IRON MINING IN CONNECTICUT.

I. Ores and Ore-Beds.

BY W. H. C. PYNCHON.

IT is rather a pleasant change to turn from the geological features of Connecticut which are of scientific interest only, to those other geological features which are of general interest — which not only concern the structure of the region itself, but are intimately connected with the life of its inhabitants and with the development of its industries. This twofold interest is possessed in a marked degree by the iron deposits of Connecticut.

Our forefathers found that their promised land, like the Canaan of the Israelites of old, was "a land whose stones are iron and out of whose hills thou mayest dig brass." The industries connected with the mining of copper, which flourished in Connecticut until the opening of richer fields in other parts of the United States made the undertaking unprofitable, have been fully treated in a previous article in the Connecticut Quarterly by Mr. E. M. Hulbert.* Accordingly, these papers simply undertake to give a short sketch of the rise and decline of the iron industries of the State, which at one time had a wide spread and well deserved fame. Although it is a temptation to begin at once with the early history of iron smelting in the "land of steady habits," it may be well to stop a moment to consider briefly the conditions under which the irons occur and the chief steps in the process of the reduction of ore to pig-iron and of pig-iron to wrought-iron or to steel, in order that we may see just what problems presented themselves to the new world disciples of Tubal Cain.

Native Iron, that is, metallic iron—iron as we commonly know it—is of the very rarest occurence on the earth. Most of it is to be found in meteorites and is therefore not of terrestrial origin. Small grains of it have been found in basaltic and other related rocks, while masses found imbedded in similar rocks at Ovifac, Greenland, supposed at one time to be of meteoric origin, have since been fully proved to be terrestrial. This makes the sum total of occurences of native iron, as far as known.

As a matter of fact, metallic iron has such a strong tendency to unite chemically with other substances, notably oxygen, that it is only in combination with these that we find it, and the work of the iron-smelter is to break up these compounds and to isolate the iron from these substances with which it is united. Even then we have difficulty in keeping it pure, for as soon as it becomes wet it rusts; that is, it begins to take up oxygen again and to return to the form of a compound. Iron ore, then, is simply iron in natural chemical combination with other substances, and the various iron ores receive different names in accordance with the different substances with which

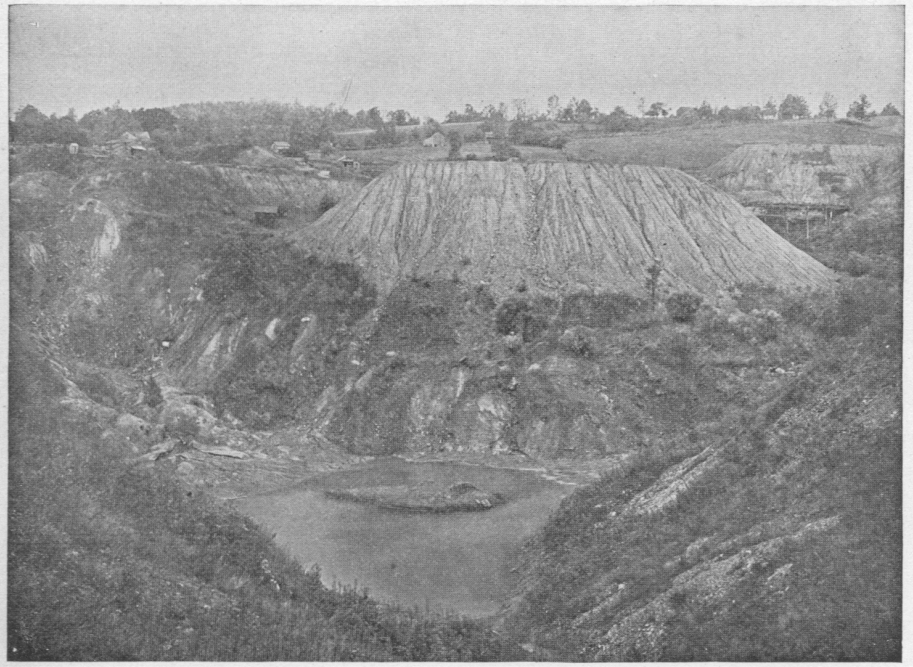
*Vol. III. No. 1.

it is united. The commoner ores, those which are of commercial value as sources of iron are as follows:

Magnetite. The richest of the ores is magnetite or magnetic iron-ore, a compound of iron and oxygen possessing about 72 per cent. of pure iron. It is black and heavy, usually massive or granular, and has the power, when in large lumps, of attracting to itself small pieces of iron. It is to the presence of magnetite that lode-stone owes its power. The ore occurs in some places in the form of sand.

Hematite. This is also a compound of iron with oxygen, but in different proportions from magnetite, although the percentage of iron is but little lower. The color is variable. When massive, it is often of a dark steel gray; when earthy, it is red. The *powdered* mineral, however, is always red or reddish and this is enough to distinguish it from the next ore, limonite, which sometimes quite closely resembles it. It is a very widely distributed and valuable ore. The red ochre of the painter is powdered hematite.

Limonite. This is a compound similar to hematite, except that there is incorporated with the iron and oxygen a certain amount of water. This, of course, lowers the proportion of iron in a given amount of ore, so that the metal only reaches something over 50 per cent. Though various in appearance, it may be readily distinguished from hematite by the fact that the powdered mineral is always yellow or yellowish. It should be noted that limonite is often somewhat loosely called brown hematite in distinction from red hematite which is a true hematite. A loose and porous form of limonite found



THE ABANDONED PIT, ORE HILL.

in marshy places and often containing very considerable organic remains is commonly known as bog iron or bog ore. The yellow ochre of the painter is a powdered limonite, and the yellow rust which forms when iron is exposed to water is simply a return of metallic iron to this ore. These ores are all oxides of iron, the next most common form is a carbonate.

Siderite or *Spathic Iron Ore*. This is a compound of iron, carbon and oxygen, giving 62 per cent. of the pure metal. It is usually brownish or yellowish and, to the ordinary observer, suggests anything but an iron compound. It looks more, perhaps, like an impure limestone.

Very impure clayey or earthy forms of these last three ores are rather indiscriminately known by the name of clay ironstone. It should be remembered that the proportions of iron given above for each mineral are the proportions for absolutely pure ore. Earthy impurities may exist in great quantity immensely modifying the percentage of metal.

It must not be understood that these are the only iron minerals that occur, but these are the principal ores which are the source of the metallic iron of commerce.

The ore deposits of Connecticut lie principally in the western part of the state and extend over into the neighboring portions of New York and Massachusetts. These deposits many years ago gave rise to a most flourishing industry along the general line of the Housatonic river, until the iron produced in that region had a reputation above that of the iron from any other section. The opening of new deposits in portions of the country, where conditions were vastly more favorable to a cheap production of metal, long ago carried the center of the industry far from New England. But the superiority of Salisbury iron for special castings requiring great strength, notably car wheels, still makes it profitable for certain manufacturers to pay the higher price which the difficulty of production makes necessary. The Barnum Richardson Company are now the sole producers, but the deserted furnaces scattered throughout the region tell of the period when it was expected that Western Connecticut would contain the Birmingham of the New World.

Of the several varieties of iron ore found in Connecticut, the most important on account of its quantity, accessibility, and the excellence of the iron produced is the so-called brown hematite, a hard dark form of limonite. Of the three towns, Salisbury, Sharon and Kent, within which this ore has principally been mined, the former has the more important deposits. In fact, these are the only beds from which ore is being taken at the present day.

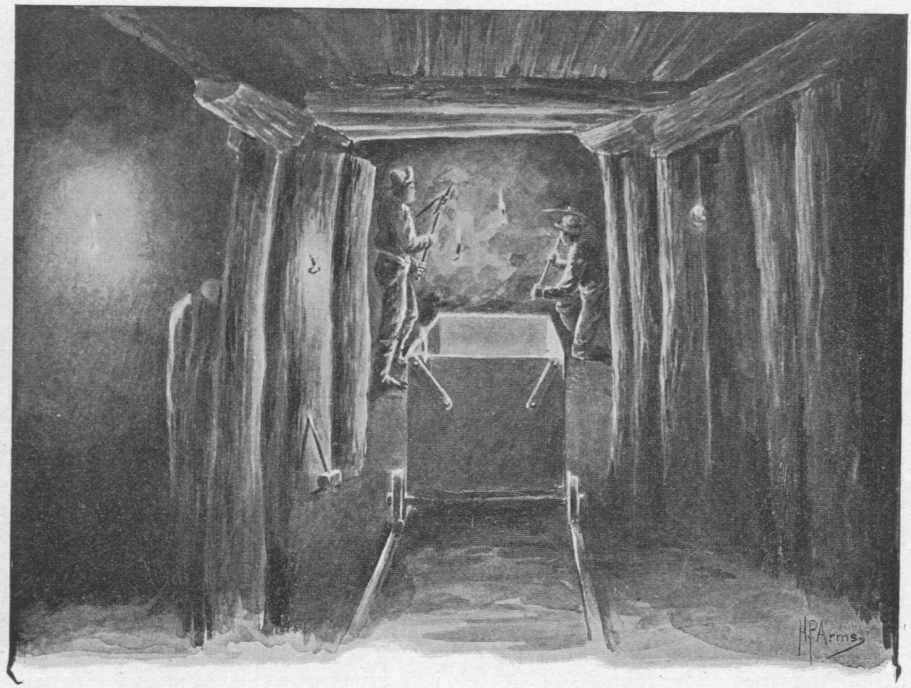
The town of Salisbury occupies the extreme northwest corner of the state and has been probably more identified with the iron industry than any of the neighboring towns. It contains within its limits three beds of brown hematite of which the bed at Ore Hill, or, as it is quite as often called, "Old Hill," is by all means the most important. This bed lies to the southwest of the village of Salisbury and hardly more than a mile from the New York state line. In former times it was worked as an open quarry, there being quite a number of "pits" carried into the side of the hill. The first ore was taken from this bed probably between 1730 and 1735 and it has been worked constantly ever since. In 1837 Dr. Shepard * states that the amount of ore raised during the previous forty years averaged about five thousand tons annually. At that time the

* "Report of the Geological Survey of Connecticut." By Charles Upham Shepard, M. D. 1837.

surface diggings had become exhausted in all directions except at the western edge, though it apparently continued in depth indefinitely. During the period between the close of the Civil War and the year 1873 a very great deal more ore was taken out annually than during many years previous.

In the earlier days of working the mine a double method of organization was inaugurated among those interested in the undertaking. There was an association of "Proprietors" who owned the land, and a "Mining Company" who took out the ore. The former received a certain "duty" on every ton of ore taken out, while the latter sold the ore to the furnace owners. This arrangement continued until the early part of 1898, when the Barnum Richardson Company bought the shares of both the Corporation of Proprietors and the Mining Company, and now own the mine. The company is at present (summer of 1898) sending about eighty tons of washed ore daily to its furnace at East Canaan.

Surface work at the mine ceased long ago and the great pit, which must be fully a quarter of a mile across, is for the most part deserted. The work is now carried on at a distance of from 150 to 200 feet below the surface, and the ore under the abandoned pit is honeycombed with galleries. The ore is finally hauled to the surface up an incline at the west side of the pit, and is dumped automatically into a second car which carries it to the washer, where it is screened as it is dumped. An ingenious device of a pointer traversing a dial indicates to the engineer in the power house the position of either car at any time, and he is thus enabled to attend to

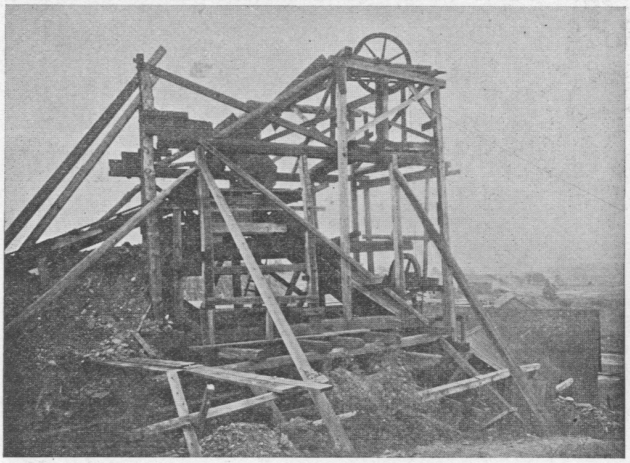


INTERIOR OF MINE AT ORE HILL.

the whole matter of raising the ore and dumping the cars single handed.

At the washer the dark, porous ore is broken up in an ordinary stone crusher and is passed down to the washer proper, where it is cleansed of earth and other adhesions and is loaded on flat-cars,—about twelve tons to a car,—and is shipped direct to the furnace at East Canaan.

On the floor of the old pit is the building containing the pumping engine which raises the water from the mine and discharges it into a small pond on the bank above the washer. It is this water from



HOISTING APPARATUS.

the mine which is again used for washing the ore. The mine employs at present about thirty men under ground.

The next nearest mine and probably another part of the same deposit is Chatfield's Bed. This lies about a quarter of a mile southeast of Ore Hill. The mining was done entirely at the surface and sixty years ago about eight hundred tons of ore were taken out annually. The bed has been abandoned and no ore has been mined there for fully five years.

The third ore bed near Salisbury is known as Davis' Bed. It lies about two and a half miles northeast of Ore Hill on the road from Lakeville to Salisbury. The bed is still worked at the surface and an enormous pit shows how long the mining has been going on. This mine has long been leased by the Barnum Richardson Company, and the washed ore, averaging from twenty to twenty–five tons a day is sent to their furnace at East Canaan. Here the ore is mixed with that from Ore Hill, the mixture giving a more satisfactory grade of iron than either used singly. The ores from these beds yield about 45 per cent. of pig iron.

These are the important mines of the town of Salisbury, and the amount of ore taken from these is vastly in excess of all that has been raised from all the other Connecticut beds taken together. From these beds were supplied furnaces at Chapinville, Mt. Riga, Cornwall, Canaan, Lakeville, Furnance Village, Lime Rock and other places, to say nothing of the ore smelted at Ancram Furnace in New York state.

Shepard reports two other deposits of ore in the town of Salisbury, known respectively as Scovill's and Chapin's Beds, but he states that at that date (1837) they had been abandoned for eight years, as it was impossible to get a good grade of iron from them.

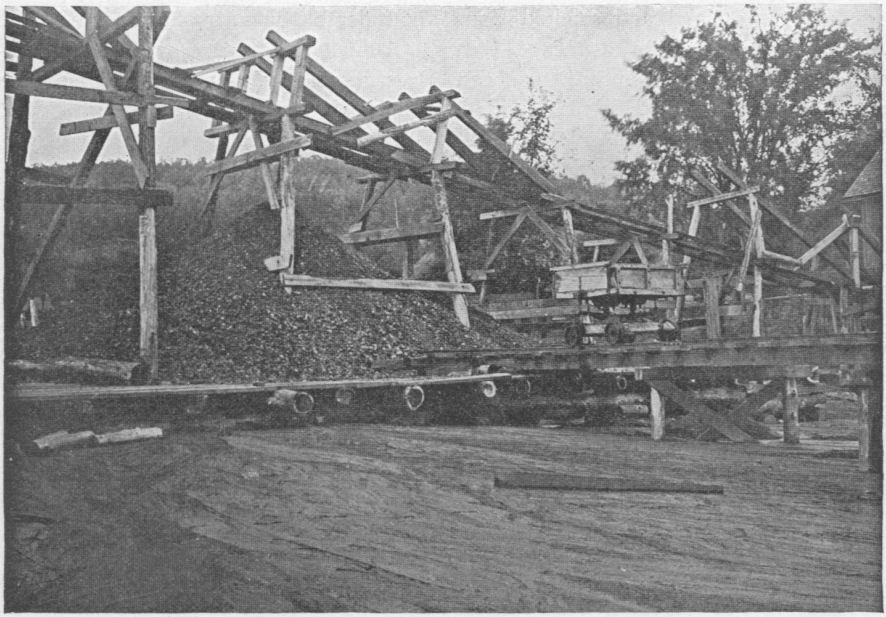
Another important deposit of brown hematite is found on the east side of Indian Lake in the town of Sharon. In 1837 about two thousand tons of ore were raised annually, being used mostly in the furnaces of Sharon. A furnace was in blast at Sharon Valley until the winter of

1897–8. At the present time no mining is going on there. Shepard states that the iron produced is somewhat "less malleable than that of Salisbury, and is principally used for castings."

Going toward the south the next important deposit of brown hematite is to be found in the town of Kent at a point about two miles to the east of the village of South Kent.

This bed used to be very important; it supplied ore for Kent Furnace and also for the furnaces at Bull's Bridge and Macedonia, all in the town of Kent, though the last two smelted New York ore to a great extent. The mine was originally worked at the surface, but later a shaft was sunk to a very considerable depth. The last ore was taken from this bed about January, 1892. The iron produced from this ore had too great shrinkage for making car wheels, but was excellent for manufacturing machinery and locomotive parts.

A remarkable deposit of siderite or spathic iron ore occurs in the town of Roxbury about four miles east of New Milford. Shepard in his geological report of 1837 considers this so important that he devotes far more space to its description than to that of any other bed. The ore is deposited in a vertical vein from six to eight feet wide outcropping at intervals for a distance of half a mile in a low mountain known as Mine Hill. The mine was opened as early as 1750, but, curiously enough, the metal sought for a number of years was silver. It was not until considerably later that its value as a source of iron was recognized. While the ores previously described furnish excellent cast and malleable iron they are not good steel ores. The Roxbury ore was the same as that furnishing the well known



WASHED ORE READY FOR SMELTER.

German steel and much was expected of it. Shepard's expectations seem to have been disappointed. There was trouble with the work in early times from faulty methods, and, though good steel was produced afterward, the enterprise seems to have declined, till at the present day the steel works, which shut down twenty years ago, are in ruins and what is perhaps the largest deposit of spathic iron in the United States has been utterly abandoned.

In the eastern part of Connecticut another variety of limonite, known as bog ore, has been mined and smelted since very early times, notably at New Haven and North Branford. Deposits have been found at "Colchester, Hebron, Tolland, Willington, Westford (in Ashford), Stafford, Union and Woodstock." The principal furnaces were at Stafford and Hebron, the latter getting its ore from Colchester. In 1837 the output of the Stafford furnace was 350 tons of castings annually. These industries have been dead for many years.

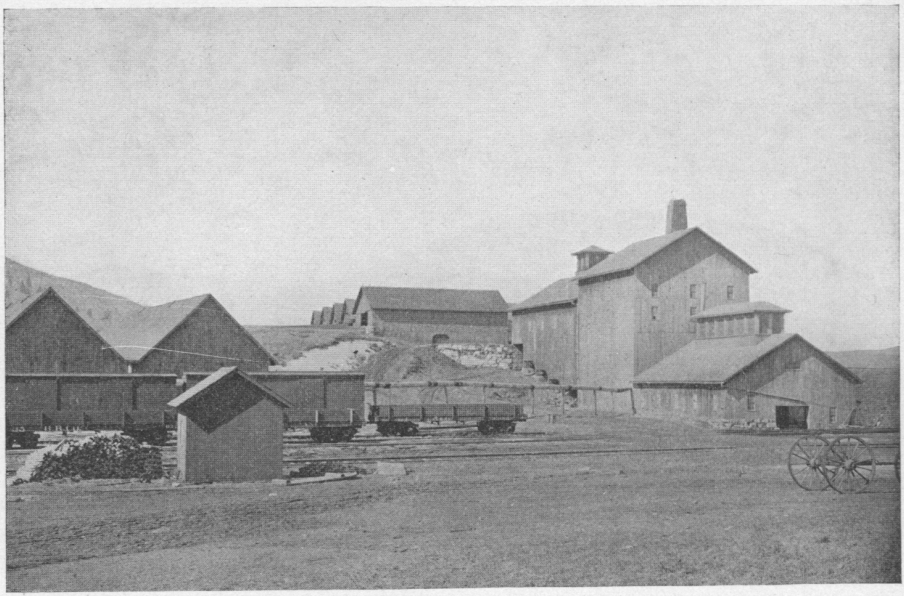
It should be mentioned as a matter of nterest that magnetite has been mined in several places, chiefly at New Preston, at Buck's Mountain in Sharon, and at Winchester. These ores have been smelted, but the undertaking never remotely approached the dignity of an industry. A considerable quantity of magnetite is to be found as an iron sand along the shore of Long Island Sound, especially from New Haven to Stonington. This sand was successfully smelted at Killingworth in Middlesex County as early as 1761 by the Rev. Jared Eliot, and a forge at Voluntown in New London County used a considerable quantity of this sand as ore.

Although there is a great deal of interest connected with the history of iron mining in Connecticut, it is only when studied in connection with the history of iron smelting in the same state that the subject reaches its greatest importance. It is hard to keep the two subjects separate, so closely are they interwoven, but the aim of this paper has been to give some account of the mining, referring to the furnaces but incidentally. A history of these furnaces will be given in the next number.

SONG OF THE TREE-TOP.

By Herbert Randall.

My love is the wind and his heart is mine;
Here under the midnight sky
We sleep and we dream in the starlit gleam,
And wake to the sea-bird's cry,
When the day comes back and the sails unfurl,
As blue billows fluff into foam;
We laugh in delight at the hurricane's flight,
And kiss when the ships come home.



FURNACE NO. 3, EAST CANAAN.

IRON MINING IN CONNECTICUT.

II. SMELTING.

BY W. H. C. PYNCHON.

IN a previous paper an attempt was made to give a brief sketch of the ore-beds of western Connecticut and of the extent to which iron mining has been carried on and is still being carried on in that region. It is perhaps even more interesting to trace the story of the ore after it passes from the miner's hands into those of the smelter and to see how prominent a place the iron-master has occupied in the history of the state.

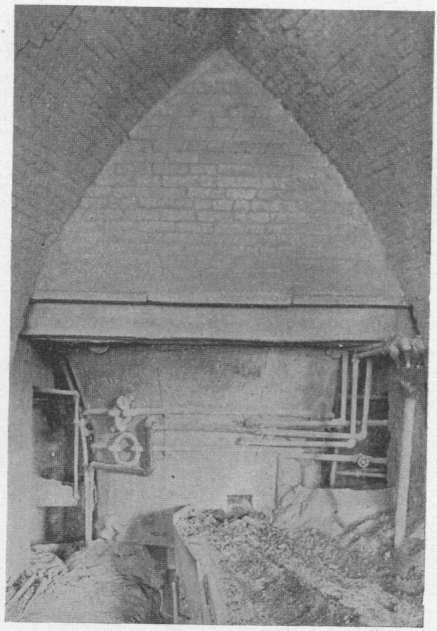
If iron ore were always a pure oxide, hydrate or carbonate of iron—if it were simply the metal combined with oxygen, or oxygen and hydrogen, or oxygen and carbon—the process of smelting it would be almost as simple practically as it is theoretically. The chemical and physical characters of the commercial ores were reviewed in the previous paper. Attention, however, again is called to the fact that these ores are practically four in number, namely, magnetite and hematite, compounds of iron and oxygen; limonite, a compound of iron, oxygen and hydrogen, and siderite or spathic iron ore, a compound of iron, oxygen and carbon. Theoretically the last two may be reduced

to the condition of oxides by heat alone. In the case of limonite the hydrogen and a part of the oxygen are driven off in the form of vaporized water, and in siderite the carbon and a part of the oxygen are driven off as a carbonic acid gas, leaving the residue as a compound of iron and oxygen only. This, then, leaves all three ores practically alike and amenable to the same process for the final expulsion of the oxygen, when only the metallic iron will remain.

The question now is, how to get rid of the oxygen. This is answered if we can find some substance which shall have a stronger attraction for oxygen than has the iron. This is found in carbon, and the fuel with which we heat the iron furnishes this element. Theoretically we have only to heat the iron with a plentiful amount of fuel assisted by a proper supply of air. The oxygen of this air is necessary to burn the coal, the result being carbonic acid gas. But not all of the carbon of the coal is thus consumed. Under the influence of the heat, the remaining carbon having only a partial supply of oxygen, wrests the oxygen from the ore, combines with it and passes away as carbonic acid gas also, leaving behind the pure iron which is desired.

This is the theoretical process of iron-smelting. The practical process which is based upon it would be equally simple, but for two obstacles. The first is the difficulty of supplying such perfectly balanced amounts of carbon and oxygen as shall do the work without leaving a residue of either. The second is the presence of certain impurities in both ore and fuel which form new and undesirable compounds and materially affect both the economy of the process and the value of the iron produced. To modify the theoretical process so as to overcome these obstacles in the most effective manner is the practical problem with which the iron-master has to deal.

The first obstacle is not a serious one to overcome if a sufficient supply of carbon is furnished to dispose of all oxygen present. It is true that the iron takes up a certain amount of carbon, but this addition is valuable in many cases and can

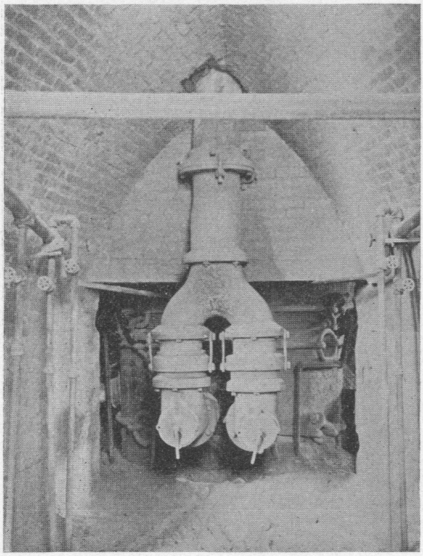


FURNACE NO. 3. THE HEARTH.

(The opening at the right is for running off the slag, that at the left for drawing off the iron. The pipes carry water for cooling the walls of the hearth.)

be eliminated entirely, when desired, by a subsequent process. The second obstacle is a far more serious one. The presence of sulphur or phosphorus is extremely detrimental to the quality of the iron, the former rendering it liable to crack when worked at a high temperature, the latter, when it is worked cold. Sulphur can be driven off to a considerable extent by a preliminary roasting of the ore, but the

last traces of both are very hard to eliminate. There are other impurities, mostly of a silicious nature, which are found always to a varying extent in the ore. These are eliminated by smelting, but in the process they combine with a portion of the iron itself, producing a troublesome slag within the furnace and materially reducing the amount of pure metal finally obtained. In practical smelting this obstacle is overcome by adding a certain amount of "flux," usually limestone, to the ore smelted. The lime takes the place



FURNACE NO. 3. TWYER ARCH.

(Showing the Hearth and two Twyers. The pipes carry water for cooling the Twyers.)

of the iron in the slag and the lime-slag thus formed is readily fusible and can be readily removed.

The device universally used at the present day for smelting is known as the blast furnace. It is essentially a short, wide chimney which tapers at both top and bottom. There is an opening at the top of this "stack" where the "charge," consisting of ore, fuel and "flux" can be introduced. At the lower end is the "hearth," a reservoir for the melted iron and for the molten slag which floats upon its surface. The oxygen for the smelting is furnished by a copious blast of air which is introduced near the base of the furnace by several air-nozzles, known as "twyers" or "tuyers," the pressure being obtained from a pumping device of some kind. Both the sides of the hearth and the ends of the twyers are protected by a jacket through which water is kept continually running. As the molten slag which floats on the surface of the liquid iron in the hearth accumulates in sufficient quantity, it is drawn off through an opening provided for the purpose and, when sufficiently cooled, is removed. When the molten iron has risen nearly to the level of the twyers it is drawn off through another opening near the bottom of the furnace. The liquid metal flows through a narrow ditch to where, on the moulding floor, it is turned off into numerous short side channels where it is allowed to cool. These bars, when separated from the mass in the long ditch, form the "pigs" of commercial iron.

The chemical reactions which go on inside the furnace are not quite so simple as the previous statement would suggest —the statement represents, practically, the final result. The heated gases of various kinds which issue from the top of the stack may be allowed to escape directly into the air where they burn, or, more frequently, they are utilized. Of course the introduction of cold air into the furnace through the twyers tends to reduce the temperature of the interior and causes a distinct waste of heat. In all blast furnaces of the present day it is the practice to heat the blast to a very high temperature before it enters the twyers, and for this purpose the exceedingly hot gases which escape at the top

of the furnace are utilized. The blast is, however, sometimes heated by separate fires.

These are the essential features of the blast furnace. Its product is known as "cast iron." This is iron with which is combined a considerable amount of carbon. Cast iron is fusible and, upon being suddenly "chilled" when hot, becomes very hard and brittle. But this "chilled" iron is not capable of taking a temper nor does it possess the extreme ductility and malleability necessary for certain commercial uses. These are only obtained by subjecting it to a process of "refining," which removes the carbon and leaves what is known as "wrought iron." This cannot be melted, but can be heated to a plastic condition when it can be wrought into any shape desired. It always retains its wonderful tenacity, but can be neither tempered nor chilled. Intermediate between cast iron and wrought iron, both as to the amount of carbon contained and the qualities possessed, stand the "steels." Steel may be melted and chilled like cast iron, but, by a subsequent re-heating and by a gradual cooling carried to exactly the right point, it may be "tempered," that is, brought to a condition where hardness and elasticity are balanced to any desired degree.

The manufacture of steel may be considered, in the present case, as a matter by itself, but the process of refining cast iron should receive some mention, as it held a prominent part in the iron industries of Connecticut. The refining of cast iron is carried on in several different kinds of furnaces, though what is known as the "puddling" furnace is perhaps the most important. In all cases, however, the process is essentially the same and consists in re-melting the pig iron and subjecting it to a draft of air. As a final result of somewhat complicated reactions, the carbon of the iron combines with the oxygen of the air, and the silicon, sulphur, phosphorus, a certain amount of the iron itself and a large amount of oxygen combine to form a slag. As the particles of infusible pure iron appear in the fused mass, they are mechanically

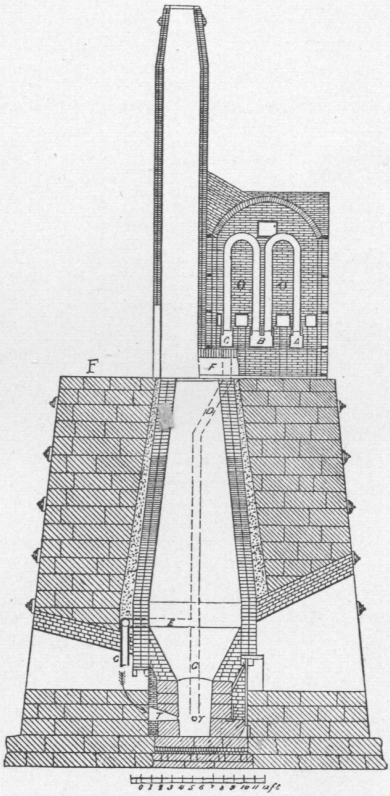


DIAGRAM OF A CONNECTICUT BLAST FURNACE.

(O, oven. A, B, C, pipes for heating blast. D, E, G, pipes carrying blast to twyers, TT.)

collected into masses called "blooms" which are extracted from the furnace and are subjected to blows of a power hammer. This squeezes out all slag contained and compresses the spongy mass into a solid piece which is subsequently re-heated and

rolled. Under primitive conditions of iron smelting, where ore was rich and charcoal plenty, wrought iron was often produced directly from the ore, but at a great sacrifice of iron and fuel. The process was essentially the same as that of refining, except that the ore itself was treated instead of cast iron. The furnace in which this was done was known as a "forge." These are still in use in the Adirondack region.

It is rather a common idea that all that is necessary to render a locality an iron producing region is the presence of rich

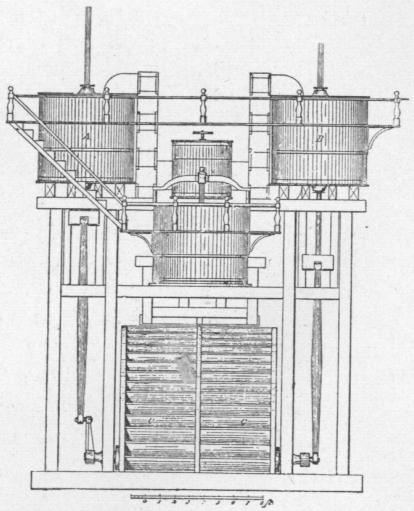


DIAGRAM OF BLOWING ENGINE.
(A and B, blowing cylinders. C, water wheel.)

ore in sufficient quantity. Strangely enough, however, in this era of economic production this is almost the last requisite. A very large part of the English iron producing ores are of an inferior quality,—much below many ores which are allowed to lie unused in this country. What is really necessary is that the three essentials —ore, fuel and flux—shall exist in close proximity. When, in addition, the ore is rich and pure, the conditions are exceptionally good for the establishment of a great industry. For many uses the best grades of iron are not at all necessary and the cheaper product will fill all needs. It is for these reasons that the furnaces of Connecticut, which produced the best iron that this country has ever known, are cold to-day. Exceptional ore and abundant flux are there, but fuel is wanting. In consequence the output must be small and the price per ton high. Of late years steel has become so cheap that it is used for many purposes for which iron was formerly employed; and it is a curious fact that the brown hematite of Connecticut, while producing the best of cast and wrought iron, is not a good steel ore. Nevertheless, the demand for this iron for certain special uses, notably for the manufacture of car wheels, will always keep the industry alive.

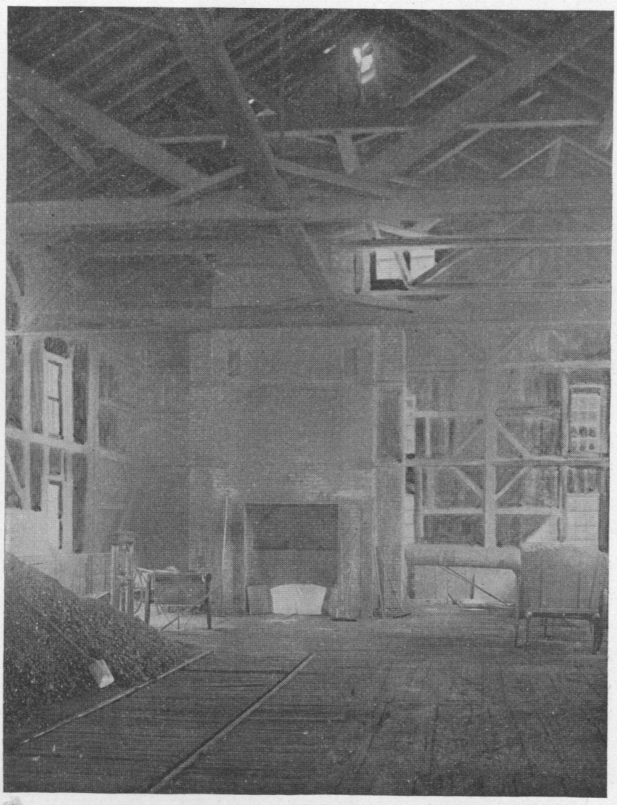
But if we return to a time when the life of the country was massed along the eastern seaboard, when the great iron and coal fields of the continent had not been even explored, we shall see that Connecticut possessed all the requisites and enjoyed all the prestige of a great iron region. The history of the development of the industry, will however, have to be postponed to the third and last paper of this series, although it is almost impossible to exclude all history from a consideration of the industrial and economic phases of the subject.

The fuel for the modern blast furnace is mineral coal, although this has to be coked before it comes in active contact with the ore in order to drive off the impurities which would be detrimental to the finished product. In the earlier forges and furnaces charcoal, which is free from these impurities, was the universal fuel and Connecticut possessed abundant facilities for producing this. Scattered through the chief iron bearing region of the state

were abundant deposits of pure, white limestone and Connecticut thus found itself in possession of the three requisites—ore, fuel and flux—in close proximity. In fact, at the old Maltby works, which lie just across the line in the state of New York, the ore bed lies directly on one side of the furnace and the limestone quarry a few hundred feet in the opposite direction. Curiously enough there was a fourth condition which always determined the location of a furnace. Of course our fathers had no conception of any motive power for machinery except water-power and, as a result, we find all furnaces located near some stream which could be utilized to drive the pumps which furnished the air-blast.

The furnaces which are scattered through the Housatonic region are, with few exceptions, essentially alike, — in fact, in some cases they seem to be identical to the smallest details. I refer to those constructed for smelting brown hematite; the Roxbury plant, constructed for smelting siderite, should receive separate notice in the paper devoted to the history of the industry. The furnaces of Connecticut, though their construction has been much improved in the course of years, still follow to a great extent the old models. Charcoal is the only fuel used and it is to this fact that the iron owes much of its purity. A description of Furnace No. 3 at East Canaan, the only furnace in blast when I visited the region in the late summer of 1898, will give a good idea of their construction and method of working.

The actual furnace or "stack" is 35 feet high and is imbedded in a mass of masonry which is about 35 feet square at the base, but which tapers to somewhat less proportions at the top. At its base the masonry is pierced on each side by a deep arch giving access to the hearth. The arches on the sides accommodate two twyers each and the arch at the back, one. The arch at the front, which is the



FURNACE NO. 3. THE TOP OF THE STACK.
(Showing ore heap, charcoal cars and charging plate where the charge is dumped into the furnace. At the right is the pipe carrying the blast into the oven.)

largest, gives ample room for drawing off the slag and the iron. In one-half of the moulding floor, which lies in front of the furnace, are made the moulds in which the pigs are to be cast, in the other half the slag is received and allowed to lie until sufficiently cool for removal. The slag is run off twice an hour and the iron four times in twenty-four hours. The building which contains the plant is built upon a side hill in such a manner that the floor of the portion *behind* the furnace is on a level with the *top* of the stack, 35 feet above the moulding floor. This upper floor is occupied by the ore and flux bins and by handcarts full of charcoal, all in reasonable proximity to the mouth of the stack.

Above and slightly in front of the stack is the oven where the blast is heated. It is a brick room, some ten feet square, closely filled by large U-shaped pipes of cast iron, all connected in series, through which the blast passes. The entire volume of the heated gasses from the stack is diverted into this chamber where they heat the pipes to a white heat, with the result that, when the blast leaves the chamber for the twyers, it is at a temperature of 900° F. The heated gasses finally escape through a chimney to the outer air.

The furnace was erected by the Barnum Richardson Company about 1872. It smelts ore from the Ore Hill and Davis beds and has an average output of fifteen tons of pig iron daily. The ore yields from 40 per cent to 45 per cent of cast iron. This is largely used at the company's foundry at Lime Rock, where it is made into car wheels and into castings for the Consolidated Road. A part of the charcoal for the furnace is burned in the vicinity and a part is brought from Pennsylvania. The consumption averages about 1,500 bushels a day. The blast is supplied by a blowing engine of the type in common use in Connecticut furnaces. It consists essentially of two large double-action pumps connected directly with the shaft of a water-wheel, which may be of either the undershot or overshot type. These pumps, which have a diameter of about six feet. discharge the air into a large pipe which runs directly to the oven for heating the blast. In the furnace in question the blowing engine is several hundred feet from the stack on the banks of the Blackberry River. The accompanying cuts, which originally appeared in the "Railroad Gazette," will show the essential features of both furnace and blower. At the time of my visit Furnace No. 3 had been in blast for some three years.

There has been no attempt made in this article to take up anything but the essentials of iron smelting in general and the special methods in which they are applied in the furnaces of this state,— it has been simply a discussion of processes.

In the remaining article of this series it is proposed to trace something of the rise, development and present condition of the industry, with some brief notice of the more famous castings which have come from Connecticut's furnaces, in the years gone by. It was a Connecticut iron-master that took Ticonderoga; it was with guns of Salisbury iron that the naval supremacy of Great Britain was broken in the War of 1812. It is this history which converts the dull details of iron mining and iron smelting into a romance.

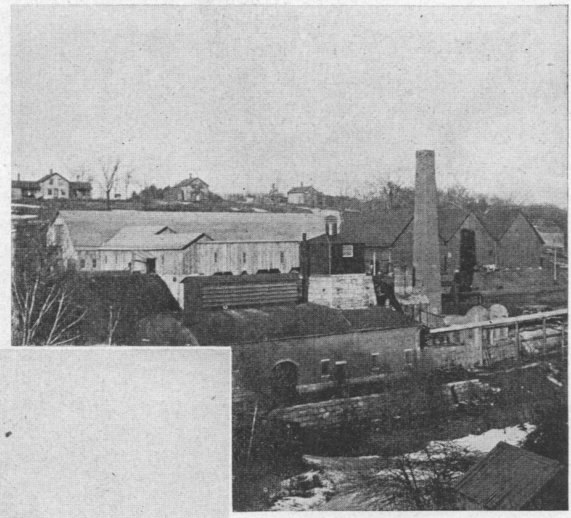
IRON MINING IN CONNECTICUT.

III. Historical Sketch.

BY W. H. C. PYNCHON.

THE two previous articles of this series have contained some account of the iron deposits of Connecticut, and of the methods of smelting practiced in the state. The aim of the present paper is to give a brief sketch of the history of the industry from colonial times to the present day.

It is in the town of Salisbury, which occupies the north-west corner of the state, that the industry was first developed, and here it has always centered, although valuable deposits of ore were found much farther to the south, and a number of important furnaces sprang up as a result. A number of smaller enterprises both in mining and smelting iron were carried on in different parts of the state, but they were of importance almost solely from an historical point of view.



BECKLEY FURNACE.

FURNACE NO. 3.
FURNACES AT EAST CANAAN.

The first ore was discovered about 1732 "in lands appropriated by the Colony to Yale College, and then occupied by one Bissell." This was at Ore Hill in Salisbury, about a mile from the New York state line, and this deposit

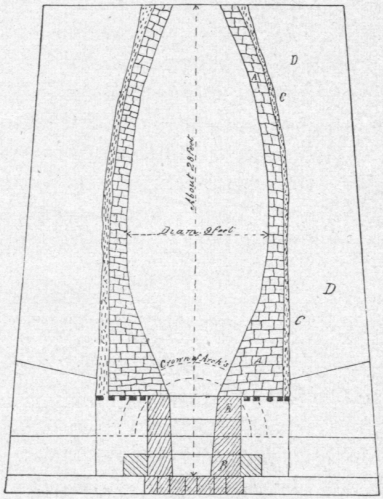
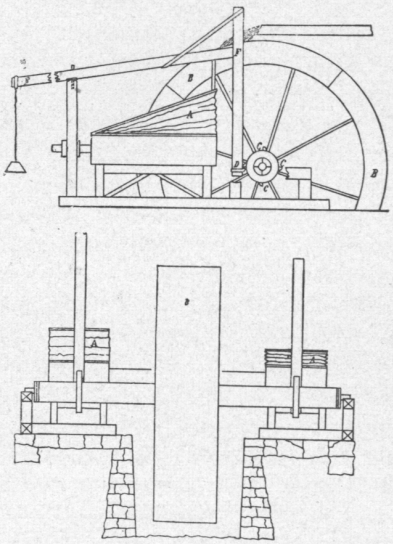


DIAGRAM OF THE FIRST BLAST FURNACE BUILT IN CONNECTICUT.

of brown hematite became the site of the most famous mine in Connecticut. As a result of this discovery the first forge was built in 1734 at Lime Rock, some five miles from the ore-bed, by "Philip Livingstone of Albany, N.Y., and others." About 1748 a forge was erected at Lakeville, "and in 1762 John Haseltine, Samuel Forbes and Ethan Allen, the latter of Ticonderoga fame, purchased the property and built a blast-furnace, which is supposed to have been the first blast-furnace built in the state." Its location is said to have been at the outlet of Wononscopomus Lake, about three miles nearer the ore-bed than the forge at Lime Rock. This furnace passed into the hands of Charles and George Caldwell of Hartford, who ran it until 1768, when they sold it to Richard Smith of the same city. In 1770 the furnace was rebuilt and, apparently, previous to the war of the Revolution, cast shot and shell for His Majesty's troops. On the breaking out of the war, Smith, who was a loyalist, abandoned his possessions and went to England. The Colonial Government did not confiscate the property, but took possession of it and appointed Dr. Joshua Porter, agent. The Council of Safety expended £1,450 in fitting up the furnace, and they put it into full operation with a corps of fifty-nine workmen, furnishing supplies for the Continental army. Cannon of various weights up to 32-pounders were cast here, and shot and shell in abundance. These guns were carefully tested under the eye of famous leaders of the day, such as Jay, Morris, Hamilton and Trumbull, and the shot fired at these times are still dug up occasionally. The guns which Commodore Truxton's ship, the "Constellation," carried, were cast at this furnace. The "Constitution," in common with many other battle-ships of the old navy, were equipped with cannon of Salisbury iron, and the guns of the battery at New York were also of the same metal. Probably many of them were cast at Lakeville.

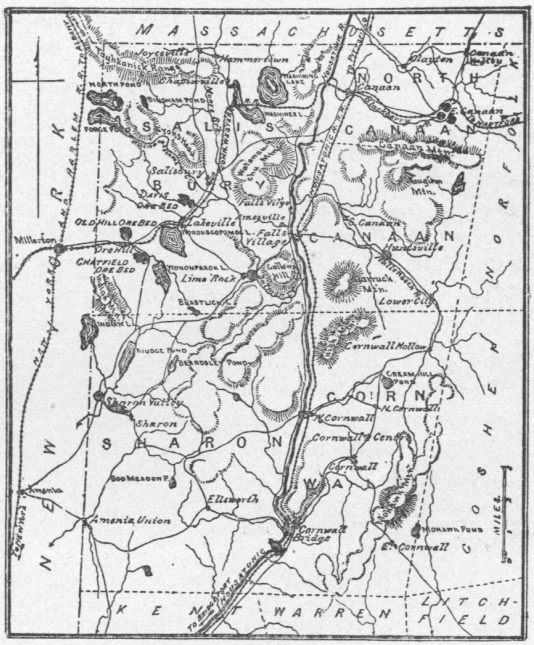
This historic furnace was standing in the early thirties, and was then reputed to be the oldest in the region.



BLOWING ENGINE USED WITH THE LAKEVILLE FURNACE IN 1776.

Though Lakeville was the site of the first blast-furnace in Connecticut, there was built but little later and in the town of Salisbury another furnace, perhaps even more famous—the furnace upon Mount Riga. Mount Riga is the southern end of a strong range starting in the northwestern portion of the town of Salisbury and running in a generally northern direction far into Massachusetts. The range attains its greatest height at Mount Everett in Massachusetts, with an elevation of 2,624 feet above the sea, and Mount Riga itself reaches a height of about 2,000 feet. Steep, rugged and desolate, it seems strange that it should have been selected as the location of such an industry. Yet it was so chosen for reasons which will presently appear.

In 1781 a forge was erected on this range by Abner and Peter Woodin. In 1785 one Daniel Ball came into possession, and from him the forge took the name of Ball's Forge. It was not till 1806 that work was begun on an actual blast-furnace. The enterprise was undertaken by Seth King and John Kelsey, but they were unable to carry it through, and in 1810 it came into the hands of the firm of Holley & Coffing. They completed the furnace immediately and started it upon a long and famous career. The furnace was situated on Wochocastigook Creek at an elevation of some 1,700 feet above the sea. All about were acres upon acres of timberland, and the creek and this timberland were the advantages which more than justified the selection of this strange site. The waters of the creek, confined in Forge Pond by a dam, furnished abundant motive power for the blowing-engines, and the timber furnished an almost inexhaustible supply of material for charcoal. With power and fuel at hand it was a matter of minor consequence that ore and flux had to be carted some four miles up hill. The finished products were hauled by oxen down hill again and across country to the Hudson, where they were shipped to the markets by water.

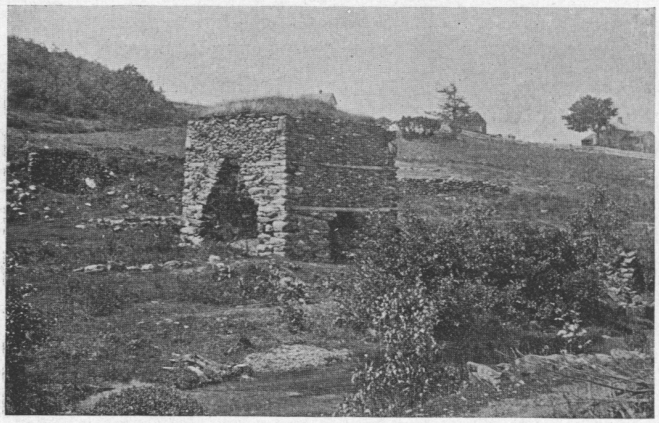


NORTHWESTERN CORNER OF CONNECTICUT.
(The chief iron region of the State.)

About this furnace and the attendant forges scattered along the stream the commercial and industrial life of Salisbury centered for many years. Among the articles manufactured here many anchors were forged for the government and were duly tested on the grounds by navy officials, the masterpiece of Mount Riga being the anchor of the "Constitution." One authority states that the furnace was

built as early as 1800, and was rebuilt in 1845.

Finally the introduction of steam transportation and the exhausted condition of the woodlands upon Mount Riga caused the decline of the industry, till in 1847 the famous old furnace was abandoned and the seat of the industry descended again to the lowlands. At the present day nothing is left but the gray stack and the weather-beaten heaps of slag. A few houses still stand in the vicinity, and farther down the stream irregular lines of stones mark the sites of the old forges.



THE OLD STACK AT MT. RIGA.

The stack, which is pierced for only a single twyer, is a small one, not more than twenty feet high, an insignificant thing when compared with the great Pennsylvania furnaces of to-day, but through its crumbling arch which looks across the mountains to the rising sun, has flowed the iron which has helped to make the history of the nation. Mount Riga furnace has done its work. Peace to its memory.

It is not to be supposed that these were the only points in the town of Salisbury where iron-smelting was carried on. Other deposits of brown hematite were opened, notably Chatfield's and Davis' beds in the town of Salisbury, a bed at Indian Pond in Sharon, and one in Kent. In connection with these deposits, as well as with that at Ore Hill, furnaces sprang up. In his geological report of 1837 Shepard mentions the furnace of the Salisbury Iron Company at Mount Riga, Chapin furnace at Chapinville, the furnace of Canfield, Sterling & Co., on the Housatonic, that of Holly & Co., at Lime Rock, the two furnaces of the Cornwall Iron Company and the Cornwall Bridge Iron Company, in the western part of Cornwall, the furnace of Messrs. Brinsmade, Wolcott & Smith, in Sharon, one or more furnaces at Canaan, and several furnaces in the vicinity of Kent. These last may be rightly considered to be Kent furnaces proper, the furnace at Bull's Bridge and the furnace at Macedonia.

Of the furnaces mentioned in this list, Chapin furnace stands about half a mile north of Chapinville station in the town of Salisbury. It was probably built by one Chapin about one hundred years ago, and had as subsequent early owners the Landon Iron Company. The furnace was rebuilt about 1870, and was in blast more or less regularly until November, 1897, when the blowing engine broke down. At that time it was run by J. J. Morehouse, who also carried on business at the furnaces at Copake and Chatham in New York. Chapin furnace, which in former years smelted ore from Ore Hill, had of late years obtained its ore at Amenia, N. Y.

The break in the machinery was serious, and it was considered unwise to incur the expense of repairs. Most of the oven pipes were removed to the Copake furnace, and the works, though in good repair, are at present closed.

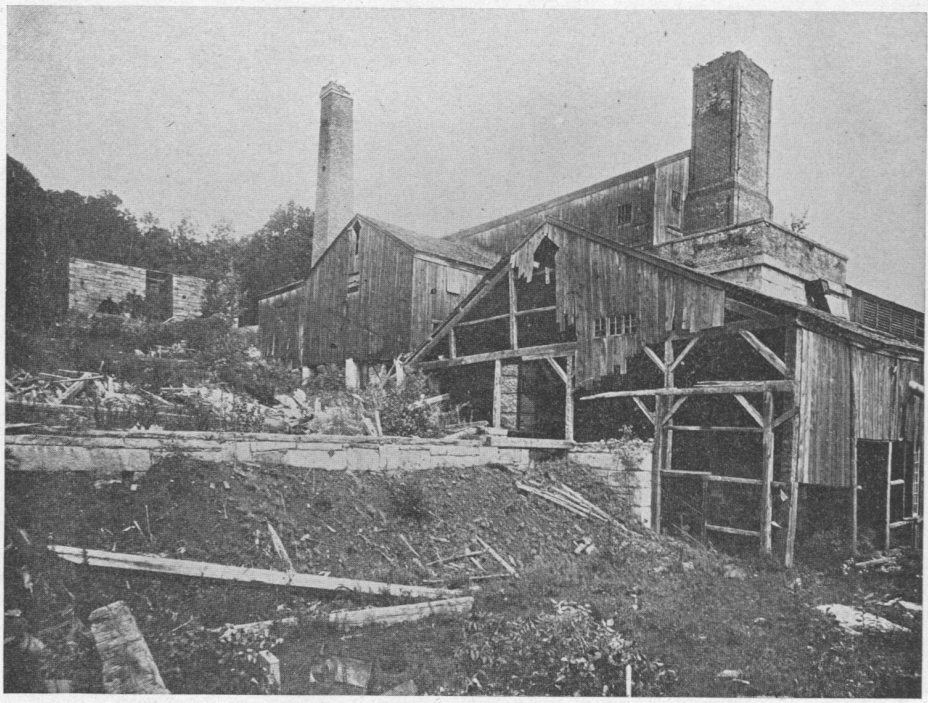
Probably furnaces were in operation at Canaan prior to 1776, and it is in this town, at East Canaan, that the industry centers at the present day. Samuel Forbes, who was associated with Ethan Allen at the Lakeville furnace, had a forge, slitting mill and anchor works at this place, and it is said that here was forged a portion of the great chain which was stretched across the Hudson during the war of the Revolution.

In 1810 Milo Barnum of Dover, Duchess County, N. Y., settled in Lime Rock, and some ten years later built a furnace for re-melting pig iron. From this enterprise sprang a firm which, with various slight changes of name, has existed ever since and now, as the Barnum, Richardson Company, controls the entire business of mining and smelting iron in western Connecticut. In 1858 they purchased the Beckley furnace at East Canaan, and four years later they purchased the neighboring Forbes furnace of the Forbes Iron Company. In 1872 the company constructed another furnace known as the "New" furnace, the three furnaces being thereafter designated as No. 1, No. 2 and No. 3 respectively. Of these, "Forbes furnace" No. 2, has not been running for sixteen years. About 1895 "Beckley fur-

RUINS OF THE STACK, BULL'S BRIDGE FURNACE.

nace" No. 1, was seriously injured by fire, and since that time has been undergoing extensive repairs and improvements. Within a few months it has gone into blast, and this and the "New" furnace No. 3, which is now also in blast, are considered to be as modern as any charcoal furnaces in the country.

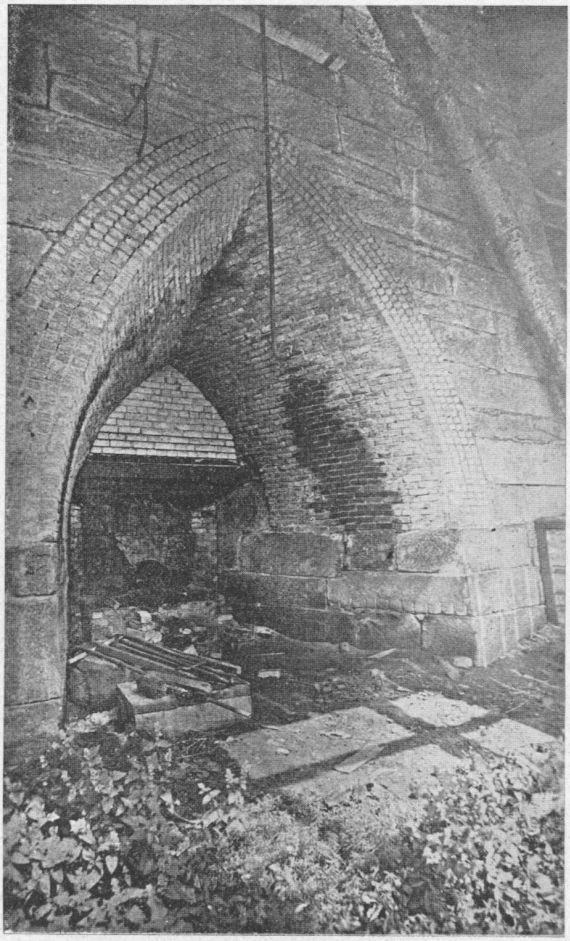
In 1883 there were eight furnaces in operation, all controlled by the Barnum, Richardson Company, namely, "three at East Canaan, one at Lime Rock, one at Millerton, in New York State, one at Sharon Valley, one at Cornwall Bridge, and one at Huntsville." During the next fifteen years there was a distinct decline in the industry until in the summer of 1898, of the five furnaces owned at that time by the company, there was but one furnace in blast, No. 3, of East Canaan. In 1898 the company bought all the rights of the mine at Ore Hill and reorganized the business. The wisdom of this step is already apparent, for since that time Beckley furnace has gone into blast and it is expected that soon smelting will be resumed at the Lime Rock furnace. The remaining furnace of the five, that at Sharon Valley, shut down temporarily, perhaps a couple of years ago.



RUINS OF ROXBURY FURNACE.

It should be remembered that these furnaces (with the exception of the last one, which smelted a great deal of Sharon ore), smelted for the most part ores from the Ore Hill and associated beds. Going southward, however, into the town of Kent, we find another smaller group of furnaces centered about the Kent ore-bed. Perhaps the best known of these furnaces is "Kent furnace," standing on the east

ank of the Housatonic, about a mile above the main village. The first stack on this site was built by the Kent Furnace Company about one hundred years ago, this company being succeeded in 1868 by the Kent Iron Company. Besides Kent ore, this furnace smelted also ores from Ore Hill and Richmond. The furnace went out of blast early in 1892, and the oven pipes were sold to the establishment at Copake. In the summer of 1898 the buildings, which were all in good repair, were in use as tobacco sheds. The second furnace, which stands at Bull's Bridge about four miles southwest of the village of Kent, was built about 1826. It has been abandoned for thirty years and is now in ruins. The third furnace, at Macedonia, about two miles northwest of Kent, was abandoned long ago. All these establishments smelted both Kent and New York State ores.



THE HEARTH, ROXBURY FURNACE.

It is impossible to give a detailed account of all the furnaces of the Housatonic region, but there is one plant that should not go unmentioned, that is the plant at Roxbury for smelting the so-called "steel ore" of Mine Hill. Mention has been made in a previous paper of the location and nature of this deposit of siderite, and of the great hopes which were based upon it. The mine was opened about 1750 by Hurlbut & Hawley, but, strange to say, it was in the endeavor to obtain silver. A second attempt was made later by the Bronson Brothers. It would seem that the German goldsmith who superintended the work deceived them for a long time by a pretence of discovering the precious metal. But it is also said that he produced steel for his tools from the spathic ore of the mine. Later an attempt, unsuccessful through lack of skill, was made by a Mr. Bacon to produce steel from the ore direct. Finally, at a later date, D. J. Styles succeeded in making good steel from the siderite.

The works which are now standing were not begun until 1865, and at the very outset the company imported from Germany six of Krupp's skilled workmen to take charge of the smelting. This furnace, which was of the cold-blast type, produced successfully about ten tons of excellent pig-iron daily, but the Germans failed to accomplish that for which the works were primarily built, the conversion of this iron into steel. A refining or "puddling" furnace was therefore built, the pig was converted into wrought-iron, and this having been sent to the company's works at Bridgeport, was subsequently converted into good steel. The German workmen for their failure to produce steel from the pig-iron direct, were discharged. The next superintendent, against the wishes of all concerned, converted the furnace into a hot-blast furnace with disastrous results. The amount of iron produced fell to two or three tons a day, and this fact, combined with the great drop in the price of iron, induced the company to shut down the furnaces. The steel works have been abandoned for about twenty years, and are fast falling into decay.

In the first article of this series sufficient mention was made of the lesser efforts in the way of iron mining and smelting which were made in different parts of the state, such as the handling of bog-ore at Stafford and Hebron, and of magnetic sand at Killingworth and Voluntown. These enterprises, though very interesting historically, were of small commercial importance when compared with those of the western part of the state, and even from the historical standpoint they occupy a minor position. The works at Stafford were the only ones of importance, where was made a large amount of hollow ware which was sent all over the state. These furnaces long ago went out of blast.

Though it is quite possible to obtain a fairly complete list of the blast-furnaces which have been built in the state, it is quite a different matter to obtain the data of the forges and refineries. The former were the more primitive devices which, at great loss of ore and fuel, obtained wrought-iron directly from the ore. Since they came earlier and were more numerous than the furnaces, the data concerning them are more difficult to obtain. I have mentioned a number of them, but beside these there seems to have been a great many scattered through all the region of western Connecticut. Before 1800 the town of New Milford alone had seven forges, and at one time Litchfield County contained as many as fifty. By refineries are meant establishments for making wrought-iron from the pig-iron of the furnaces. Shepard, in his report, states that most of the iron from the furnaces of the town of Salisbury was sent to Winsted and Canaan to be refined into bar-iron for musket and rifle barrels, and for innumerable commercial purposes. There were refineries at Mount Riga, and unquestionably at other places. Certain it is that from the Salisbury region for years the government arsenals at Springfield and Harper's Ferry were supplied with metal suitable for gun barrels, in fact, this has been one of the chief uses for the iron of western Connecticut.

"The old order changeth, yielding place to new."

The great Pennsylvania plants turn out in a day more iron than the best Connecticut furnace ever put out in a month. Yet the cold and crumbling stacks along the Housatonic have done their work and have earned their rest. They saw the youth of the nation; they forged for its hand the implements of war and peace, and its glorious history is theirs. And perhaps it is fitting that with the passing

of the wooden frigate should pass the ancient industry that gave her her anchor and her guns. Honor alike to the mouldering hull of the "Constitution" and to the crumbling stack of Mount Riga furnace, comrades of war who entered into their rest.

AUTHOR'S ACKNOWLEDGMENT.

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THE FLEET IN SANTIAGO BAY.

BY MARGHERITA ARLINA HAMM.

I.

Into the bay they came
With faces all aflame,
The victors hot from war;
Behind them ships and slain
Lay buried in the main
Or shapeless on the shore.

II.

They saw through open ports
The battlemented forts
Where late the foeman fought;
But now the guns were mute
And dead men frowned salute
From ruins war had wrought.

III.

Beyond them row on row
They saw the tented foe
Prostrated by defeat—
The distant captured town,
The populace cast down
Or flying in retreat.

IV.

All, all was theirs they saw;
The iron hand was law;
The sword was lord and king.
Let martial music rise
To stifle sobs and sighs!
Exult and proudly sing!

V.

But from the victor's fleet
No drum nor cymbal beat
No cheer arose on high;
And yet that silence told
A story of fine gold
Which cannot ever die.

VI.

Instead of war's displays
The victors used all ways
Of doing others good;
They, generous as brave
Clothes to the naked gave
And to the hungry, food.

VII.

They helped and healed their foes,
They gave the land repose,
They fought disease and ill;
They made their captives feel
That back of fire and steel
Kindness and love ruled still.

VIII.

O, land with sons like these
In camp or on the seas
In peace or war's stern strife,
Thy star shall never set,
Nor will the world forget
The grandeur of thy life.