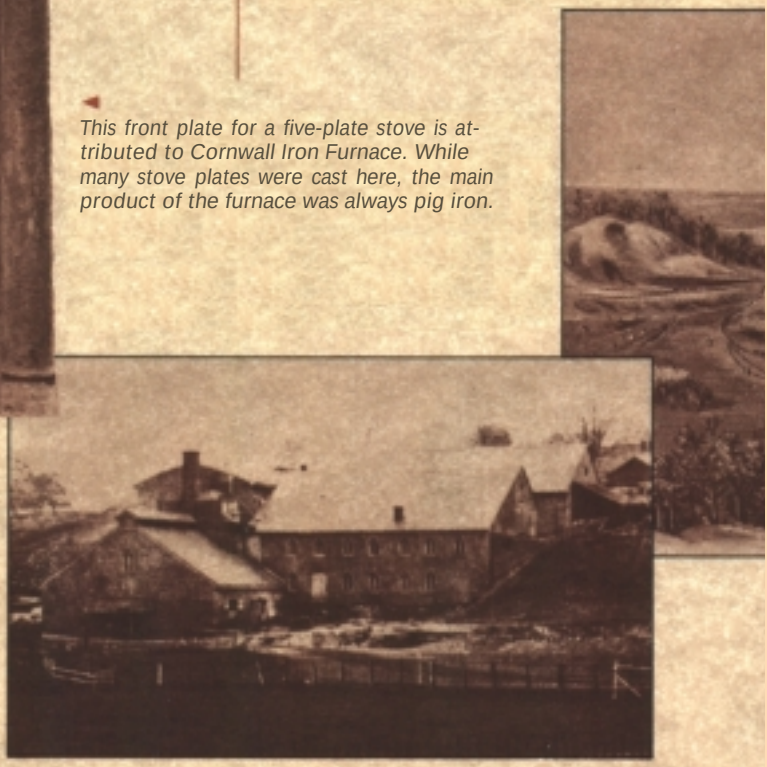
It was Pennsylvania, however, that eventually became the prime center of iron production in the colonies, a simple consequence of the happy combination within its borders of seemingly infinite deposits of the richest iron ores, endless timberlands, great deposits of limestone needed as a flux in the blast furnace, and plentiful water power to drive both the bellows that provided the blast air to the furnaces and the hammers and rolls that worked the pig iron into wrought-iron plate and bar. Finally—and nearly as vital as the resources put in place by nature—Pennsylvania was blessed with a great pool of ironmasters and workmen, mostly German, skilled in furnace and forge operation.

Despite both competition from British furnaces and forges, and a variety of restrictive measures imposed by Britain on the colonial iron industry in an effort to maintain its own interests, Pennsylvania's iron production flourished and grew between the early years of the 18th century and the Revolutionary War. Iron was first produced in the colony about 1720 at the Colebrookdale Furnace in Berks County, perhaps named for the celebrated Coalbrookdale Furnace operated by the Darbys in Shropshire. By the time of Cornwall Furnace's establishment 22 years later there were nearly a dozen furnaces in Pennsylvania and twice as many forges.

At the start of the Revolution the colonial iron industry actually was larger than that of the mother country, with 80 furnaces in nine of the colonies. There were more in Pennsylvania than any other colony—about twenty. America produced about one-seventh of the world's iron at the time, ranking third in production behind Russia and Sweden. Great Britain ranked fourth. It was this capacity that enabled the colonies to manufacture ordnance and ammunition in quantities sufficient to wage a successful war with England.

This front plate for a five-plate stove is attributed to Cornwall Iron Furnace. While many stove plates were cast here, the main product of the furnace was always pig iron.

Most iron furnaces were called on during the American Revolution to cast cannon, and Cornwall was no exception. Forty-two naval cannon were cast here, along with much ammunition. This cannon, once displayed on the lawn at the ironmaster's estate, has been returned to the Cast House where it was made, probably in 1775.



CORNWALL IRON FURNACE as it appeared circa 1860. Left to right: Cast House, Top of Furnace, Bridge House, and Engine House. In the background are visible the Charcoal House and Mule Stables. Notice the railroad tracks terminating just outside the Cast House.

THE CORNWALL FURNACE

From its inception Cornwall occupied a special position among Pennsylvania's iron furnaces. It owes its existance to the renowned Cornwall Ore Banks a few miles south of Lebanon, a deposit of extraordinarily rich magnetite ore that until development of the Lake Superior deposits was one of the most valuable iron-ore bodies in the U.S. It had been discovered in 1734 by Peter Grubb during a prospect. By 1737 he had purchased some 450 acres of the iron-rich land and in 1742 built a blast furnace, naming the site Cornwall for the English county of mining fame where his father had been born. Both mine and furnace survive to the present day in testimony to the vital role played by the American iron industry during the 18th and 19th centuries in the nation's growth. The mine when in work was the largest open-pit metaliferous mine in the eastern U.S. It was exploited until 1973 when the damage caused the previous year by the flooding accompanying Hurricane Agnes damaged the underground sections beyond economic restoration and it was abandoned by the Bethlehem Steel Company, which had operated the mine since about 1883. The decision to quit the workings at that time was reinforced by the fact that the ore was about played out in any case. With the cessation of mining operations, and accordingly, pumping, came the inevitable flooding, leaving the mine a pleasant, rock-bound lake.

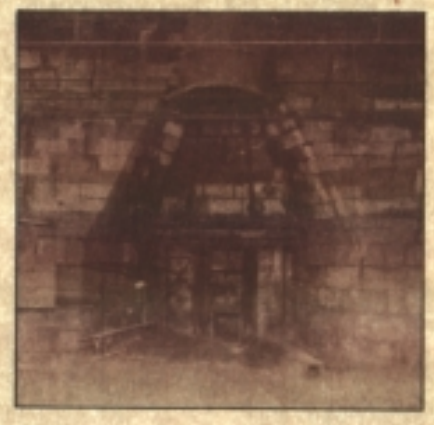
The history of mine and furnace diverged in 1883. Grubb operated the furnace only until about 1745 when he leased it to a company. He retained oversight of the ore banks, however, until his death in 1754 when it passed to his sons Curtis and Peter. The entire site was purchased from various Grubb heirs between 1785 and 1798 by Robert Coleman. Under the Coleman family's stewardship Cornwall flourished during the century following, going out of blast, finally, in February, 1883.

At that point, the saga of the Cornwall Furnace ceases to be one simply of a successful Pennsylvania blast furnace that had been brought up-to-date in 1856, prospered during a heyday of some 25 years following, and then shut down in the face of competition from the newer, larger, furnaces of the trans-Allegheny region that were based on the vastly more efficient technology of the hot-blast and coke fuel. The sequence was a common one. Even today the former iron-producing regions of Pennsylvania and many of the other central Atlantic states are dotted with the remains of many of these furnaces, in nearly all cases nothing more surviving than the stone furnace stack. The blowing and other machinery early was salvaged for either reuse or, more frequently, for its value as scrap metal; the timber roofs and walls of the buildings in time succumbed to the weather; and in more cases than not even the durable furnace itself was laid waste by local builders who took it as a source of ready-quarried-and-cut architectural stone.

That Cornwall was spared the depredations of weather and salvage is nothing less than a miracle of industrial archeology. That it has survived as the only 18th/19th-century American blast furnace with its original fabric essentially intact is the result of nothing less, apparently, than family pride—if not sentiment—bolstered by the means that made disposal of the land unnecessary. When the furnace went out of blast in 1883, it remained in the Coleman family which continued to operate other, more modern furnaces in the area. Clearly, the old site was kept and, most important, maintained, as a monument to earlier generations of Coleman ironmasters. In 1931 Margaret C. Buckingham, a great-granddaughter of Robert Coleman, deeded the furance and its immediate ancillary structures, with their land, to the Commonwealth as a historic site, in the capable hands of which it survives today. In the visitors' center and throughout the site the technology of ironmaking in general and the saga of the Cornwall mine and furnace in particular, are clearly laid out.

THE FURNACE'S PHYSICAL HISTORY

Cornwall had two distinctly different lives. When constructed in the middle of the 18th century it seems from the scant surviving descriptions to have been entirely typical of American iron furnaces of the period. It was a squat stone stack 20-feet square at the base and 11 at the top, with a height of 31 feet. The blast air was provided by a pair of wood-and-leather bellows nearly 21 feet long driven by an overshot water wheel taking its energy from



This photograph of the front of the furnace was taken in 1898. Built in 1742. the furnace stack was rebuilt in 1856 and enlarged from 20 to 28 feet square at the base and from 11 to 21 feet square at the top. The hood over the arch is now missing, but the rake remains.

In the mid-19th century boilers were placed on top of the furnace stack to power the steam engine, which drove the blast equipment. The boilers are clearly seen in the brick structure atop the furnace. The furnace gases passed beneath them and were exhausted through the chimney.

a small stream that traversed the site. The furnace was open at the top, and the measured batches of ore, charcoal fuel, and limestone were charged in more or less continuously simply by being dumped into the opening by wheelbarrow. When the furnacemaster determined that a sufficient quantity of molten iron had been smelted from the boiling mass the blast was stopped and the simple clay dam at the opening in the furnace bottom was partially removed allowing the liquid slag to run off. The dam then was further lowered and the iron, pooled at the very bottom of the furnace, ran out into the moulds prepared in the floor of the casting house, to form the pigs and the pots, firebacks, or other, mainly domestic, products being cast at the moment. The pigs were about three feet long and weighed something less than 100 pounds, so sized that a man could lift and handle them. During the Revolutionary War cannon and shot were cast at Cornwall as at many other colonial furnaces.

The average weekly production was about 20 tons of iron although in one record year 1457 tons were run out, a weekly average of some 28 tons.

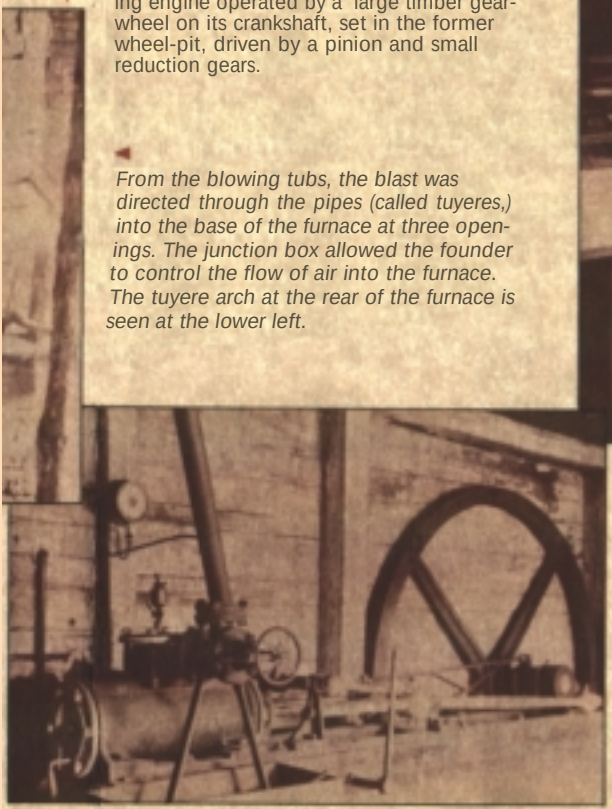
In 1856-57, after more than a century of service, the furnace was almost totally rebuilt. It is apparent that the only original fabric retained was the core of the furnace itself and the masonry of the waterwheel pit. The furnace buildings were rebuilt in stone and the furnace strengthened and enlarged to its present size, although the capacity was not increased. The major functional change was replacement of the bellows by a vertical blast engine consisting of two wooden blowing cylinders or "tubs." This was driven by a 20-horsepower horizontal steam engine that superceded the waterwheel. The engine was built by the West Point Foundry of Cold Spring-on-Hudson, New York. The engine's relatively high speed was reduced to the lower speed at which the blowing engine operated by a large timber gearwheel on its crankshaft, set in the former wheel-pit, driven by a pinion and small reduction gears.

Steam for the engine was provided by a pair of plain cylindrical West Point boilers set in the throat of the furnace, heated directly by the escaping furnace gases.

The result of this campaign of modernization is the Cornwall Furnace we see today. Interestingly, the basic ironmaking process remained the same. Neither anthracite coal nor coke were introduced as the smelting fuel although both by then had found limited use in some furnaces of the region, and the "cold blast" was retained despite the fact that the system of heating the b blast air by heat exchange with the furnace exhaust had been in use for nearly a quarter of a century at a number of American blast furnaces. It was a process around which controversy still swirled, however Although generally it was conceded that use of the hot blast did increase production efficiency, opinion among ironmasters and users was strongly divided on the question of the quality of the iron so produced. There was sufficient force of argument holding that a higher quality of both pig and wrought iron resulted from the "cold-blast, charcoal process" that the adoption of the newer methods was far from immediate or universal. During the transition period from about 1860 to 1890 the principal uses for charcoal iron were for the production of specialty steels employed in the tool and allied industries, and for those elements of railroad rolling stock most subject to impact and stress reversal: car wheels and axles, and locomotive driving-wheel tires. Improved methods of steel making—particularly the widespread use of the open-hearth furnace—resulted in the ready availablity of steels equal to those produced from charcoal iron and the eventual total demise of the old process.

Iron vessels cross the ocean;
Iron engines give them motion;
Iron needles northward veering;
Iron tillers vessels steering;
Iron pipes our gas delivers;
Iron bridges span our rivers;
Iron pens are used for writing;
Iron ink our thoughts inditing;
Iron stoves for cooking victuals;
Iron ovens, pots and kettles;
Iron horses draw our loads;
Iron rails compose our roads;
Iron anchors hold in sands;
Iron bolts and rods and bands;
Iron houses, iron walls;
Iron cannon; iron balls;
Iron axes, knives and chains;
Iron augers, saws and planes;
Iron globules in our blood;
Iron particles in food;
Iron lightning-rods on spires;
Iron telegraphic wires;
Iron hammers, nails and screws
Iron everything we use!

An anonymous 19th-century poem intended to instill in children an appreciation of iron's universality.



From the blowing tubs, the blast was directed through the pipes (called tuyeres,) into the base of the furnace at three openings. The junction box allowed the founder to control the flow of air into the furnace. The tuyere arch at the rear of the furnace is seen at the lower left.

The large gear wheel which ran the blowing tubs and provided the cold air blast measures 76 feet in circumference.

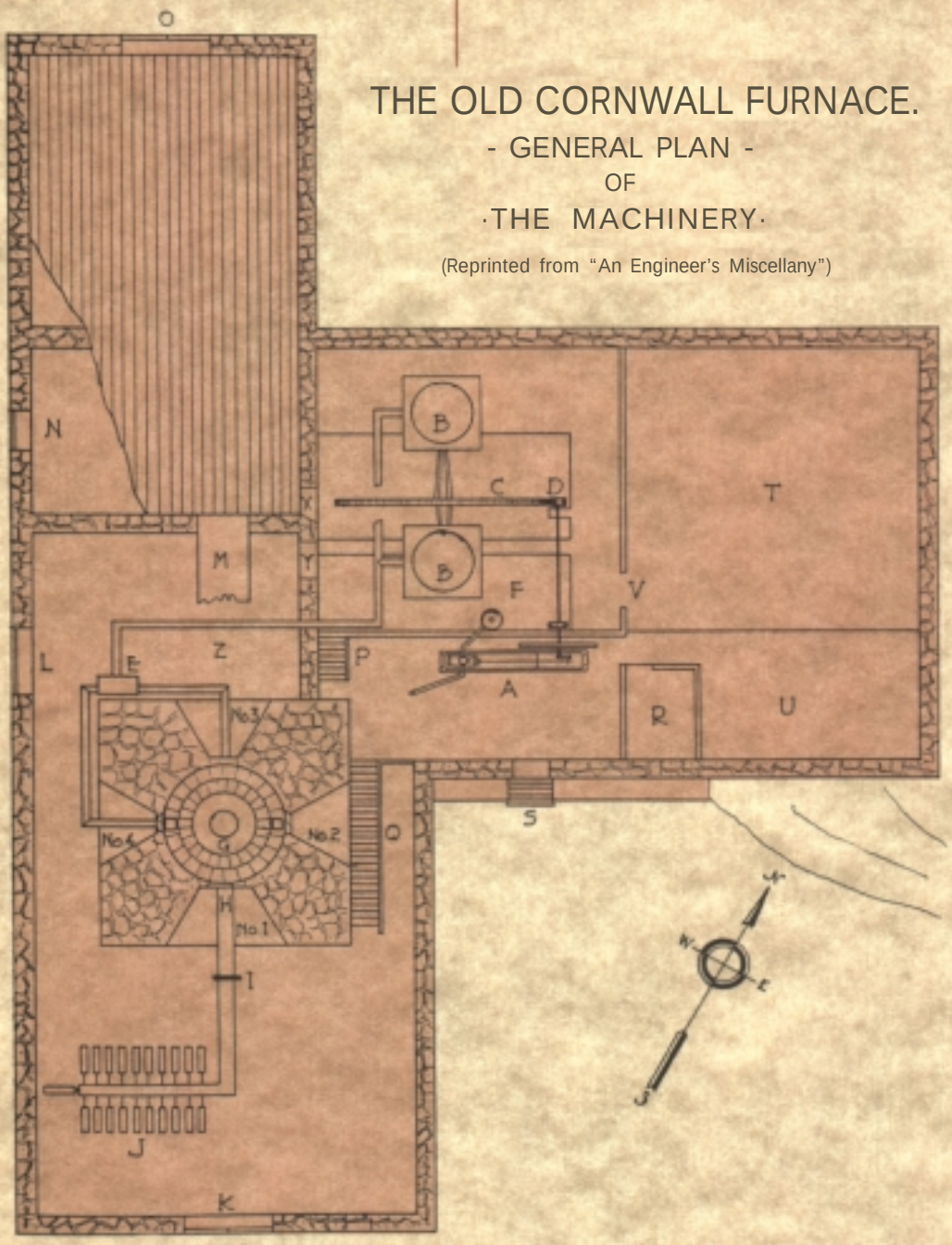
The steam engine which drove the blast equipment was made at the West Point Foundry at Cold Spring, New York. It was installed around 1856. A 20 horse power, single cylinder engine, it has a fly wheel 9 feet in diameter. Steam was generated by two boilers on top of the furnace stack, using otherwise wasted heat.

OFFICE OF THE CORNWALL IRON COMPANY LIMITED stands at the entrance to the ironmaster's estate, adjacent to the furnace site. This building also served as an office for the estate and was built probably by 1875.

THE OLD CORNWALL FURNACE.

- GENERAL PLAN -
OF
·THE MACHINERY·

(Reprinted from "An Engineer's Miscellany")



During its active existence and under the management of its many masters, the Cornwall Iron Furnace was a leading producer of pig iron as well as other products of the foundry floor. Now that its commercial usefulness has long since passed away and the quiescent silence of old age is wrapped around its ancient walls, few who now visit there can conceive it as it was in younger days, rampant and roaring with flame and noise, one out of many that have played their part in our iron age.

KEY TO THE FLOOR PLAN OF THE CORNWALL IRON FURNACE AND FOUNDRY

A–The engine room.
B–Cylinders of the blowing engine.
C–The great gear wheel.
D–Pinion and shaft.
E–Regulator valve for the blast.
F–Old water wheel pit.
G–Boshes of the furnace.
H–Damstone of the crucible.
I–Slag dam.
J–Pig iron moulds
K–Entrance to the foundry floor.
L–Old entrance to the foundry.
M–-Charging platform.
N–Foreman's room.
O–Entrance to the weighing room.
P–Stairway to men's sleeping quarters.
Q–Stairway down to the foundry floor.
R–Watchman's room.
S–Steps up tp the engine room.
T–Copper room, upper level.
U–Copper room, lower level.
V–Entrance to the blowing engine room.
X–Exit from weighing room to stairs P.
Y–Opening for the pitman, on early water wheel.
Z–Position of the early bellows.
1 to 4–Furnace arches as originally designated.

FOR FURTHER READING

Greville Bathe, *AN ENGINEER'S MISCELLANY.* Philadelphia: Patterson & White Co., 1938. Chapter VI, "The Old Cornwall Furnace" (pp. 61-77), is the most complete account of Cornwall and contains the most detailed description of its physical plant, with photographs and measured drawings by the author (his plan is reproduced in this booklet). Long out of print but available in many libraries.

Arthur Cecil Bining, *PENNSYLVANIA IRON MANUFACTURING IN THE EIGHTEENTH CENTURY.* Harrisburg: Pennsylvania Historical & Museum Commission, 1973.

W. K. V. Gale, *IRON & STEEL.* The Ironbridge Gorge Museum Trust, 1979. 32pp., illustrated. A good general exposition on the historical development of the technology, principally in Great Britian. Available: IGMT, Ironbridge, Telford, Shropshire TF8 7AW, England.

W. David Lewis, *IRON & STEEL IN AMERICA.* Greenville: Eleutherian Mills-Hagley Foundation, 1976. 60pp., illustrated. The best brief survey of the industry in this country, describing not only its growth but also the principal processes for making iron and steel. Available: The Hagley Museum & Library, Box 3630, Greenville, Wilmington, DE 19807.

James R, Mitchell, *CORNWALL'S ROLE IN THE HISTORY Of AMERICAN MANUFACTURING.* Manuscript. Harrisburg: Pennsylvania Historical & Museum Commission, 1985.

Robert G. Peets, *MINING HISTORY AT CORNWALL, PA.* 1957; revised by H. O. Olsen, 1970. Bethlehem Mines Corporation, Cornwall, PA.

James M. Swank, *HISTORY OF THE MANUFACTURE OF IRON IN ALL AGES, AND PARTICULARLY IN THE UNITED STATES FROM COLONIAL TIMES TO 1891.* Philadelphia: The American Iron & Steel Association, 1892 (2nd Edition). While the references to Cornwall are sparce, this is regarded as still the best broad history of the industry in America.

THE MAKING, SHAPING & TREATING OF STEEL. Pittsburgh: United States Steel Co., 11th edition, 1985. This immensely informative and interesting work, published since 1920 by USS, is principally an industry textbook on all aspects of steelmaking, from the mine to the finished product. Available: The Assn. of Iron & Steel Engineers, 3 Gateway Center, Pittsburgh, PA 15222.

ACKNOWLEDGEMENTS

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NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

WHEN ERECTED BY PETER GRUBB TO SMELT THE RICH IRON ORE OF THE NEARBY CORNWALL ORE BANKS, THIS STONE-BUILT BLAST FURNACE WAS TYPICAL FOR ITS TIME, PRODUCING ABOUT 20 TONS OF PIG IRON AND CAST-IRON PRODUCT PER WEEK

A MAJOR RECONSTRUCTION IN 1856-57 PRODUCED IMPORTANT CHANGES. THE FURNACE ITSELF WAS ENLARGED; THE BLAST-AIR BELLOWS WERE REPLACED BY A OF PAIR OF WOODEN CYLINDER "BLOWING TUBS"; THE WATER WHEEL THAT HAD POWERED THEM WAS REPLACED BY A 20-HORSEPOWER STEAM ENGINE; AND A PAIR OF WASTE-HEAT BOILERS TO SUPPLY THE ENGINE WAS INTO THE OPEN STACK OF THE FURNACE.

THE FURNACE WAS IN BLAST UNTIL 1883 IN THIS FORM, AND SO REMAINS THE ONLY ONE OF AMERICA'S HUNDREDS OF 19TH-CENTURY CHARCOAL-FUELED BLAST FURNACES TO SURVIVE FULLY INTACT.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS–1985

Over 80 National Historic Landmarks have been designated since the program began in 1973. **14** International Landmarks and **8** Regional Landmarks have also been recognized by the Society. Each represents a progressive step in the evolution of mechanical engineering, and each reflects its influence on society, whether it is of significance in its immediate locale, in the nation, or throughout the world. For more information about this and other programs sponsored by the ASME History and Heritage Committee please contact the ASME Public Information Dept. at 345 E. 47th St., New York, NY 10017. (212) 705-7740.

IMPORTANT DATES FOR CORNWALL IRON FURNACE

1734-
Peter Grubb buys land containing iron ore which became the great Cornwall Ore Banks.

1739-
Construction of Cornwall Furnace begins

1742-
Furnace put in blast.

1785-98
Cornwall Furnace and mine pass into the hands of Robert Coleman.

1856-57-
Furnace rebuilt and enlarged; steam engine and blowing tubs installed.

1883-
Furnace goes out of blast in February.

1932-
Furnace site is donated to the Commonwealth by Margaret C. Buckingham.

1966-
Cornwall Iron Furnace is designated a National Historic Landmark by the United States Department of the Interior.

1976-
Cornwall Iron Furnace is designated an ASM Historical Landmark by the American Society for Metals.

1985-
Cornwall Iron Furnace is designated a National Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers.

Making Sure Our Past Has A Future

CORNWALL IRON FURNACE ASSOCIATES, INC.

The ASME Susquehanna Section—
Mechanical Engineering Landmarks to date:

Kaplan Turbine–
York Haven Hydroelectric Station
York Haven, Pennsylvania
October 20,1980.

Worthington Pumping Engine–
York Water Company
York, Pennsylvania
May 7, 1982.

Electric Locomotive GG1 4800—
Railroad Museum of Pennsylvania
Strasburg, Pennsylvania
April 23, 1983